7.3. Land use

Although the land use classes in Phase 2 were kept same as that in Phase 1, at some locations, different land use classes were found along the border of Phase 1 and Phase 2 as shown below:

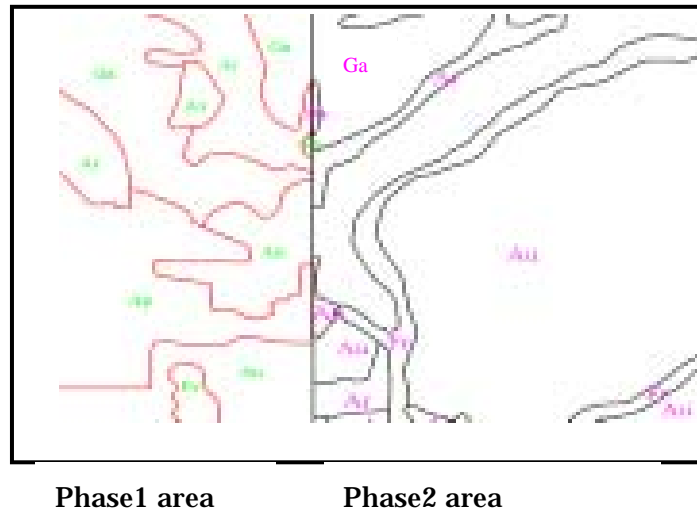**Phase1 area**   **Phase2 area**

Figure 26: land use data

This discrepancy was mainly due to different dated resource data used to delineate land use data, that is, the change in land use over the period. In order to facilitate the seamless integration of land use data of Phase 1 with Phase 2, the land use data of Phase 1 along the border with Phase 2 was updated using latest resource data prior to perform the integration. The result was as below:

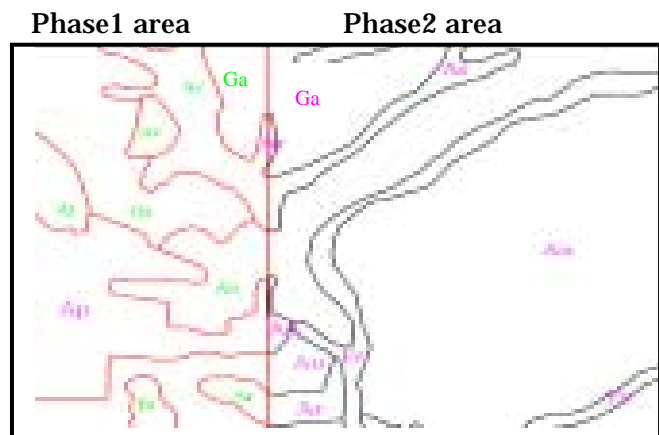**Phase1 area**   **Phase2 area**

Figure 27: land use data at the border of Phase 1 and Phase 2

Then, the land use data of phase 2 was integrated with that of phase 1. As the result, the seamless land use data of whole Cambodia was achieved. An example is shown below:
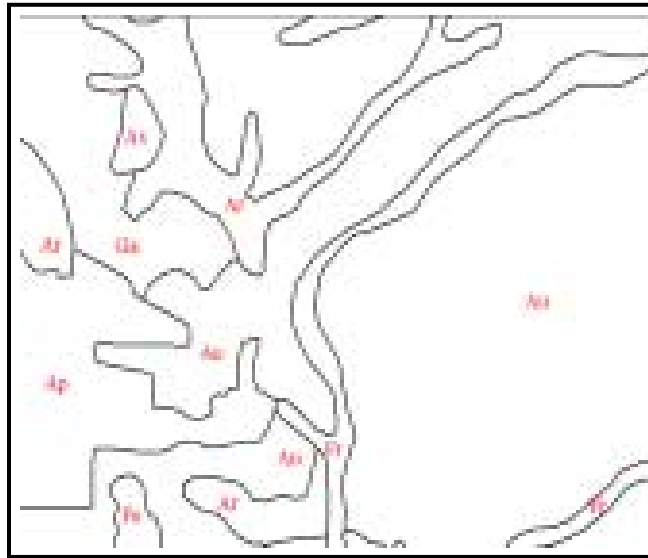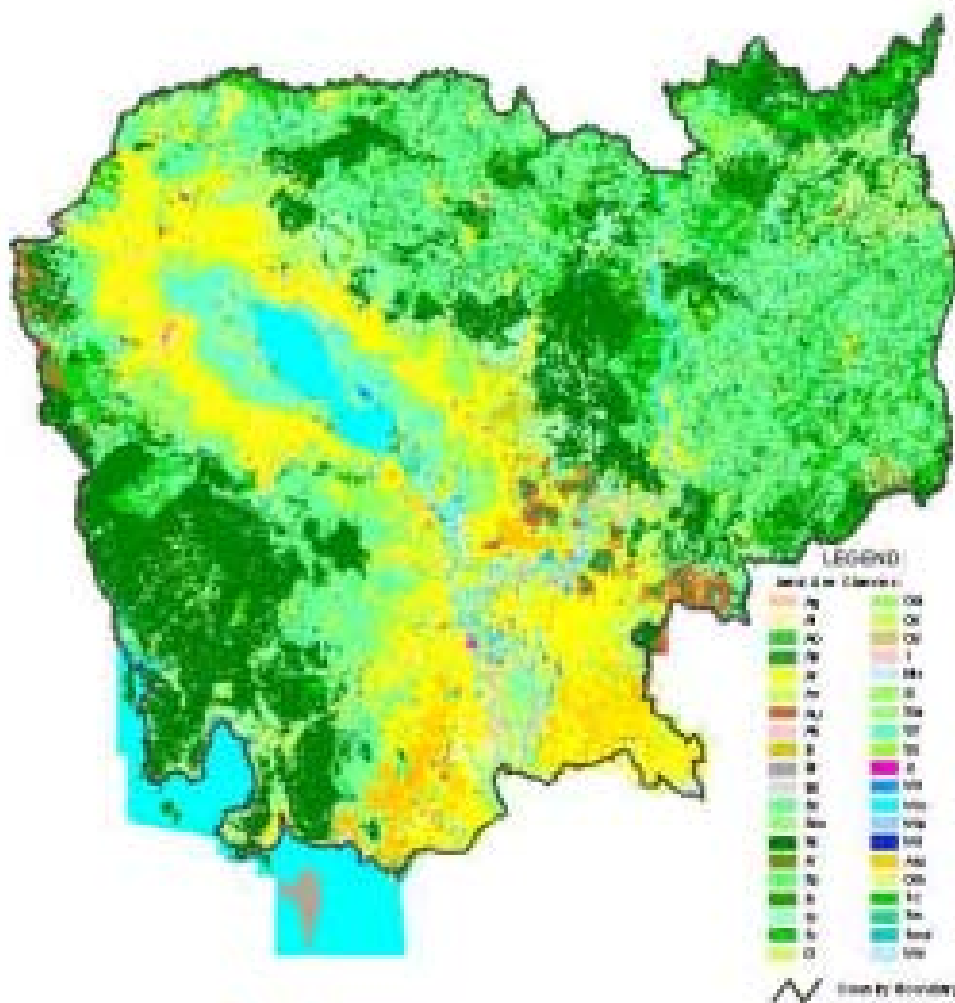

Figure 28: Seamless land use data

7.3.1. Integrated dataset for Land use

Integrated seamless infrastructure dataset is as shone in Figure 29.

.Figure 29: Integrated seamless Land use dataset

Table 13: Land Use Classes with 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	Bamboo forest and Secondary 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

7.4. Geology/Geomophology (Land Form)

The procedure of mapping the landform is the same for both Phase 1 and 2, as there is no change over time and consists mainly of integrating the geomorphology data boundaries with the rock polygons based on the original French/Cambodian map.

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 14 to show the integrated data image in Fig.30.

Table 14 Legend for Geology/Geomorphology Map of Cambodia

	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 ediments 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

7.4.1. Integrated dataset for Geology/Geomophology　Land Form

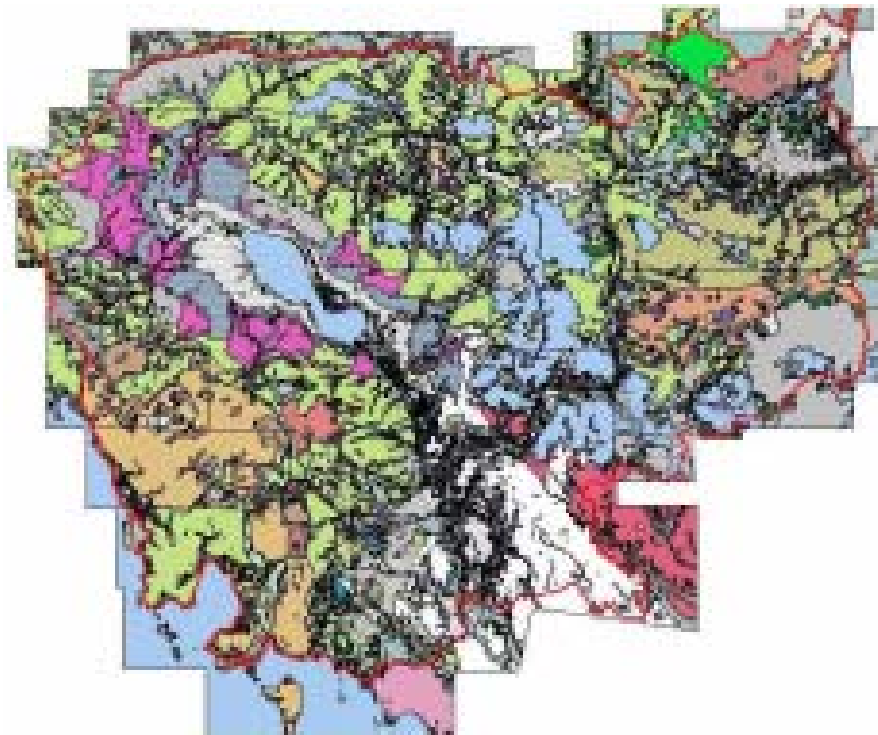Integrated seamless land form dataset is as shone in Figure 30.

Figure 30: Integrated seamless Land Form dataset

7.5. Metadata

The meta-database produced under project name "The Study on the Establishment of GIS Base Data for the Kingdom of Cambodia" are all that was used to produce the updated topographic maps and land use maps and geology/geomorphology (land form) maps. This project was carried out to prepare the latest GIS database for the whole of Cambodia. The study was completed in two Phases. 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. During both phases, the source data used were satellite data Landsat, SPOT, and aerial photographs along with employing limited field verification whenever and wherever possible.

7.5.1. The Data Sources

Data source for Phase1 and Phase2 is as shown in Table 15.

Table 15:Data sources

	Data Type	Date
Phase 1	**Landsat (TM)**	**1995–96**
	SPOT (Panchromatic)	**1995–96**
	Aerial Photos	1992–1994
	Topographic maps with1/50,000	1967(AMS Map series)
Phase 2	**Landsat (TM)**	**2000**
	Spot image (Panchromatic)	1995–96
	Aerial Photos for the east side of Mekong	1994–95
	Aerial Photos for the west side of Mekong	2001–2002
	IRS image for northwest part	2001
	Topographic maps with1/50,000	1967(AMS Map series)
	MRC contour line data	2000(note; This data is based on AMS maps)

7.5.2. Coordinate System Used

At the time when Phase 1 was carried out, existing maps with two different datums were prevailing in Cambodia. Some had datum as Indian 1954 and others as Indian 1960 (Vietnam near 16$^°$ 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˚ N). Thus, in Phase 2, all database were prepared using this datum.

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

7.5.3. Special Note for Contour Line

Source data were the existing 1:50,000 topographic maps obtained from the Mekong River commission (MRC) in Phase 2.

Contour line data was produced from the STEREO-SPOT satellite data in Phase 1. Because of different technical approaches, some mismatching of the contour lines along the boundary of Phase 1 and Phase 2 were found. The reported difference is approximately 20m from 10m. This is acceptable error because the specification of SW agreement is 40m line as principal. For the edges matching adjoined sheets, some modification was made to take into account topographic conditions. MRC contour data included 10m line for Phase 2 and was still kept in the integrated GIS database. Accordingly, 10m line is not matched along the boundary of Phase 1 and Phase 2 because of no 10m line in Phase 1.

8. Field Activity

Field verification was conducted on almost every map sheet to fill up and correct the missing data, such as new bridges and new development constructions (school, temple). In each case, the field verification by using hand GPS has been introduced to apply as the field verification method for the study.

In the study the field reconnaissance survey on land use landform were also conducted to collect ground information of land use vegetation classification and their conditions and of landform observation points. This information was used as a reference to improve interpretation of land use and vegetation classes.

Field identification is one of the very significant tasks undertaken to ensure the accuracy of data obtained from unclear interpretation. It leads to improving the data quality of the GIS database as well as the raw data for compiling the topographic map. Even though we could not access all target areas, most of the infrastructure and topography features along the main road have been identified. The field activity was conducted from April to January 2003.

8.1. Objectives

(1) To improve the quality of GIS base data and raw data of topographic map.

(2) Apply the field verification by using hand GPS

8.2. Identified Objects
The following infrastructure and topography features were identified:

- Building
- Villages
- Khet or Krong office
- Srok or Khan office
- Temple
- School
- Church
- Mosque
- Stupa
- Post office
- Hospital
- Cemetery
- Historical Site
- Airfield
- Port
- Playground
- Earthen dam, Masonry dam
- Water tower, tank.
- Road
- Bridge

8.3. Data sources

The data sources used for data capture in the field of the Study area are aerial photograph of scale 1/25,000 and 1/40,000 1996-2002 and SPOT satellite with resolution 10m, date of SPOT capture varied from 1998 to 2000.

Using the above data sources, the infrastructure data were extracted as GIS base data and the sources for producing topographic map (scale 1/100,000). According to the date of data sources and working only in the project office, the accuracy of interpretation of the infrastructure data is not good enough as based data. To improve the data quality of the study, the above field verification is needed. So, field verification conducted almost every map sheet to fill up and correct the missing data such as new bridge and new development constructions (school,

temple..). In the case, the field verification using hand GPS has been introduced to apply as field verification method for the study.

In the Study the field reconnaissance survey on Land Use Land Form were also conducted to collect ground information of land use vegetation classification and their conditions and of land form observation points. This information will be used as reference to improve interpretation of land use and vegetation classes. The was conducted April and November 2002 along National Road No. 7 at Kratie; Bantey Mean Chey Uddar Mean Chey and Pailin.

8.4. Field Verification Area

The field verification areas have been conducted for the above mentioned schedule on the following bases:

1. Ratanak Kiri and Mondul Kiri;
2. Kratie;
3. Stung Treng;
4. Kg Thom;
5. Prah Vihear;
6. Siem Reap;
7. Uddar MeanChey, Battambang;
8. Pailin;
9. Pursat;
10. Koh Kong

8.5. Methodology

This field verification using hand GPS is the first method that was selected by the expert of the project for use in Cambodia to ensure an improvement in accuracy of GIS base data as well as topographic map scale 1/100,000.

Field activity was carried out by bringing hand GPS (single positioning accuracy of 15m) and the draft topographic map sheet on which the interpretation had been reflected, and the data was developed and updated over ArcView maps after the coordinates had been obtained. It has been confirmed that field data collection is an

effective means to improve the accuracy of map information.

The methodology covered:

1. Pick up the coordinate by GPS for the unclear or missing features on the draft map.
2. Prepare the description of picked-up location for the ground objects.
3. Plot the result of field verification on the draft map.
4. Evaluate the result of field verification for every map sheet.
5. Update the GIS base data and topographic map scale 1/100,000 by using the final result of the field verification.

8.6. Materials Used

The following materials were used for the field activity.

1. Hand GPS
2. Draft topographic map sheet (ArcView Map)
3. Camera
4. Field survey Form

8.7. Example of Field Verification Results

Field verification was conducted in Prah Vihear Province to check road classification and bridge location from Tbeng Mean Chey to Prah.

Through filed verification, it was notified:

1. The code of some existing roads should be changed because it is under reconstruction.
2. Some features (such as bridges) were not presented on the draft map due to a misunderstanding of the aerial photo interpretation process. These features

were updated by picking up the real-world coordinate from the field using hand GPS.

3. Most of the roads and bridge data were completely updated. The sample points will be indicated before and after field identification as follows:

. These features were updated by picked up the real world coordinate from the field using hand GPS.

Most the roads and bridge data were completed updated. The sample points will be indicated before and after field identification as the following:
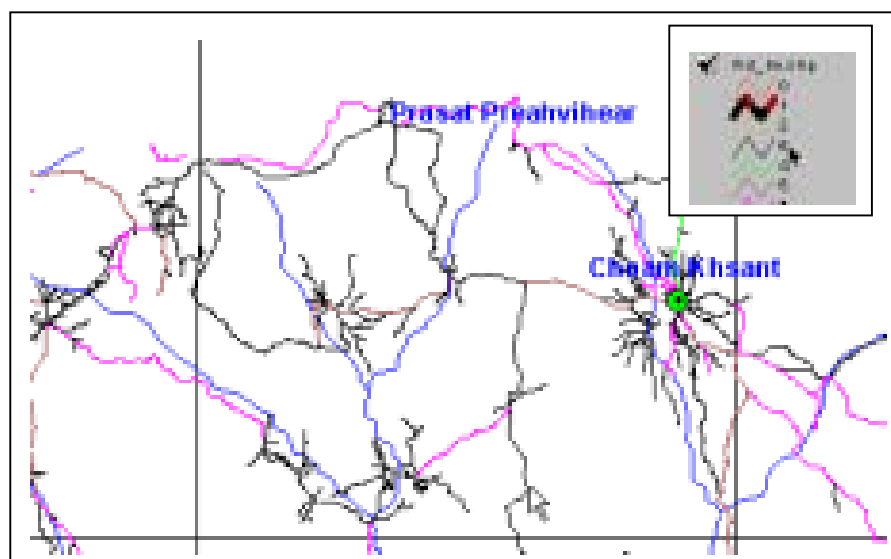
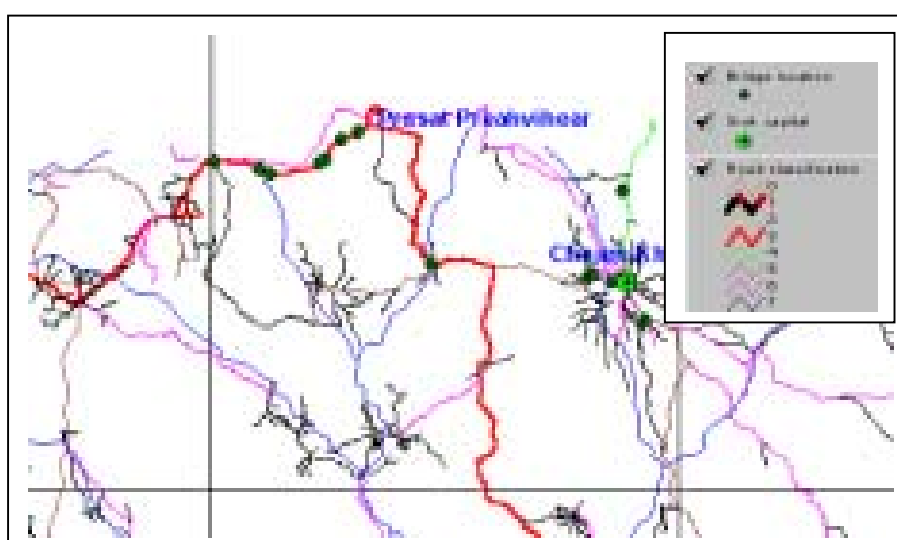Figure 31: Code Rd before field identification

Figure 32: Code Rd after field identification

The Detail of field verification and land use reconnaissance survey method and result from the field shown in annex VII of the report.

9. Preparation for General use map at the scale of 1/500,000

Seamless GIS database coverage of the entire country was prepared at a scale of 1:500,000. The data layers of the administration boundaries, topography, and roads were compiled at the scale above. The purpose is to distribute it to every school in the country. The actual production was carried out in the Mapping centre of MPWT under the supervision of the JICA Team. Work was carried out by the map symbolization technique, which was transferred by the Team. One thousand copies of the maps (approximately five map sheets) were printed by local printing house in Cambodia.