CHAPTER9 RESULTS AND THEIR QUALITY

The whole data layers composing the Mekong GIS Database are listed in Table 10.

Table 10: Specification of the Mekong GIS Database Layers

Feature	Administrative Boundary					
Data Format	ARC/INFO Coverage					
Description [Code]	International Boundary [8001], Provincial Boundary [8002], District Boundary [8003]					
Info Table Name	"Each map number".aat and "Each map number".pat					
Attribute	Item Name	Description	Format width	Output	Type*	Decimals
.AAT (arc attribute table)	FNODE#	from-node sequence number	4	5	B	-
	TNODE#	to-node sequence number	4	5	B	-
	LPOLY#	left-polygon sequence number	4	5	B	-
	RPOLY#	right-polygon sequence number	4	5	B	-
	LENGTH	length in coverage units calculated from designed coordinate system	4	12	F	3
	"Each map number"#	arc internal sequence number	4	5	B	-
	"Each map number"-ID	arc feature ID	4	5	B	-
	CLSID	code number	4	5	I	-
.PAT (polygon attribute table)	AREA	polygon area in coverage units calculated from designed coordinate system	4	12	F	3
	PERIMETER	perimeter in coverage units calculated from designed coordinate system	4	12	F	3
	"Each map number"#	polygon internal number	4	5	B	-
	"Each map number"-ID	polygon feature ID	4	5	B	-
	PNAME	province name	30	30	C	-

	DNAME	district name	30	30	C	-
Feature Class	polygon					
Folder Name	Admin					

Feature	Road					
Data Format	ARC/INFO Coverage					
Description [Code]	Paved Road [2101], Street Town [2102], Improved Unpaved Road [2103], Unpaved Road [2104], Temporary Road [2105], Footpath [2106]					
Info Table Name	"Each map number".aat					
Attribute	Item Name	Description	Format width	Output	Type	Decimals
.AAT (arc attribute table)	FNODE#	from-node sequence number	4	5	B	-
	TNODE#	to-node sequence number	4	5	B	-
	LPOLY#	left-polygon sequence number	4	5	B	-
	RPOLY#	right-polygon sequence number	4	5	B	-
	LENGTH	length in coverage units calculated from designed coordinate system	4	12	F	3
	"Each map number"#	arc internal sequence number	4	5	B	-
	"Each map number"-ID	arc feature ID	4	5	B	-
	CLSID	code number	8	8	I	-
Feature Class	Arc					
Folder Name	Road					

Feature	River					
Data Format	ARC/INFO Coverage					
Description [Code]	River and Stream [5101], Intermittent River and Stream [5102], River and Stream (center line)[5111], Intermittent River and Stream (center line)[5112], canal [5113]					
Info Table Name	"Each map number".aat					
Attribute	Item Name	Description	Format width	Output	Type	Decimals
.AAT (arc attribute table)	FNODE#	from-node sequence number	4	5	B	-

	TNODE#	to-node sequence number	4	5	B	-
	LPOLY#	left-polygon sequence number	4	5	B	-
	RPOLY#	right-polygon sequence number	4	5	B	-
	LENGTH	length in coverage units calculated from designed coordinate system	4	12	F	3
	"Each map number"#	arc internal sequence number	4	5	B	-
	"Each map number"-ID	arc feature ID	4	5	B	-
	CLSID	code number	8	8	I	-
	NAME	river name	30	30	C	
Feature Class	Arc					
Folder Name	Hydro-lin					

Feature	River					
Data Format	ARC/INFO Coverage					
Description [Code]	River and Stream [5101], Intermittent River and Stream [5102], Lake and Pond [5103], Intermittent Lake and Pond [5104], Island [0]					
Info Table Name	"Each map number".pat					
Attribute	Item Name	Description	Format width	Output	Type	Decimals
.PAT (polygon attribute table)	AREA	polygon area in coverage units calculated from designed coordinate system	4	12	F	3
	PERIMETER	perimeter in coverage units calculated from designed coordinate system	4	12	F	3
	"Each map number"#	polygon internal number	4	5	B	-
	"Each map number"-ID	polygon feature ID	4	5	B	-
	CLSID	code number	8	9	I	-
Feature Class	Polygon					
Folder Name	Hydro-pol					

Feature	Built-up Area					
Data Format	ARC/INFO Coverage					
Description [Code]	Urban Area [1001], Rural Area [1101]					
Info Table Name	"Each map number".pat					
Attribute	Item Name	Description	Format width	Output	Type	Decimals
.PAT (polygon attribute table)	AREA	polygon area in coverage units calculated from designed coordinate system	4	12	F	3
	PERIMETER	perimeter in coverage units calculated from designed coordinate system	4	12	F	3
	"Each map number"#	polygon internal number	4	5	B	-
	"Each map number"-ID	polygon feature ID	4	5	B	-
	CLSID	code number	8	9	I	-
Feature Class	Polygon					
Folder Name	Built-up					

Feature	Small Objects					
Data Format	ARC/INFO Coverage					
Description [Code]	School [1202], Buddhist Monastery [3001], Bridge (Length < 3m)[2201], Bridge (Length >= 3m)[2203], Dam (practicable)[2207], Dam (non-practicable)[2208], Airport [3004], Airfield [3005], Water Gauge [2204]					
Info Table Name	"Each map number".pat					
Attribute	Item Name	Description	Format width	Output	Type	Decimals
.PAT (point attribute table)	AREA	(polygon area in coverage units calculated from designed coordinate system.) Set to 0 for point features.	4	12	F	3

	PERIMETER	(perimeter in coverage units calculated from designed coordinate system.) Set to 0 for point features.	4	12	F	3
	"Each map number"#	point internal number	4	5	B	-
	"Each map number"-ID	point feature ID	4	5	B	-
	CLSID	code number	8	9	I	-
	INTID	ID by VecEdit	8	9	I	-
Feature Class	Point					
Folder Name	sm_object					

Feature	Village name					
Data Format	ARC/INFO Coverage					
Description [Code]	Big Village (Household >= 250)[1002], Small Village (Household < 249)[1102]					
Info Table Name	"Each map number".pat					
Attribute	Item Name	Description	Format width	Output	Type	Decimals
.PAT (point attribute table)	AREA	(polygon area in coverage units calculated from designed coordinate system.) Set to 0 for point features.	4	12	F	3
	PERIMETER	(perimeter in coverage units calculated from designed coordinate system.) Set to 0 for point features.	4	12	F	3
	"Each map number"#	point internal number	4	5	B	-
	"Each map number"-ID	point feature ID	4	5	B	-
	CODE	village code number	8	9	I	-
	NAME	village name in English	21	21	C	-
	POPULATION	a number of population	8	10	I	-
	HOUSEHOLD	a number of houses	8	10	I	-

	X	x coordinate of existing 1:100,000 scale topographic map	8	9	I	-
	Y	y coordinate of existing 1:100,000 scale topographic map	8	9	I	-
	MAP	map index number of existing 1:100,000 scale topographic map	8	9	I	-
	CLSID	code number	8	9	I	-
Feature Class	Point					
Folder Name	Village					

Feature	Elevation Point					
Data Format	ARC/INFO Coverage					
Description [Code]	Geodetic Point [7201], Spot Height [7301]					
Info Table Name	"Each map number".pat					
Attribute	Item Name	Description	Format width	Output	Type	Decimals
.PAT (point attribute table)	AREA	(polygon area in coverage units calculated from designed coordinate system.) Set to 0 for point features.	4	12	F	3
	PERIMETER	(perimeter in coverage units calculated from designed coordinate system.) Set to 0 for point features.	4	12	F	3
	"Each map number"#	point internal number	4	5	B	-
	"Each map number"-ID	point feature ID	4	5	B	-
	CLSID	code number	8	9	I	-
	ELEVATION	elevation value	8	12	F	1
	INTID	ID by VecEdit	8	9	I	-
Feature Class	Point					
Folder Name	Elevation point					

Feature	Land Use					
Data Format	ARC/INFO Coverage					
Description [Code]	Dry Evergreen [8011], Mixed Deciduous [8013], Dry Dipterocarp[8015], Gallery Forest[8016], Coniferous Forest[8017], Mixed Board Leaved Coniferous[8018], Forest Plantation[8019], Bamboo[8021], Un-stocked Forest[8022], Natural Regeneration[8023], Ray[8024], Savannah[8031], Scrub[8032], Rice Paddy[8041], Agricultural Plantation[8043], Other Agricultural Land[8043], Barren Land and Rock[8051], Grass Land[8052], Swamp[8053], Urban or Built up Area[8054], Other Land[8055], Cloud or Cloud Effects[8056], Water[8061]					
Info Table Name	"Each map number".pat					
Attribute	Item Name	Description	Format width	Output	Type	Decimals
.PAT (polygon attribute table)	AREA	polygon area in coverage units calculated from designed coordinate system	4	12	F	3
	PERIMETER	perimeter in coverage units calculated from designed coordinate system	4	12	F	3
	"Each map number"#	polygon internal number	4	5	B	-
	"Each map number"-ID	polygon feature ID	4	5	B	-
	TYPE-NGD	classification of land use in NGD	8	9	I	-
Feature Class	Polygon					
Folder Name	Land use					

Feature	Contour Line					
Data Format	ARC/INFO Coverage					
Description [Code]	Principal Contour [7101], Secondary Contour [7102], Supplementary Contour [7103], Auxiliary Contour [7104]					
Info Table Name	"Each map number".aat					
Attribute	Item Name	Description	Format width	Output	Type	Decimals
.AAT (arc attribute table)	FNODE#	from-node sequence number	4	5	B	-
	TNODE#	to-node sequence number	4	5	B	-

	LPOLY#	left-polygon sequence number	4	5	B	-
	RPOLY#	right-polygon sequence number	4	5	B	-
	"Each map number"#	arc internal sequence number	4	5	B	-
	"Each map number"-ID	arc feature ID	4	5	B	-
	LENGTH	length in coverage units calculated from designed coordinate system	8	18	F	5
	CLSID	code number	8	8	I	
	ELEVATION	elevation value	8	8	I	-
Feature Class	Arc					
Folder Name	Contour					

Feature	Ortho Satellite Image
Data Format	TIFF (Tagged Image File Format) with World file
Pixel Size	10m
Feature Class	Raster
Folder Name	Ortho

Feature	Digital Elevation Model
Data Format	ARC/INFO GRID
Data Type	Floating point
Grid Cell Size	30m
Feature Class	Raster
Folder Name	Dem

Note:

* Item types;

F: decimal numbers stored in internal floating-point representation (width of 4 or 8 bytes only). A 4-byte width is single-precision real (approximately 7 digits of precision), and 8 bytes is double precision (approximately 15 digits of precision).

I: integers stored as 1 byte per digit (width from 1 to 16, maximum value possible is 9,999,999,999,999,998, minimum is -999,999,999,999,999).

B: whole numbers stored as binary integers (width of 2 or 4 bytes only). The maximum value for width of 2 is 32,767; for width of 4 is 2,147,483,647. The minimum value for width of 2 is -32,768; for width of 4 is -2,147,483,648.

C: characters (width up to 320 alphanumeric characters).

All of the layers except elevation point are updated. The surveying dates are in a range of several years by layer. For example, in the Vientiane area, topographic features such as road and built-up area were updated with aerial photos taken in 1997, but in the Louangphabang area, they were updated with photos taken in 1999, and in the Bolikhamxai area, they were updated with topographic maps made by photos taken in 1992-1993.

The data quality is not uniform by layer. The following data layers have some problems in quality, which should be informed to users in particular:

(1) Administrative Boundary

Administrative boundary data is partially tentative, because the boundaries have not been fixed at many sections throughout the country.

(2) Contour

In a printed map, the contours of mountains look rather unnatural, because some of the lines are skipped. Since DEM generating was the main objective in WSCP, not all the contour lines in sloping areas were digitized.

(3) Land Use and Forest Cover

Land use and forest cover data, as a whole, varies in date and classification with region. This variety was caused by difference of data sources, method and surveying date.

(4) Built-up Area and Village Name

Built-up area and the position of village name do not correlate with each other in some places. This nonconformity was caused by using two different source materials of different surveying dates, namely the UXO data for village name and aerial photo interpretation results for built-up area. Field check is not sufficient at present.

(5) Topographic Features in the Southern Region

Topographic feature data in the southern four provinces excluding Champasak area and Bolaven Plateau are not more up-to-date than in the existing 1:100,000 topographic maps, because recent aerial photos were not available. For updating the areas ortho satellite images were used. Therefore, small features have not been well updated. The rest of the GIS data layers are judged to be almost standard in quality.

Surveying date and quality are very important for using the data. Therefore, NGD is required to inform users at the outset of surveying dates and quality of the data.

CHAPTER10 GIS DATA PRINTING OUT

During the processes of data updating and structuring mentioned in Chapter 8, the counterparts had experienced map printing out under the guidance of the Team, in order to visualize specific data for error checking and correcting many times. These maps were helpful enough for the purpose of error checking, but they did not express all the data layers for general uses. It was foreseen that hard copies of the new maps would be demanded by users instead of the existing topographic maps. Therefore, the Team transferred the know-how of map designing as well as printing. After completion of the database, in accordance with the plan, the counterparts printed out all the data excluding satellite image and DEM at a scale of 1:100,000 for 163 quadrangles of map sheet with colored ink jet plotter. A portion of a sample sheet is attached as Appendix E.

These hard copies are superior to the existing 1:100,000 topographic maps due to up-to-date information. Considerable increase of built-up areas in the vicinity of big towns can be easily found. Also, a big change of roads and their types can be found. It is, however, unavoidable that these hard copies are inferior in visual expression to conventional analogue maps, because the GIS data was not prepared for the purpose of map compilation from the first. For examples, the symbol of bridge cannot present its true direction and a contour line is not exactly identified by an annotated elevation value due to inflexibility in data indication. But, if a digital map compilation technology is introduced, NGD will be able to compile better analogue maps based on the GIS base map data.

Technical Remarks

In operational works, there were no problems for the counterparts due to automatic process. But, map designing requires them much more experience and research on cartographic expression. For example, categories of roads and rivers are in need of more systematic symbol design in line gauge, color and so on. Elevation annotations for contours should be reduced in number and each should be placed exactly to identify the very contour. Marginal information should be logically improved. For example, designations “Big city” and “Small city” are not appropriate.

CHAPTER11 ENVIRONMENTAL ANALYSIS

Considering that an analysis of environmental change is essential for any analyses regarding environment, the Team attempted to analyze some changes using earlier data and newly updated data. But it was difficult to find reliable existing data due to limitation of data availability. Existing 1:50,000 and 1:100,000 topographic maps would, however, provide earlier data on road (6 classes), water body (8 classes), built-up area (village), and land use and land cover. Accordingly, in spite of poor conformity between the existing data and newly updated data in definition and accuracy, there was a possibility to utilize the information. On the other hand, there were land use and forest cover data prepared by NOFIP. These data were updated by FIPC for Louangphabang Province and by NGD during the Study for the northern part of the country except Louangphabang. Also, in spite of questions in data conformity and horizontal accuracy, there was a possibility to analyze land use changes.

Taking the above-mentioned land use and forest cover data, the Team analyzed land use change for nine provinces of the northern region in cooperation with the NGD counterparts. Since definitions of classes and surveying date are not even throughout the area, satisfactory analysis was not necessarily performed. But, rough information on land use change from 1982 to 2001 were made for each province of nine. Land use changes from class to class were not identified because of nonconformity of classification by surveying date. According to the results, the current forest for the whole of nine provinces gained 5.3% from 1982 to 2001 and potential forest lost 2.7%. These values are not official, because the analysis was done on an experimental basis for using the data stored in the GIS database.

The Database should be utilized for a variety of analyses. Utilization of the database, however, depends on availability of reliable data, which end-users should collect or prepare according to their objectives. However, the NGD counterparts are required to be able to perform basic data manipulation such as data overlaying and calculation on demand. Also, they should be able to output hardcopy maps or diagrams from the new data on demand. Therefore, the Team suggested and guided the counterparts in figuring out some sets of data from the stored data.

Using DEM of the database, some kinds of classification maps regarding environment can be generated. For example, relief energy map, slope map and elevation map can be generated. These are meaningful maps by overlaying other thematic maps such as soil map and land use map. As a tool for presentation of environmental analysis and planning, visualization of the results is very useful. For these purposes, DEM provides various outputs such as shaded relief image and bird's-eye view. Some samples, including animated images, were presented at the seminar held in the end of the Study.

Overlaying and calculation using other data from the GIS database can make various new values such as length of road and river and size of administrative unit. Some of them were performed in this Study.

The above-mentioned results are attached as Appendix F.

Technical Remarks

The Team suggested and guided the NGD counterparts in data analysis during the Study. However, because of a large variety of data applications, training was not sufficient. Through repeated trials and errors, the counterparts should acquire further ability to overlay different data layers to produce new information and to output visual images on demand. For this purpose, it is desirable that some expert of data analysis would give further guidance to the counterparts in the near future.

CHAPTER12 TECHNOLOGY TRANSFER

One of the objectives of the Study was "Technology Transfer" to the NGD counterparts, which enables NGD to generate and update the GIS base map data and manage the System without help in the future. There are two ways of training in this Study. The first way is lecture for understanding the theory of the technology used in the Study. The second way is on-the-job training for learning practical processing conducted in the Study. The Team conducted technology transfer, considering that both ways are equally necessary. Twenty-three (23) counterparts participated in the works. In connection with the Study, four counterparts were sent to Japan to learn advanced technologies for 1.5 to 2 months each during the Study as well.

In the beginning of the Study, these participants had no experience to use computer systems. Since then, they have been working hard and been very serious in learning the system operations. They made gradual progress during these years and, finally, they acquired the technologies as was expected. It is judged that all these participants have attained the level of ability to process standardized works without assistance. Some of them have acquired the ability to improve the processes or to develop some new products and services. A list of the counterparts is shown in Table 11 on the last page in this Chapter.

The Team conducted technology transfer as mentioned below.

12.1 Lecture

The creation of GIS data is the first experience for all the NGD counterparts. The Study Team members gave five lectures first, using the textbooks that they had prepared. The titles of the lectures are listed below:

Lecture1. The Technology Overview.
Lecture2. GIS Database Design.
Lecture3. Analog to Digital Data Creation
Lecture4. Data Error Correction
Lecture5. Coordinate System design

Through above lectures, the counterparts understood the concept of the GIS database and the outline of technologies to be used in the project.

For starting OJT in practical processing, the following lectures were also given:

Lecture6. Vector Data Edit – How to edit the vector data in the digitizing work by using Arc View software.
Lecture7. MRC Data Update – How to convert the MRC contour data into the Mekong GIS database by using ARC/INFO software.

Lecture8. Geometric Correction – How to rectify an image data, and to convert the projection by using IMAGINE software.

Lecture9. DEM and Ortho Image Creation – How to generate DEM from contour data and how to create the ortho images from DEM, road data and river data.

The course notes used in each lecture were combined into "The Textbook of the OJT Lectures." After the lectures and training, the counterparts became able to use the technologies in their daily work.

12.2 OJT

In the actual works, OJT was conducted. The NGD counterparts practiced each process under the individual guidance of the Team members. Explanations were given to the counterparts as the occasion demanded. The Team intended to take care that each counterpart would experience as a variety of processes as was possible. Time limitations, however, hindered this goal from being fully realized.

Through the OJT, the counterparts made considerable progress in each process. It was observed that the counterparts often utilized free time to prepare their own manuals using MS Word and Excel on various subjects that were pointed out and advised by the Team. During this preparation, they were exchanging manuals with each other to improve their ability.

12.3 Special Lecture

During the works, the Team thought that it would be desirable for the counterparts to fully understand the theory of technologies and gain an appreciate for the wider use of this project and considered that it would be rather effective to give additional lectures as they were advancing in their understanding and experience.

Therefore, in the end of the fourth year, the Team gave a three-day special lecture on GIS and Remote Sensing. As a result, the NGD counterparts made satisfactory progress in understanding the technology and project.

12.4 Transferred Technologies

The technologies transferred to the NGD counterparts are itemized below:

(1) Geodetic Datum Network Survey and Calculation of Datum Shift Parameters

a) GPS survey to obtain the conversion parameters.

b) Method to analyze the values which were obtained by the survey

c) Method to obtain the three dimensional parameters by using the result of analysis

d) Formulation from conversion parameters

Since the NGD counterparts from the Survey Division had experience of GDP survey and calculations, there were no technical problems in particular. The shift parameters for Indian Datum-1960 would be low in accuracy, so they should be updated by further observation in the northern part of Laos in the future.

(2) PC System Operation and Excel File Creation

Usage of PC system including scanner and CAD software was transferred through making a database of existing flight index maps and through exercising administrative boundary digitizing. Before the start of the Study, all the counterparts had had no experience to operate PC systems, but they made remarkable progress in map digitizing and understood the layer structures of GIS data through digitizing work of administrative boundaries and other layers. It is judged that, as far as the project is concerned, they have entirely mastered the operation. In addition, the counterparts extracted names of rivers and villages from the 1:100,000 topographic map and compiled a place name list with each code number by using MS Excel. Through this work, they mastered how to make a database and acquired ability to apply the system to other works.

Computer systems are, however, making rapid advance today. Therefore, NGD should make every endeavor to research contemporary technologies for the future, when the current system will be partly or entirely renewed and upgraded.

(3) Scanner and Image Software

For compiling the sheets of aerial photo interpretation keys, the counterparts used a small color scanner and Photoshop software for image layout and Illustration software for drawing map symbols. Through this work, they became familiar with the software. These skills are helpful for publishing some documents of NGD.

(4) Aerial Photography

a) Planning for aerial photography
b) Decision of equipment and materials for film processing
c) Method of image inspection
d) Marking method on the film

The counterparts from Photogrammetry Division had knowledge and experience of aerial photography. There were no technical problems in particular, because the aerial photography for the Study was a standard technology.

(5) Aerial Photo Interpretation

a) Understanding the definitions of topographic features that appear in the 1:100,000 topographic map
b) Orientation of a stereoscopic pair of photos
c) Appearance of each topographic features and land uses on photos
d) Stereoscopic vision with stereoscopes
e) Preparation off interpretation keys with field check
f) Photo interpretation of land use and forest cover
g) Interpretation of satellite image

The NGD counterparts completed aerial photo interpretation of topographic features through trials and errors. It is judged that they have mastered identification of the features for this Study at least. When they identify other features, however, they need to learn the appearance of these features on photos. But, there will be no difficulty for them because of experience.

The counterparts performed aerial photo interpretation for classifying land use. In this classification system, there were several classes that were categorized into forest type, because the purpose of land use classification in this Study was to update the NOFIP's land use and forest cover data. Forest type classification requires not only identification of objects but also interpretation with a special knowledge and experience of forestry. From this point of view, the results are in need of correction.

In addition, the counterparts had a propensity to classify the land use too detailed for the scale of 1:100,000. They used 1:16,000, 1:20,000 and 1:50,000 scale photos. When larger scale photos are interpreted for smaller scale mapping, it is essential to generalize the polygons during interpretation. This is an advanced skill with highly arbitrary judgment. This should be applied for compilation of any maps including topographic map. The counterparts are required more experience of polygon generalization.

Transcribing

Manual transcribing of interpreted results from photos onto ortho satellite images was a laborious task that requires precision and carefulness. This process required comparison of photo and satellite images. Therefore, the counterparts needed to be familiar with satellite images as well as photographic images. They attained the standard level of ability for this process.

(6) Processes of Data Digitizing and Updating

a) Scanning of map (TruInfo)

b) Image data rectification (ARC/INFO, IMAGINE, Trprj98)
c) Raster/vector conversion (R2V)
d) Screen updating (ArcView, ARC/INFO)
e) Data digitizing (VecEdit98, ArcView)
f) Edge matching (ArcView, ARC/INFO)
g) Data appending (ARC/INFO)
h) Data splitting (ARC/INFO)

Data digitizing and updating works required to take several steps of the above-itemized processes. Among them, scanning, rectification, R/V conversion, data appending and splitting were fully automatic. So, there were no problems in particular. While, screen updating, data digitizing and edge matching required carefulness and perseverance. Carefulness was especially vital. Without carefulness, mistakes in inputting and checking of data and attributes are apt to occur. It is judged that the counterparts have attained the standard level of ability in these processes.

(7) Ortho Satellite Image Preparation

a) GCP selection (IMAGINE)
b) Preparation of ortho satellite image data (IMAGINE)

(8) Contour Data Generating and Updating

a) Raster/vector conversion of UXO Lao contour data (R2V)
b) Conversion to Shapefile (ArcView)
c) Conversion to Coverage (ARC/INFO)
d) Coordinate system conversion and attribute redefinition (ARC/INFO)
e) Rubber Sheeting (ARC/INFO)

Since most of the processes are automatic, the counterparts will be able to apply theses steps for other cases of contour data generating. Carefulness is vital in identifying contours and inputting their attributes.

(9) DEM Generating (ARC/INFO)

DEM generating was the first experience for the counterparts. But, the operation was rather simple due to highly automatic processes.

(10) Data Analysis

a) Appliance of GIS Data (ARC/INFO, Arc/View, Excel)

The Team suggested the counterparts some themes of analysis regarding environmental issues, which require overlaying of data stored in the database. The counterparts should be able to overlay different data layers and obtain new data on demand. Also, they should be able to printing out hardcopy maps from the new data on demand.

(11) GIS Data Printing Out

a) Operation of color plotter
b) Map design (symbol, color, size of point and annotation, line gauge, position of annotation, and marginal information)
c) Plot file creation (ARC/INFO, Arc/View, IMAGINE)

There were no problems in operations due to automatic processes; while there were cartographic problems in map designing. Map designing requires cartographic knowledge and experience. These maps are just hardcopies simply output from the GIS data. Because flexibility of expression is very much limited, these maps are inferior to ordinary maps. In spite of the limitation, the Team gave the counterparts several advices regarding usage of symbol, color and so on. They were successful in printing out, but more research and experience of cartographic designing are required for the future.

It is recommended that NGD should introduce digital map compilation technology in the future as mentioned in Chapter 14.

12.5 Manuals

The Study Team prepared a Data Generation Manual that helps the NGD technical staff in generating and updating the GIS data in the future. The counterparts also prepared some manuals in Lao by themselves.

The Team also prepared a Data Usage Manual that helps the NGD technical staff and data users in manipulating the data for usage. These manuals are available in NGD.

12.6 Seminar

In the last stage of the Study, the JICA Study Team and NGD jointly held a one-day seminar to introduce the GIS base map data for the Mekong River Basin to the user organizations and experts in Laos. The NGD counterparts presented the outline of the database and the methods applied to data preparation. The Team made some introductions of GIS database usages. NAFRI and UXO Lao presented their activities in GIS utilization. After then, the Team stated recommendations on distribution, utilization and maintenance of the GIS database. Finally NGD stated its future plan regarding the GIS database. A scene of the seminar is shown in Figure 16.

Figure 16: Seminar

Technical Remarks

The NGD counterparts acquired the technologies as was expected. It is judged that all the participants have attained the level of ability to process standardized works without assistance. Some of them have acquired the ability to improve the process or to develop some new products and services.

Table 11: The Counterparts

Ms. Sisouphanh PHOUMIVONG	Ms. Somkhith KHOUNPHONESAVANH
Mr. Aksone SIMMAVONG	Ms. Imphone CHANNGAKHAM
Mr. Thavisay KHAMPHICHITH	Ms. Noun PHOMMIXAI
Mr. Michith THAVONG	Ms. Sikhay S.SIRIBOUNMA
Mr. Phatnakhone INSISIENGMAI	Mr. Souvanny VONGSOUVATH
Mr. Bounkeuth SINDAVONG	Mr. Samliang PHILAPHA
Mr. Phoukham PHONGMALAYKHAM	Mr. Chanthavy CHOUTDARA
Mr. Bounpheng PHENGKHOUANE	Mr. Vannalath PHIMMAVONG
Ms. Ammala KEONOUCHANH	Mr. Sangkhane THIANGTHAMMAVONG
Ms. Somsanouk MUANGVONG	Mr. Phouangphanh SAYASANE
Ms. Chanthone PIOKEOPASEUT	Mr. Bounnhom KEOVONGSY
Ms. Phothin XAMONTY	

CHAPTER13 PRESENT SITUATION OF NGD

13.1 The Present Situation of NGD

According to the Prime Minister's Office's Decree No.73/PM (20.9.1994, Article 14), the National Geographic Department (NGD) is the surveying, aerial photography and mapping authority of the Lao PDR, under the supervision of the Prime Minister's Office. NGD's responsibility is to control, to inspect and also to plan and to implement if needed, surveying, aerial photography and mapping activities in Lao PDR. More detailed duties such as establishment of restrictions, study of demands, technical inspection of quality and efficiency are prescribed.

13.1.1 Activities

NGD prepared a document "Strategic Plan 2001-5" in 2001, in which the present main activities of the Department are listed as follows:

(1) establishment of national networks of geodetic control points throughout the country,
(2) preparation of topographic base maps,
(3) preparation of thematic maps at different scales,
(4) provision of map products and aerial photos,
(5) accomplishment of GPS, leveling and other ground survey,
(6) provision of geodetic and leveling data, and
(7) provision of surveying equipment and survey personnel.

NGD also states that it has the following three large projects on going, which are focused to meet the most actual needs:

(1) Cadastral Field Survey for Lao Land Titling Project
(2) Mekong GIS Project (that means this Project)
(3) Vientiane Plain Topographic Mapping Project.

13.1.2 Products and Services

NGD's main products are topographic maps, thematic maps, photomaps and aerial photos. The scales of topographic maps covering the whole country are 1:1,000,000, 1:500,000, 1:200,000, 1:100,000 and 1:50,000. They are now over 20 years old.

The series of 1:50,000 maps are the oldest that were prepared in 1966 by AMS and the sheets in the southern part of the country were updated in 1996 and 1998. But it has not been

determined if a series of this scale should be the basic format for the future. There are many sheets out of stock.

The series of 1:100,000 maps, 20 years old, have not been revised since the publication. It is, however, the latest series covering the whole country and the demand is the highest now, being approximately 40% of all map sheets sold. The most popular sheets are those of the eastern and northeastern part of Vientiane Plain. The stock of several sheets will be depleted in a few years.

For specific project purposes, small amounts of basic maps in a large scale have been produced in some areas. But, these will run out as well.

Several thematic maps are published, but some are out of stock. Among them are tourist maps in a scale of 1:10,000 to attract foreign travelers. They were published for a few areas such as Louangphabang and Vientiane, but Vientiane tourist maps are now out of stock.

Photomaps have been produced in large scales of 1:1,000, 1:2,000 or 1:4,000 for Lao Land Titling Project in limited rural and urban areas.

Since 1954, aerial photographs have been taken in various parts of the country. The photos taken for the whole country in one season are the 1:30,000 and 1:60,000 photos taken by the former Soviet Union in 1982. Relatively new photos are in scales of 1:16,000 for Vientiane, Savannakhet and Champasak areas; 1:12,500 for limited urban areas in 1997; 1:20,000 for Vangvieng in 1996; 1:15,000 for Vientiane Plain in 1999; and 1:50,000 for the rest of the above areas in 1999. Besides, during the years from 1993 to 1997 over twenty projects took aerial photos in limited areas in the country.

As well as selling maps and photos, NGD offers a variety of services such as distribution of geodetic data, dispatching of surveying staff, lending of equipment. Price list is presented later in this Chapter.

13.1.3 Human Resources

There are 105 persons engaged in surveying and mapping activities except for one general director and three deputy directors. Among these, 80% is in technical jobs and 20% in administrative jobs. Yearly from one to four new persons are recruited and about the same number of persons are pensioned.

13.1.4 Divisions

NGD has seven divisions: Administrative, Planning and Personnel Division, Finance Division, Cartography Division, Photogrammetry Division, Survey Division, Technology and Science Division and Technical Supply and Services Division. The organization of NGD is presented in Figure 17.

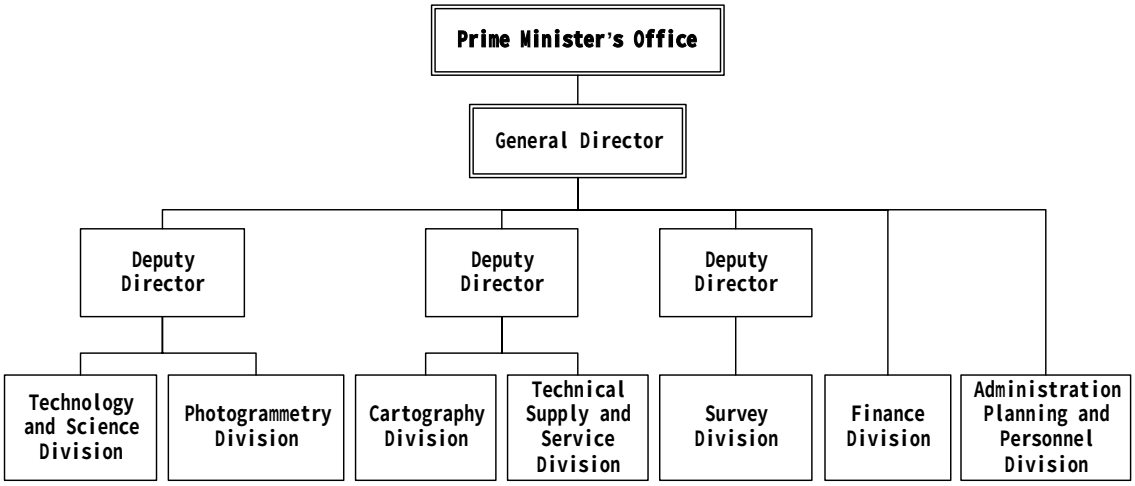

Figure 17: The Organization chart of NGD

According to the NGD's document, activities of each division are itemized below:

(1) Administrative, Planning and Personnel Division (7 persons)

Assistance and secretary services to the Board of Directors

Financial planning for other divisions

Personnel services

Other administrative services

Management of policy work

(2) Finance Division (6 persons)

Budget planning

Salary works

Accounting

Map selling and data

(3) Cartography Division (15 persons)

Map design

Map establishment

Map printing

: This division has been engaged with the Mekong GIS Project. Eleven counterparts have participated in aerial photo interpretation, data generating, updating, checking, and place name extraction and satellite image processing.

(4) Photogrammetry Division (20 persons)

Management of aerial photography

Photo processing

Stereo compilation

Photogrammetric mapping

Providing photogrammetric data

: This division is currently engaged with providing stereo compilation and photogrammetric data for Vientiane Plain Topographic Mapping Project.

Six counterparts have participated in the Mekong GIS Project, particularly in aerial photo interpretation and satellite image processing.

(5) Survey Division (36 persons)

Establishment of geodetic control point network

GPS and leveling work

Topographic ground survey

Providing geodetic and leveling data

Providing survey resources (equipment and surveyors)

: This division is currently engaged with providing control points and geodetic survey for Lao Land Titling Project of Department of Land and Housing under Ministry of Finance.

Four counterparts have participated in GDP observation and transformation of datum shift parameters in the Mekong GIS Project.

(6) Technology and Science Division (6 persons)

Monitoring of research, science and technology of surveying and mapping

Registration of surveying and mapping companies and surveyor license

International relationship

Consultancy of surveying and mapping techniques

: One counterpart has participated in GPS surveying and the other in data generating and updating in the Mekong GIS Project.

(7) Technical Supply and Service Division (15 persons)

Vehicle service for NGD activities and projects

Vehicle maintenance

Real estate and building maintenance

13.1.5 Facilities

NGD has equipment and processing facilities for most mapping activities such as computers, computer network, GPS equipment, analytical plotters, mapping software and map size plotters. Aerial photography camera and film processing laboratory are missing. Existing map printers do not work.

13.1.6 Finance

The activities of NGD are first of all financed from the national funds. During the years 1995-1999 the national funds have been reduced. NGD generates income through selling maps and surveying services, which are described in the previous section. The income has also been diminishing. Since the fiscal year 1998─1999, NGD has received donor funds from Vientiane Plain Mapping Project, which amounts to almost one half of the total funding. Annual funding for fiscal years 1995-2001 is shown in Table 12.

Table 12: Annual Funding in Fiscal Years 1995-2001

Funds/ Cost Recovery	1995-96	1996-97	1997-98	1998-99	1999-2000	2000-01	2001-02
Rate 1US$ =	926 Kip	1,058 Kip	2,120 Kip	4,775 Kip	7,045 Kip	9,400 Kip	10,100 Kip
National Funds (million kip) (US$)	173,190 187,030	127,962 120,947	625,985 295,276	215,334 45,096	311,805 44,259	770,693 81,989	540,900 53,554
Income (US$)	99,282	81,559	37,959	47,048	17,265	22,722	16,426
Together (US$)	286,312	202,506	333,235	92,144	61,524	104,711	69,980
Cost Recovery (income/national funds and income (%))	35	40	11	51	28	22	23

The national funds primarily cover minimum salaries and materials. The funds also cover management of some specific governmental projects, for example, border surveying project between Laos and the neighboring countries. All the income generated through selling maps goes to the national treasury. But, according to the provisional agreement with the Prime Minister's Office, NGD is presently able to use about 80% of the income generated from surveying services for operational costs and additional salaries to employees.

Table 13 shows annual income generated through selling products and surveying services and expenditure from the income for the recent three fiscal years. It is found that fluctuation of annual income is very large and fluctuation of amounts of money returned to the National

Treasury is also large. Consequently, expenditures for operating costs such as surveying, map printing, water and electricity are not constant. But, national funds do not reduce the fluctuation.

Table 13: Income and Expense in the last 3 Fiscal Years

		1999-2000	2000-2001	2001-2002
Income (million kip)		121,635	213,585	165,902
Expense (million kip)		115,959	142,788	169,971
	Given to the Treasury	41,752	66,134 4,336 US$ 50,500 Bath	51,234 1,250 US$
	Other expense	74,207	24,000 (approx)	106,000 (approx)

National funds for salary and other expenses (million kip)	311,805	770,693	540,900

The current price of maps and services is shown in Table 14.

Table 14: The Current Price of Maps and Services

Price List of maps

Description	**Price per map sheet (kip)**
Topographic maps	
1:1,000,000	4,500
1:500,000	5,000
1:250,000	4,000
1:200,000	5,500
1:100,000	6,000
1:50,000 UTM	6,500
1:50,000 Updated	6,500
1:25,000	7,000
1:25,000 Russian	6,000
1:10,000	6,000
Derived and Thematic Maps	
World Map	6,000
Administrative Map	6,000
Economical-Geographic Map	6,000
Vientiane Tourist Map	5,000
Louangphabang Tourist Map	5,000
Savannakhet Tourist Map	5,000
Khammouane Tourist Map	5,000
Second Vientiane Tourist Map	5,000
Lao Atlas (English)	8 US$
Lao Atlas (Laotian)	5,000
Prefecture de Vientiane Map	5,000

Price list of other products

Description		**Price per photo (US$)**
Aerial Photos		

Contact print		5
Diapositive		9
Negative		12
Photo enlargement	**Size (cm)**	**Price per enlargement (US$)**
Enlargement 2-7x	18-25	6
Enlargement 2-7x	30-53	7.5
Enlargement 2-7x	40-50	10.5
Enlargement 2-7x	50-60	17.5
Enlargement 2-7x	>60	25
Copies/Blue Prints		**Price per copy (kip)**
From National Geographic Department original		15,000
Own original		8,000
Measurement Data		**Price per copy (US$)**
Geodetic point I and II order (xyz)		50
Geodetic point III order (xyz)		10
Gravimetric point		10
Astronomy point		10
Leveling point		5

Price list of other services

Description		**Price per day/max 9 days (US$)**	**Price per day/min 10 days (US$)**
Technical service			
Technical officer		25	20
Technician		20	15
Middle and lower level technician		15	10
Survey equipment rent	**Model (amount of equipment)**	**Manufacturer**	**Price per Unit per Day (US$)**
Theodolite	T2 (3)	Wilde/Switzerland	20
	T2 (new model) (3)	Wilde/Switzerland	25
	2T2 (2)	Russian	10
	2T5K (3)	Russian	5
	Theo010B (1)	Zeiss/Germany	20
	T3 (4)	Wilde/Switzerland	20
	T0 (1)	Wilde/Switzerland	10
Leveling instrument	NAK2, NA2 (6)	Wilde/Switzerland	15
	H3 (2)	Russian	5
	Ni002 (2)	Zeiss/Germany	15
Distance Measurement Equipment	Di1001 (1)	Leica/Switzerland	30
	Di1600 (1)	Leica/Switzerland	35
	2CT2 (1)	Bleck/Russian	10
	2CT10 (1)	Bleck/Russian	15
GPS Equipment	4000SSI (3)	Trimble/USA	80
	Geo II (3)	USA	15
Altimeter	AL (2)	France	10
Survey equipment import permission			**Price per equipment (kip)**
Leveling instrument			2,000
Theodolite			3,000
Total station/GPS			5,000

handset			
GPS equipment			20,000
Car repair for National Geographic Department projects			**Price/day (kip)**
			30,000
Bar keeping in National Geographic Department premises			**Price/month (kip)**
			35,000

13.1.7 User Community

NGD is interested in its customers. In the document "Strategic Plan 2001-5," NGD presents a table of major customers of the NGD's products and services. The table indicates the Divisions of NGD concerned with each customer's demands. (See Table 15)

All the customers visit the counter of map products. In spite of out-of-date information, topographic maps at the scale of 1:100,000 and 1:50,000 are still widely used by various departments and authorities for planning, and also by private sectors.

Table 15: User Community of NGD's products and services (Strategic Plan 2001-5, NGD)

	Survey Division Services	Cartography Division Services	Photogrammetry Division Services	Technical Supply & Services Division	Technical Science Division	Map Products
Public	◆					◆
Private Sector Companies	◆	◆	◆		◆	◆
Government Agencies	◆	◆				◆
Communication Department	◆					◆
Construction Department	◆					◆
Irrigation Organization	◆					◆
Geological Department	◆					◆
Hydro-electro Project	◆					◆
Forestry & Soil Investigation Organization	◆					◆
Mekong GIS Project		◆	◆			◆
Vientiane Topographic Mapping Project	◆		◆	◆		◆
Lao Land Titling Project	◆			◆		◆

CHAPTER14 RECOMMENDATIONS

14.1 Improvement of the Survey Law

As mentioned in the above section, Prime Minister Decrees No.73/PM is the relevant law covering surveying, aerial photography and mapping activities in the territory of the Lao PDR. Scale of maps, surveying data and aerial photos are prescribed by this decree, but digital mapping data and the GIS data are not prescribed. For these new activities, NGD needs new national funds and cooperation of a variety of organizations in data updating, facility maintenance and so on. To fulfill these requirements, the activities need to be authorized by law. Therefore, the JICA Study Team suggests that the Lao government should amend the decree as follows.

(1) All sentences that mentioned the terms map, surveying data and aerial photos should also mention the digital mapping data and GIS data.

(2) The definition and interpretation of digital mapping data or GIS data should include:
Data Source Information: The data sources for generating the digital mapping data should be referenced. This includes information related to the Map, GPS, Aerial Photos, Satellite Images and other survey resources.
Data Precision: The digital mapping data quality should be referenced. This includes the Maximum or the Average Vertical and Horizontal Errors.
Data Definition: Data Format, Attribute Data Specification and Projection Definition should be referenced.

14.2 Budget of NGD for GIS Base Map Data Maintenance

Since the GIS database was established, data maintenance in NGD has become very important. NGD will be in need of more national funds for data updating, because the budget of NGD does not include the cost. Accordingly, the Team suggested amendment of the decree in the above Section. But, it will be hard to consider allotting a new fund for it in the near future because of the financial difficulties in Laos. To overcome the financial problems, the GIS base map data should be released at a reasonable price that enables NGD to balance the budget, which covers reproducing materials, reproducing labor, facility maintenance, and surveying for updating. In addition, other new products with added value should be developed and published as mentioned below.

14.3 Suggestions on the Mekong GIS Database Service

The following suggestions are what should be done in the early stage of data service.

Public Relation of the Mekong GIS Database

It is important for NGD to announce the publication of the Mekong GIS Database to promote its utilization. In the early stage of service at least, NGD should publicize the database service with effective measures as frequently as possible. Distribution of pamphlets and announcement by mass media are indispensable in general. Exhibition and demonstration on the GIS are also advisable as effective measures

Data Distribution

NGD is required to decide how to distribute the data. For advertising the usefulness of the database and encouraging further utilization, it is necessary to publicize a variety of ways in which the data can be utilized. This is very important in the early stage at least. To accumulate examples should be a top priority. Therefore, it is advisable for NGD to provide the data at a rather low price to power users engaged in various governmental or public projects. It is suggested that only reproducing materials and labor should set the price. Duration of this service should depend on the accumulation of usages. It is also suggested that NGD should hold occasional seminars to inform some cases of data utilization to the public.

Pricing

It is suggested that NGD should price the GIS base map data at a level that enables NGD to balance the budget, which covers reproducing labor, reproducing materials such as CD, FD, ink, paper, etc., facility maintenance, surveying for updating and depreciation expenses of facilities.

There will be various users. Some users need all the digital data but some need specific parts of the data and some need outputted analogue maps. Therefore, NGD should categorize the data into several ready made products, for example, Topographic Features, Administrative Boundary, Road and River, Contour, DEM, Ortho Satellite Image, Analogue Maps, etc. The digital data should be compiled into areas by province or quadrangle of 1:100,000 topographic map, etc.

Information of Data Quality

Data quality and surveying date are important for using the data. Therefore, NGD is required to inform users of such information before providing. The Team has prepared a data usage manual of the GIS data. NGD should use this manual for informing users of the way to use the data. NGD is also required to improve the usage manual occasionally.

Demand for Hard Copy of Map

It is foreseen that a user who is interested in the database would want hard copies of the new data in the form of a map initially, with the goal being to evaluate the usefulness of the data before a decision is made to utilize it. It is also foreseen that many people would want hard copies instead of the existing 1:100,000 topographic maps only because the data are updated. Hard copies of the map will be a promising source of revenue. NGD has acquired the technical ability to output the maps. NGD should prepare its working system for quick and exact printing on demand (POD) and gather associated costs. Considerable income can be expected from this endeavor.

Data Correction

New data are not necessarily perfect in general. When a data error was found, NGD should correct it as quickly as possible.

The following suggestions are what should be done in any stage of data service.

Maintenance of Technology

During the Study fifteen (15) NGD counterparts participated in map digitizing, data editing and other cartographic processing with computers, and acquired the expertise to process information on demand. It is essential that the transferred technologies should be kept at a sustainable maintenance and for the improvement of the Mekong GIS Database into the future. Therefore, NGD should research various ways of training, including OJT. For the training, a technician who has experience in the work should be assigned as an instructor for new technicians. The data generation manual prepared by the Team should be utilized for instructing them, and experienced technicians should improve it occasionally.

Therefore, it is important that NGD should establish a basic plan for technical training as well as for personnel, based on estimations of how many technicians and for what process are needed every year or every term of years for reasonable maintenance of the technology.

The Data Generation Manual prepared by the Team should be utilized for instructing new technicians, and it should be improved by experienced staff when necessary in the future.

Data Updating

Data updating is very important for GIS database with regard to the sustainable utilization of data by end-users. Data updating is also effective to secure the demand of the data. It is especially important that the information tentatively stored in the databases, as mentioned earlier, be consistently updated in the future. Updating every year or every two years will be essential for satisfying the demand for accuracy.

Data Quality Improvement

Data storing of the basic layers to the database has been done, but it has not been finalized in data quality for several reasons as mentioned in Chapter 9. For instance, administrative boundaries should be updated soon after determination in the future.

Contour data for steep slope areas is at the interval of 40-20-40 meters. The main purpose of contour data generation in this Study was to generate DEM. Accordingly, contour lines look unnatural on the hard copies, but this is sufficient for the time being. For digital map revision in the future, however, it is worthwhile improving the contour data by digitizing the original contour lines again.

Land use data is not necessarily continuous between two areas because of the difference of data acquisition methods, differences in classification systems and differences in surveying date. This discontinuity can only be solved by future updating with a definite classification system and method. It is desirable that a basic land use classification system (useful for the majority of uses in this country) be established. It is suggested that forest should be classified basically by density.

The position of village name (point) does not necessarily meet the built-up area (polygon), because the information is from two different source materials, namely the UXO data for village position and name, and aerial photo interpretation results for built-up area. Field surveys are indispensable for quality improvement in the near future.

In spite of unavailability of new aerial photos, topographic features in the southern region should be updated as soon as possible by other means such as field check.

Data Adding

Necessary data for use should be prepared by the end-user. It is, however, suggested that, when requested, NGD should undertake the data preparation. For example, data layers of hospital and medical center (point) will be requested by the authorities concerned, cave and fall or rapid (point) will be by tourism, and watershed boundary (line) will be by the authorities concerned with watershed management. In addition, NGD should prepare the basic data layers for general uses when many users recognize the layers are essential to be added to the database.

Data Protection

Copyright of the data must be protected for maintaining the data service. Data protection is technically possible for the moment, but any protection will not be durable. At present, there is no complete way to solve this issue. It can be said that frequent data updating would avoid the infringement of copyright.

Archive Reservation

The existing aerial photographs and topographic maps held by NGD are very precious national properties as scientific records of natural and social conditions in the past. It is suggested that NGD should strictly preserve negative films of these photos and some sets of printed map sheets. From the same point of view, NGD should preserve all the GIS data even after becoming out-of-date through data updating, because these data will be precious records for analyzing the past conditions of the country and their changes.

The followings are suggestions regarding digital map compilation in the future.

Digital Map Compilation

The above-mentioned hard copy service will satisfy everyone's minimum requirement for updated maps. From a viewpoint of up-to-date information service, these hard copies are superior to the existing topographic maps indeed, but it can be pointed out that this service should be provisional.

The hard copies for the whole Study area outputted by the counterparts are based on a design formulated after repeated trial and error, but these hard copies are far inferior to the existing topographic maps in cartographic expression. In general, it is unavoidable that a hard copy outputted from a GIS data is inferior in visual expression to a conventional map, because the GIS data is not created for the purpose of paper map compilation from the first. A good map is produced through elaborate compilation processes based on a proper cartographic design in order that every user can reach geographic facts easily and correctly.

Conventional method for map compilation requires manual processes and experience for the greater part of processing. Accordingly, it requires high cost as well. But, modern method including digital map compilation has been rapidly developed and spreading today. It is more efficient and economical than the conventional method. Therefore, if digital base map data are available, digital method should be applied to map compilation. Since the GIS base map data for the Mekong River Basin are available now, NGD has had the advantage for digital map compilation as well as digital map updating. One thing that NGD is in need of is technology of digital map compilation. Therefore, NGD should acquire this condition as soon as possible for the near future.

Demand for added value

It is foreseen that many people would want the data with an added value. If their demands are technically acceptable, NGD should meet these user needs as well as possible. Therefore, it is

advisable that NGD should acquire a minimum ability to add value to the data on demand, and should become a GIS data processing center for the country.

It is advisable that NGD should publish some new maps that will be a promising source of revenue. For example, a series of road maps will meet the needs of tourist enterprises and foreign travelers. Also tourist maps of historical sites and scenic places will be promising. The existing tourist maps of cities should be revised. If the digital map compilation method is available, all these maps can be compiled by utilizing the base map data.

14.4 Uses of the Database

The Mekong GIS Database is a national spatial database in Laos, with which various organizations, irrespective governmental or nongovernmental, can make their own database and utilize it for planning, analyzing, implementation and management. In addition, these users can exchange the necessary data between each other. The Data Usage Manual prepared by the Team is available for the users and the NGD staff.

Usages of the database are exemplified below.

Watershed Management

Watershed management is one of the biggest subjects in Laos where 80% of the territory is mountainous. The database will be highly utilized in the field of watershed management. Watershed management is indispensable for keeping sustainable water resources for social and economic activities, such as irrigation and hydropower industry and also important for conserving soil, forest and natural environment including biodiversity. In addition, the management is important for preventing natural disasters such as landslides in mountainous areas and floods in plains.

The GIS database is expected to be a useful tool for watershed management programs. In any field of watershed management, DEM will work as the source data for topographic analyses for picturing the geographical characteristics of watersheds, such as slope classification and relief energy classification. Any user concerned with watershed programs will be required to create watershed boundary data and add them to the database. Also he will be required to add the position of meteor-hydrology stations and the data. These added data will be common to every field of watershed management. If requested, the NGD technical staff could identify watershed boundaries using contours and/or aerial photos, and also digitize them.

Hydrometeorological stations are still insufficient in number and quality in mountainous areas for every purpose, for example, weather and flood forecast for agriculture and rain water

estimation for hydropower development. The database is useful for planning of meteor-hydrology station allocation and rehabilitation.

Water Distribution Planning

Macro-level water use and distribution for agriculture, urban, industry and hydropower sectors is a fundamental subject in Laos. Also monitoring and coordinating the water use for different end-users is unavoidable. For this purpose, the database will be helpful because of its function for wide perspectives.

Soil Survey and Land Classification

National Agriculture and Forestry Research Institute of Ministry of Agriculture and Forestry is conducting nationwide soil surveying using GIS and classifying the land characteristics and suitability for agriculture and forestry at the Soil Survey and Land Classification Center. The Institute is also preparing irrigation maps and maps of existing inundations along the Mekong. These data and other necessary data can be integrated using the GIS database.

Agricultural Planning

The database is useful for irrigation planning and management in the plains and cropping planning and so on. If the data of agricultural production are available, the data can be added to the database for analysis. And it will be possible to analyze the present status of agricultural production nationwide. But, for micro-level analyzing, the usefulness of the database will be lowered.

Forestry

Forestry Inventory and Planning Center of Ministry of Agriculture and Forestry (the former NOFIP) are conducting nationwide forest cover classification under "Forest Strategy 2020." In addition, a project of monitoring illegal deforestation is planned. Soil erosion is a serious problem in forestry, environmental conservation and natural disaster control. The database will be useful for integrating the systems of these projects.

Hydropower Development

Using DEM of the database, suitable topography for potential dam sites and reservoir sites can be analyzed for rough planning. Through this analysis, approximate estimation of population, properties, forest cover and other land uses that will be covered by water can be made. The data is not suitable for detailed planning and designing in scale.

Development of micro hydropower stations is planned in mountainous areas. The usefulness of the data will be lowered for searching suitable sites, but market research for electrification can be made using built-up area data, with population data and production data, although production data will be poor throughout the mountainous areas.

Electrification rate is rather low in Laos due to undeveloped facilities. For prioritization of transmission line network and substation system, the GIS data, especially contour data and DEM, will be useful.

Mining

For field surveying of geology and mines, the digital map of up-to-date information is useful. When GPS is used for positioning of outcrops, the digital map would be helpful. Moreover, contour data and DEM stored in the database will be useful for digital compilation of geological maps and creation of 3D perspectives of geology.

Tourism

Laos is an attractive country from a viewpoint of tourism because there remain precious natural resources, traditional cultures and historical places. There are two world heritages: Louangphabang and Wat Phu Champasak. At present, foreign tourists amount to 700,000 annually. Tourism is a promising industry for the future in Laos. Trekking, rafting and cave exploration will become increasingly popular, as well as touring historical places. The GIS database provides the framework for storing necessary data regarding tourism as well as road and river data for analyzing touring routes, accessibility and cost.

UXO

UXO Lao surveys the distribution of unexploded ordnances and prepares the data for its activity. Employing the GIS database, UXO data will be linked with other useful data such as population, land use of small-scale agriculture, surface geology and earth displacement by heavy rainfall.

Natural Disaster Prevention

The major natural disasters in Laos are landslides in mountainous areas and floods in lowlands. The GIS database provides the framework for recording the past landslide areas, inundated areas and eroded riverbanks.

Slope classification maps and relief energy maps can be generated with DEM. Slope classification maps, as well as land cover maps and the above past landslide maps, are basic

source materials for landslide hazard mapping. It is helpful for hazard evaluation to integrate these thematic maps in the GIS database.

Health and Medical Service

Health and medical service in Laos is in need of improvement, especially for mothers and children in mountainous areas or isolated areas. For mapping the districts benefited by primary health care, the GIS database provides basic data such as roads, rivers and contours in mountainous areas and also it provides the framework to store other necessary data regarding the service.

The GIS database provides the framework to store statistics on epidemics, which are taking place throughout the country. Based on these data, epidemiological analyses can be effectively performed. The GIS database will also provide the framework to store hygienic data of drinking water for each village. By analyzing these data, it will be able to prioritize the districts of drinking water supply.

For selection of sites for dumping garbage and industrial waste, the database provides the framework to analyze the data concerned.

The database provides the framework for prioritization of districts to supply water in a municipality, while it is not helpful for designing a detailed water supply network because of limitation of data scale.

Education

The Ministry of Education is updating the data of primary and secondary schools and plotting their positions at present. Coordinate determination is also planned. For storing and analyzing the data; the GIS database provides the framework with which school allocation planning will be facilitated, along with other necessary data such as population by age and sex, accessibility, race and culture.

Environment

Laos is characterized by diverse natural resources with high levels of biodiversity. Environmental conservation is required for sustainable economic activities. For this purpose, it should be emphasized that environmental monitoring should be executed and reasonable measures for conservation and utilization should be formulated. The GIS database provides the framework for monitoring and analyzing environmental changes.

Communications

Developed transportation and telecommunication are essential for improving and developing the current state of all the above-mentioned industries and administrations.

Roads, which are currently the most important infrastructure for transportation in Laos, are still undeveloped. The country is in need of completion of principal roads and rehabilitation of feeder roads for promoting economic activities for the future. The GIS database will provide the framework that links various necessary data together for making plans of road construction and maintenance. It is also helpful for daily management of roads.

The basic telecommunication network from the north to the south has been completed. But, the saturation level of telephone is still low as a whole. The database provides the framework with which a network master planning will be facilitated, along with other necessary data such as population, industry and economic activities. DEM from the database will provide basic information for analyzing the areas benefited by radio wave.