No.

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

THE NATIONAL GEOGRAPHIC DEPARTMENT (NGD)
THE PRIME MINISTER'S OFFICE OF LAO P.D.R.

THE STUDY FOR THE ESTABLISHMENT OF GIS BASE MAP DATA FOR THE MEKONG RIVER BASIN IN LAO PEOPLE'S DEMOCRATIC REPUBLIC

FINAL REPORT

February 2003

PASCO CORPORATION
AERO ASAHI CORPORATION

SSF
JR
03-16

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

THE NATIONAL GEOGRAPHIC DEPARTMENT (NGD)
THE PRIME MINISTER'S OFFICE OF LAO P.D.R.

THE STUDY FOR THE ESTABLISHMENT OF GIS BASE MAP DATA FOR THE MEKONG RIVER BASIN IN LAO PEOPLE'S DEMOCRATIC REPUBLIC

FINAL REPORT

February 2003

PASCO CORPORATION
AERO ASAHI CORPORATION

Contents

List of Tables

Lists of Figures

Lists of Appendixes

CHAPTER1 INTRODUCTION

In 1996, the Government of the Lao People's Democratic Republic (hereinafter referred to as "Laos") requested the Government of Japan to establish a GIS database for the Mekong River Basin in Laos and to transfer the technology to utilize and update the digital data. "Terms of Reference for the Technical Cooperation" submitted by the Government of Laos is attached as Appendix A.

In response to the request, the Government of Japan decided to conduct "The Study for the Establishment of GIS Base Map Data for the Mekong River Basin" (hereinafter referred to as "the Study") as a part of Japan's Overseas Technical Cooperation Program in 1997.

The Japan International Cooperation Agency (hereinafter referred to as "JICA"), the official agency responsible for the implementation of the technical cooperation programs of Japan, dispatched the Contact Mission to Laos in March 1998 and the Preparatory Study Mission in May 1998, to discuss the Scope of Work (hereinafter referred to as "S/W") with the Laotian side. After the discussion, S/W was agreed upon between the Prime Minister's Office of Laos and the JICA Preparatory Study Mission on 29 May 1998. S/W and Minutes of Meeting (hereinafter referred to as "M/M") are attached as Appendix B.

Based on S/W, the five-year work plan was settled on and the JICA Study Team (hereinafter referred to as "the Team") was organized as the implementing body. The National Geographic Department of the Prime Minister's Office (hereinafter referred to as "NGD") was assigned as the counterpart agency to the Team.

"The Steering Committee for the Establishment of GIS Base Map Data for the Mekong River Basin" (hereinafter referred to as "the Steering Committee") was organized as a coordinating body of related Laotian governmental agencies for smooth implementation of the Study and for future effective utilization of the result. M/M are attached as Appendix C.

The Study started in November 1998 and ended in January 2003.

1.1 Objectives of the Study

There are two objectives: The first objective is to generate the digital base map data for the Mekong River Basin in Laos at a scale of 1:100,000 and to create a database "the Mekong GIS Database" in cooperation with NGD.

The second objective is to transfer the technology of GIS data generating, updating and data base management to NGD.

1.2 Study Area

The Study area consists of seventeen (17) administrative units included in the Mekong River Basin, namely, Vientiane Municipality, Xaisomboun Special Region and fifteen (15) Provinces excluding Houaphan and parts of Phongsali and Xiangkhouang. The size of the area is 214,000 square kilometers, making up 90% of the country. The study area is shown in Figure 1.

Figure 1: Study Area

1.3 Organizations of the Study

1.3.1 The Steering Committee

The GIS base map database, which is to be established through the Study, should be used by a variety of governmental and non-governmental organizations concerned with national or regional development planning and management, environmental planning and management, etc. Therefore, it is essential for the Team to hear these users' needs and opinions, and also to have their cooperation for smooth implementation of the Study. By considering potential users' suggestions, the Team can better determine needs. For this reason, the Government of Laos organized the Steering Committee for the Study as the coordinating body at the beginning of the Study. The members were from governmental agencies. Table 1 shows the members.

Table 1: The Steering Committee

Name	Organization
Mr. Khamsouk SAIGNASONE	(Chairman of the Committee) Vice Minister, Prime Minister's Office
Mr. Kali KHANOPHET	Director General of NGD, Prime Minister's Office
Mr. Linseng DOUANGSAVANH	Deputy Director, General, Secretarist of Lao National Mekong Committee
Mr. Phouvang SAYALATH	Director General, Department of Integrated Resource and Science Technology Information
Mr. Mani CHANHSOUK	Officer, National Office of Forest Inventory Planning
Mr. Khampha PHOMMAKAYSONE	Chief of Division, Department of Geology and Mines
Dr. Thongchan MANIXAY	3rd Deputy Director of NGD

The Steering Committee had five meetings during the Study.

1. 23 November 1998 Inception Report
2. 1 August 2000 Progress Report 2
3. 2 March 2001 Progress Report 3
4. 21 February 2002 Progress Report 4
5. 16 December 2002 Draft Final Report

1.3.2 The National Geographic Department

The National Geographic Department, which was assigned as the Laotian counterpart agency to the Team, is the surveying, aerial photography and mapping authority of Laos, under the

supervision of the Prime Minister's Office. According to decree, its responsibility is to control, to inspect and also to plan and, if needed, to implement surveying, aerial topography and mapping activities in Laos. NGD has seven (7) divisions and a staff of 105. The details of the Department are described in Chapter 13.

In accordance with S/W, NGD took necessary measures and made provisions such as operation space and the counterpart personnel to the Team. Twenty-three (23) NGD counterparts participated in the technical operation and received technology transfer.

1.3.3 The JICA Study Team

The JICA Study Team, which was organized by JICA as the implementing body, was sent to Laos every year. Mr. Koichi MIKI headed it for the first year and Mr. Kiyoo SAZANAMI from the second to the fifth year. According to the specialty of each process, members of the Team were assigned each year. Each members guided the counterparts in specialized field of process. There were a total of thirteen (13) members during the five years. The details of member assignment are shown in Table 2 on the end of this Chapter.

1.3.4 The Technical Committee

For discussing and making important decisions on technical matters during the Study, the NGD engineers and the Team members were organized into the Technical Committee. Table 3 shows the members.

Table 3: The Technical Committee

Name	Position
Mr. Khamkhong DETCHANTHACHACK	Deputy Director
Dr. Thongchanh MANIXAY	Deputy Director
Mr. Bounkong SOUGNATTI	Deputy Director
Mr. Bouasoth SOUVANNAKUMMAN	Head of Division
Mr. Kongkham SOURIGNA	Head of Division
Mr. Phouangphanh SAYASANE	Head of Division
Mr. Sangkhane THIANGTHAMMAVONG	Deputy of Division
Ms. Sikhay S.SIRIBOUNMA	Deputy of Division

The Committee had four meetings during the Study.

1. 25 February 1999
2. 10 December 1999
3. 21 September 2000
4. 20 February 2002

1.4 Contents of the Study

In accordance with the previously mentioned objectives, the Mekong GIS Database was established and technology of GIS data creation, updating and management was transferred to NGD.

1.4.1 Establishment of GIS Base Map Data

A database of GIS base map data was established. It consists of basic layers of information (such as administrative boundaries and place names, roads, rivers, villages, small objects and land use). Data resolution is based on the map scale of 1:100,000. Also it has ortho satellite images and digital elevation model (DEM).

All these data were created in Laos by the NGD counterparts under the guidance of the Team. The flowchart of establishing the database is shown in Figure 2 below.

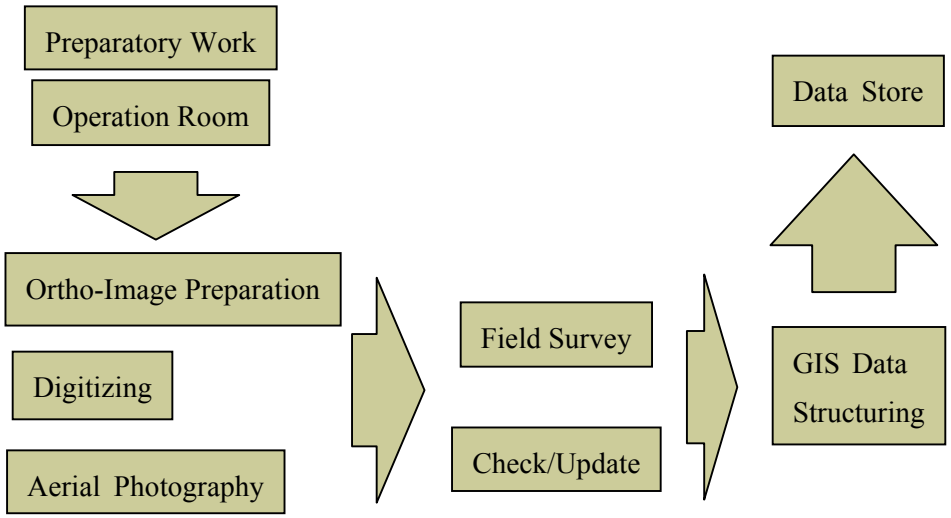

Figure 2: The Flowchart of Establishing the Database

1.4.2 Technology Transfer

Technology transfers to the NGD counterparts were conducted in order to make NGD able to generate and update the GIS base map data and manage the system in the future without assistance. Basically the counterparts learned the technology through on-the-job training (OJT) in Laos with necessary lectures and instructions given by the Team. There were 23 counterparts who participated in technical operations during the Study. 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. In addition, several special sessions were held for data users.

Technology transfers are described in Chapter 12 with a list of counterparts who participated in technical operations.

1.5 Background of the Study

The Mekong River is the largest international river in Indochina, flowing over six countries and forming a drainage basin of approximately 800,000 square kilometers, which is called "the Mekong River Basin." Laos is one of six riparian countries and it alone is landlocked, covering 237,000 square kilometer. About 90% of the country, 214,000 square kilometers, is within the Mekong River Basin. Houaphan Province and parts of Phongsali and Xiangkhouang Provinces are outside of the Basin. The nation's share in the whole Basin is about 27%.

Geography

Climatically Laos is located within the monsoon region of Indochina and experiences three seasons. A rainy season with relatively high temperature occurs from May to September. It is followed by a dry season from November to April. In the first half of the dry season it is cool, but from March to May the temperature is the highest in the year, reaching 38°C. Precipitation is very high in the central and southernmost regions of the country, especially in mountainous areas near the border with Vietnam, where annual average rainfall is over 3,000mm. In Savannakhet Province and the northern region, it is relatively low, under 2,000mm. In the Louangphabang and Louang Nam Tha areas, it is under 1,500mm.

Laos is as mountainous as Japan. Mountains and hills occupy about 80% of the country (as compared to nearly 70% in Japan). The greater part of the northern region and the areas along the eastern border with Vietnam are very mountainous. These mountains and plateaus are 1,000 to 2,500 meters in height. The highest peak is Phu Bia, 2,820 meters high, located in Xiangkhouang Province. A large part of the central and southern regions is also mountainous and hilly. Especially in the areas near the border with Vietnam, mountainous topography is dominant. These mountains are rich in attractive landscapes such as rugged peaks, long chains of cliffs, deep gorges and falls. Some of them are peculiar to limestone geology.

Large alluvial plains are distributed in the vicinity of Vientiane and along some tributaries of the Mekong River in the central and southern regions, yet they are small and minimal in the northern region. A large part of the plains is used for agriculture.

Since many hundreds of years ago, the Mekong River and its tributaries in Laotian territory have been playing an important part in collecting abundant rainwater and providing water to the lower regions of Indochina

Population

According to the census of 2000, population of Laos is 5,200,000. The population density is 22 people per square kilometer. Approximately 11% of the population resides in Vientiane Municipality. The rest of the population is distributed throughout the country, but the population tends to increase near towns. Savannakhet and Champasak provinces are more densely populated than the other provinces.

According to the national statistics, there are 49 ethnic groups. Lao-Thai groups are the most dominant, living in plains throughout the country. The other groups are, in general, minor in population, living in mountainous areas. Most of them are occupied with traditional industries, keeping their own cultures.

Industry

Based on above-mentioned geography, population and culture, several traditional industries have been developed, especially in agriculture and forestry. Also, modern industries such as hydropower have been developed, and they are going to be further developed. From the geographic characteristics it can be said that there is a great potential for further development in agriculture, forestry, hydropower and water transport in Laos, if necessary infrastructure were to be developed in the future. A brief description of industry is presented below.

Laos is a country of agriculture and forestry. About 90% of the working population engages in agriculture or forestry and produces 50% of GNP.

Agriculture is found throughout the country not only in plains but also in mountainous areas. Most of the farming is rain fed and liable to suffer from drought as well as flood. Rice is the major product in Laos, but it is still difficult to attain a stable self-sufficiency due to repeated droughts and floods. Slash-and-burn farming in the forests is a traditional system of agriculture in mountainous and hilly areas. But, recently a fallow term tends to be shorter than ever for economical reasons. In turn, this causes ecological deterioration.

Forests cover the mountainous and hilly areas. But, most of them are predominantly un-stocked forests, which have not grown up enough after deforestation, especially in the Northern Region. Although forests are interesting resources for timber, law strictly controls timber production at the present time.

A big problem in agriculture and forestry is undeveloped infrastructures for transportation of products for domestic consumption as well as exportation.

Laos does not produce oil. Most of the energy is produced by hydropower generation. From a viewpoint of hydropower development, mountainous areas have many suitable sites for creating reservoirs due to the peculiar landform, especially in north and east of Vientiane. But the potential depends, essentially, on the stability of an available supply of rainwater. Since rainfall is very seasonal in the mountains, solid observation of rainfall is necessary. An example of large-scale reservoirs is "Angkep Nam Ngum," north of Vientiane, which has been producing electricity since 1971. At the moment, further projects of hydropower development are in the way of planning or study in the Central and Southern regions.

Electricity production in Laos plays an important part in receiving foreign currency, because much of the electricity produced is exported to neighboring countries. But there are many districts that do not receive electricity due to the distance from the producing places or absence of power lines. In some areas, imported electricity from Thailand and Vietnam is used for irrigation.

The notable domestic industries are food processing, wood processing and sewing. Sewing is currently the most active exported product. But, the exportation of Laotian goods is relatively small, while many items of manufactured goods are imported.

Health and Education

Health and medical services are, in general, unsatisfactory. This is especially seen in agricultural areas and distant places where birthing procedures have not been developed enough to reduce the high rate of infant and nursing mother mortality. Development of service systems at the smallest units is vital.

There are about 8,400 primary schools and 860 secondary schools. The regional, sexual and racial differences in the rate of school attendance are very large. Therefore, the government has developed a policy for strengthening basic education. There is a shortage of school buildings as well as a shortage of teachers and educational materials.

Communications

Communication infrastructures have not been well developed in this country. The Mekong River and its tributaries have always played an important part in the system of transportation throughout the long history of Indochina. Such transportation, however, has been largely dependent on the seasonal change of water level and the river bottom conditions. There are plans for future development of permanent water transportation in some limited sections of the rivers.

Car transport is currently the most important means for transportation of goods and passengers in Laos. Since the 1980s, the high-priority development of roads has been realized, mainly through the assistance of developed countries. A minimum level of construction and rehabilitation of principal roads has almost been attained. After this, systematic road maintenance and development of feeder roads will be indispensable for promoting the formation of market spheres throughout the country.

There is a concrete plan to extend a railroad from Nong Khai on the Thai side to Vientiane through the Friendship Bridge. But, at this time, the construction has not been realized.

The basic telecommunication network from the north to the south has been completed. But the saturation level of telephone service is, on the whole, minimal.

Necessity of GIS Database

After the Paris Peace Accord in 1973, peace in Indochina was restored, and nations in the region have been accelerating their efforts in economic development through shifts from the centralized economies to market oriented economies. The "Greater Mekong Subregion Economic Cooperation Program" (sponsored by the Asian Development Bank since 1992 and the re-inauguration of the Mekong River Commission in 1995) is international cooperation measures supporting economic linkages as market economies beyond the national boundaries.

Japan hosted the "Ministerial Meeting of the Forum for Comprehensive Development in Indochina" in Tokyo in 1995, along with the "Task Force for Strategies for Development of the Great Mekong Area." The Task Force prepared a report, in 1996, focusing on infrastructure development, priority support to Cambodia and Laos, and emphasis on environmental issues in the Mekong River Basin.

Today, various projects of production and land development are on-going in Laos. And many new projects are in the research and planning stage s. But, many problems of environmental deterioration would likely be a result of land development.

As is often the case with any country, there are conflicts between development and conservation in Laos. In order to refrain from possible deterioration and keep sustainable economic activities, development planners and decision makers are required to evaluate the broader concept of land development, taking a variety of factors into consideration. In addition, it is important to monitor the environmental changes together with the rapid social and economic changes and to make various analyses for finding the problems and solutions. Geographic Information System (GIS) is a tool to monitor chronological environmental changes and help the planners and decision makers to make more rational and efficient analyses and discussions.

GIS is a framework formed with basic spatial data layers such as shoreline, river, road and administrative boundary. It provides a user with rooms for storing his spatial data necessary for analyses. Taking an example of land use change monitoring and analyzing by periodical surveys with remote sensing or some other methods, there are no efficient means but GIS for correctly overlaying the data of different dates and, moreover, overlaying other contemporary data such as industrial and economical activities, infrastructures, natural disasters, land use regulations and proposals. Without this system, it has been impossible to understand the correct status of land use change and find the real problems and solutions.

From this point of view, the necessity of establishing a GIS database for the Mekong River Basin, a so-called "National Spatial Data Infrastructure (NSDI)," was identified. This database provides a basic spatial framework, with which user organizations, whether governmental or non-governmental, can construct their own database not only for monitoring environmental changes but also for analyzing data, making plans, making decisions, implementing programs and managing projects as well.

Table 2: Study Team Member Assignment

CHAPTER2 PREPARATORY WORKS

First, for determining the methodology and the work system to apply to the Study, the JICA Study Team investigated the reference materials provided by JICA and collected by the Team. The investigated materials were existing topographic maps covering the Study area, existing aerial photographs and their index maps, existing control point network charts and surveying records, LANDSAT index maps, thematic maps and so on.

Then, based on S/W, the Team prepared a detailed working plan of the Study. Based on the working plan, the Team prepared the Inception Report, which covered the five-year work plan. After the approval of JICA, the Team submitted the Inception Report to NGD for explanation and discussion on the basic policy, study methodology, work processes, work schedule, staffing/equipment/facilities, technology transfer, and NGD's undertaking. The Report was agreed upon between NGD and the Team in November 1998. At the same time, the Team joined the Steering Committee to discuss the basic concept of GIS base map data, its maintenance and operation systems, its contents and so on.

After the agreement upon the Inception Report, the actual works in Laos started. During the five-year Study, most of the work was carried out in Laos by the NGD counterparts under the guidance of the Team. The work schedule in the initial work plan was partly changed due to circumstantial changes. The study ended in January 2003. The chronological proceeding of the Study is shown in Table 4 on the end of this Chapter.

2.1 Specifications of the GIS Base Map Data

The actual works in Laos started with close investigations of the legend of the existing 1:100,000 topographic map by the Team, for preparing the detailed specifications of the GIS base map data. They also studied photo interpretation keys for the topographic features itemized in the legend.

The detailed specifications of topographic feature layers were finalized in the beginning of the second year. But, during the second year, it was determined to be a high priority to digitize the most basic features because the Mekong GIS Database is the national spatial frame.

The GIS base map data created in this Study is fundamentally composed of roads, rivers and their names, villages and their names, other small objects, land use, administrative unit, elevation point, contour line, DEM and ortho satellite image. The data resolution expressed with the scale is 1:100,000, because the existing 1:100,000 topographic map was the standard base for digitizing and updating.

A geodetic datum is fundamental for establishing a GIS database. In order to decide a datum for the Mekong GIS Database, the Team discussed with NGD at the Technical Committee meeting based on the Inception Report and both sides confirmed to adopt the Lao National Datum 1997, which had been defined as a new geodetic datum through the Land Titling Project (LTP). They also confirmed to adopt UTM for the map projection coordinate system.

The specifications of the GIS data are shown in Table 5.

Table 5: Specifications of the GIS Data

Layer	Format	Type	Code	Description
Road	ARC/INFO Coverage	Line	2101	Paved road
			2102	Street road
			2103	Improved unpaved road
			2104	Unpaved road
			2105	Temporary road
			2106	Footpath
River	ARC/INFO Coverage	Line	5101	River and Stream line
			5102	Intermittent River and Stream
			5111	River and Stream line (Center Line)
			5112	Intermittent River and Stream (Center Line)
			5113	Canal
				River name
		Polygon	5101	River and Stream
			5102	Intermittent river and Stream
			5103	Lake and Pond
			5104	Intermittent Lake and Pond
			0	Island
Administrative Boundary	ARC/INFO Coverage	Polygon		Province Name
				District Name
		Line	8001	International boundary
			8002	Provincial boundary
			8003	District boundary
Built-up Area	ARC/INFO Coverage	Polygon	1001	Urban Area
			1101	Rural Area
Contour	ARC/INFO Coverage	Line		Elevation
			7101	Principal Contour
			7102	Secondary Contour
			7103	Supplementary Contour
			7104	Auxiliary Contour
Land Use	ARC/INFO Coverage	Polygon	8011	Dry Evergreen
			8013	Mixed Deciduous
			8015	Dry Dipterocarp
			8016	Gallery Forest

			8017	Coniferous Forest
			8018	Mixed Board Leaved Coniferous
			8019	Forest Plantation
			8021	Bamboo
			8022	Unstocked Forest
			8023	Natural Regeneration
			8024	Ray
			8031	Savannah
			8032	Scrub
			8041	Rice Paddy
			8042	Agricultural Plantation
			8043	Other Agricultural Land
			8051	Barren Land and Rock
			8052	Grass Land
			8053	Swamp
			8054	Urban or Built-up Area
			8055	Other Land
			8056	Cloud / Cloud Effects
			8061	Water
Village	ARC/INFO Coverage	Point		Village Name
				Village Code
				X, Y Coordinate
				Map Number
				Population
				Household
			1002	Big Village
			1102	Small Village
Small Object	ARC/INFO Coverage	Point	1202	School
			3001	Buddhist Monastery
			2201	Bridge (less than 3m)
			2203	Bridge (more than 3m)
			2207	Dam (practicable)
			2208	Dam (non-practicable)
			3004	Airport
			3005	Airfield
			2204	Water Gauge
Elevation Point	ARC/INFO Coverage	Point	7201	Geodetic Point
			7301	Spot Height
				Elevation
Ortho Image	Tiff with World File	Raster		10m resolution
DEM	ARC/INFO Grid	Raster		30m resolution

Horizontal datum: The Lao National Datum 1997, Spheroid: Krasovsky

Projection: UTM (Zone 47 and 48)

2.2 Research of the Existing Maps and Aerial Photographs

For updating the basic features on the 1:100,000 topographic maps for the whole Study area, ortho satellite imagery was utilized to provide current information. Its resolution, however, is not high enough to identify the changed artificial features such as roads, villages, small objects (mainly temples and schools) and water bodies. Therefore, the Team applied interpretation of recent topographic maps and aerial photos to the identification of such features in accordance with the Inception Report.

It was known to the Team that 112 sheets of recent 1:25,000 topographic maps were available for the Bolikhamxai area. These sheets were completed in technical cooperation between NGD and JICA in 1995. The area is 13,000 km². 1: 40,000 aerial photos taken for the mapping in 1992-1993 were also available.

In addition, the S/W Report of the JICA Preparatory Study Mission informed the Team that recently updated 1:50,000 topographic maps were available for the southern four Provinces (Salavan, Xekong, Champasak and Attapu). The updating was done with the assistance of Vietnam in 1996. The area is 44,000 km². There are 81 map sheets. For Bolaven Plateau located in the central part of the area, 1:40,000 aerial photos were taken in 1994. These photos were used for the above-mentioned updating of the topographic maps.

The S/W Report also informed the Team that new aerial photos were taken after publication of the 1:100,000 maps for several areas. The Team researched these photos in details and made it clear that there are 5,830 monochromatic aerial photos at a scale of 1:16,000 taken in 1997 for Vientiane, Savannakhet and Champasak areas and 1,347 color aerial photos at a scale of 1:20,000 taken in 1996 for the Vangviang area. Coverage of these photos is 21,600 km².

The total coverage of the above-mentioned maps and photos is approximately 74,000 km² subtracting the overlapping Champasak area and Bolaven Plateau. The areas are shown in Figure 3 on the next page.

After final checking of the existing aerial photos, the Team instructed the NGD counterparts in digitizing of the existing flight index maps by using a PC system including scanner and CAD software. Through this work, the counterparts completed the directory of the existing aerial photos, which was helpful for the photo interpretation work described later. At the same time, the counterparts became familiar with the PC operation.

A company in Laos printed contact prints of the existing photos necessary for photo interpretation.

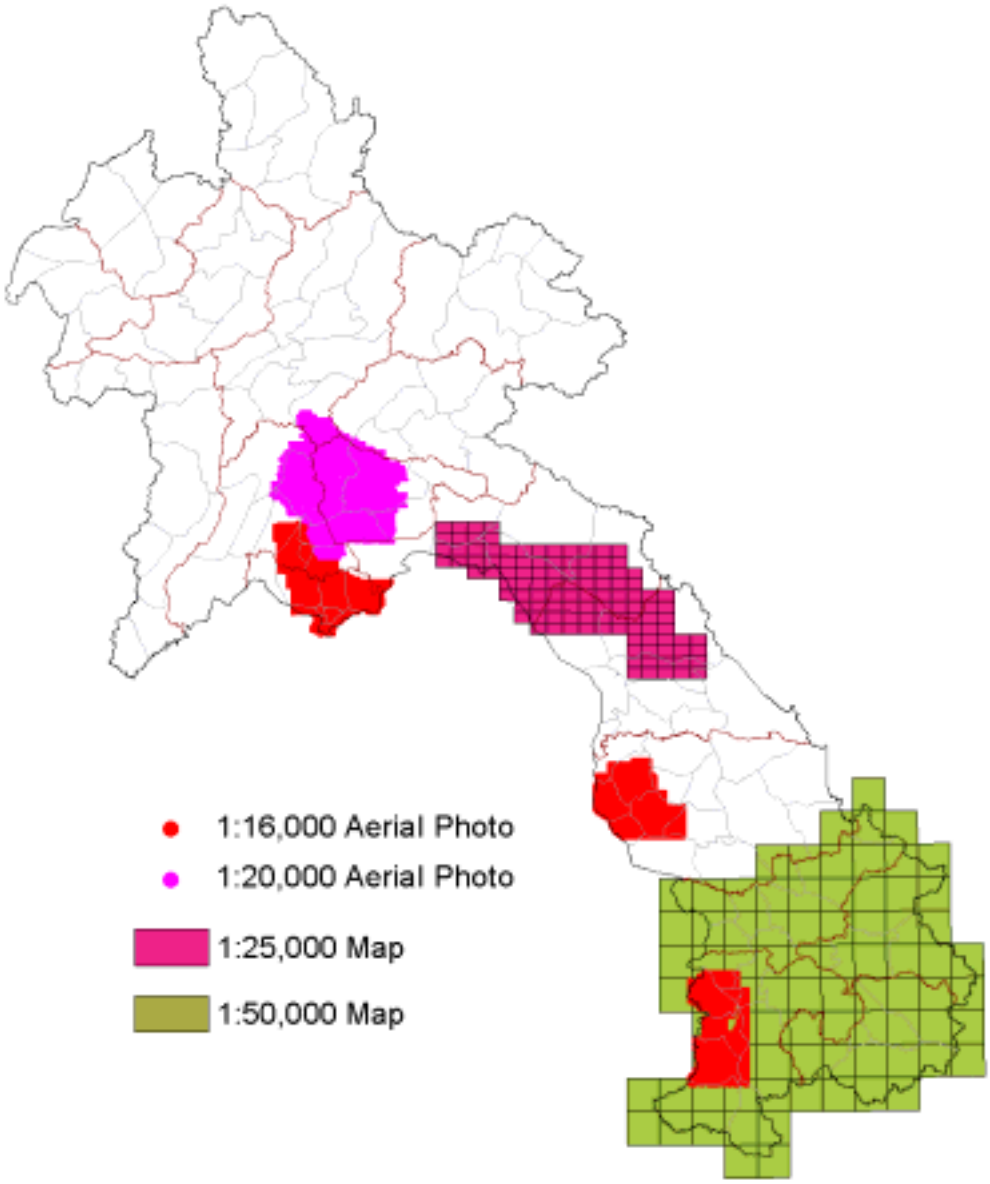

Figure 3: Existing Photos and Maps

2.3 Preparation of Operation Room and Computer Network System

In the first year, the Team discussed with NGD the necessary facilities for system operation. After reaching an agreement, the Team made final designs for the configuration of the Digital Map Editing System (including network) and operation environment such as office layout, air conditioning, distribution board, wiring, furniture and so on.

In the second year, the two existing rooms of the NGD building, which NGD provided, were repaired and remodeled into an operation room and an office room. New electricity was introduced for avoiding power failure and voltage fluctuation. Afterward, in early November 1999, the Digital Map Editing System was installed in the operation room.

The Digital Map Editing System is composed of twelve PCs, three CD-ROM writers, two network hubs, one A4 size laser printer, one A3 size color ink jet printer, three A4 size color scanners, one A0 size color ink plotter, one A0 size rolling scanner, three A0 size digitizers. Windows 98 for nine PCs and Windows NT for three PCs had been pre-installed as Operating Systems.

After the installation and adjustment of these devices, the GIS software such as ARC/INFO, Arc/View and Arc/Tin were installed in the PCs and IMAGINE was installed in three PCs as image processing software to generate ortho satellite images.

Configuration of the computer network system is shown in Figure 4.

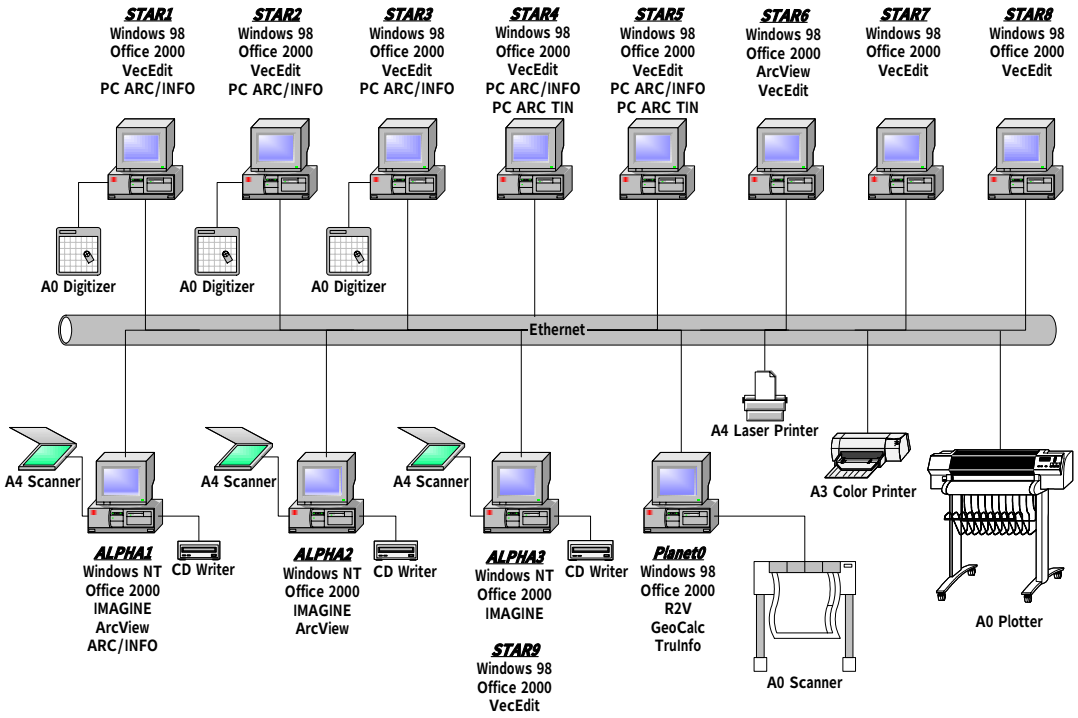

Figure 4: Computer Network

Table 4: Chronology of the Study

CHAPTER3 GEODETIC DATUM NETWORK SURVEY AND CALCULATION OF DATUM SHIFT PARAMETERS

There have been several different geodetic datums used in Laos and the neighboring countries. In order to utilize various maps and surveying results as GIS base map data, it is necessary that the Mekong GIS data and other data can be converted to/from each other. Therefore, the NGD counterparts carried out a net linking of intervals among control points of various datums by GPS static observation in the first year and, also, calculated the amount of each displacement for obtaining datum shift parameters. The following four datums were the subjects to GPS observation:

WGS-84

Lao National Datum-1997

Vientiane Datum-1982

Indian Datum-1975

During January and February of 1999, four parties composed of the NGD counterparts carried out GPS observation. A network of evenly distributed GPS observation points throughout the country would have been ideal, but points in the greater part of mountainous areas were excluded due to the limitation of accessibility and time. Since the existing control points for each datum range only along the Mekong River, 27 control points were selected out of them. The counterparts conducted approximately two-hour observation simultaneously at four points for each session by using four sets of two-frequency GPS receivers. After each session, tentative coordinate calculation, in accordance with the WGS-84 coordinates, was conducted to ensure accuracy of observation. The results were satisfactory.

Every input value for calculation of datum transformation was net-linked after completing all GPS observation. Each existing national control point, based on various datum systems, was established as a base point. Then, an average value of each net was determined by each datum system to calculate geocentric coordinates as the final results. A stone marker that displays the final result of Indian-1960 datum was not recognized in Laos. Twenty-three triangulation points, of which results were derived by Vientiane Datum-1982, were compared with the same points illustrated in the existing 1:50,000 topographic map (Indian Datum-1960 UTM coordinates) instead of a transformation formula for this datum.

Based on the GPS observation data, the Team calculated the datum shift parameters. The parameters to be added to each local datum Cartesian coordinates, to produce WGS84 Cartesian coordinates, are shown in Table 6.

Table 6: Datum Shift Parameters 1

Local Datum	Dx(m)	Dy(m)	Dz(m)
Lao National Datum 1997	44.586	-131.222	-39.543
Vientiane Datum 1982	42.640	-125.341	-37.682
Indian Datum 1975	201.148	838.024	293.960
Indian Datum 1960	207.065	840.053	308.815

Through a comparison of the control point networks of the Study and LTP, it was judged that the latter was better than the former in balance of point distribution. Therefore, the Team and NGD made an agreement upon datum shift parameters to be chosen for each local datum. The parameters are shown in Table 7, and the control point network by the study team is shown in Figure 5.

Table 7: Datum Shift Parameters 2

Local Datum	Dx(m)	Dy(m)	Dz(m)
Lao National Datum 1997	44.585	-131.212	-39.544
Vientiane Datum 1982	42.358	-124.688	-37.366
Indian Datum 1975	201.148	838.024	293.960
Indian Datum 1960	198	881	317

Figure 5: The GPS Observation Networks

Technical Remarks

Since the counterparts from the Survey Division had experience of GDP survey and calculations, there were no problems in particular. The data and document are available in NGD.

CHAPTER4 AERIAL PHOTOGRAPHY

The above-mentioned research made it clear that the areas where recent aerial photos and topographic maps were not available totaled approximately 140,000 km². For these areas, the Team took monochromatic aerial photos at a scale of 1:50,000 in the beginning of 1999, subcontracting with a company in Laos. The area of photography is approximately 150,000 km² including some overlapping areas with the existing coverage. It is shown in Figure 6 together with the areas of existing maps and photos described in the former Section 2.2. One of the Team members was assigned as the supervisor on this work.

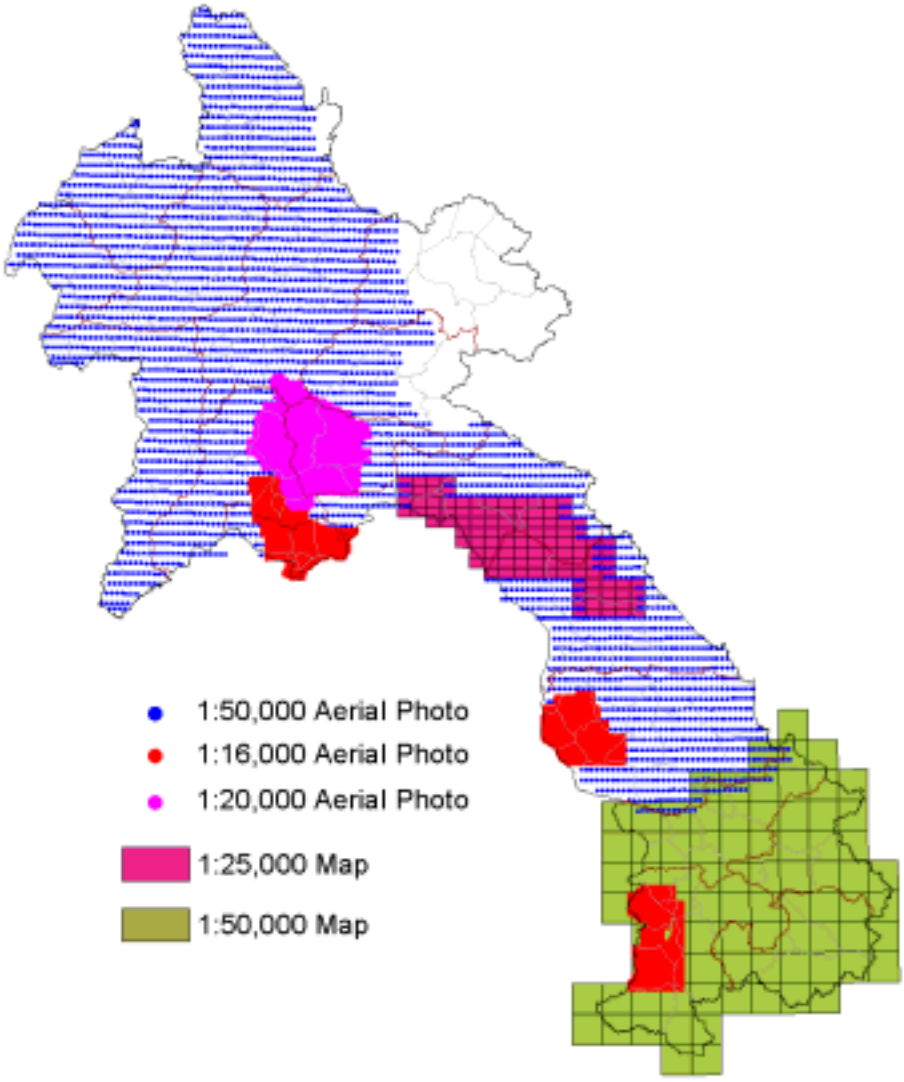

Figure 6: Index of the 1:50,000 photos

Specifications of aerial photography are:

Film	panchromatic
Flight direction	east-west
Photographic scale	1:50,000
Camera	with wide-angle lens (f = 150mm)
Forward overlap	60%± 5%
Side overlap	20%±5%
Flight altitude	±5%
Tip and tilt	less than 5°
Crab	less than 10°
Cloud cover	less than 3% in consecutive 5 photos

Within January 1999, 85% of the photography had been completed, except for northern mountainous areas where bad weather continued through February. All the photos had been taken by early March and totaled 3,903. The supervisor inspected the result with rush contact prints. The inspection items were: forward overlap, side overlap, inclination, cloud cover and others noted in the preceding specifications. All photos satisfied the requirements of the project.

Each frame of negative film was given annotations such as flight course number, photo number and other required information specified in the discussion between NGD and the Team. Flight course index maps were prepared at a scale of 1:50,000, showing flight course numbers, photo numbers, principal points, etc.

The results of aerial photography:

Original negative films	one set
Rush prints	one set
Contact prints	three sets
Flight course index maps	one set
Flight records	one set

Technical Remarks

Although these photos were taken for the purpose of photo interpretation of topographic features, they have satisfactory conditions for performing photogrammetry if needed in the future. Needless to say, control survey and pricking would be required in such cases.