JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
MINISTRY OF PUBLIC WORKS AND TRANSPORT
THE KINGDOM OF CAMBODIA

The Study on the Establishment of GIS Base Data

for

The Kingdom of Cambodia

Summery Report

March 2003

PASCO CORPORATION

PREFACE

In response to a request from the Government of the Kingdom of Cambodia, the Government of Japan decided to conduct the Study on the Establishment of GIS Base Data for the Kingdom of Cambodia and entrusted the Study to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched a Study Team consisting of Pasco Corporation to Cambodia from May 2001 to March 2003. The Team had discussions with the Ministry of Public Works and Transport (MPWT) and other agencies concerned and conducted Study in Japan and Cambodia. Technology transfer to the counterparts was made through the Study. Finally, the Study and technology transfer were successfully completed.

I hope that this report would contribute to the promotion of GIS projects in Cambodia and to the enhancement of friendly relationship between our two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of Kingdom of Cambodia for their close cooperation extended to the Team.

March 2003

川上隆朗

Takao KAWAKAMI
President
Japan International Cooperation Agency

LETTER OF TRANSMTTAL

March 2003

Mr. Takao KAWAKAMI
President
Japan International Cooperation Agency

Dear Sir,

It is a great honor for me to submit herewith the Final Report of the Study on the Establishment of GIS Base Data for the Kingdom of Cambodia.

Based on the contract with JICA, the Study team; composed of members of Pasco Corporation, implemented the preparation of geographic information data from March 2001 to March 2003. Moreover, the data was combined with the geographic information data prepared by Phase1 study, which was completed in 1999, thus GIS database to cover the entire land of Kingdom of Cambodia has been finally competed. Technical transfer to Ministry of Public Works and Transport of Cambodia which was the counterpart of the study was conducted as well.

On behalf of the Team, I would like to express my heartfelt appreciation to the officials concerned of the Government of Kingdom of Cambodia for their warm friendship and cooperation extended to us during our stay in Cambodia.

I also would like to express my gratitude to JICA, Ministry of Foreign Affairs, Ministry of Land Infrastructure and Transport, Embassy of Japan in Cambodia and other concerned government authorities for their valuable advice and supports.

Yours faithfully,

伊藤二治男

Fujio ITO
Team Leader
The Study on Establishment of GIS
Base Data for the Kingdom of Cambodia

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EXECUTIVE SUMMARY

The government of Cambodia, after decades of war, requested the "Study of Establishment for Geographic Information database " in 1995 to the government of Japan in order to make Master plan for Rehabilitation and Reconstruction. In accordance with the request of the study, the Japan International Cooperation Agency implemented “The Reconnaissance Survey Project for the Establishment of An Emergency Rehabilitation and Reconstruction” from 1996 to 1999, which covered the most populated regions around the Tonle Sap Lake and the Mekong delta with a total area of about 80,000 square kilometers. The Ministry of Public Works was selected as the implementing organization for the Study. This was called as the Phase 1 study.

In 2000, when the political situation became stable, Phase 2 study covering the remaining 101,000 square kilometers along the Thai border and the eastern part of the Mekong River facing the Vietnam border, was requested by the Government of Cambodia. As a result, a Scope of Work (S/W) Mission team was dispatched in December 2000 to finalize the scope of work. “The Study on the Establishment of Geographic Information database (GIS) Base Data for the Kingdom of Cambodia” (Phase 2) was started in March 2001.

Both Phase 1 and 2 utilized aerial photographs and satellite images for fast completion of data preparation central to the GIS database on topography, land use, surface geology/landform classification. During the Phase 2 existing data was used as much as possible.

Other than the aerial photograph interpretation, the field identification was conducted on very limited scale during the Phase 1 because of safety concern. During Phase 2, when safety of local areas was confirmed, the field identification covered more extensive areas and this contributed to higher accuracy of interpretation

Spot satellite imagery were ortho-rectified and used as the base maps to transfer the thematic data such as land use, landforms and infrastructure for the purpose of data transfer and digitizing. The data was carefully checked to ensure proper integration of the map boundaries, and especially to fuse the gap between the Phase 1 and 2 data, which often differ in date by eight years.

In the process of photo and image interpretation many new discoveries were made, such as the possibility of the buried limestone deposits, extensive erosion, and land suitable for agriculture. These efforts were not in the main scope of this project, but should be considered as forms of utilization of GIS database.

Three consultative meetings were held, mainly to discuss problems and issues of the project. At a time, one major concern was the replacement of the local counterpart for Phase 2. After a discussion among JICA, MPWT and the project team, it was agreed to complete the project by inviting National Geographic Department as a cooperative agency.

The project team has prepared a technical manual for each working stage in order to update and maintain GIS database on regular basis. An appraisal of the technical transfer was stated before and after the Project since 1996.

A GIS training session was held jointly by the project team and MPWT for a number of members of governmental agencies for data dissemination and use. Many participants expressed their wish for further GIS training sessions on a continued basis and for user support.

In order to make the digital GIS database available to public, a website was set up, but the data downloading system was not completed due to lack of facility in Cambodia with the capacity to download the huge amount of data. However, the website has contributed to increase the availability of the data.

The final GIS database were stored in CD/ROM, while a certain number of hard copy maps were printed including topographical maps and land use maps at a scale of 1/100,000 as well as geology/landform classification maps at a scale of 1/500,000.

Three workshops were held to conduct the introduction of the GIS application to the various agencies of the Government of Cambodia. The presentation was done step by step, increasing the complexity of the subject matter at each new workshop. Several applications have been developed to bring out the true benefits of GIS. Such applications include: Bridge inventory that links to maps, Distribution maps to support

social rehabilitation of discharged soldier, Detection of a land which has insufficient productivity and forest monitoring. In order for such applications developed from the prepared GIS database to become solutions to actual problems, greater knowledge of the counterpart and sufficient amount of data are required. For this, further training of technical personnel would be required.

Finally, recommendations have been made in order for the Cambodian government to sufficiently benefit from the use of GIS database covering the entire nation prepared in the project. The recommendations are addressed to the main counterpart MPWT and the cooperative agency NGD, and mention the method of updating the data. As a continued form of development of the project, whose goals are to promote GIS database maintenance and management in Cambodia in the future, and to familiarize the access and use of the data, it is recommended that a GIS coordination center be founded as a crossover organization made up of representatives from relevant ministries and agencies, in the aim of contributing to preparation of the national master plan for a rehabilitation and development.

1. Introduction

1.1. Background

The geographic information development study for rehabilitation and development of Cambodia has two phases. The first phase, the "Study of Mapping Information for an Urgent Reconstruction", was carried out from 1996 to 1999, having an approximate total land coverage of 80,000 square kilometers in the western half of Cambodia with an objective to develop a GIS database at a scale of 1:100,000. The 2nd phase started in March, 2001, covering the remaining land area of 101,000 square kilometers including the mountainous areas along the Thai and Vietnamese international borders. The data produced during the first and the second phases were integrated under the 2nd phase, and the geographic information database, which covered the whole country, was completed.

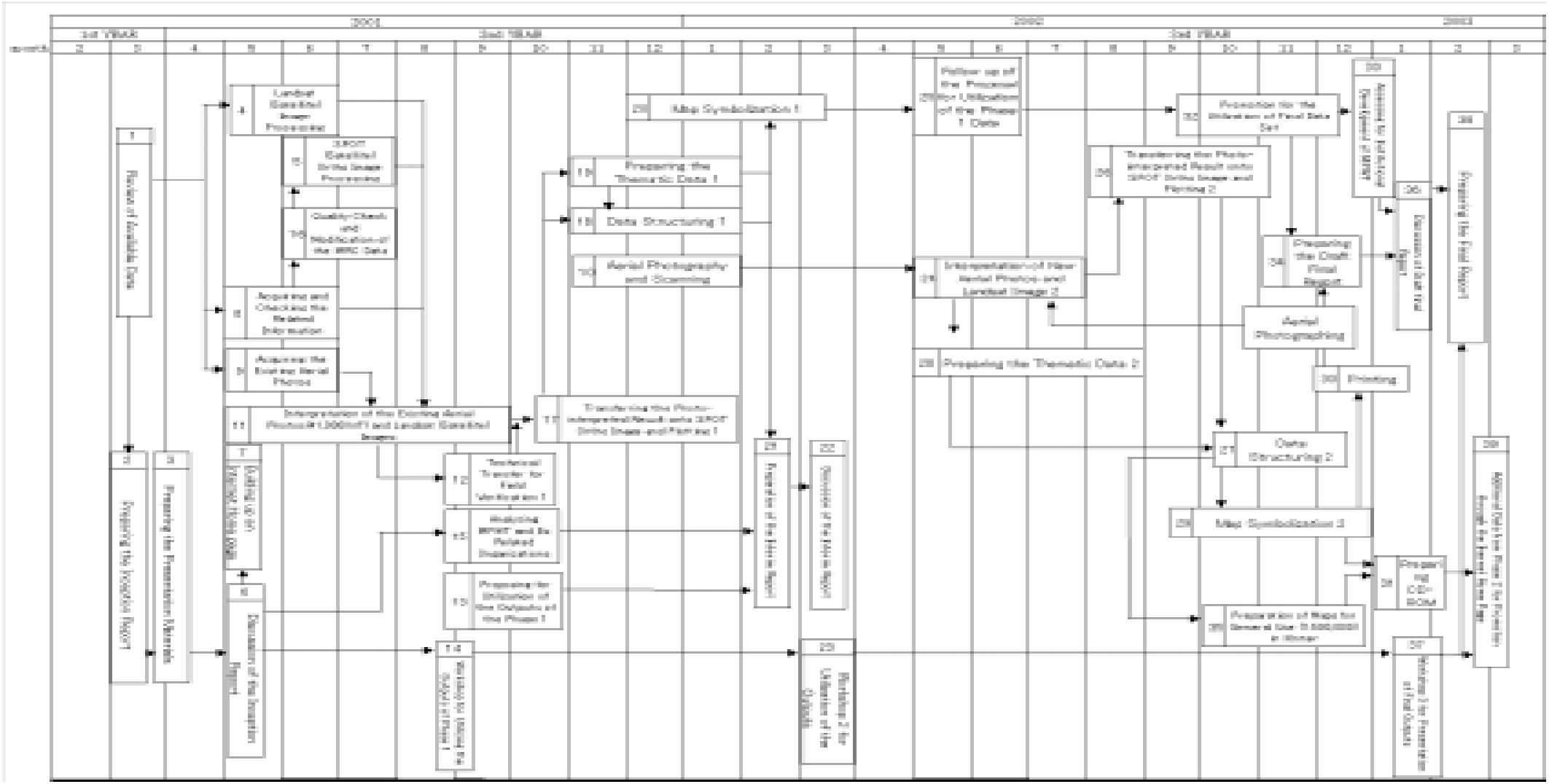
After two years of study, the Draft Final report (D/FR) was presented and discussed with the Ministry of Public Works and Transport (MPWT) of Cambodia, the counterpart agency, in March 2003. Based on the comments from MPWT, the final report will be presented to MPWT. The report includes the working items and results from March 2001 to February 2003. Conclusion and recommendation also mentioned in the Final Report.

1.2. Study Period and Study Flow

The geographic information development study (2nd phase) was started in March 2001 and completed after 24 months, in March 2003, requiring 26 Japanese engineers and work cost in this country.

The overall flow chart of the study is shown in Fig. 1.

Figure 1: Study Flowchart



1.3. Roles of the Study

The national use of GIS is only significant if we developed a digital database for a large area or ideally the country as a whole. A resources inventory can be made available to show the distribution of resources. The GIS can subsequently be utilized to identify areas of concern and further analyze the data to find solutions by using the GIS as a Decision Support System.

GIS was undertaken for the previously mentioned reasons under the Phase 1 project, and its completion to cover the whole country is being considered to provide a broad database for national planning. At present development projects are undertaken on a piecemeal basis, and often depending on the individual experts opinion. The result is the uncoordinated approach to regional planning.

The database developed under the Phase 2 will provide the minimum basic information for the Cambodian Government to evaluate its land resources, locate missing infrastructure and negative impact of population on its environment. It will also provide the Government with the capability to monitor project activities, to avoid overlap and make proper use of the limited human and financial resources.

1.4. Objectives

The objectives of the Study are as follows:

(1) To prepare database for a GIS (Geographic Information Systems) which shall be widely used by government agencies and other related parties, and

(2) To pursue technology transfer in the course of the implementation of the study.

1.5. Implementing Organizations

1.5.1. Study Team

Qualified engineers who are familiar with the status of the Phase 1 Study were organized for the project implementation of Phase 2.

1.5.2. Host agencies

The Ministry of Public Works and Transport (hereinafter referred to as "MPWT") initially acts as the main counterpart agency. And after the second meeting in September 2001 the National Geographic Department (hereinafter referred as "NGD"), the Ministry of Land Management, Urban Planning and Construction (hereinafter referred as "LMUPC") joined the project as a cooperation agency. NGD was responsible for the topographic data preparation for the demarcation of administration boundaries, topographic names, other information and field activity.

2. Study Area

The Study area covers 101,000 km^2 along the Mekong river basin and the northern and western border of Thailand.

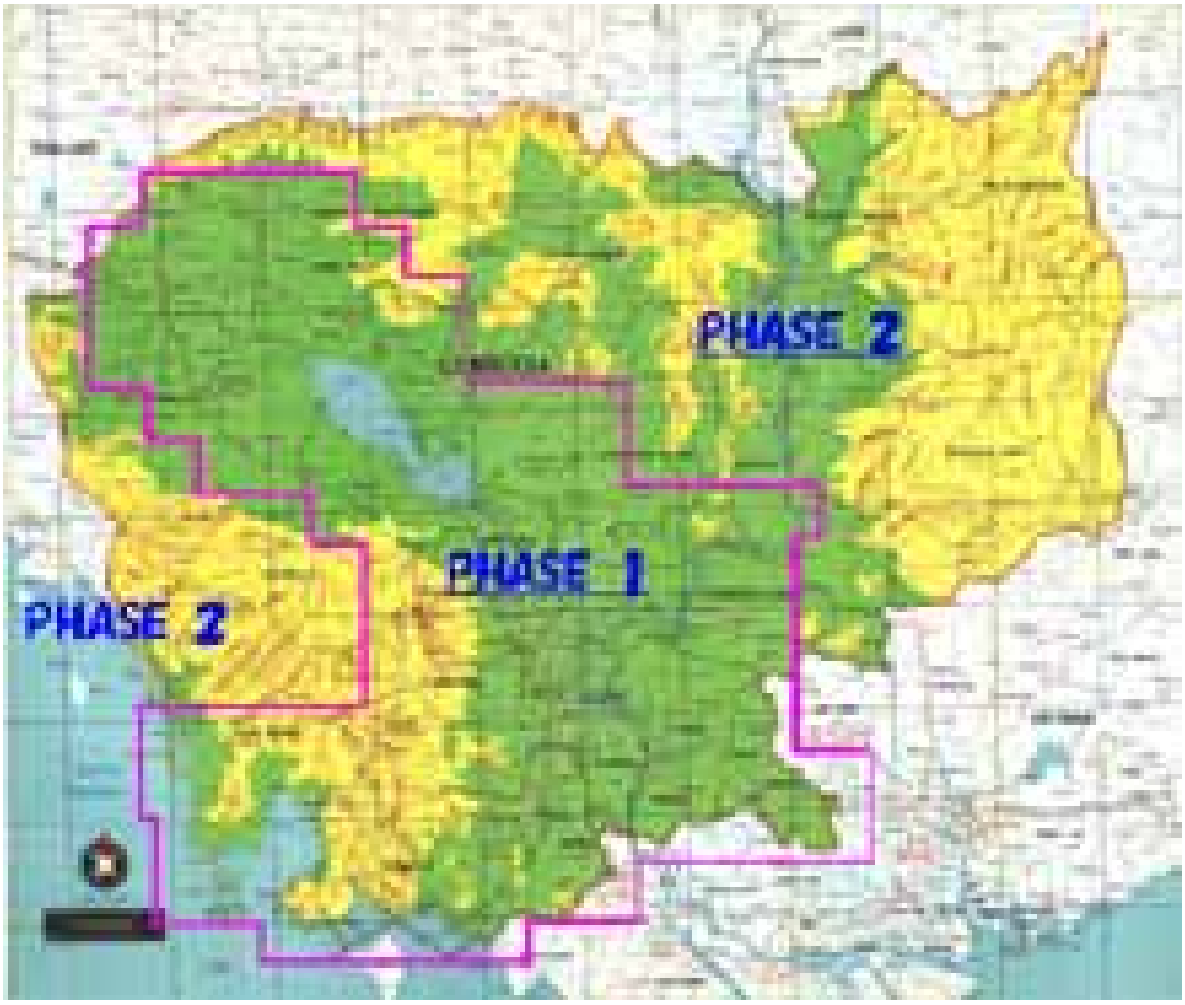


Figure 2: Study Area Coverage

3. Specifications

3.1. Topographic Maps

The specifications of the base maps are shown in Table 1.

Table 1: Specifications of the Study

Map symbols	Same legend as Phase 1
Reference ellipsoid	: Everest 1830
Projection:	Projection: UTM (Universal Transverse Mercator)
Scale:	1:100,000
Neat lines:	Neat lines: 30' x 30'
Contour lines:	Contour lines: 40m principal contour lines; 20m intermediate contour lines

4. Methodology

For data preparation, along with collecting as much existing data as possible, images were developed for interpretation by acquiring new aerial photos and satellite imagery. Interpretation work for extracting the main data, such as infrastructure data, land use and geology/landform classification, was executed on site. The results of the interpretation work were numerically expressed by transferring to SPOT ortho-imagery. The numerically expressed data was structured as a GIS database and consists of map data, land use data, and geology/landform classification data covering an area of 101,000 square kilometers.

4.1. Data Sources

The following was used as data sources for Phases 1 and 2 of the project:

Table 2: Data souses f the Study

Data Type	Date
Topographic maps with 1/50,000	1967(AMS Map series)
MRC Contour and DTM	Created at 2000 but data is based on 1967(AMS Map series)
Landsat (TM)	2000
SPOT image (Panchromatic)	1995–96
IRS image (Panchromatic)	1967(AMS Map series)
Aerial Photos for the East side of Mekong	1994-1995
Aerial Photos for the West side of Mekong	2001–2002
Geographical name and administrative data	2000 National Gazetteer from NGD

4.1.1. Topographical Maps

Topographical maps were purchased locally from old stock and digital contour lines and river vector data obtained from the Mekong River Commission; while raster digital topographic data was acquired from the Forestry Department.

4.1.2. Satellite imagery

Landsat imagery (30m resolution) was geometrically corrected and used for the main interpretation base for the land use and geology/landform mapping. This satellite imagery was enhanced to provide the best contrast of the classification.

Spot imagery (10-m resolution) was ortho-rectified and used for extracting important infrastructures and assisting in field data collection, such as roads, canals and villages. This was placed as a base map for digitizing the interpretation results.

IRS imagery (5-m resolution) was also ortho-rectified in a manner similar to the spot imagery. This was used to prepare data for some areas along the border where no aerial photos could be acquired during the photo-interpretation work.

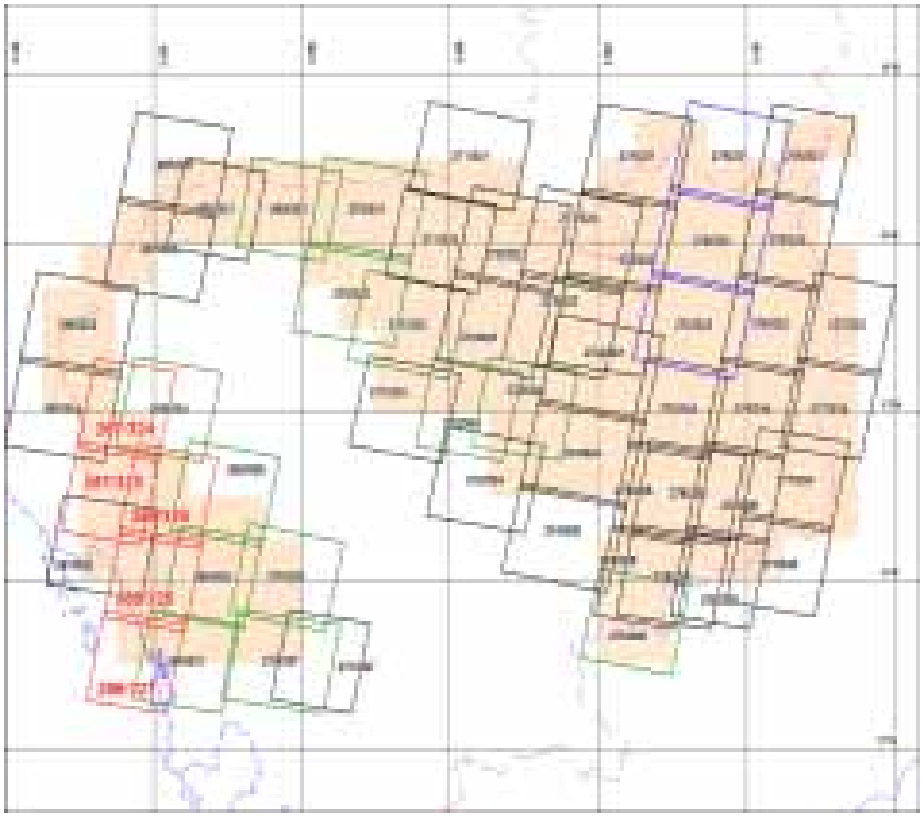


Figure 3: SPOT Coverage

4.1.3. Aerial Photographs

(1) Existing photography

The interpretation work was executed by using the aerial photographs acquired in 1992–1995 at a scale of 1:25,000 that the MRC owns in the area between the Eastern Mekong basin and the Vietnamese border. The aerial photos were purchased under assistance from year 2001 of the World Bank project and used for the land use and infrastructure interpretation of the Ratanakiri region.

(2) New photography

New aerial photographs were taken for the Western Mekong basin and Thai border where there are significant changes of the population and the land use. The

target area of photography was approximately 60,000 square kilometers and the new photography was executed from November 2001 to January 2003. However, photographs of the Thai and Vietnam border were not photographed because there was no reply to requests for flight permission. Thus, 2% of the estimated photographs in total was not acquired. These photographs were taken under the following specifications and scaned with 25- μ resolution to store on DVD.

Scale of photography: 1:40,000

No. of photography courses: 96 courses, approx. 3,300 photos, about 12,000 km flight

Camera specifications: Wide-angle lens (f 150 mm・23 ㎝×23 ㎝)

Height of photography: 6,000 m±5%

Overlap degree: Overlap 60±5%

Sidelap 30±10%

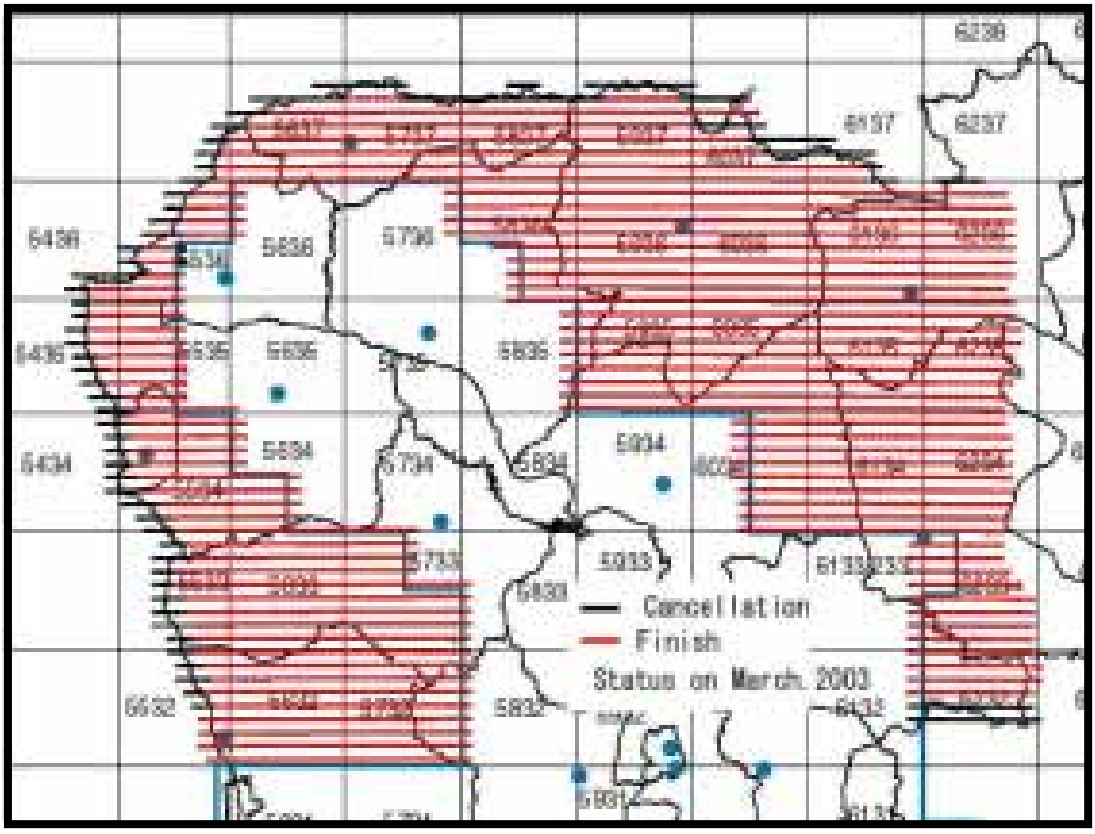


Figure 4: Photo-index

4.1.4. Geographical name and Administrative Boundaries

Geographical names were acquired from the National Gazetteer of the Geographic Also, Geographic Department supplied administrative boundaries data.

4.2. Coordinate System Used

At the time when Phase 1 was carried out, existing maps with two different data were prevailing in Cambodia. Some had datum as Indian 1954 and others as Indian 1960 (Vietnam near 16^{0^o} N). Also, in the Phase 1 project, data were prepared with datum Indian 1954. Later, during the Phase 2 project, National Geographic Department (NGD) recommended preparing the GIS database with datum Indian 1960 (Vietnam near 16^{0^o} N). Thus, in Phase 2, all database were prepared using this datum.

Prior to integrating Phase 1 data and Phase 2, the datum of all Phase 1 data was converted to Indian 1960 (Vietnam near 16° N). Thus, all the integrated data were finally achieved with the same datum.

The following projection system was used for the integrated GIS database for the whole country.

- Projection: UTM, Zone 48
- Ellipsoid: Everest 1830
- Datum: Indian 1960 (Vietnam near 16^{o} N)

4.3. Preparation of Satellite imagery

4.3.1. Landsat Imagery

The Landsat imagery was geometrically corrected, and image enhancement was executed to assist in the interpretation of both the land use and landforms. The interpretation classification was directly interpreted from the landsat imagery using aerial photographs.

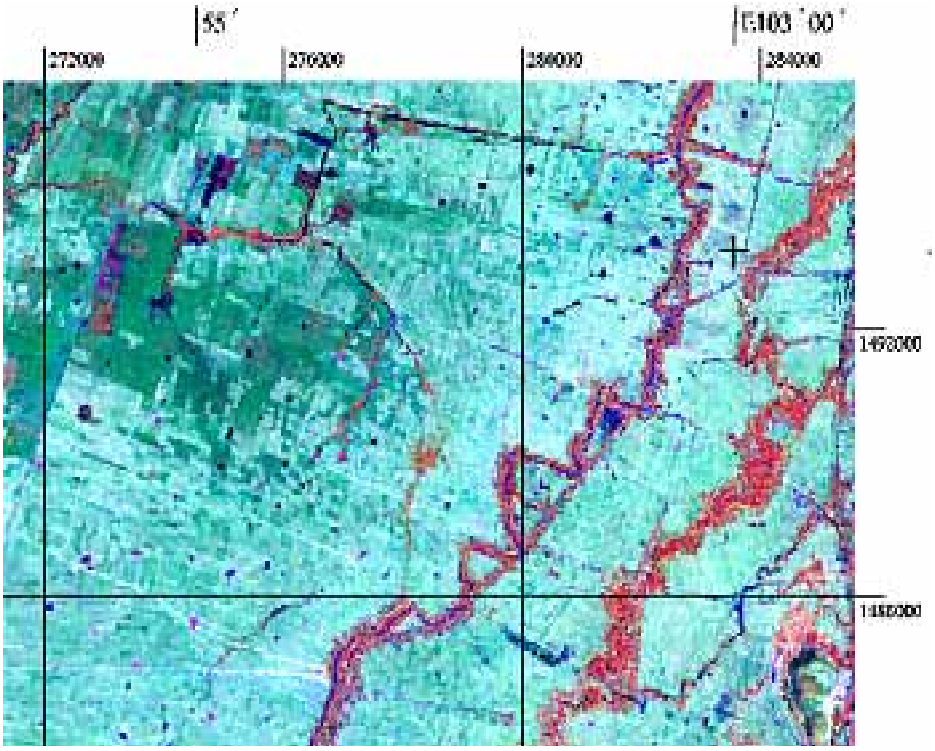


Figure 5 Landsad Imagery

4.3.2. SPOT Ortho-images.

The SPOT satellite images were used as the data source for extracting important ground features such as roads, canals and villages. Newly 5 scenes were taken in places where there were no images available in the archives. The ortho-rectified images to be base data for all dataset were generated using the contour line data and DTM obtained from the Mekong River Committee.

Sample images is as shown in Fig.6.

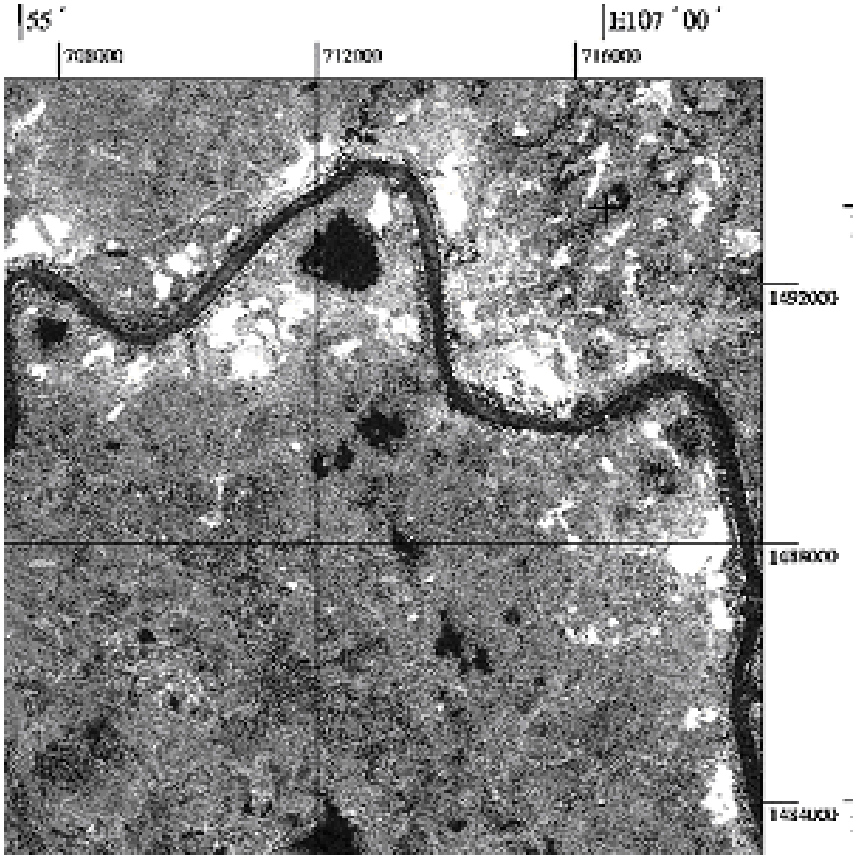


Figure 6: Spot ortho-rectified imagery

4.3.3. Ortho-photography

All data-capturing activity should be based on SPOT as base data, fundamentally. Some sections, however, could not be seen clearly on the SPOT images, due to technical problems (10-m resolution) related to the extraction of ground features. For acquiring information, the aerial photographs were scanned and ortho-rectified. The distortion of the aerial photographs was rectified using DTM after acquiring GCP from the SPOT ortho-imagery. The base images for interpretation and graphic were overlaid on the SPOT images.

4.3.4. Scanned Map Data

The data from the Forestry Department originated from the paper topographic maps. Before using the data, it was confirmed that the sufficient verification and regularization were correctly executed. As a result, the raster data from the Forestry Department was evaluated and, where necessary, it was edited to correct any errors.

Figure 7: Geo-referenced scanned Map

4.4. Interpretation

4.4.1. Interpretation of Infrastructure Information

The infrastructure information was acquired by interpretation of the existing aerial photographs with a scale of 1:25,000 and the latest aerial photographs with a scale of 1:40,000. The infrastructure information about interpreted features such as the road classifications, canals, villages, and small ground features (schools, temples, etc.) were confirmed by the fieldwork and corrected if necessary.

4.4.2. Interpretation for Land use

The resources data for interpretation of land use consisted of the latest Landsat, SPOT imagery at a scale of 1:100,000, and aerial photos. However, aerial photos of some parts of the western section could not be acquired within the timeframe of land use interpretation work. Thus, there was a great dependence on satellite imagery. The same land use classification legend as used in Phase 1 that the MRC prepared was applied.

4.4.3. Interpretation of Geology/Geomorphology (Landform)

The analysis process for geology/landform classification consists of two steps. The polygons expressed in the existing Cambodian geology maps consisted of only alluvial deposit, and these were classified in detail based on the interpretation of Landsat, SPOT imagery and aerial photography. After that, all rock formations were outlined as rock (RX). The RX polygons were subdivided by the detailed rock information acquired from the existing Cambodian geology map using GIS.

4.5. Data transfer and Digital Data preparation

4.5.1. Infrastructure Information

The photo-interpreted infra-structural data were transferred with the results of interpretation onto SPOT imagery with ortho-photos. The fine ground features and linear ground features were extracted by ArcView. The results are as follows.

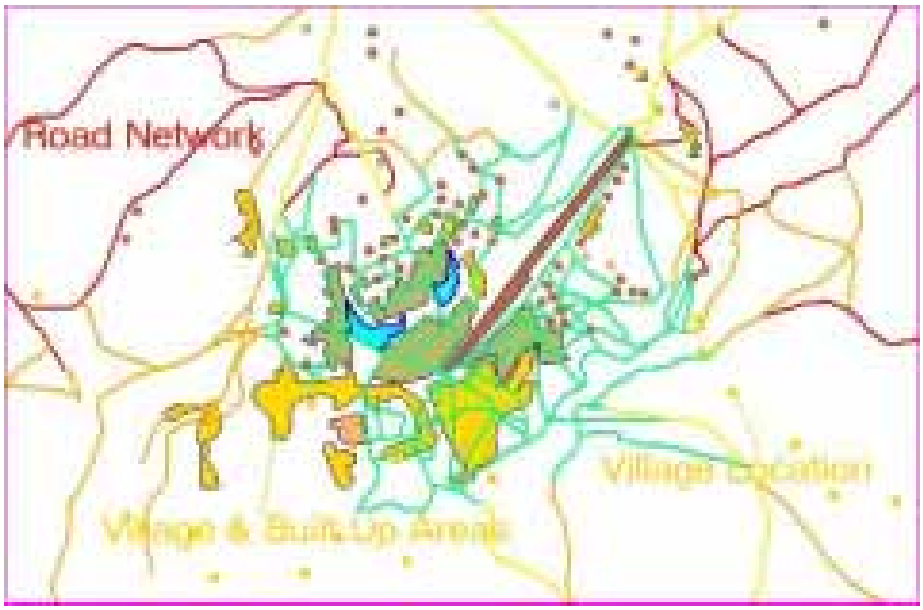


Figure 8: Results of Screen digitizing by ArcView

4.5.2. Vegetation

For keeping matching of the vegetation boundaries and land use, the polygon data for land use was re-classified and placed as a vegetation boundary polygon of landform maps.

4.5.3. Contour Data Update

The original MRC contour lines were converted to the format of the ArcView Shape file, and deletion of duplicate line, correction of joined lines, addition of new contour lines, and correction of line attributes were executed.

The available MRC data set did not have spot height or used old benchmark information. The information was therefore re-digitized newly based on the raster map. The attribute data (height value) was also given by ArcInfo.

4.5.4. Land use

After the Landsat interpretation, the interpreted results were transferred to the SPOT as a base image, then visually adjusted to make sure that the land use, infrastructure and river system information fit properly.

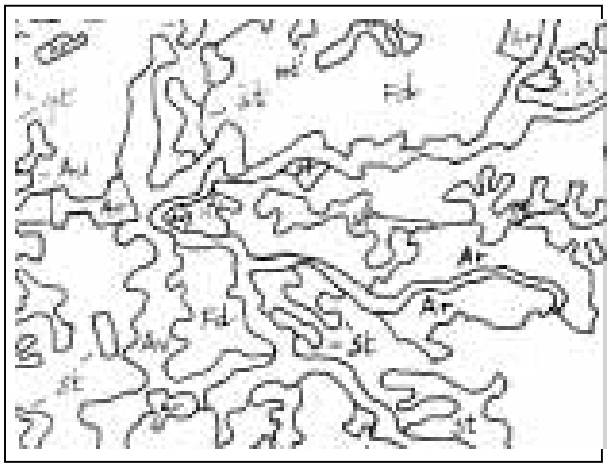
The interpreted Mylar land use maps were scanned at 400 dpi using either A0 color or black and white scanner, then raster vector conversion was executed.

The converted vector data gave the attribute to each polygon, after the polygon closure, missing labels, and wrong labels were verified and corrected by ArcView/ArcInfo.

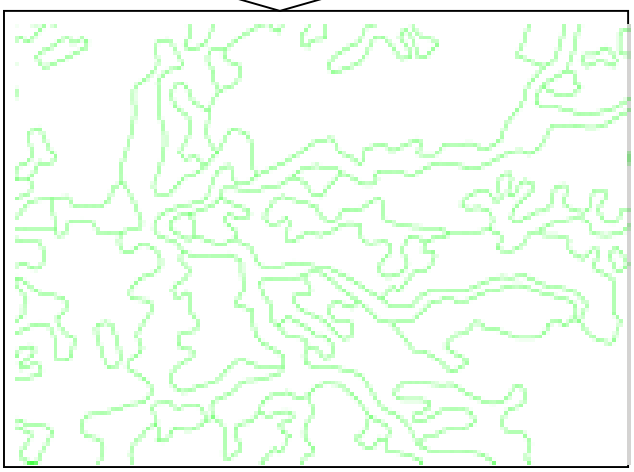
All the adjacent map sheets were first edge matched, and then joined to ensure that they fit together.

The procedure of Raster/Vector conversion is as shown in Fig.9

(1)Scanning



(2)R/V conversion



(3)Attribute

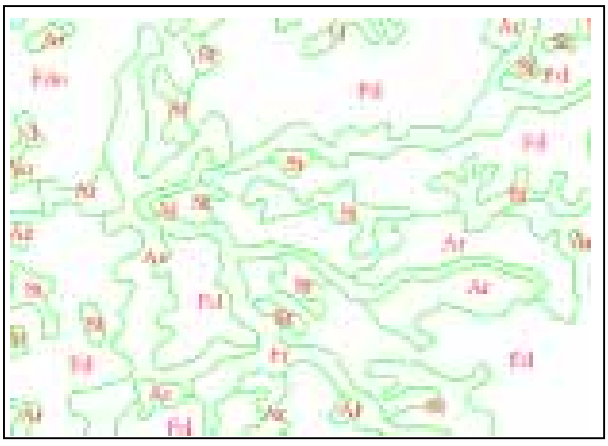


Figure 9: Procedure of Raster/Vector conversion

4.5.5. Geology/Geomorphology (Landform)

The method for preparing landform data was executed in a manner similar to the above land use data.

4.6. Map symbolization

Adobe Illustrator was used as editing software for the map symbolization. The various infrastructure data screen-digitized by ArcView was converted from ArcView shape file to individual Adobe Illustrator file. In addition, the contour lines, vegetation boundaries, administration boundaries, village names and annotations were also output into separate Illustrator files. A Khmer annotation character file was created under cooperation with MPWT and NGD.

All of these layer files are then combined within Adobe Illustrator to create a single file for each specific map sheet. Symbol coloring, line types and patterning were all created. The map was adjusted, and map symbolization and patterns was prepared according to the application rules.Finaly,Marginal design was prepared same as Phasee1.

Figure 10:Map symbolization

4.7. Map printing.

Final topographic maps were printed by offset printing. The procedure was as follows:

(1) Five positive films for plate making were prepared for each map sheet.

(2) Printing plates for the respective colors were made from the positive film using aluminum PS plates.

(3) Proof prints from the printing plates were made by a flatbed-offset machine.

(4) The proof prints were checked for the quality of coloring and matching. Defective sheets in matching were corrected and reprinted. The proof prints were approved by MPWT when the draft final report was discussed.

(5) Printing paper was chosen in terms of representation and endurance. High quality printing ink was used that had good color tones and less change.

(6) Each printed map sheet was checked for any presence of smears from printing, blurs, missing lines, matching, color tones, etc.

4.8. Plotting or Printing of Land Use Maps

Land use maps at the scale of 1:100,000 were output in 25 copies using a color-ink plotter. The output file is in Illustrator format in consideration of future additional printing.

4.9. Plotting of Surface Geology/Geomorphology (Landform)

Geology/Geomorphology (Landform) at the scale of 1:500,000 were output in 25 copies. The output file is in Illustrator format in consideration of future additional printing same as Land use maps.

5. Database Integration for the whole country

About 80,000 Km^2 areas were covered in Phase 1 and the remaining areas, about 101,000 Km^2, were covered in Phase 2. Topographic and thematic data covering

the entire 181,000 km^2 area were constructed and built up as a seamless GIS database.

5.1. Integration of Contour Line

The contour lines are also matched between the Phase 1 and Phase 2 data-set.

In Phase 1, the contour lines were created using the stereo images of the spot satellite. In Phase 2, the contour data based on the existing 1:50,000 topographic maps presented by the Mekong River Committee. Since each Phase used a different technical approach, the two did not quite match when put together. Errors observed lied between 10m and 20m and were considered within the allowable margin of 40m principal contour line agreed at the S/W agreement.

With regard to inconsistent parts, corrections at the joint have been made by adjusting the contour at every 20m, in consideration to the topographical conditions. Since the Mekong River Committee's contour data used in Phase 2 includes 10m of contour, it have not been deleted on GIS database. On the printed maps, however, 10m contours have not been drawn, for the purpose of matching with the Phase 1 printed maps.

5.2. Integration of Infrastructure data

The infrastructure data has also been matched between Phase 1 and 2. The integrated data image is shown below.

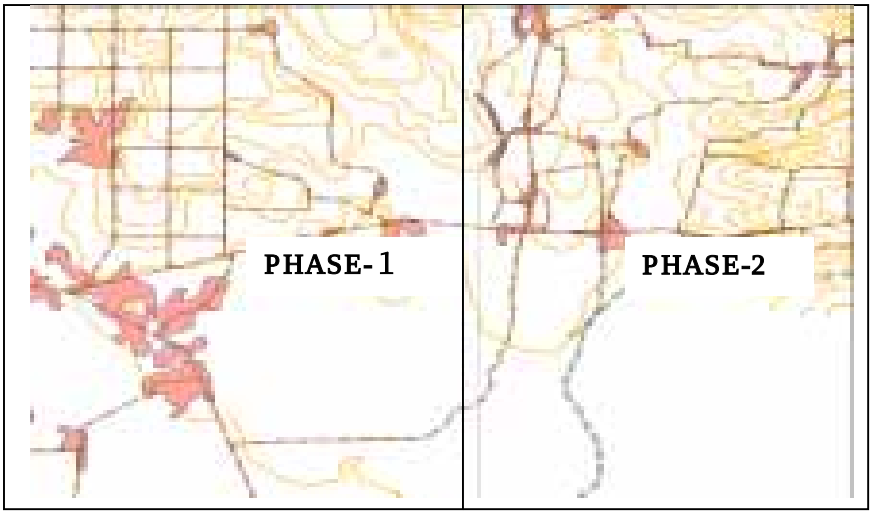


Figure11: Integrated infrastructure

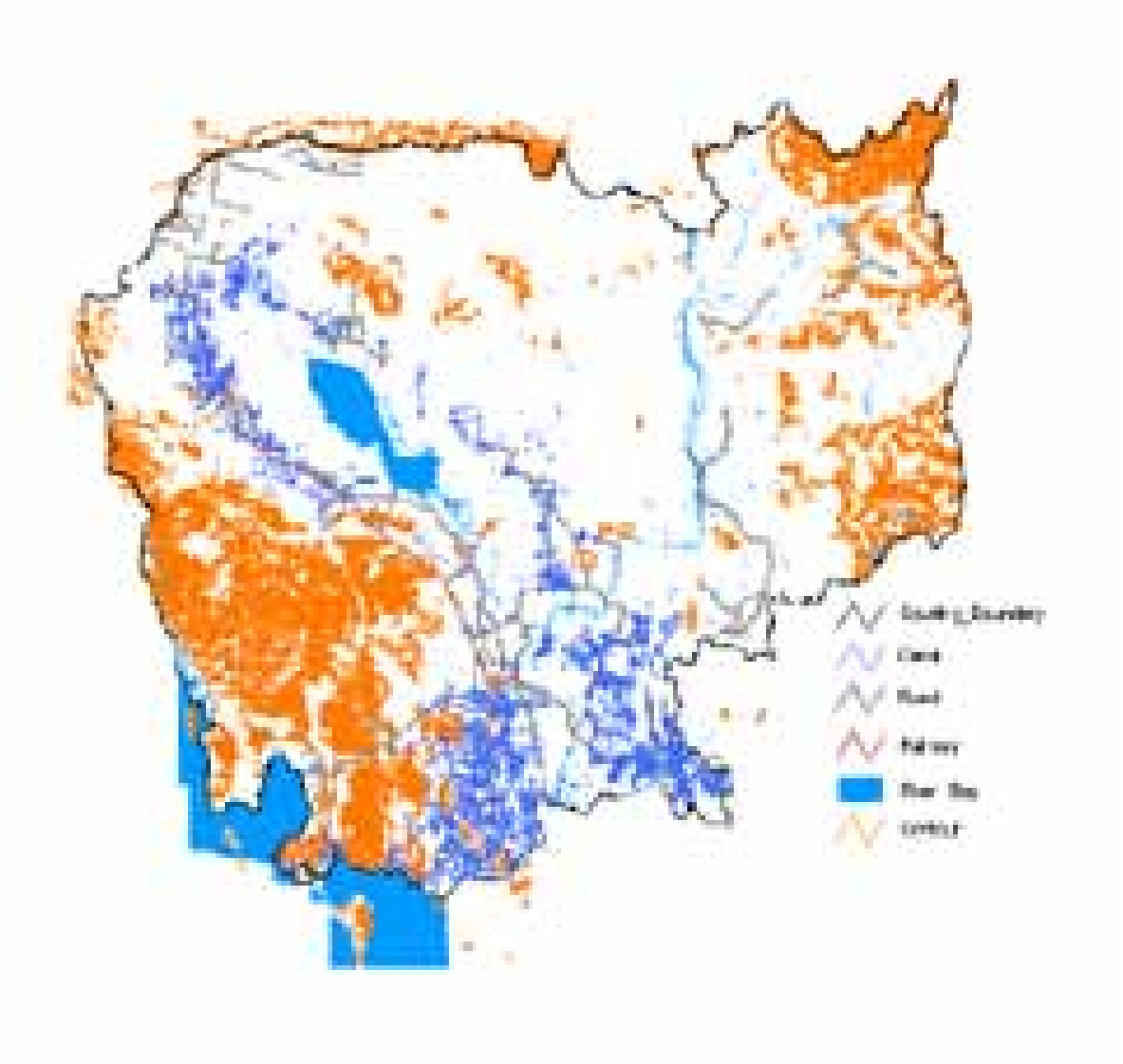


Figure 12 Integrated Topographic map data of the whole country

5.3. Integration of land use

The land use classes in Phase 2 were kept the same as that in Phase 1(refer to Table 2), but at some locations, different land use classes were found along the border of Phase 1 and Phase 2:

This discrepancy was mainly due to different dates of the resource data.

In order to facilitate the seamless integration of land use data, the data of Phase 1 along the border with Phase 2 was updated using latest aerial photos.

Table 3: Land use classification code

Lu_Code	Classification	Category	Class Name
1	U	Urban, Built-up Areas	Settlement
2	I	Urban, Built-up Areas	Infrastructure (Airfield, factory, etc.)
3	Ar	Agricultural lands	Paddy field
4	Al	Agricultural lands	Receding and Floating rice fields
5	Au	Agricultural lands	Field crop
6	As	Agricultural lands	Swidden agriculture (Slash and burn)
7	Ao	Agricultural lands	Orchard
8	Ap	Agricultural lands	Plantation (Rubber plantation)
9	Av	Agricultural lands	Village garden crop
10	Ag	Agricultural lands	Garden crop
11	Arv	Agricultural lands	Paddy field with villages
12	Fp	Agricultural lands	Forest plantation
13	G	Grasslands	Grassland (undifferentiated)
14	Ga	Grasslands	Abandoned field covered by grass
15	Gf	Grasslands	Flooded grassland
16	Gs	Grasslands	Grass savannah
17	Gm	Grasslands	Grass with termite mounds
18	Ms	Grasslands	Marsh and swamp
19	S	Shrublands	Shrubland (undifferentiated)
20	Sa	Shrublands	Abandoned field covered by shrub
21	Sf	Shrublands	Flooded shrub
22	St	Shrublands	Woodland and scattered trees (C < 10%)
23	Fe	Forest covers	Evergreen broad leafed forest
24	Fc	Forest covers	Coniferous forest
25	Fd	Forest covers	Deciduous (Dense) forest
26	Fdo	Forest covers	Deciduous (Open) forest
27	Fx	Forest covers	Mixed forest from evergreen and deciduous species
28	Fr	Forest covers	Riparian forest
29	Fs	Forest covers	Secondary forest and bamboo forest
30	Ff	Forest covers	Flooded forest
31	Fm	Forest covers	Mangrove forest
32	Fmd	Forest covers	Degraded mangrove forest
33	Wl	Water Features	Lakes (>8 ha)
34	Wp	Water Features	Lakes (<8 ha)
35	Wr	Water Features	Reservoir
36	Ws	Water Features	Shrimp/Fish farming and Salt pan
37	Wo	Water Features	Others (Sea, Bay, etc.)
38	B	Soils and Rocks	Barren land
39	Bs	Soils and Rocks	Sand bank
40	Br	Soils and Rocks	Rock outcrop

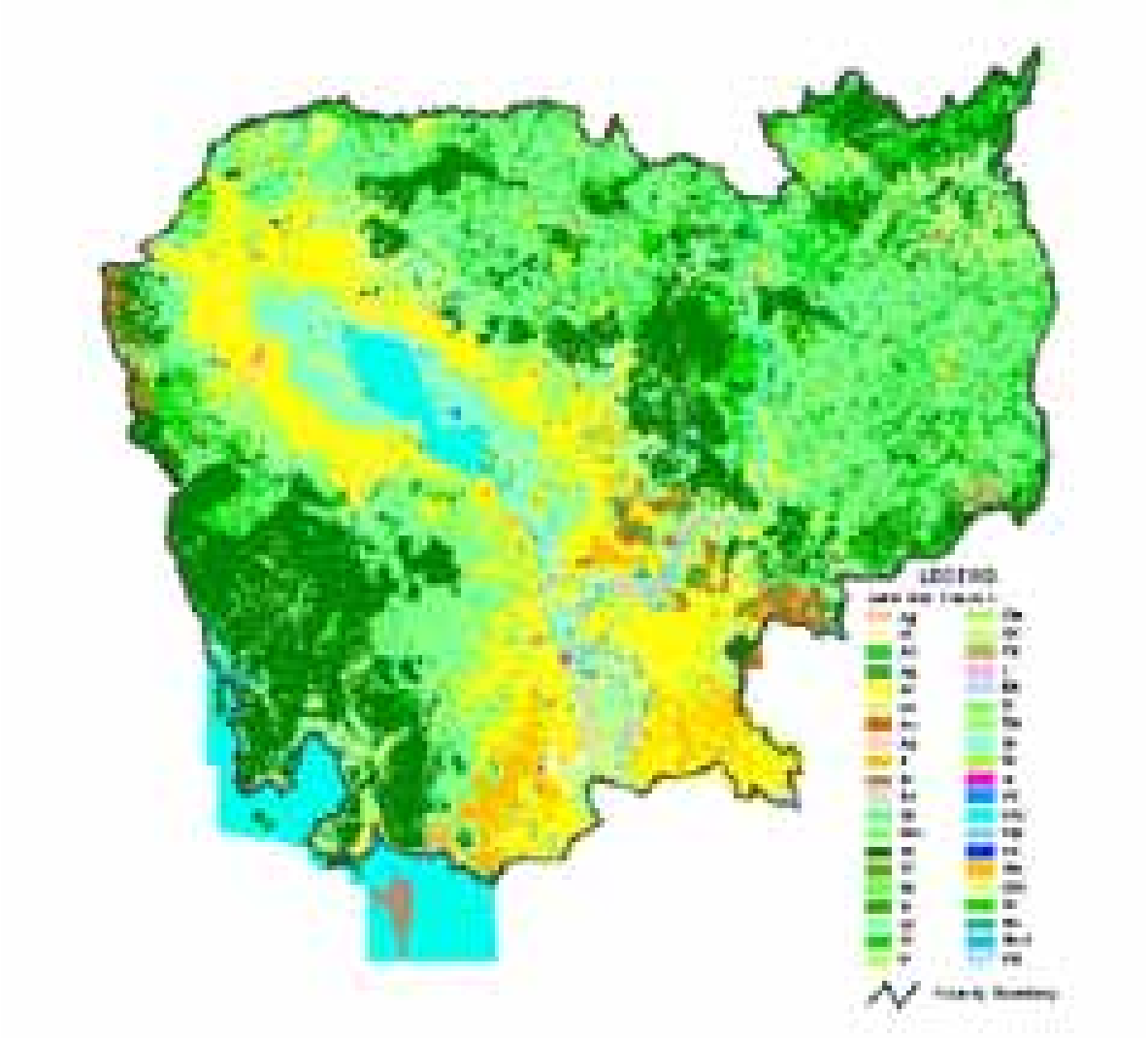


Figure 13: Integrated national land use data

5.4. Preparation for Landform Maps.

After having matched each map in the same way as land use maps, Phase 1 and Phase 2 data have been put together as a seamless integrated data. Final classification of the legend is given in Table 3 to show the integrated data image.

Table 4 Geology/landform classification code

Geo_Code	Classification	Category	Class Name
1	W	Landform	Water
Unconsolidated Materials			

2	Fp	Cenozoic	Flood plain deposits
3	Af	Cenozoic	Alluvial fan deposits
4	Co	Cenozoic	Colluvial deposits (Tallus cones)
5	Pd	Cenozoic	Pediment deposits
6	Lb	Cenozoic	Lake bed deposits
7	Db	Cenozoic	Deltaic deposits
8	Ft	Cenozoic	Tidal flats deposits
9	Br	Cenozoic	Beach ridge deposits, Natural Levee deposits
10	Sw	Cenozoic	Organic deposits (swamps)
11	Va	Cenozoic	Volcanic ash deposits
12	Ap	Cenozoic	Alluvial plain deposits
13	Cp	Cenozoic	Coastal plain deposits
14	Ta	Cenozoic	Terrace alluvial deposits
15	Tl	Cenozoic	Terrace Laterite deposits
16	Pl	Cenozoic	Peneplain deposits
Consolidated Materials			
105	Jac	Mesozoic	Claystones
106	JCg	Mesozoic	Sandstones
107	JCcg	Mesozoic	Conglomerates
108	J	Mesozoic	Sandstones
109	J1-2	Mesozoic	Red Terrace deposits (reddish brown sandstones, siltstones and marls)
111	Tg	Mesozoic	Formation (sandstones and micro-breccias)
112	Tx	Mesozoic	Formation (siltstones, schists and marls)
115	CP	Paleozoic	Limestones
116	DC	Paleozoic	Black schists, phtanites, sandstone
117	DHj	Paleozoic	Phtanites
118	DHx	Paleozoic	Schists and sandstones
123	CS2q	Paleozoic	Quartzites
124	Csq	Paleozoic	Quartzites
125	CSx	Paleozoic	Schists
126	CScg	Paleozoic	Metaconglomerates
201	C	Unknown Geologic Era	Hornfelds, meta-alkose sediments and mete-andesites
303	p2/p2b	Volcanic Rocks	Rhyolites and Dacites
305	b	Volcanic Rocks	Dacites
306	p1	Volcanic Rocks	Rhyolites
307	p	Volcanic Rocks	Rhyolites
308	α1	Volcanic Rocks	Trachyte, andesites, andesites and tuffs
309	α	Volcanic Rocks	Andesites, andesitic breccias and tuffs
310	r2t	Volcanic Rocks	Volcanic-sedimentary breccias and acidic tuffs
311	r1t	Volcanic Rocks	Acid tuffs
401	g4	Plutonic Rocks	High alumina granite
402	g3	Plutonic Rocks	Granite or g3-4 coarse grained Granites
404	g3-2	Plutonic Rocks	Fine grained Granites

407	g2	Plutonic Rocks	Granite
409	Gb	Plutonic Rocks	Granodiorite
999	NC	No Classified Rocks	No Classified Rocks

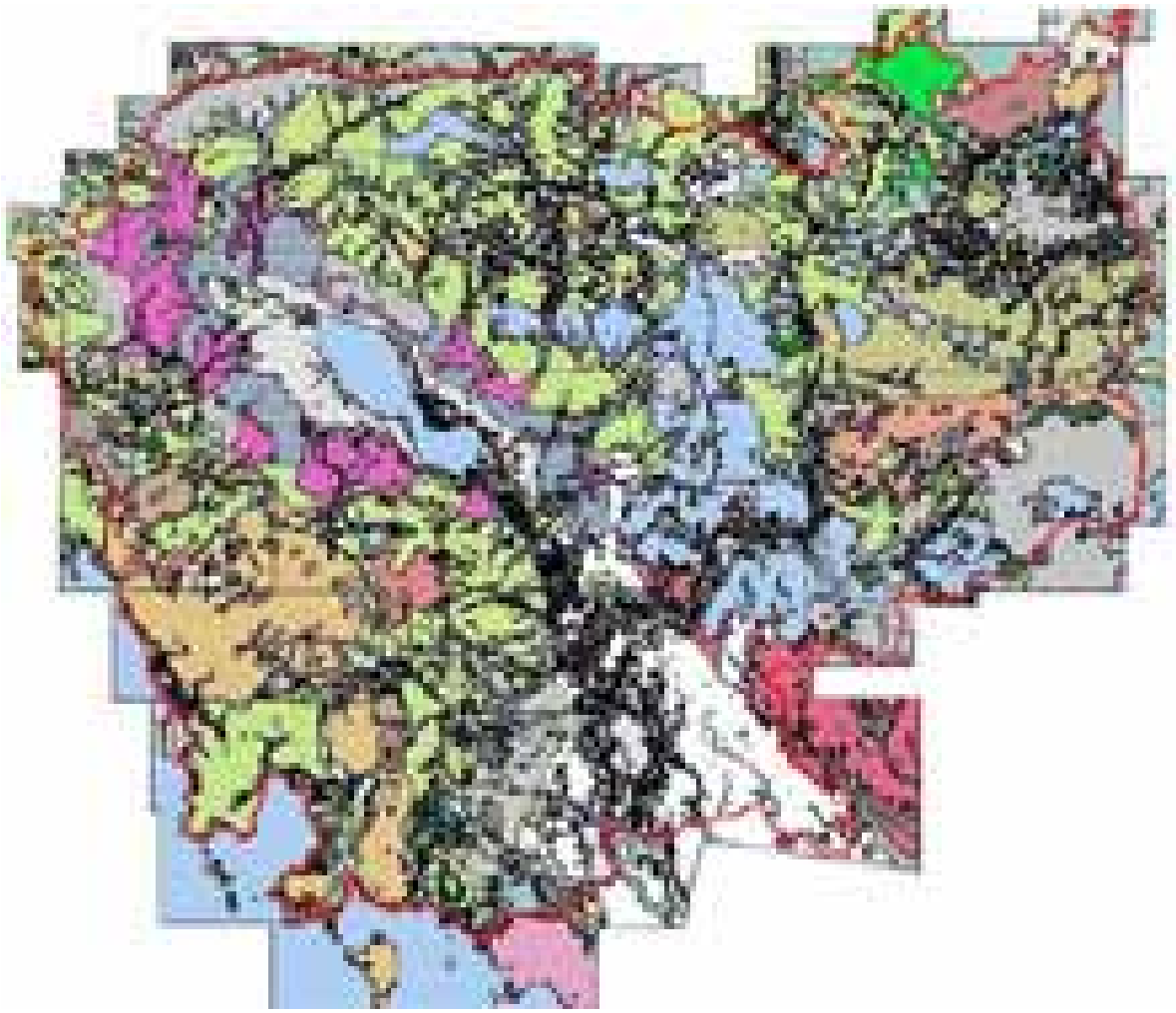


Figure 14: Integrated landform data for the whole country

5.5. Metadata

The meta-database is described using ArcGIS about the contents of the project, targeted area, data souses, the coordinate system and spheroid employed This meta-database was created.