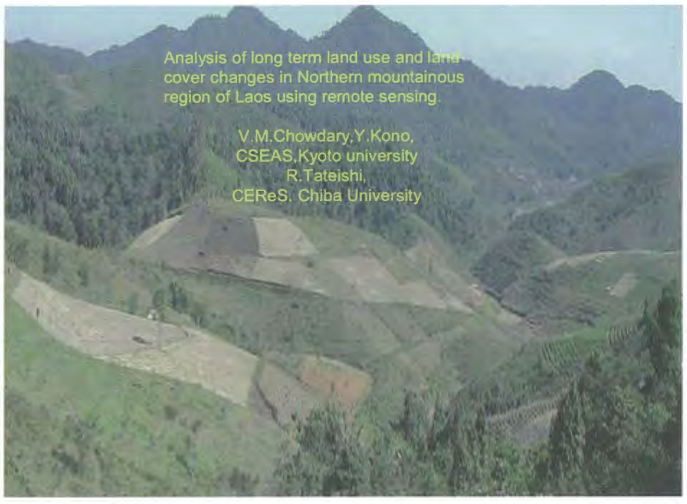
Analysis of long term land use and land cover changes in Northern mountainous region of Laos using remote sensing



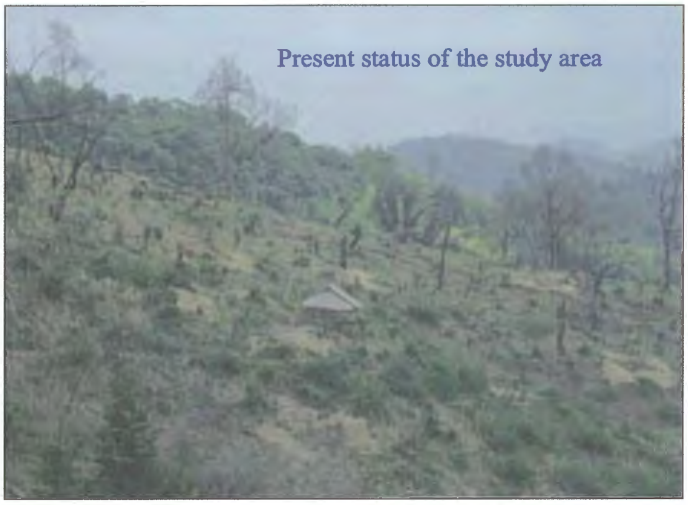
Back ground

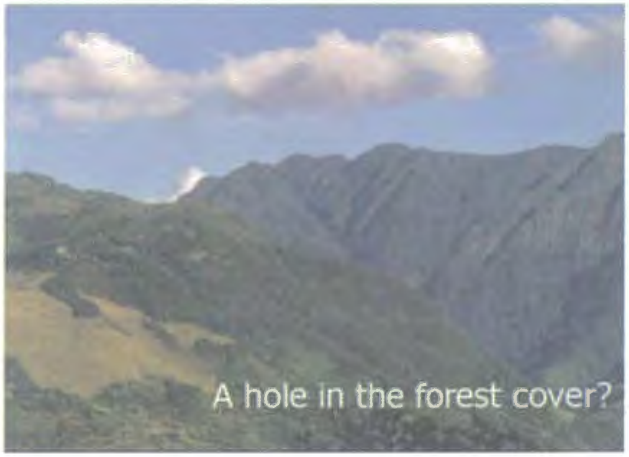
•Land Use and Land Cover change (LULC) is a key driver of global change

•To understand how LULC affects and interacts with global earth systems, information is needed on what changes occur, where and when they occur, the rates at which they occur, and the social and physical forces that drive those changes.

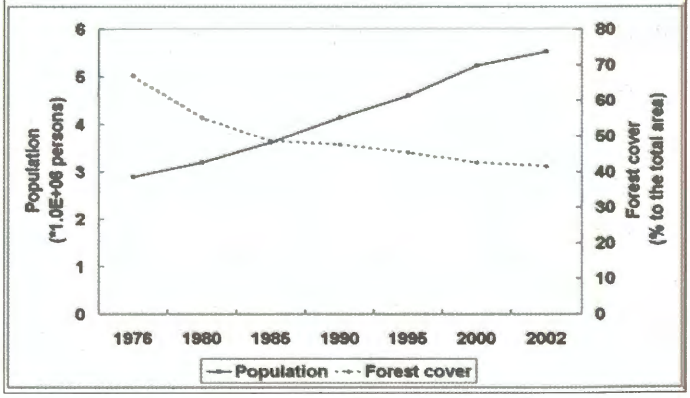
•Particularly, Land locked Lao PDR, located in mainland Southeast Asia, which was covered with 17 million hectares of forest land in 1970 was decreased to about 11.2 million in 1990 due to swiddening cultivation (also known as slash and burn or shifting cultivation).

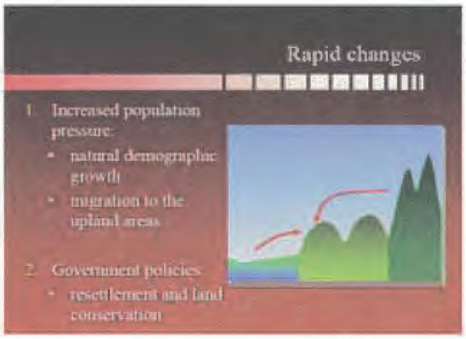
•Thus, to ensure sustainable management of natural resources, it is necessary to monitor and characterize temporal and spatial changes in land-use/land-cover change.



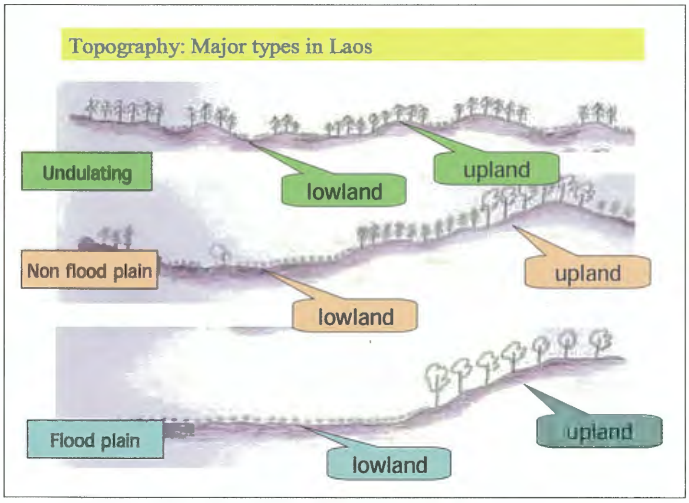


Population and forest cover in Laos




Rapid changes
1 Increased population pressure:
• natural demographic growth
• migration to the upland areas
2 Government policies:
• resettlement and land conservation


Rapid changes
3 market forces
• market demand
• market access
• needs of farmers


Topography: Major types in Laos
Undulating
lowland
upland
Non flood plain
lowland
upland
Flood plain
lowland
upland


-Upland and lowland mixed
-Narrow valley

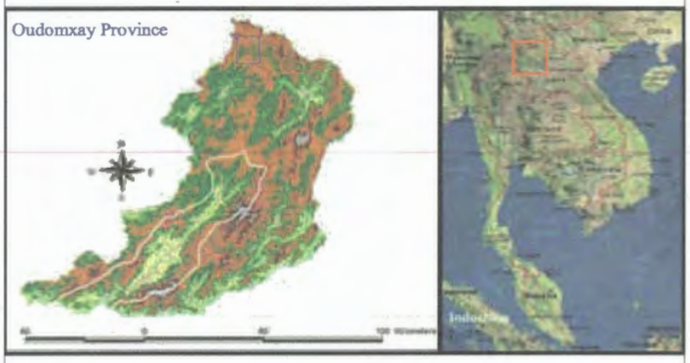

-Upland-based
-Wide valley with gentle slope


-Lowland-based
-Wide flood plain

Objectives:

1. To identify the land use/cover changes that have taken place under different slope categories during the period 1989-2000.
2. Sustainable analysis of two land conversion processes i.e conversion from forest or fallow land to swiddening agriculture and vice versa under different slope categories.
3. Generation of land use trajectory map

Study area



Study area

- The topography of the study area is typical lowland – upland complex and ranges between 500 to 1600 m above msl.
- More than 75% of households in this region have been traditionally engaged in subsistence farming, combining low land rice cultivation in the plains with shifting cultivation of upland rice on sloping lands.
- The average annual rainfall of the study area is about 1300 mm.
- The temperatures are highest in April (30-35^0 C) and lowest in December-January (7-11^0 C).
- The annual average temperature is 22.8^0 C, and
- The relative air humidity ranges from 65 to 95%.

Methodology

Step 1
- False color composite images were constructed out of Landsat band 2 and band 4 and a Normalized Difference Vegetation Index constructed from these bands consistently provides the most spectral variability and classification meaning.

Step 2
- An unsupervised classification approach was adopted for delineation of vegetated and non-vegetated areas. It identifies non-vegetation category during the non-monsoon season which includes low land and upland agriculture and other land uses (settlement), which we are concerned with.

Step 3
- Each of the resultant classified image was also overlaid with DEM, in order to find out the spatial distribution of the non vegetation (agricultural area) under different slope categories.

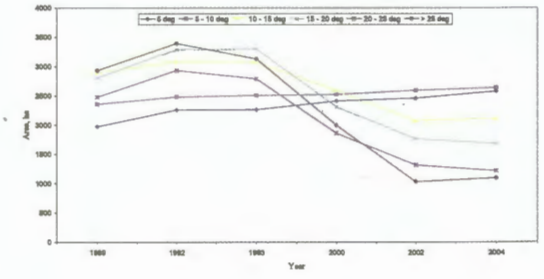
Step 4
- Further, overall classification accuracy and kappa coefficient was estimated in the present study using Quickbird data having spatial resolution of 2.4 m for the year 2004 as reference data.

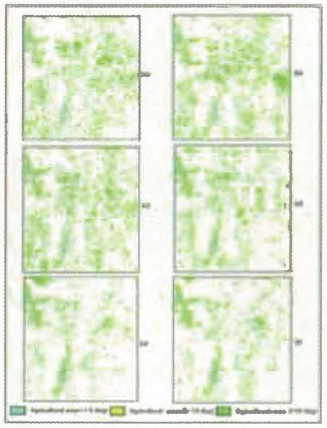
Step 5
- Subsequently, extracted binary images of the two successive datasets (1989-1992, 1992-1995, 1995-2000, 2000-2002, and 2002-2004) were overlaid using the arithmetic operator '+' under ERDAS Imagine environment in order to study the land conversion process between two successive datasets.

Step 6
- The resultant image was reclassified into one of the three categories namely i.e. conversion from swidden to fallow, fallow/forest to swidden and no change class and integrated with DEM image.

RESULTS

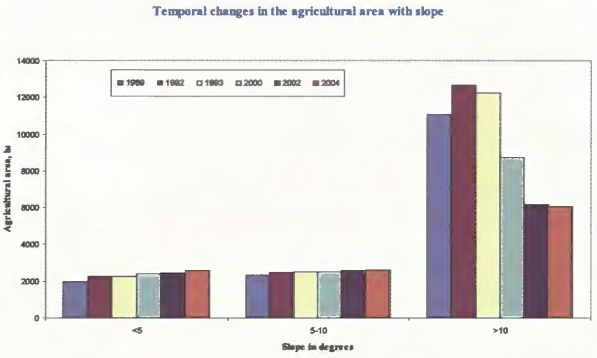
Figure. Temporal changes in the agricultural area with slope





(a) 1989
(b) 1992
(c) 1993
(d) 2000
(e) 2002
(f) 2004

Figure Spatial distribution of agricultural areas in the study area for different years



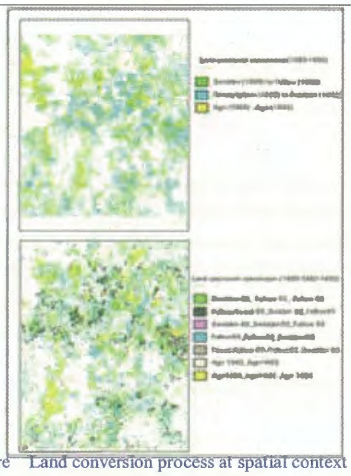


Figure Land conversion process at spatial context between consecutive years

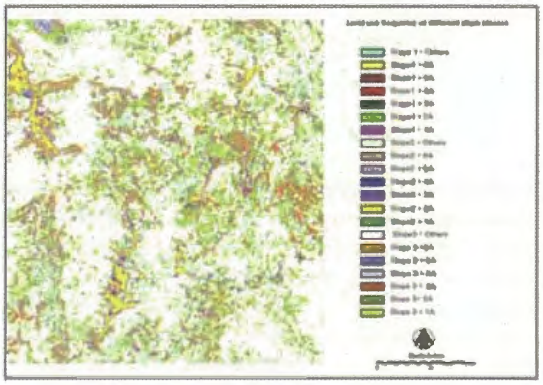
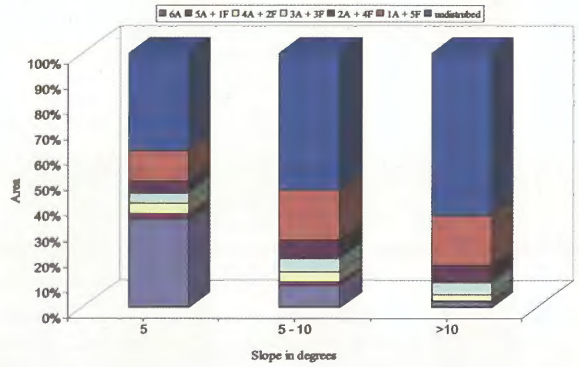
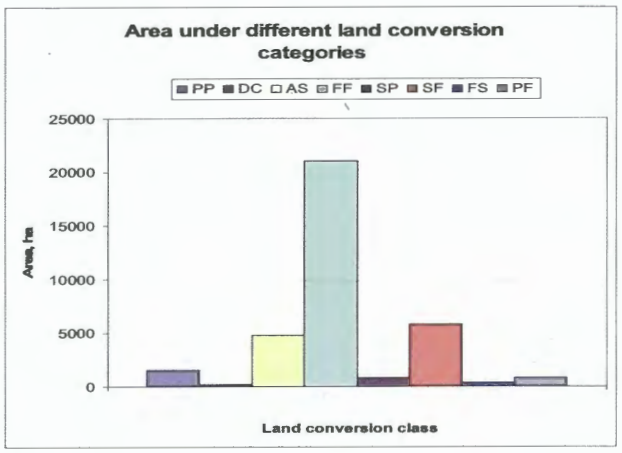


Figure Land use frequency map at spatial context under different slope categories

Fig. Land use frequency under different slope categories



Land use trajectory map



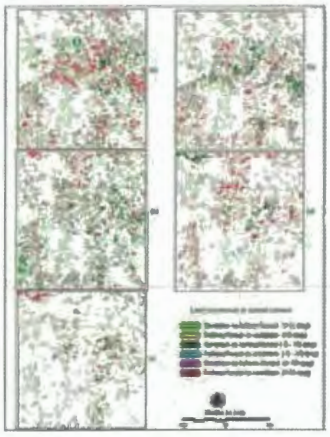
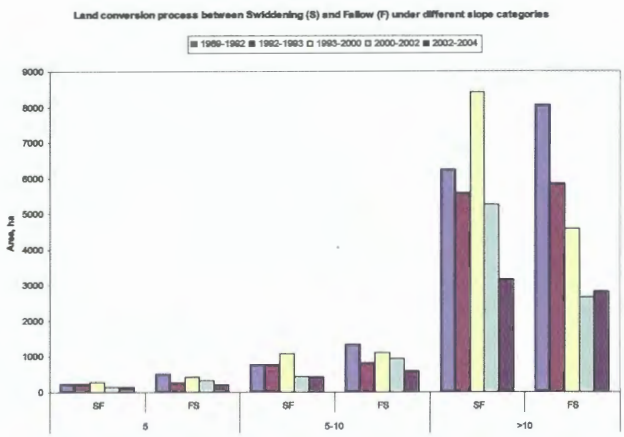


Figure Spatial distribution of land cover changes for different time periods (a) 1989-92 (b) 1992-93 (c) 1993-2000 (d) 2000-2002 (e) 2002-2004



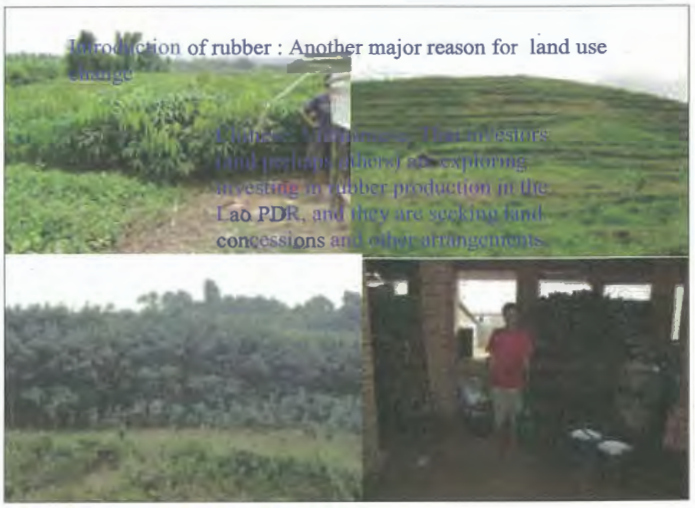
DISCUSSION

Impact of Government policies on land use/cover change :

Population growth and enforcement of government regulations against clearing new fields in forest areas have forced intensification of cropping on existing agricultural fields with a consequent reduction in the length of the fallow period.

Policy Implementation

- Decree No. 102/PM give the right, duties and responsibility of the village community in the use and management of natural resources.
- Decree No. 22/PM of 21/03/89 on the management and use of the agricultural land.
- Decree No. 03/PM 25/06/96 on implementing land management and land-forest allocation.
- Land and forest allocation policy was introduced to the Nam Beng River Basin at the beginning of 1997.



Other factors affecting land-use change:

Advanced cropping systems such as hybrid maize cultivation are also responsible for the reduction in the swiddening areas in the uplands after 1996

The 'land pioneering' habit of the people which led to establishment of new settlements also one of the major reason for land use change.

Perspectives by some researchers:

Swidden cultivation, rather than being the bane of tropical conservation may be

- –ecologically appropriate,
- –culturally suitable, and
- –best means available for preserving biodiversity in many upland areas of Southeast Asia.

Conclusions:

Land cover change detection based on remote sensing data allows the identification of major processes of change.Having an accurate picture of the scale and pace of changes in swidden farming systems on a regional basis is important, not only to better explain why the changes are taking place, but also to be able to predict possible consequences of the change from swiddening systems to other agricultural systems

Further work

Though in the present study, analysis was carried out to smaller case study area, but similar analysis can be taken up at regional level in order to frame national development strategies for the management of land and forest resources as these resources are essential for both economic and environmental purposes in the mountainous region