



# Prediction of forest cover changes using Remote sensing and GIS

Authors: Ngo, Thi Thuy Phuong (MSc)  
Supervisor: Nguyen, Thi Thanh Huong  
Data collection: Nguyen, Duc Dinh; Phan, Thi Hang  
Agricultural and Forestry Faculty,  
Tay Nguyen University



# **Prediction of forest cover change using Remote sensing and GIS: A temporal-spatial approach to look on FLR**



# Presentation structure

- Rational
- Presentation of research
  - Study area
  - Material
  - Methodology
  - Results
- Conclusions



# Rational

## General problems

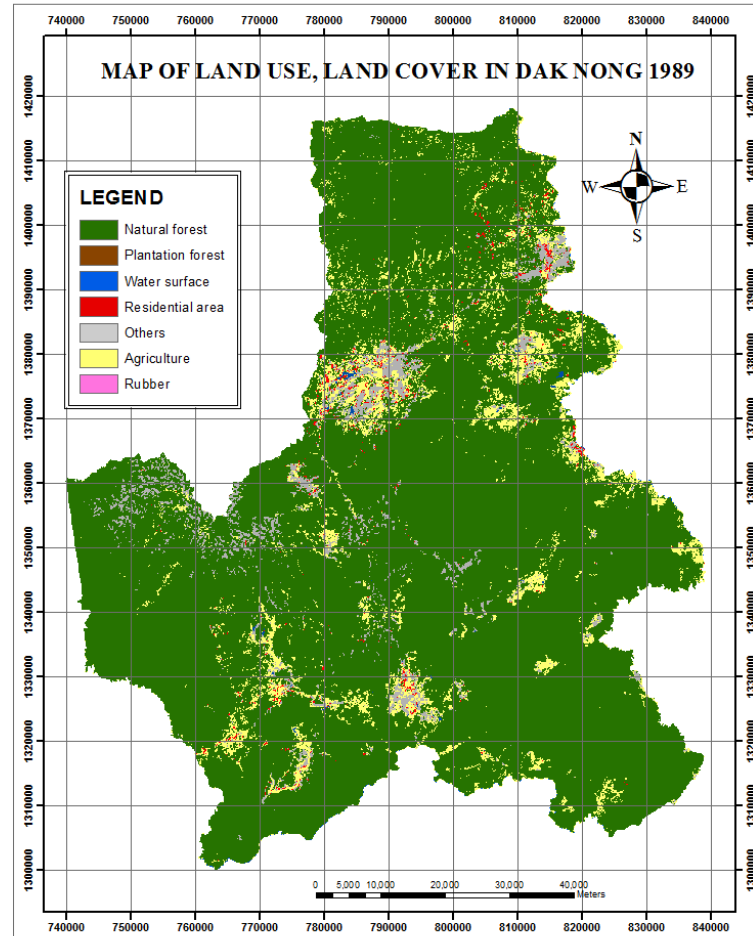
Land use and land cover (LULC) changes including deforestation are main factors contributing on global environmental change.

Daknong province of Vietnam has been experienced loss of a large area of natural forest for expanding urbanization and agricultural cultivation due to the increasing population, income, ....

Natural forests in Vietnam are among the most diverse tropical forests in the world, but they are being lost at an alarming rate.



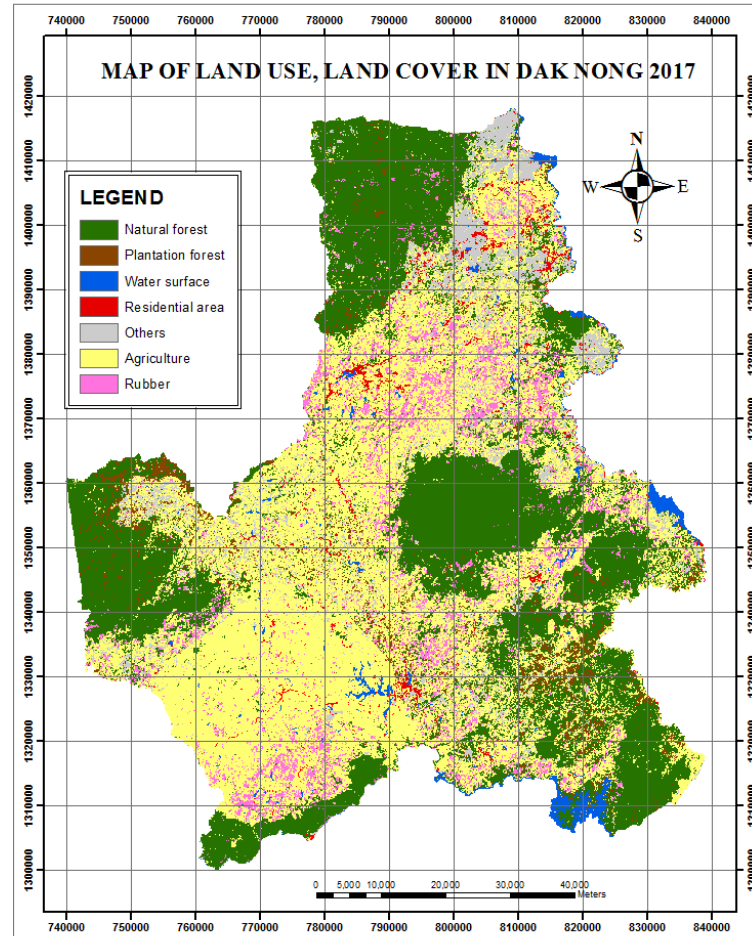
## Map of LULC 1989-1990







## Map of LULC 2017





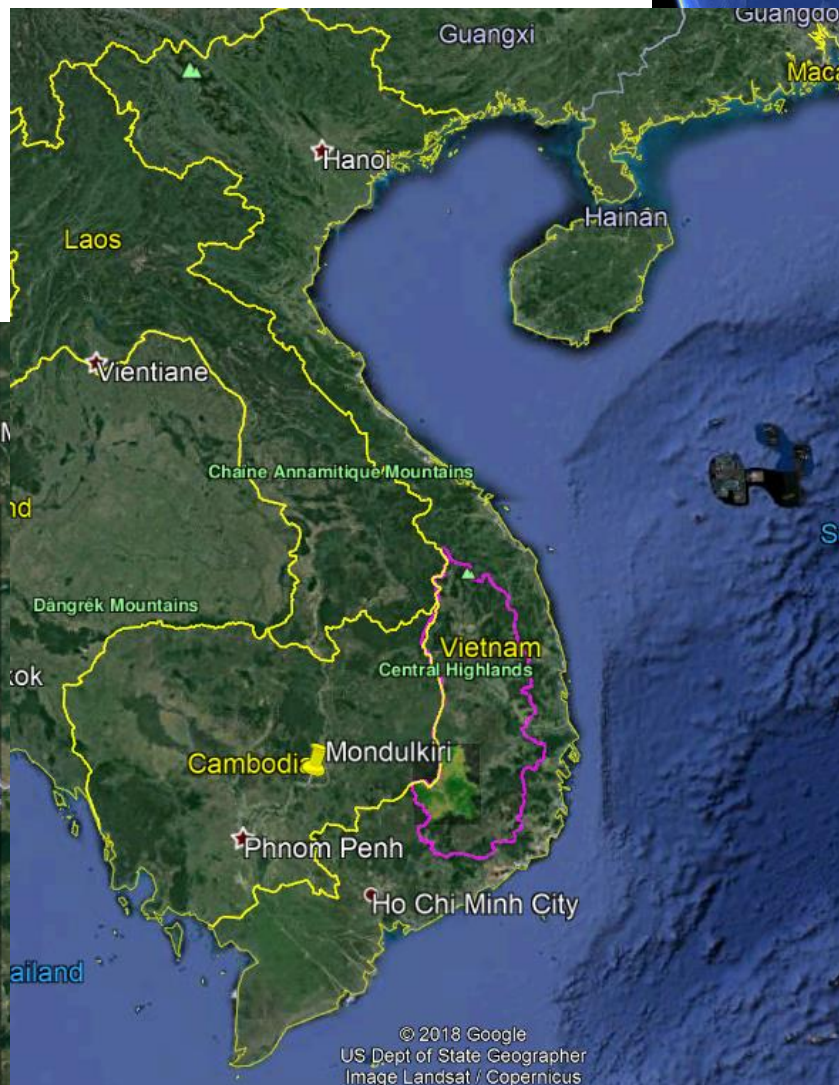
# Rational General problems

**Dak Nong province, Viet Nam**

The provincial capital is Gia Nghia.

**Area:** 6,515.6 km<sup>2</sup>

**Population:** > 600,000 peo. of which 65% Kinh, the remaining ethnic minorities from 40 groups





# Rational

## General problems

It has not considered to analysis in a systematically way; the prediction of these changes as a basis for LULC strategies in the future has not been done in the area.

Understanding a trend of these changes in the past, current, and future is important for making proper decisions to develop in a sustainable way including FLR.





# MATERIALS

## Data

- Satellite imagery: Landsat 5, 8 (1989, 1995, 2001, 2005, 2008, 2014 and 2017 )

Information of data set:

ID	Years	Satellite	Number of band	Spatial resolution (m)
1	1989	Landsat 5	6	30x30
2	1995	Landsat 5	6	30x30
3	2001	Landsat 5	6	30x30
4	2005	Landsat 5	6	30x30
5	2008	Landsat 5	6	30x30
6	2014	Landsat 8	7	30x30
7	2017	Landsat 8	7	30x30



# MATERIALS



## Data

- High resolution satellite images in Google Earth for training sites
- DEM (Digital Elevation Model) from USGS employed to classify elevation levels.
- Available data: Land use maps; Google Earth, field data



# MATERIALS

## Software

- **Image Processing Software**

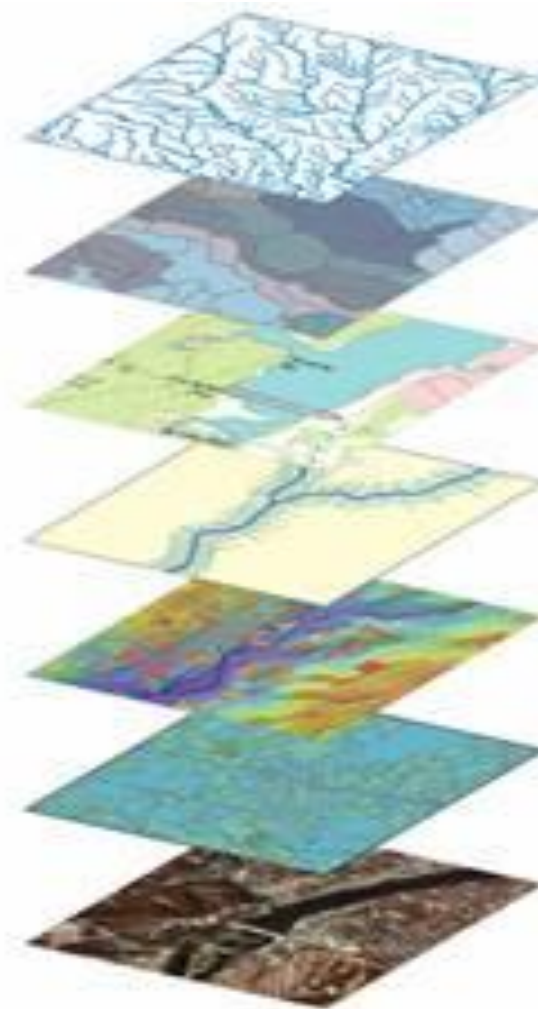
Envi 4.7, eCognition Developer 9.2

- **GIS Software**

ArcGis 10.1, MapInfo 15.0

- **Predict future LULC dynamics**

IDRISI Taiga



**Satellite image**



**USAID**  
FROM THE AMERICAN PEOPLE

# METHOD: **LULC classification**




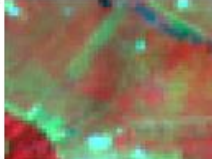























- 9 land use/cover categories have been identified:
  - (1) Evergreen broadleaved forest;
  - (2) Semi-evergreen forest;
  - (3) Dipterocarp deciduous forest;
  - (4) Plantation forest;
  - (5) Rubber;
  - (6) Agriculture;
  - (7) Residential area;
  - (8) Water surface; and
  - (9) Other lands (including other types of grassland, shrubs, bare land, unplanned land, abandoned land,...).





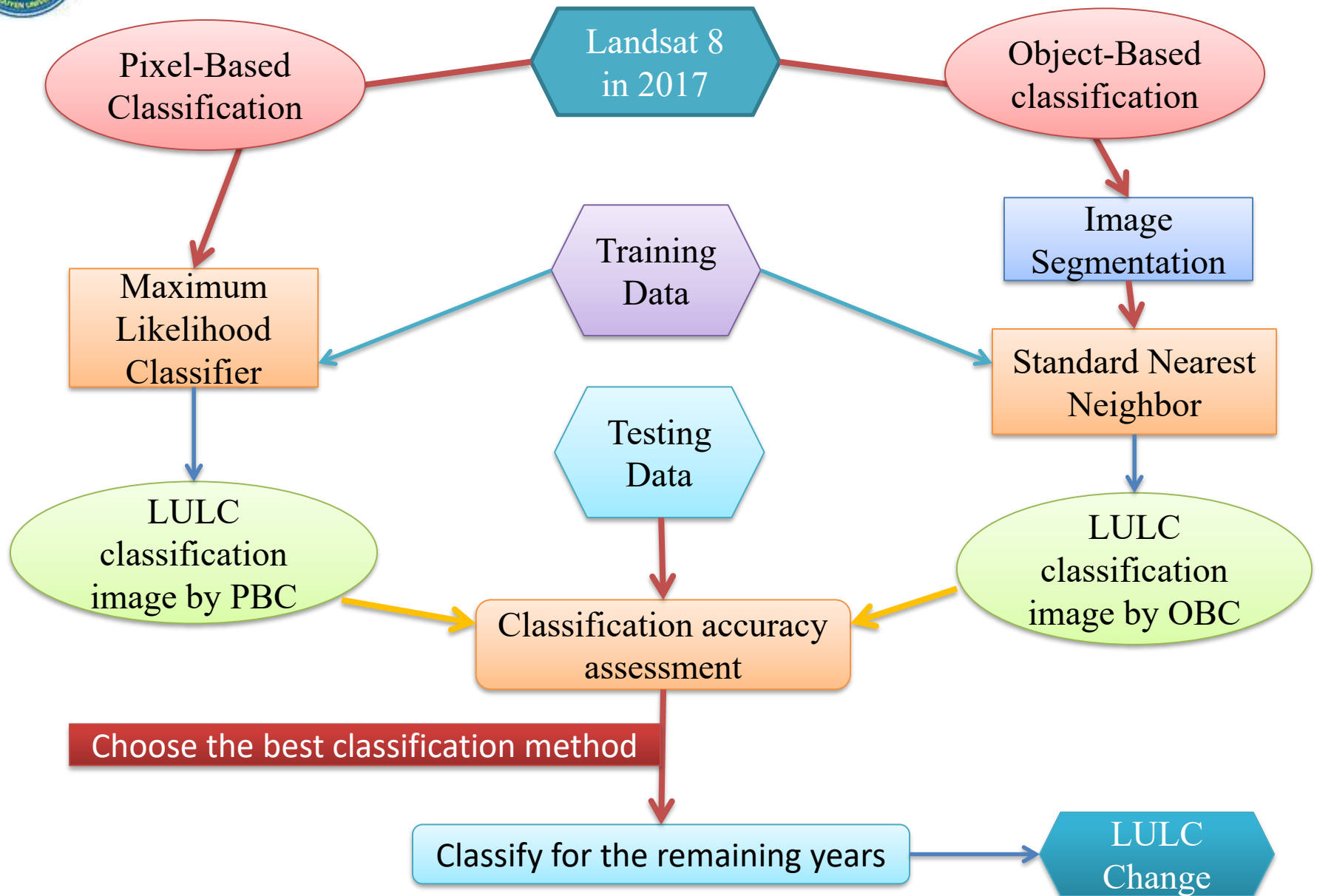
# METHOD: LULC classification

9 land use/cover categories have been identified:

No.	LULC	Landsat	Imageries on Google Earth Engine	Image Illustration on the field	No.	LULC	Landsat	Imageries on Google Earth Engine	Image Illustration on the field
01	Evergreen broadleaved forest				06	Agriculture			
02	Semi-evergreen forest				07	Residential area			
03	Dipterocarp forest				08	Water surface			
04	Plantation				09	Others Land			
05	Rubber								



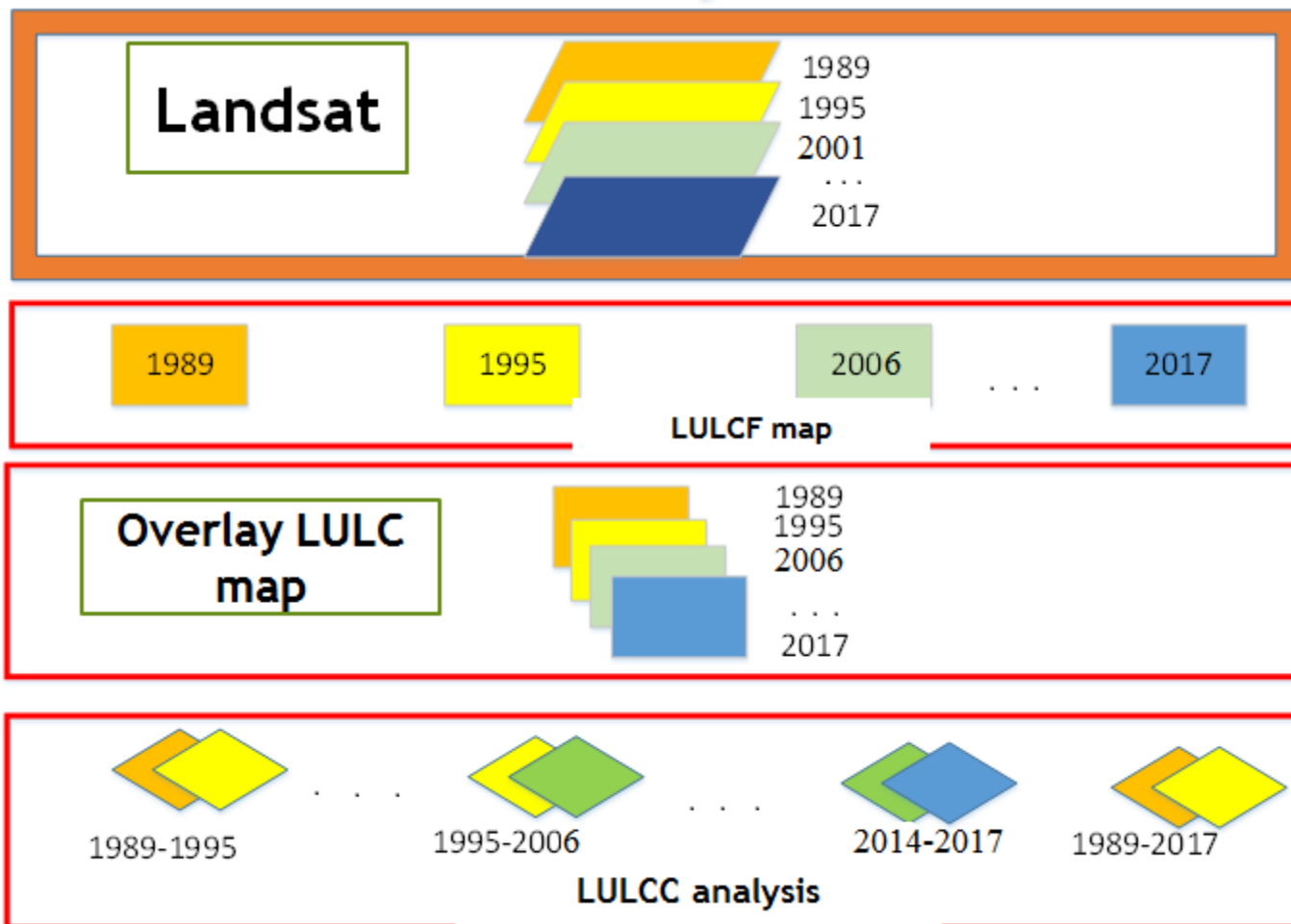
# METHOD: LULC classification





# Analysis of land use/land cover change

The results of LULC of year 1989, 1995, 2001, 2005, 2008, 2014 and 2017 were used to analyse LULC changes over time using ArcGIS software.



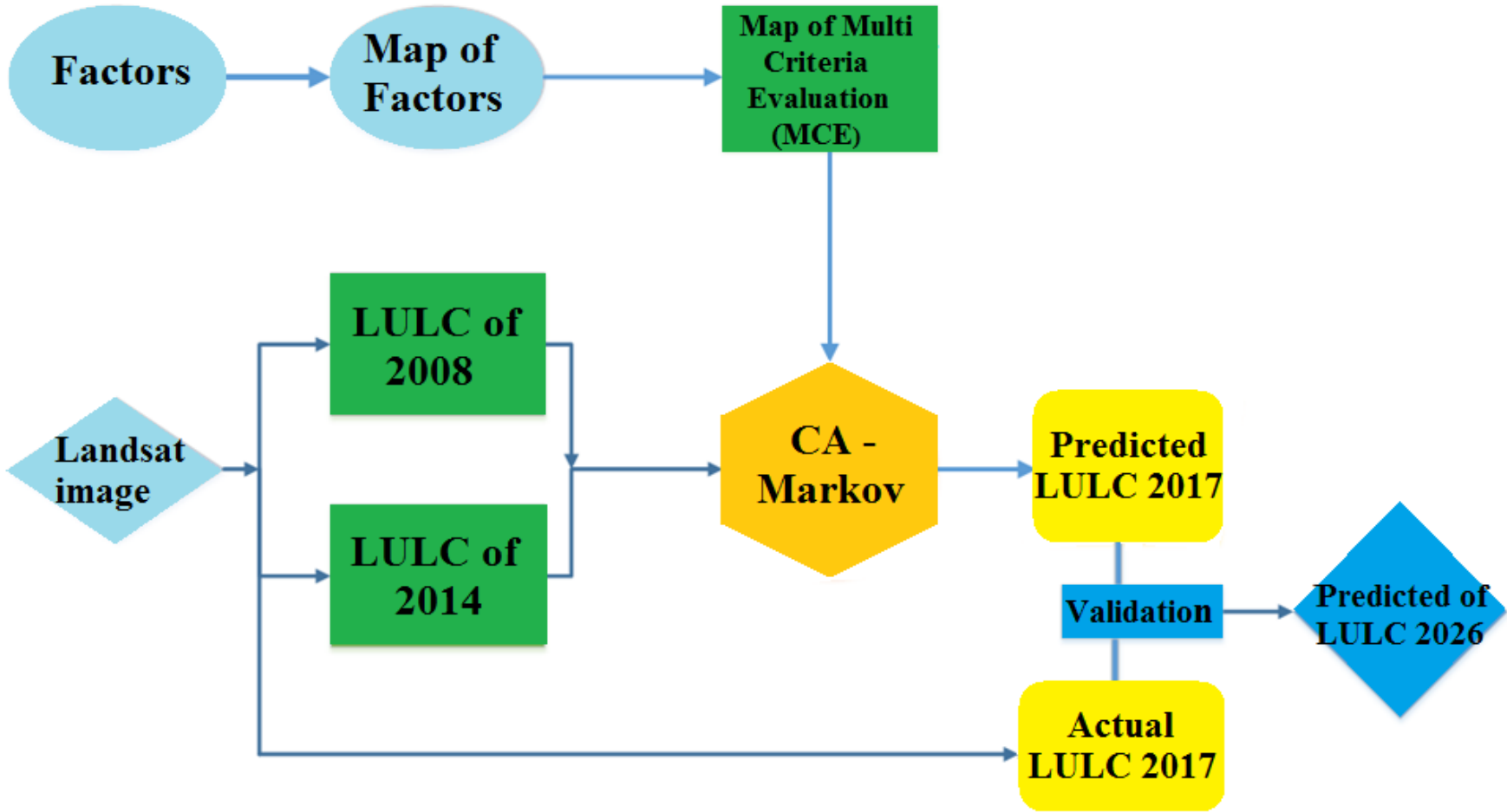


# METHOD:



## Predicting of LULC change with CA-Markov

Diagram of LULC prediction by CA\_Markov chain model







# RESULTS

- 1. Image classification and accuracy assessment**
- 2. Analysis of LULC changes**
- 3. Predicting LULC changes with CA-Markov and validation**



# 1. Image classification and accuracy assessment



# RESULTS



## Accuracy assessment by MLC and OBIA

Accuracy Methods	Overall Accuracy (%)	Kappa coefficient
OBIA classification	<b>82.30</b>	<b>0.80</b>
MLC classification	71.65	0.62



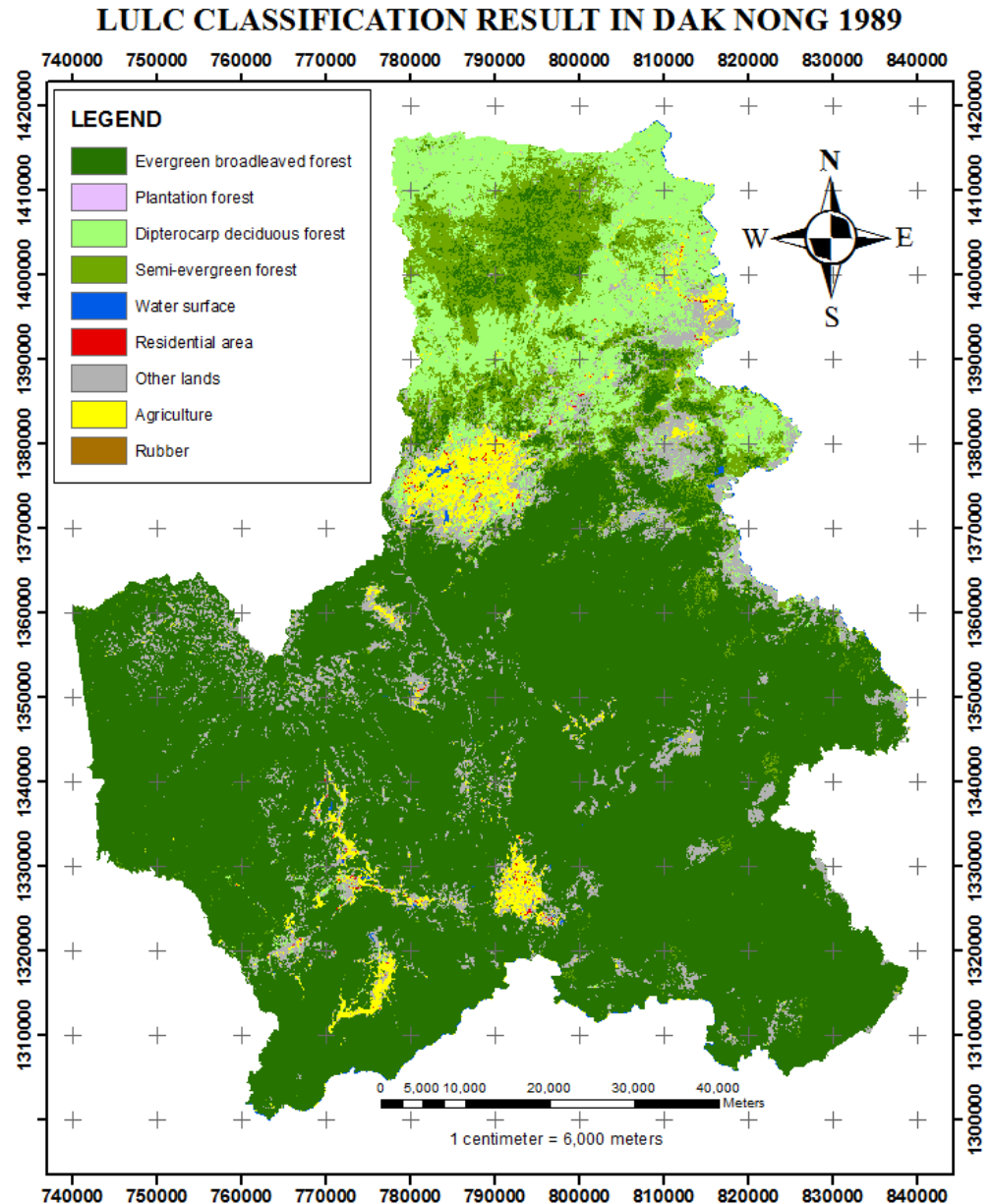
## 2. Analysis of LULC changes





# RESULTS

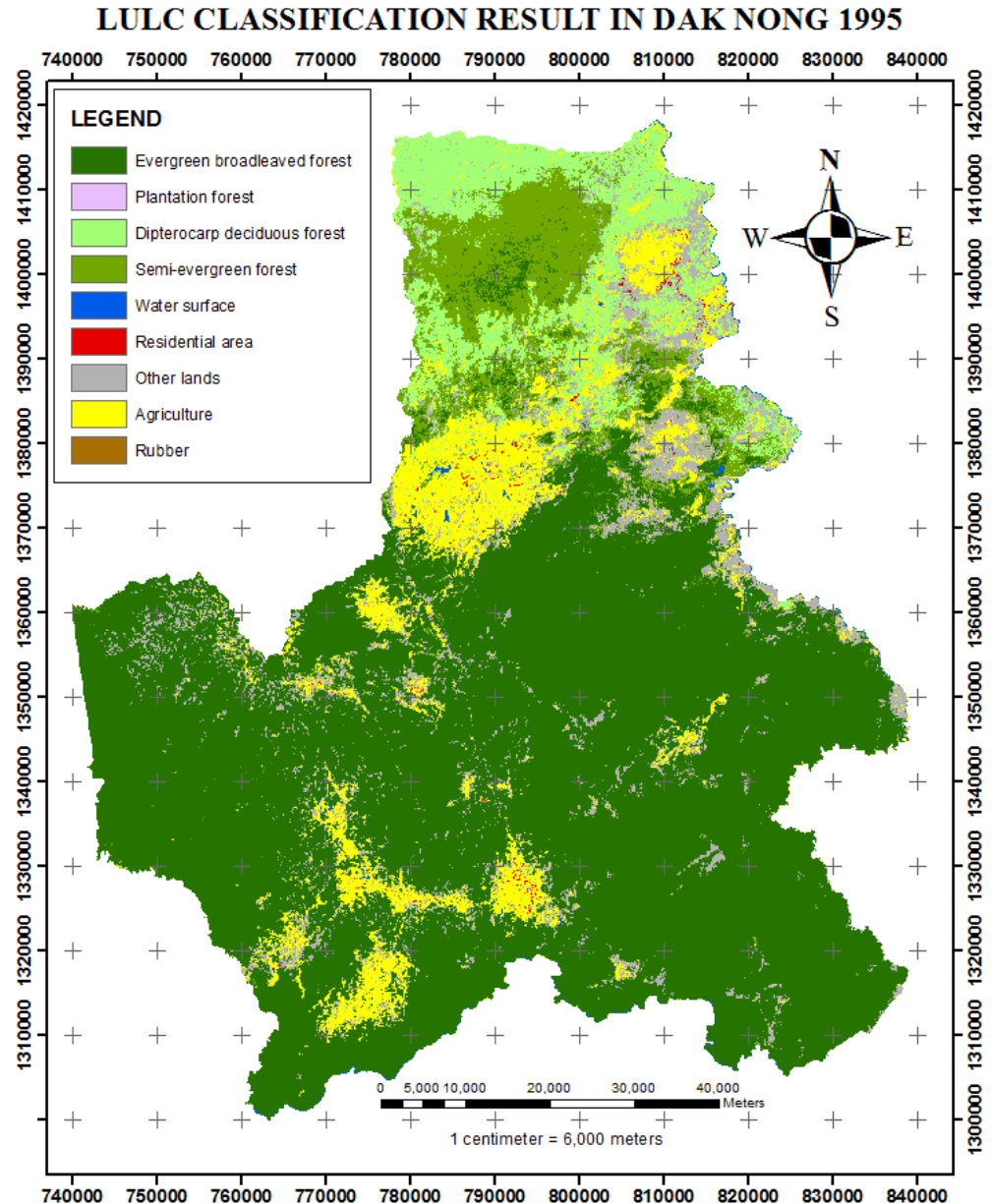
## Map of LULC 1989





# RESULTS

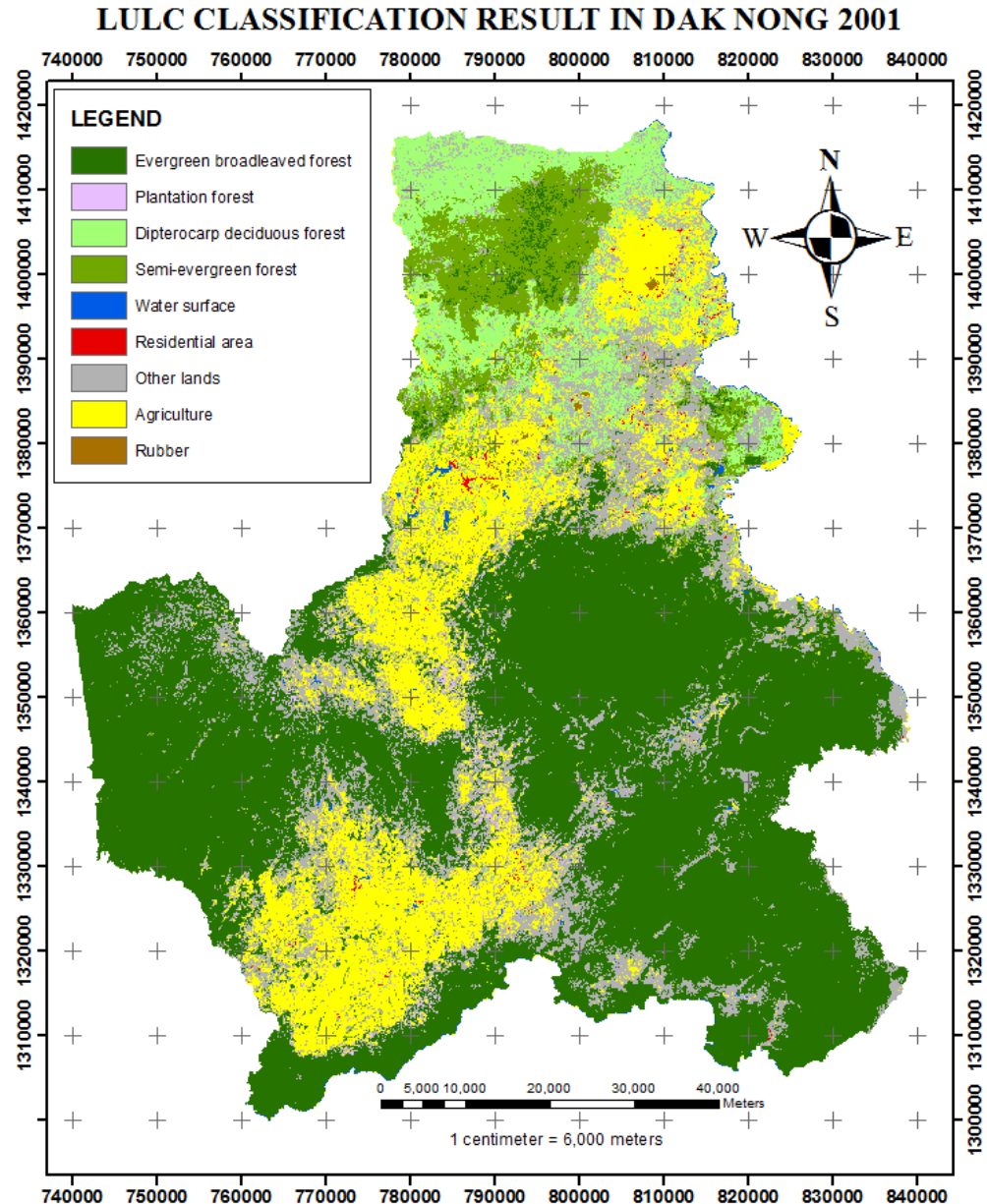
## Map of LULC 1995





# RESULTS

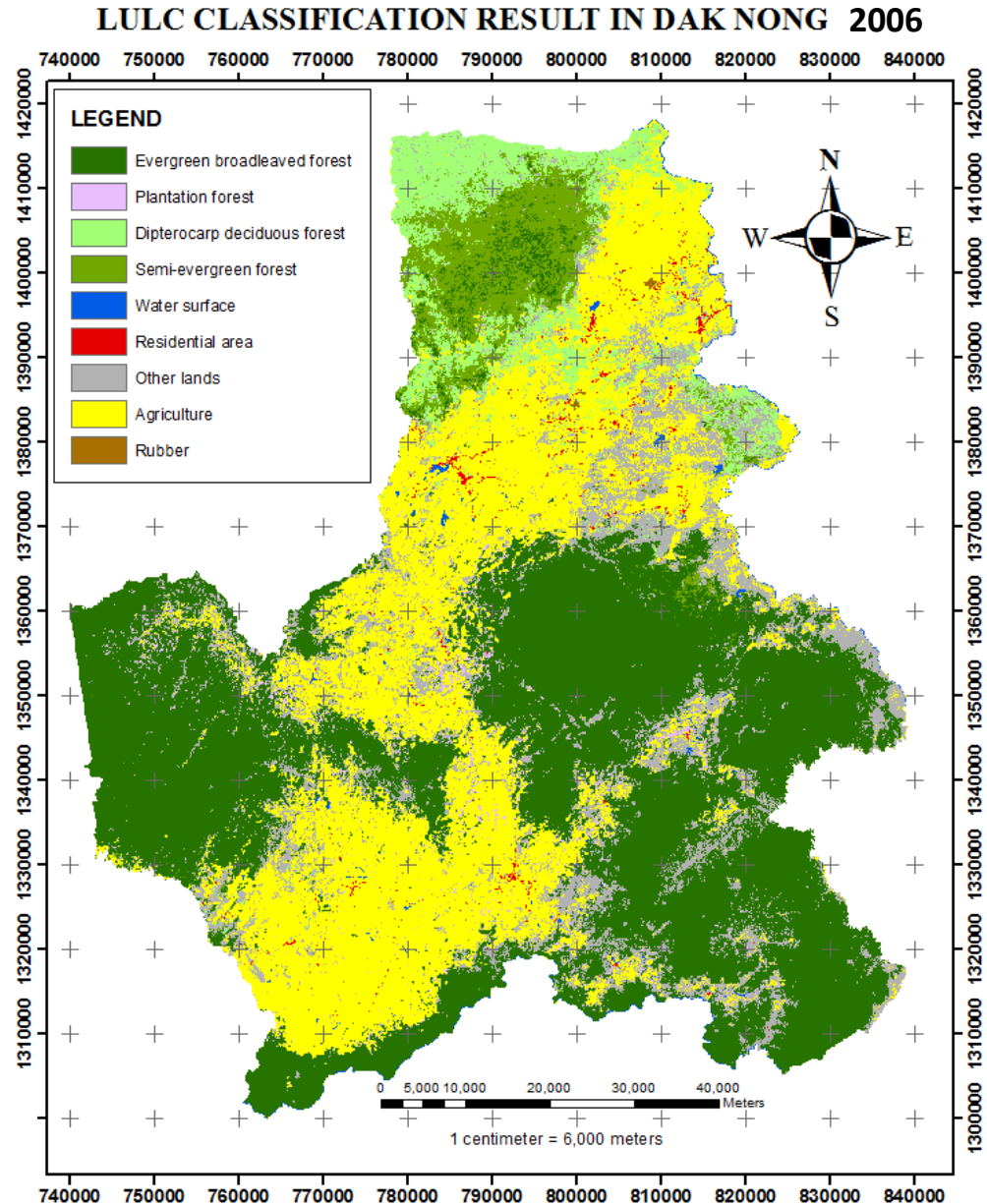
## Map of LULC 2001





# RESULTS

## Map of LULC 2006

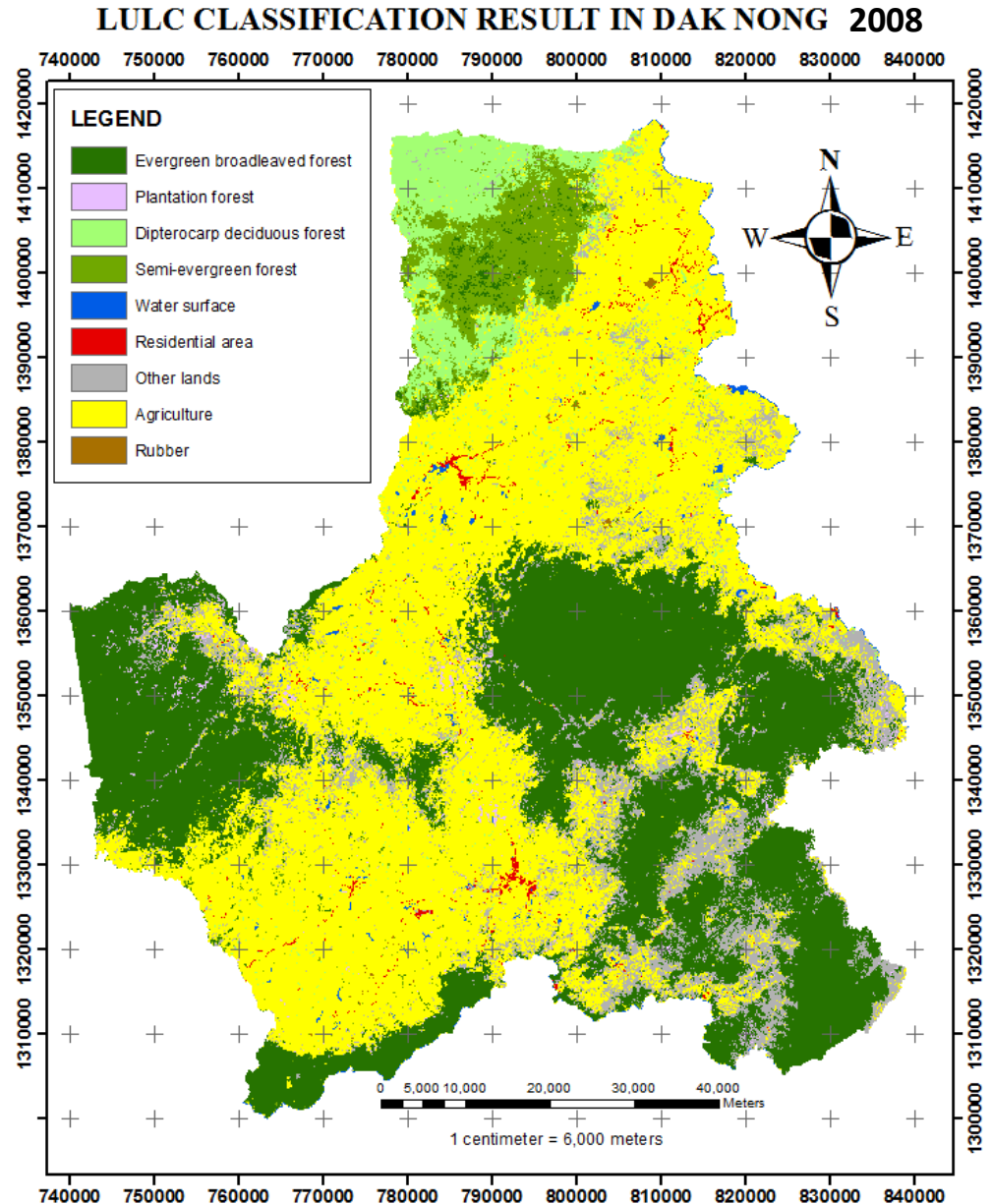






# RESULTS

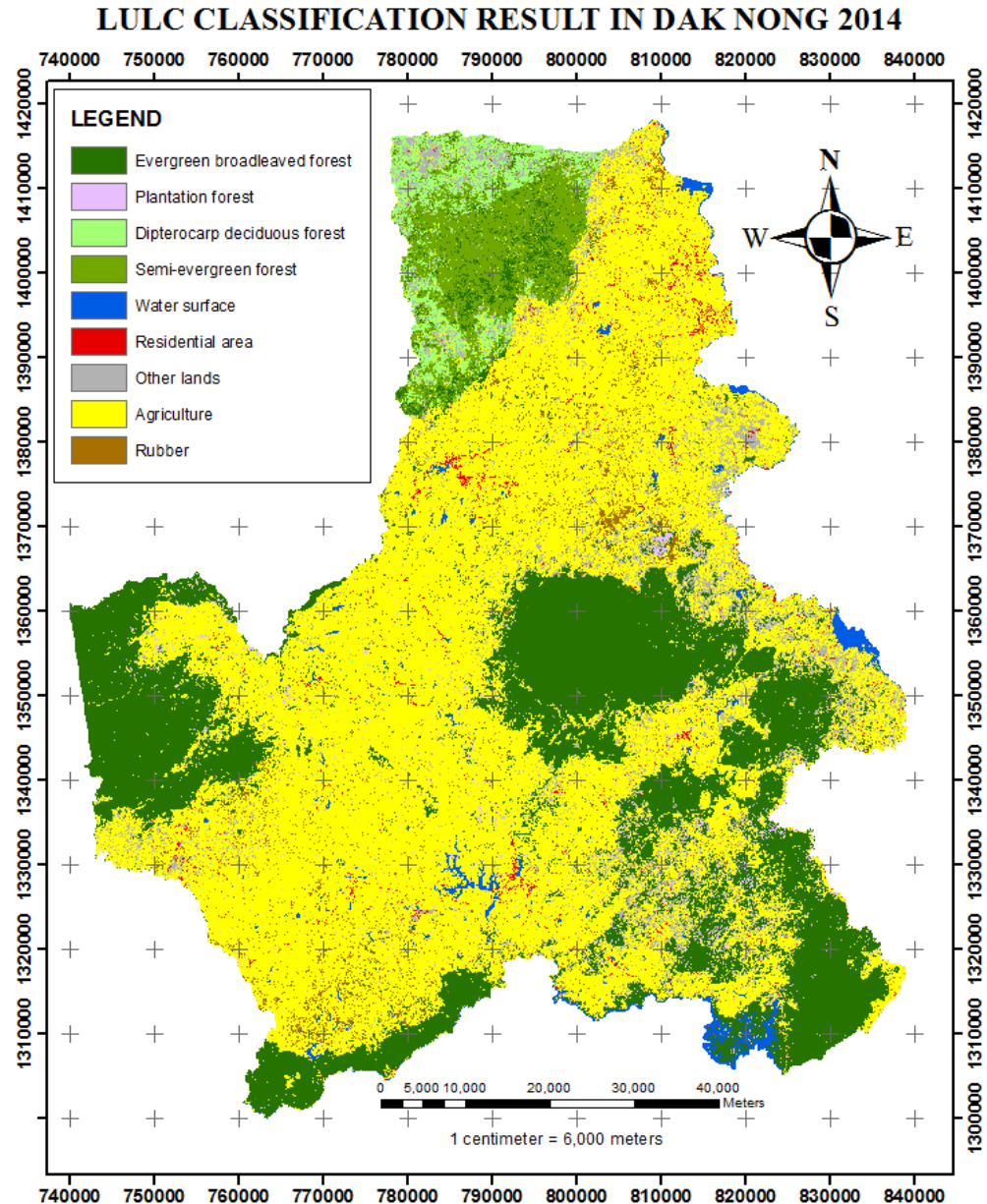
## Map of LULC 2008





# RESULTS

## Map of LULC 2014

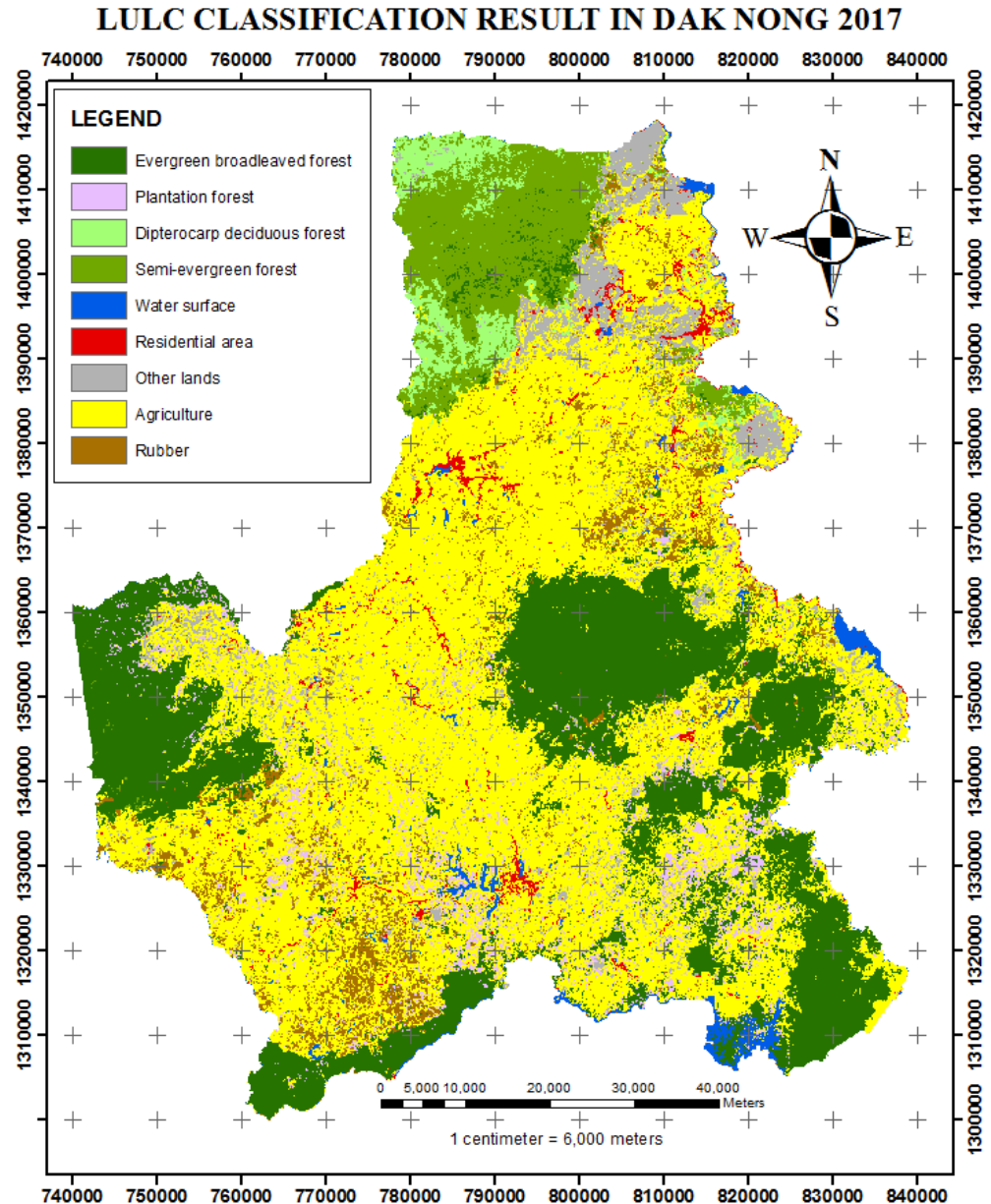






# RESULTS

## Map of LULC 2017





# Land use/land cover change



2014 (ha)	2017 (ha)									Total (ha)
	Agri	Semi-evergreen	Evergreen	Other lands	Planted forest	Residential area	Rubber	Dipterocar p forest	Water body	
Agri	258.655,95	189,90	15.528,78	43.256,34	1.761,39	7.630,83	7.909,92	639,36	1.191,42	337.506,53
Semi-evergreen	738,99	5.889,69	23,58	1.922,31	0,63	15,75	5,94	454,41	0,63	9.051,93
Evergreen	49.816,17	49,86	132.824,88	9.024,48	1.839,87	347,31	2.169,99	2.213,37	375,93	198.661,86
Other lands	17.546,85	2.287,26	1.733,49	11.547,00	89,01	461,70	724,23	3.604,14	118,44	38.112,12
Planted forest	8.019,00	3,60	2.187,54	1.550,97	1.299,69	75,96	213,12	8,37	67,59	13.425,84
Residential area	4.673,34	1,53	129,87	705,42	12,60	2.889,45	176,94	0,63	29,43	8.619,21
Rubber	5.094,00	4,14	451,44	771,66	21,60	108,81	1.013,49	7,47	8,46	7.481,07
Dipterocarp forest	1.408,14	364,77	640,53	5.897,61	6,39	4,95	108,72	21.353,22	4,14	29.788,47
Water body	609,48	4,14	352,62	155,16	8,46	15,30	4,23	2.07	8.366,04	9.517,50
Total (ha)	346.561,92	8.794,89	153.872,73	74.830,95	5.039,64	11.550,06	12.326,58	28.283,04	10.162,08	652.164,53

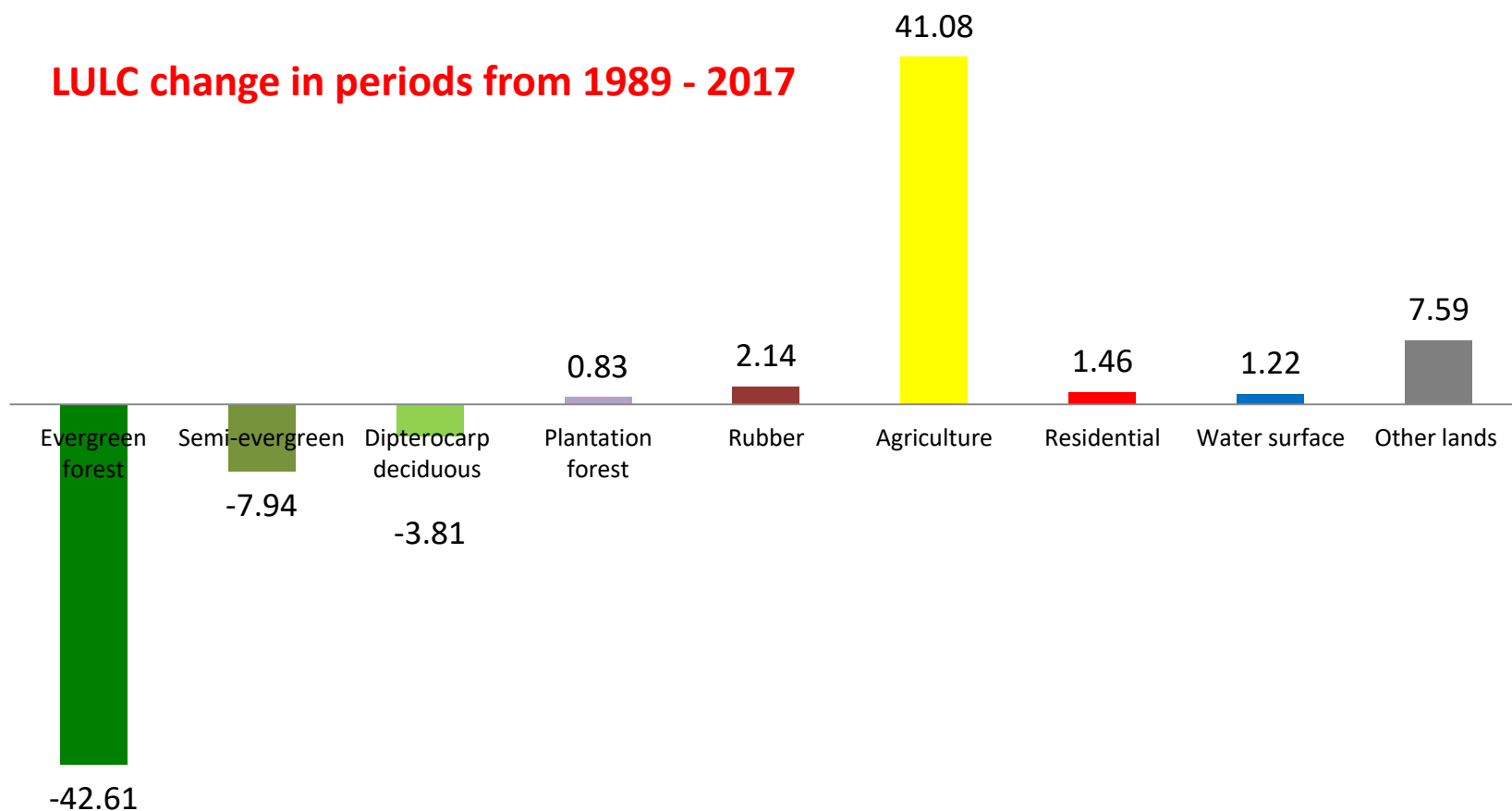


**USAID**  
FROM THE AMERICAN PEOPLE

## Land use/land cover change

The results of LULC distribution for years 1989, 1995, 2001, 2005, 2008, 2014 and 2017 showed that natural forest area accounts for a high proportion in the past, but there was a sharply decreasing trend during the periods, whereas increasing trend was observed for most remaining classes.

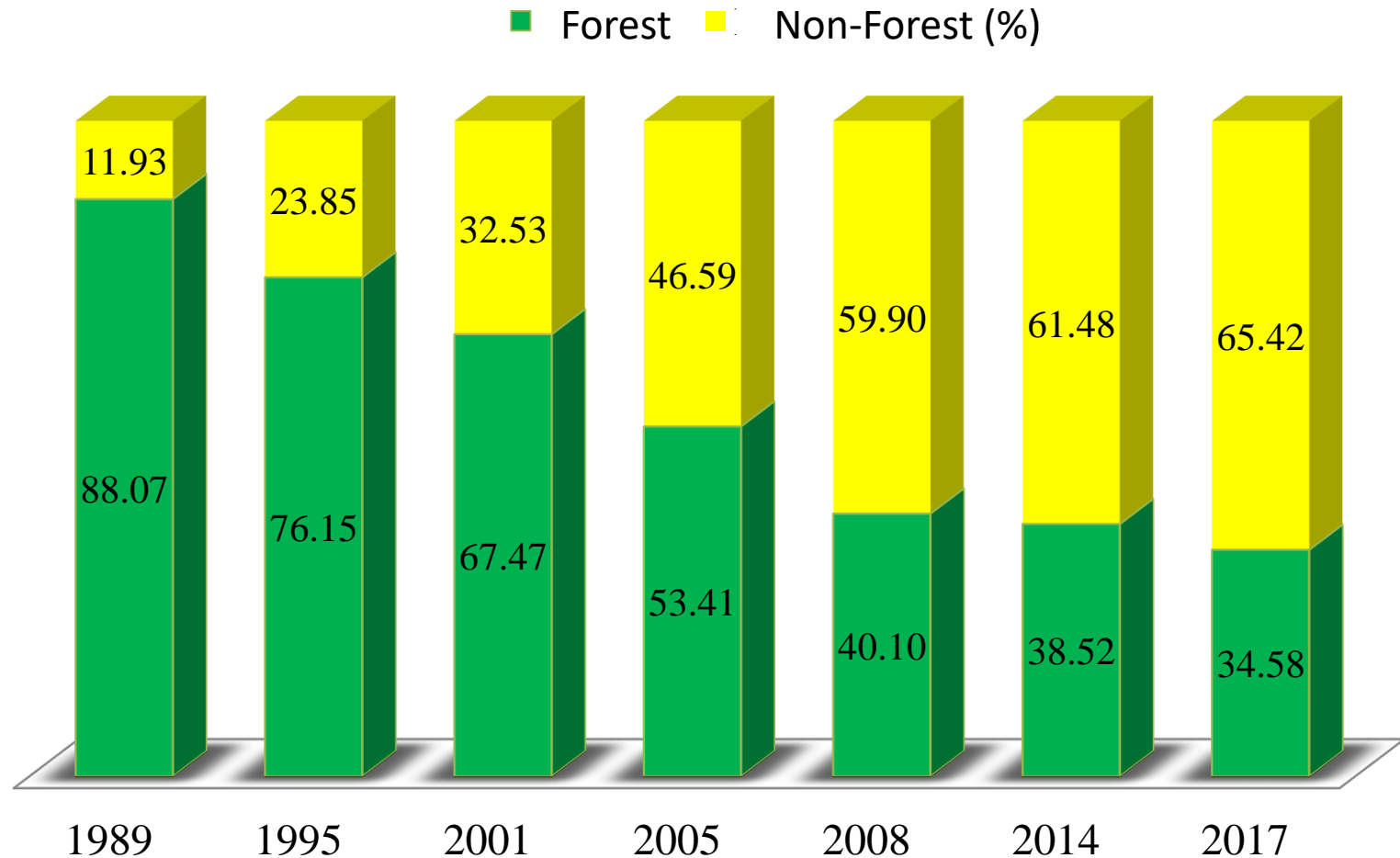
### LULC change in periods from 1989 - 2017





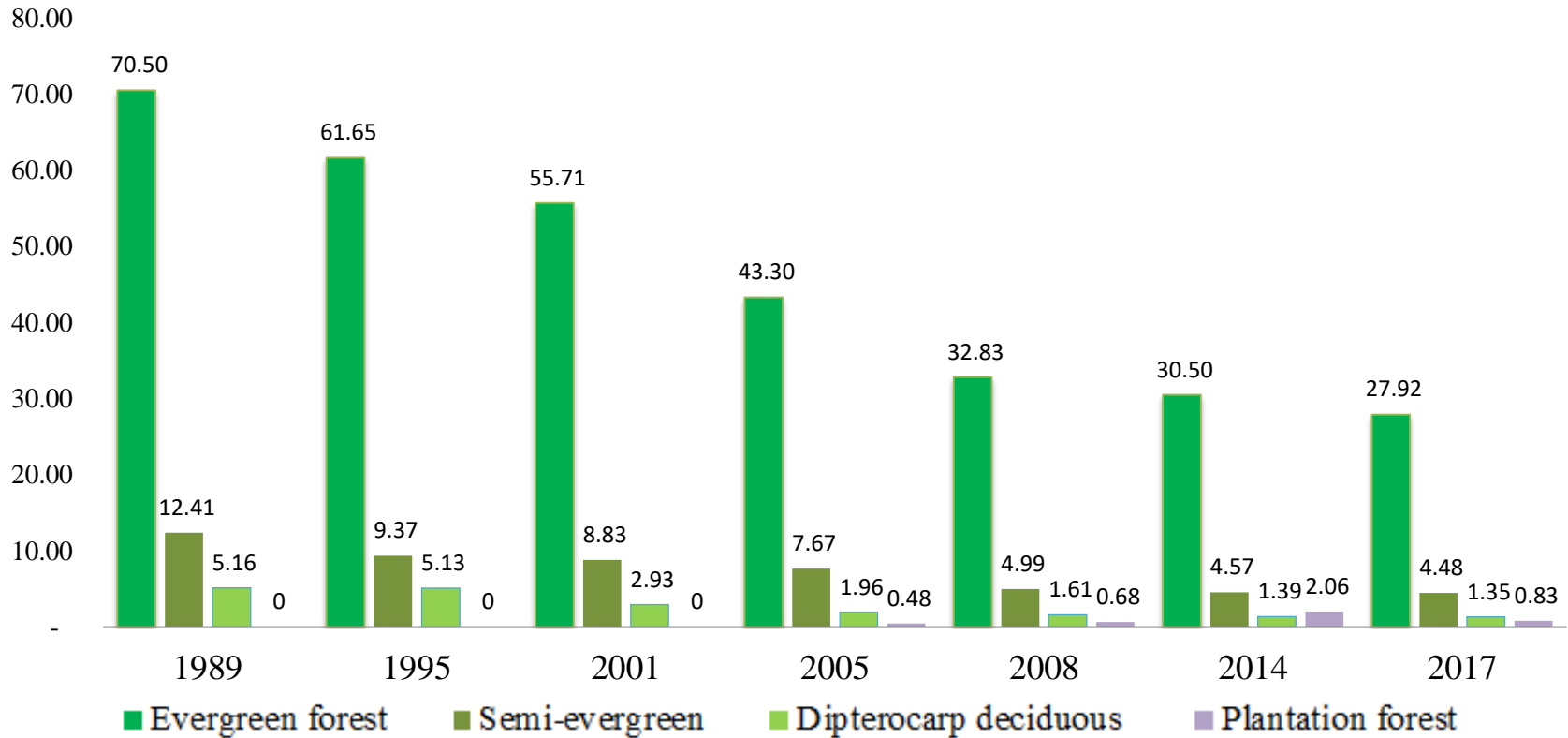
# Land use/land cover change

## Forest area changed from 1989 to 2017 (%)





# Land use/land cover change





### 3. Prediction of LULC change with CA-Markov





# Predicting of LULC change with CA-Markov and validation

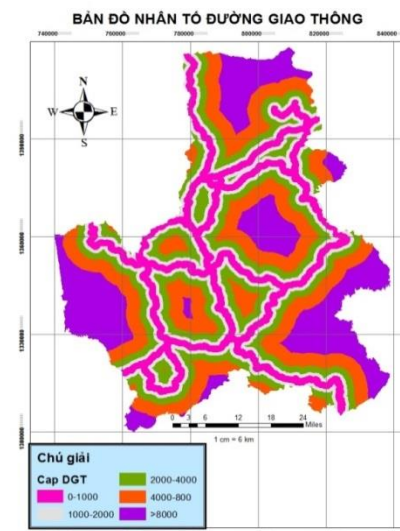
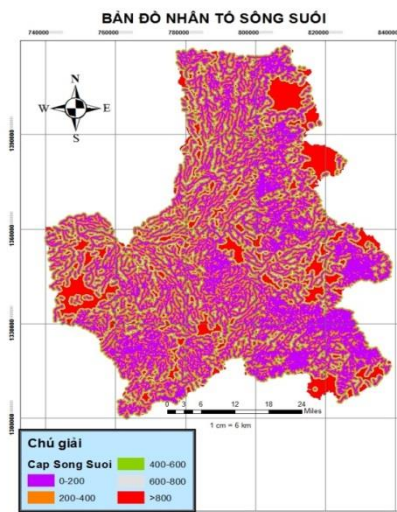
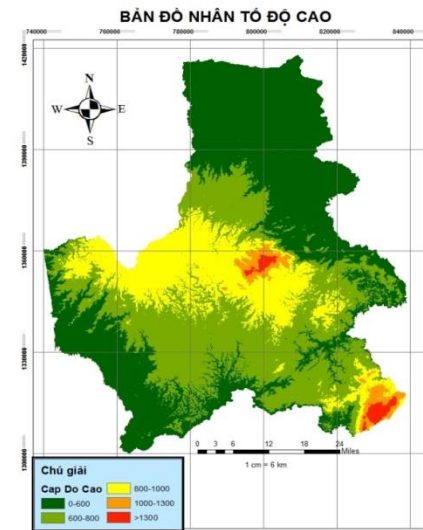
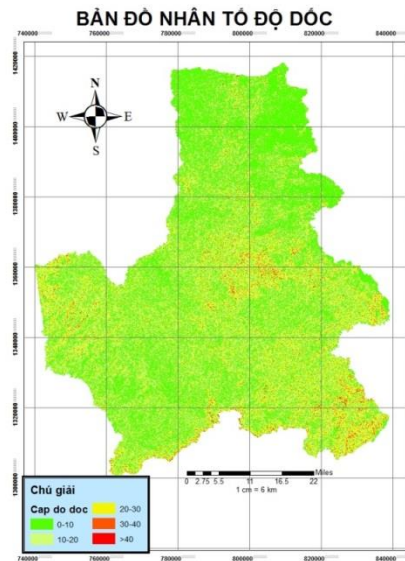


USAID  
FROM THE AMERICAN PEOPLE

## Multi-criteria evaluation map (MCE)

Available data  
such as  
topographic  
maps, slopes,  
rivers/stream,  
roads

IDRISI

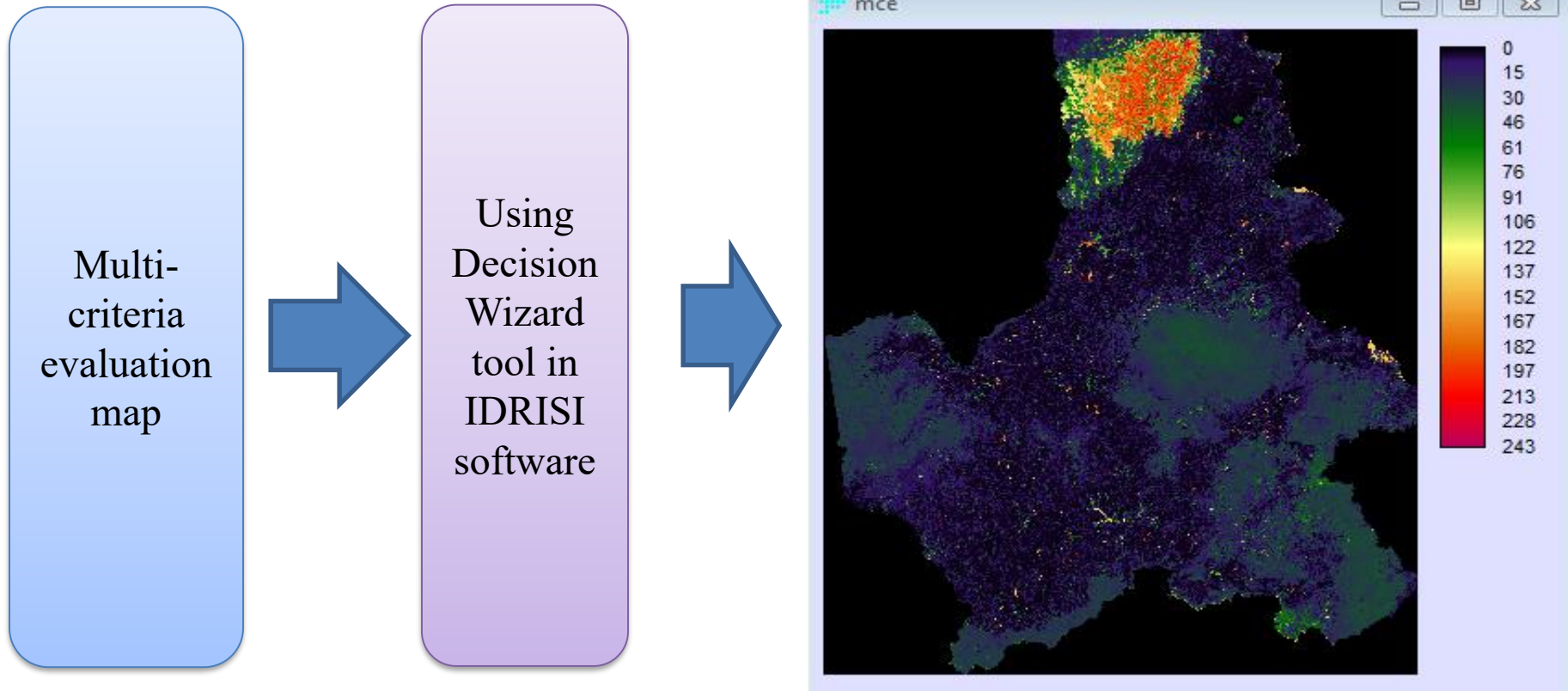




# Predicting of LULC change with CA-Markov



## Multi-criteria evaluation map (MCE)



**MCE image of influencing factors**



## Predicting of LULC change with CA-Markov



CA-Markov proven as an useful tool to predict future land use/land cover (Behera et al., 2012). In this area, transition matrix of Markov to predict LULC 2017 using LULC map of 2008 and 2014 and the LULC maps of 2014 and 2017 were used to determine transition matrix of LULC 2026.

### Transition matrix of Markov prediction to 2017 based on LULC maps 2008 and 2014

LULC	Agriculture	Dipterocar	EverGreen	Others	Planntation	Residential	Rubber	Semi-EverGreen	Water
Agriculture	0.8531	0.0001	0.0417	0.0453	0.0186	0.0158	0.0183	0	0.007
Dipterocar	0.2061	0.4501	0	0.3107	0	0.0007	0.0004	0.0321	0
EverGreen	0.1059	0	0.8539	0.0112	0.0204	0	0.0005	0.0013	0.0067
Others	0.5142	0.0736	0.0994	0.2085	0.0166	0.0072	0.0172	0.0581	0.0051
Planntation	0.6086	0	0.1131	0.0032	0.2632	0	0.0024	0	0.0096
Residential	0.4789	0.0003	0	0.037	0	0.4738	0.0077	0	0.0022
Rubber	0.6075	0	0.231	0.0614	0.023	0	0.0746	0.001	0.0015
Semi-EverGreen	0	0.0067	0.0369	0.1208	0	0	0	0.8356	0
Water	0.1884	0	0.0139	0.0174	0.0029	0.0063	0	0	0.7711



# Predicting of LULC change with CA-Markov



## Transition matrix of Markov prediction to 2026 based on LULC maps 2014 and 2017

LULC	Agriculture	Dipterocar	EverGreen	Others	Planntation	Residential	Rubber	Semi- EverGree n	Water
Agriculture	0.7688	0.0006	0.0397	0.1227	0.0054	0.025	0.0247	0.0005	0.0126
Dipterocar	0.2771	0.3018	0.0039	0.3441	0.0005	0.004	0.0042	0.0601	0.0042
EverGreen	0.2773	0.0003	0.6309	0.0519	0.0107	0.0032	0.0121	0.0023	0.0114
Others	0.5849	0.0548	0.0674	0.1849	0.0069	0.0149	0.0226	0.0534	0.0103
Planntation	0.6541	0.0001	0.0663	0.1237	0.1208	0.0064	0.0104	0.001	0.0173
Residential	0.4532	0	0.004	0.0798	0.0003	0.4315	0.024	0	0.0074
Rubber	0.6981	0.0001	0.1088	0.1071	0.0067	0.0102	0.0604	0.0019	0.0066
Semi-EverGreen	0.0446	0.0232	0.0194	0.2183	0.0005	0.0001	0.0026	0.6911	0.0001
Water	0.2494	0.0006	0.0352	0.0408	0.0019	0.0169	0.0061	0	0.6492



# Predicting of LULC change

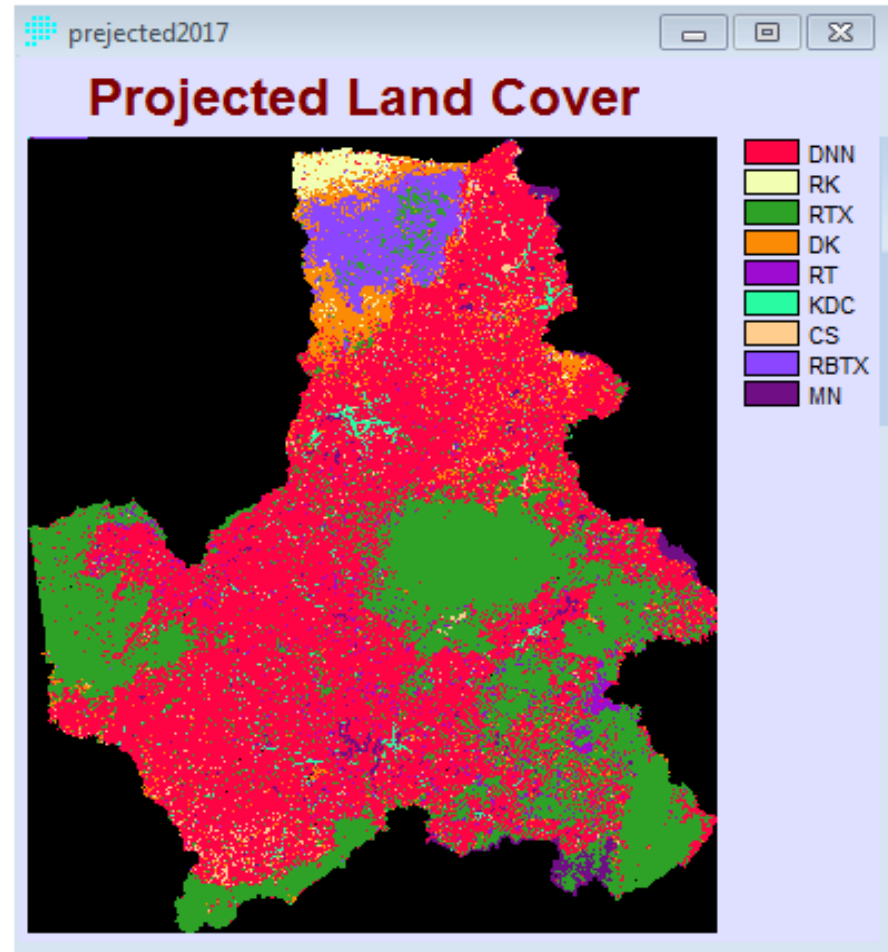
## Predicting LULC change in 2017 based on CA\_Markov chain

Classification  
image in 2014

Transition  
matrix 2017

Multi-criteria  
evaluation  
image (MCE)

CA\_Markov



**Results of land use/land cover forecast for 2017**

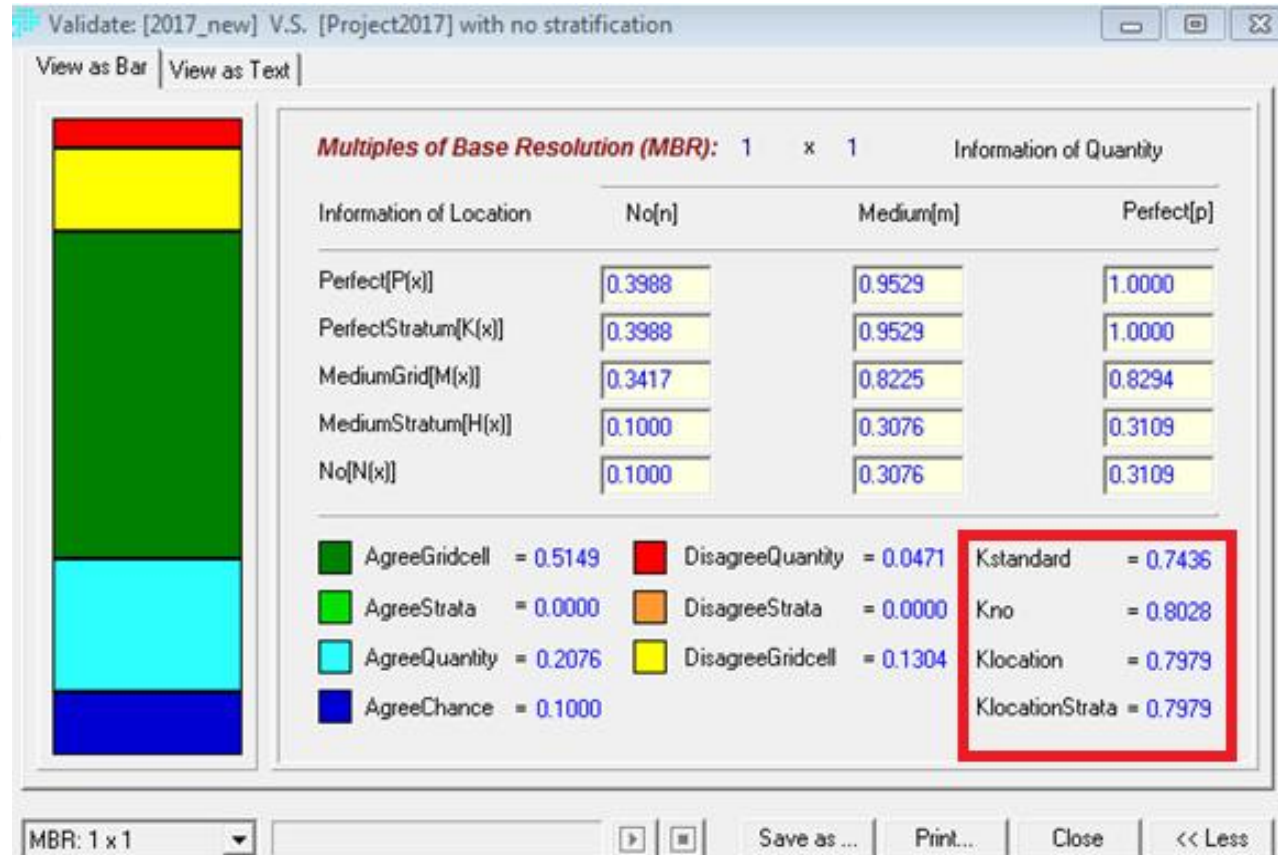
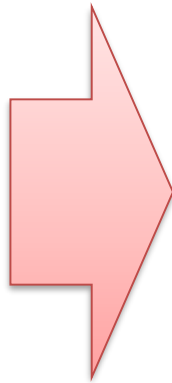




# Validation of the model LULCC prediction For 2017



Using Validate  
tool in IDRISI  
software to  
compare  
classification  
image and  
forecast image  
in 2017



Comparison of actual and predict LULC image in 2017





# Predicting area of types of LULC in 2026

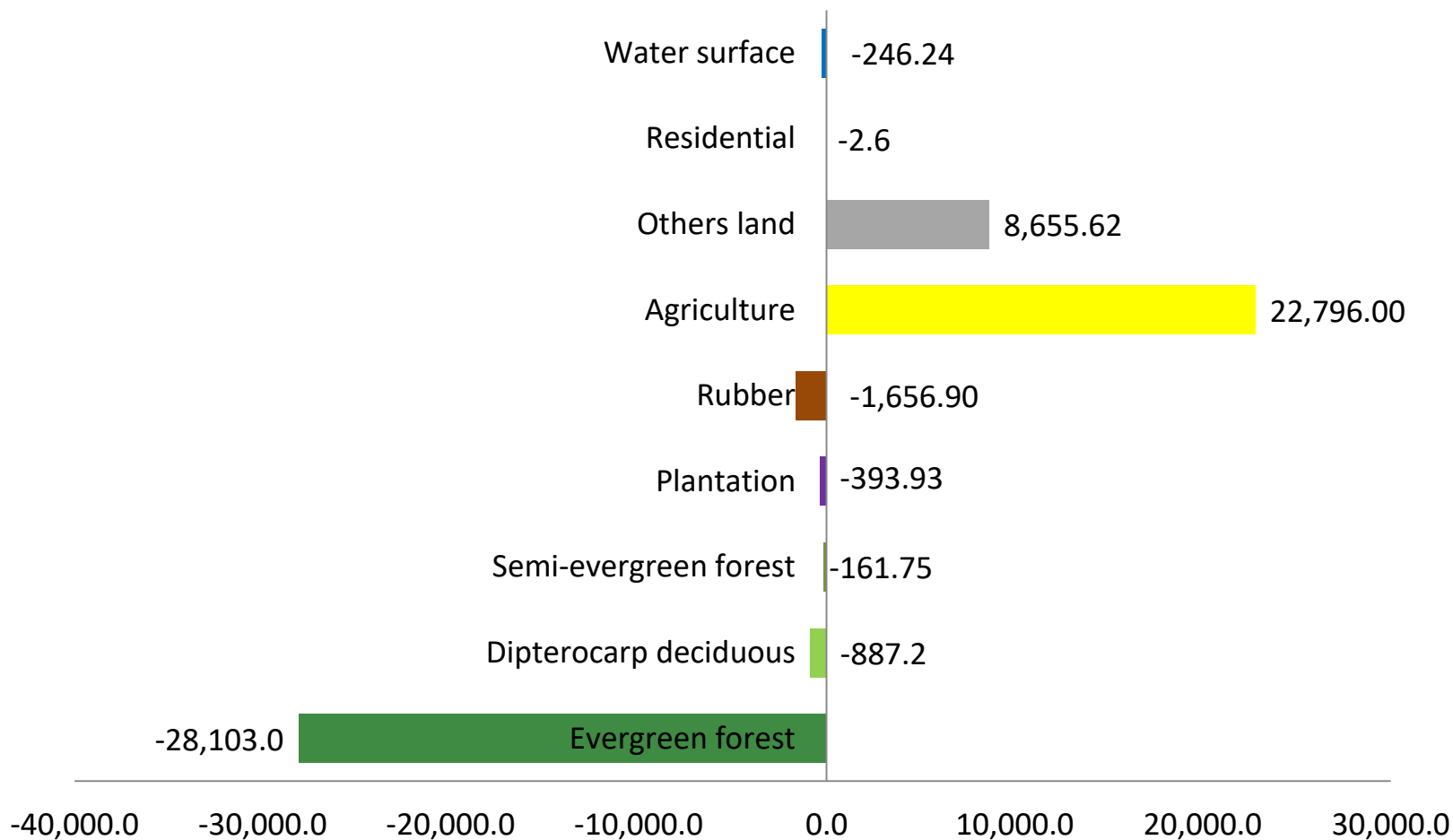
Compare LULC prediction results in 2026 with the LULC classification image in 2017

LULC	Classified image 2017	Predicted image 2026	Forecast of changes	
	Area (ha)	Aarea (ha)	Area (ha)	Percent (%)
Evergreen forest	182.064,00	153.961,00	-28.103,00	-15,44
Dipterocarp deciduous	29.189,00	28.301,80	-887,20	-0,49
Semi-evergreen forest	8.778,96	8.617,21	-161,75	-0,09
Plantation	5.442,03	5.048,10	-393,93	-0,22
Rubber	13.984,00	12.327,10	-1.656,90	-0,91
Agriculture	323.859,00	346.655,00	22.796,00	12,50
Others land	66.898,30	75.553,92	8.655,62	4,75
Residential	11.552,70	11.550,10	-2,60	0,001
Water surface	10.396,54	10.150,30	-246,24	-0,14
Total	652.164,53	652.164,53		



**USAID**  
FROM THE AMERICAN PEOPLE

## LULC change is predicted for year 2026 (ha)





## Predicting forest area in 2026

- The forecast results show that natural forests are likely to continue to decline in the future.
- By 2026, the total forest area may be reduced by more than 29.000ha, equivalent to 16.24% compared to 2017, especially evergreen forest is reduced by 15.44%.
- Total forest area may be only 195,928.11 ha, (30.04%), of which:
  - evergreen forest: 153,961.00 ha (23.61%),
  - dipterocarp forest: 28,301.80 ha (4.34%);
  - semi-evergreen forest: 8,617.21 ha (1.32%),
  - Planted forest: 5,048.10 ha (0.77%),



# Conclutions



- An object-oriented approach improved the accuracy compared to the Maximum Likelihood classification method with high resolution image of Landsat.
- In nearly 30 years, the natural forest area has decreased by 54%, ie., the coverage of natural forest was only 34% in 2017 compared to the one in 1989 with 88%.
- The analysis of LULC change shows natural forest has been decreasing and the predictions show this cover would continue reducing in the future. The projected results of LULC year 2026 indicates that total area of natural forest would dramatically decrease (about 29,000ha) if we have no suitable way to manage the remaining natural forests.
- The evident and the prediction will be a useful information for strategies for FLR.



A large, vibrant green fern frond is the central focus, growing from a tree trunk in a dense, sun-dappled forest. The frond has many long, pointed leaflets radiating from a central point. The background is filled with the trunks and foliage of other trees, creating a lush, green environment. Sunlight filters through the canopy, creating bright highlights and deep shadows.

Thank you!

Salamat!

Cảm ơn!