



Land Cover and Land Use Change (LCLUC) Dynamics in South and South East Asia (SSEA)

Atul Jain

Department of Atmospheric Sciences
University of Illinois, USA

Acknowledgements

Science Team Members

&

NASA LCLUC Program

Team Members

Lead PI

Atul K Jain (University of Illinois)

Co-Investigators

Ruth DeFries (Columbia University), Jefferson M. Fox (East-West Center), Brian O'Neill, (NCAR), Karen Seto (Yale University), Ramakrishna Nemani (NASA AMES), Prasad Thenkabail (USGS), Hanqin Tian (Auburn University), Hassan Virji (START), Xiangming Xiao (University of Oklahoma)

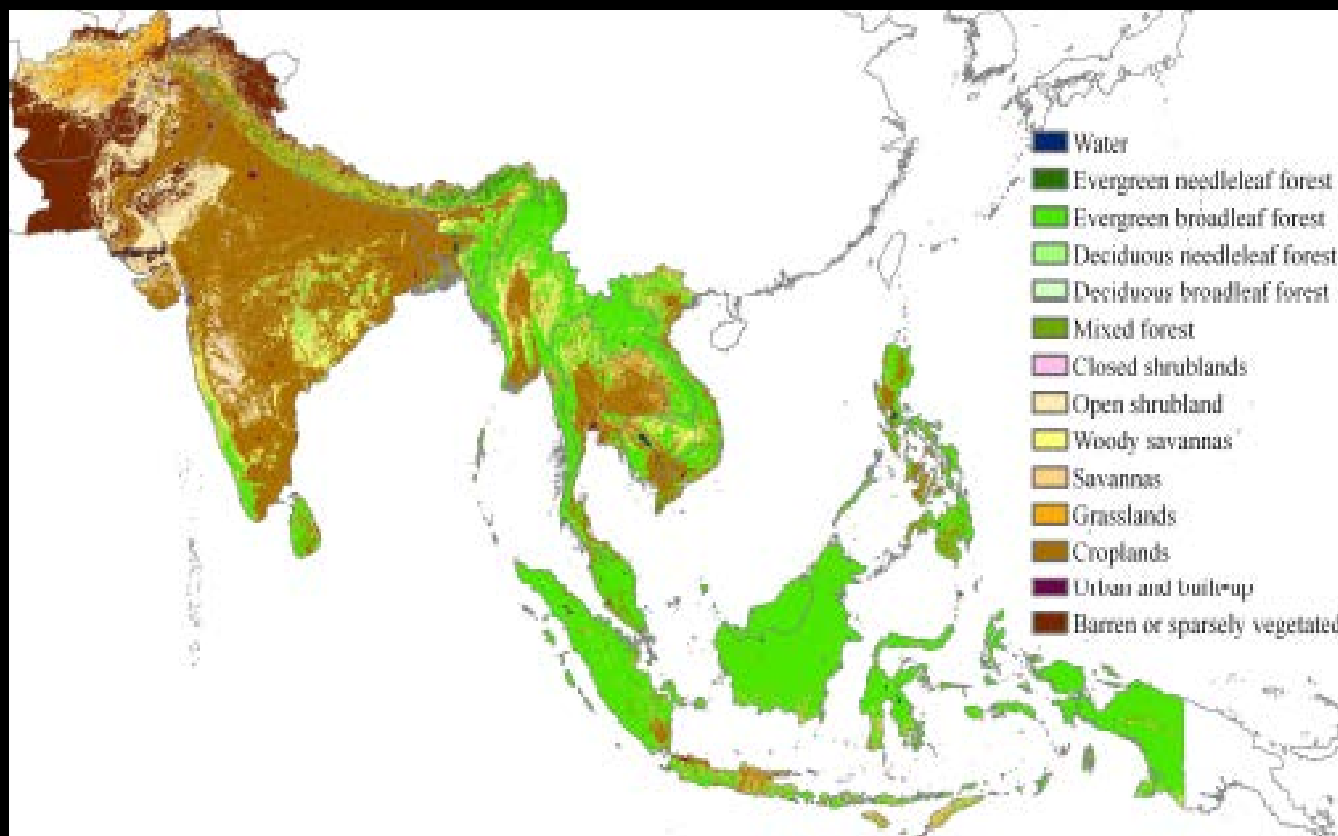
Collaborators

Nguyen Duy (Hanoi Institute of Mining), Murali Gumma (Intl Rice Research Institute), Kazuhito Ichii (Fukushima University), Etsushi Kato (Natl. Institute for Environmental Studies), P.S.Roy (Hyderabad Central University), Basanta Shrestha (ICIMOD), Rajendra Shrestha (Asian Institute of Tech.), Baktiar Siddiqui (Chittagong South Forest Division), Guido Werf (VU University)

Background

- Three principal objectives
 - *To understand the major LCLUC transition activities in the study region.*
 - *To advance our understanding of the causes of LCLUC.*
 - *To improve our understanding of the historical effects of LCLUC dynamics on the quantities and pathways of terrestrial carbon and nitrogen fluxes.*

SSEA Region



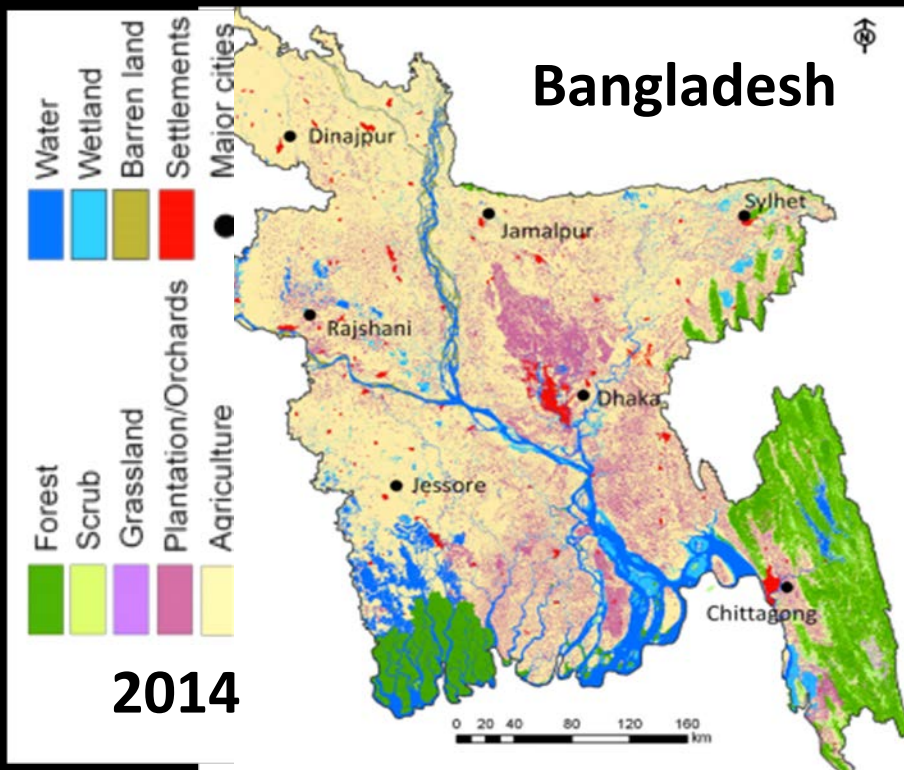
*LCLUC
distribution
in the study
region*

- The home for over 50% of the world's population
- Covers about 16% of earth's land surface
- Characterized by a long history of LCLUC activities
- *Study LCLUC dynamics country-by-country basis*

Major Accomplishments

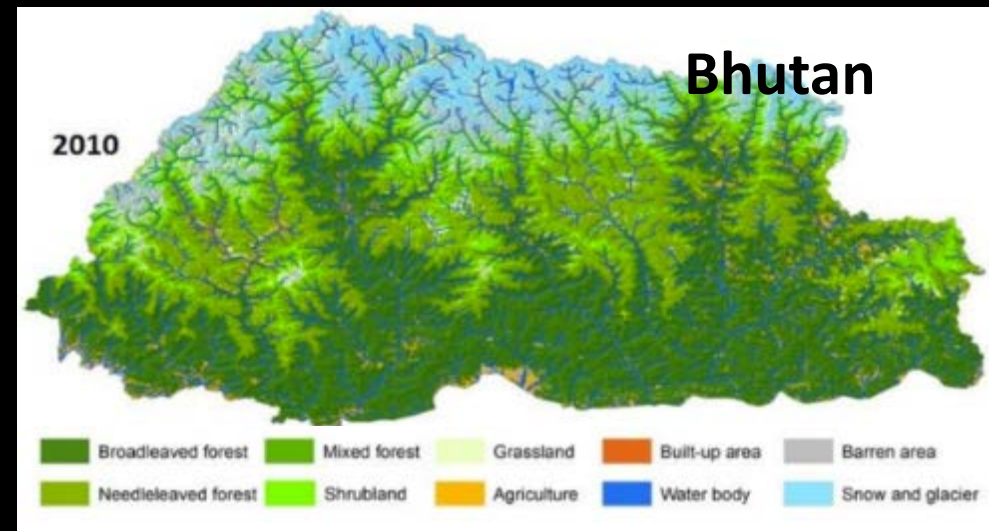
- Synthesize existing studies and the remote sensing data sets for LCLUC in the SSEA
- Estimate the rates and geographic patterns of change in forest cover, cropland and land-cover change by making use of
 - numerous local scale studies
 - national-scale forest inventory
 - agricultural census data
- Substantial progress in synthesizing the LCLUC dynamics for
 - ❖ Bangladesh
 - ❖ Bhutan
 - ❖ India
 - ❖ Indonesia
 - ❖ Nepal
 - ❖ Pakistan

Land Cover Distribution



Agriculture	62%
Plantation	12%
Forest	10%
Water	9%

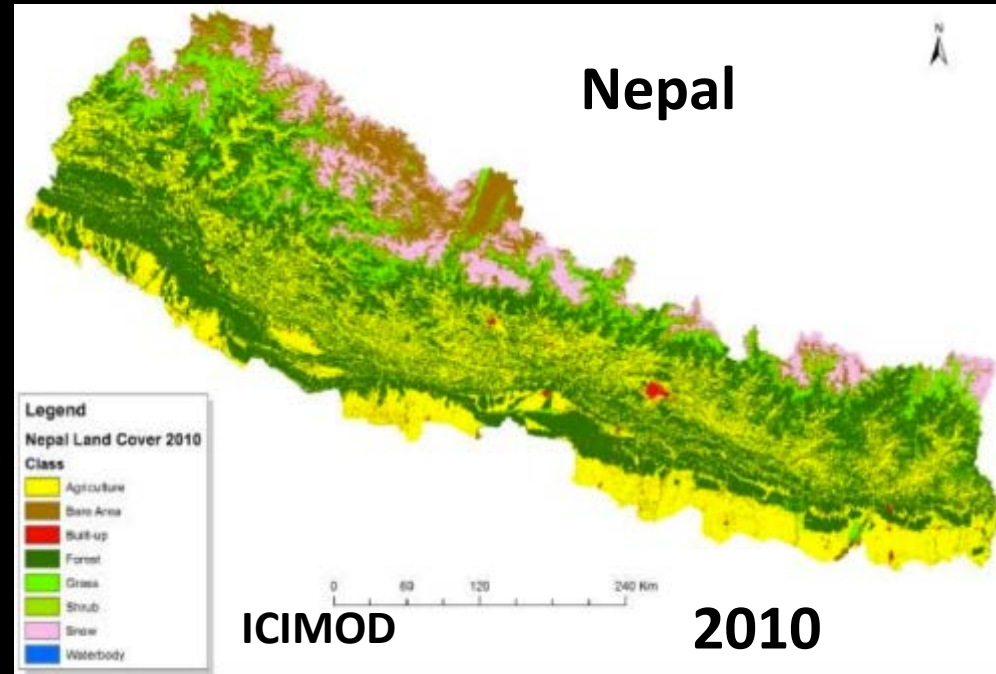
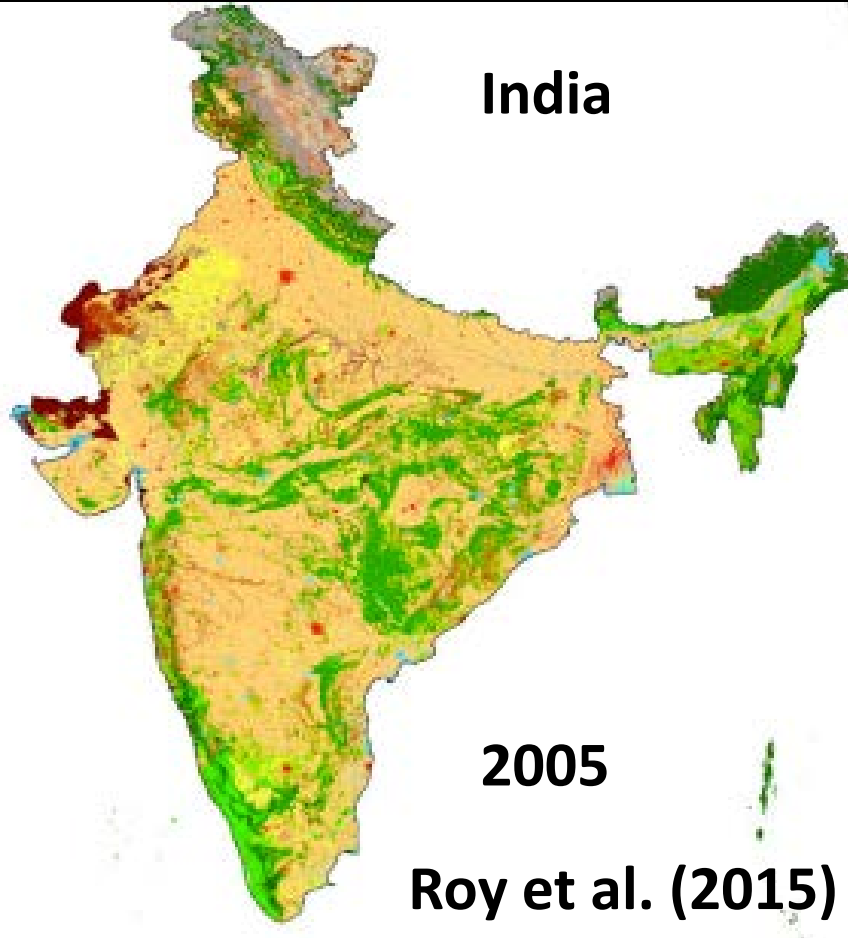
Reddy et al. (2016)



Forests	70%
Shrubs	10%
Meadows	4%
Agriculture	3%

ICIMOD and Bhutan Forestry Dept

Land Cover Distribution

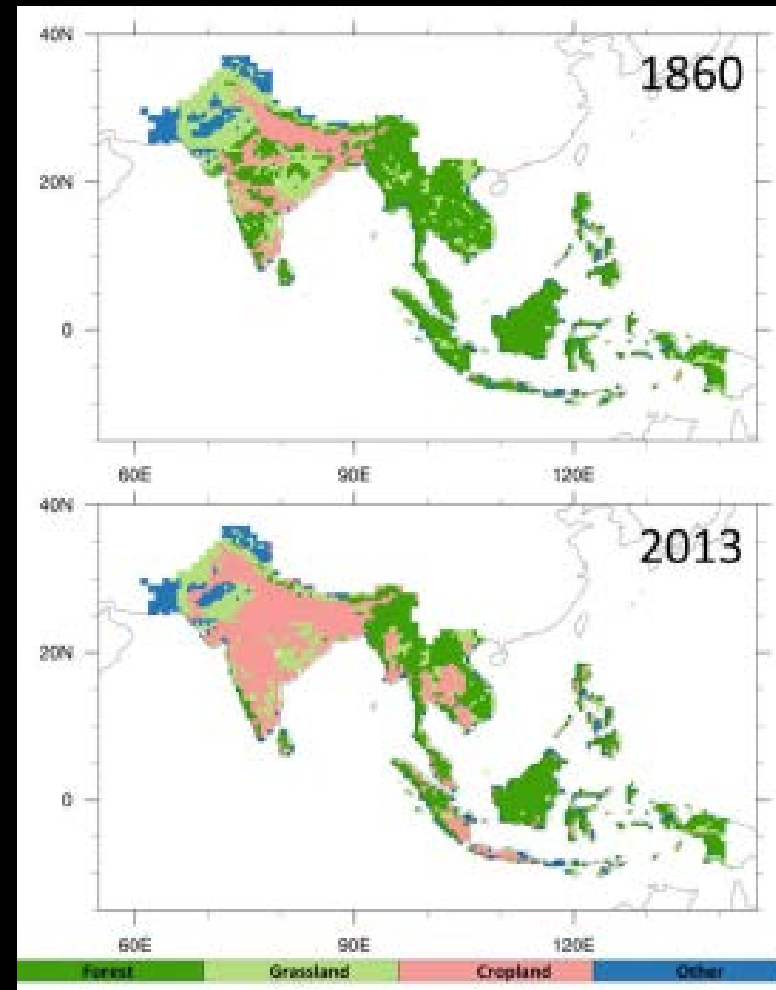


Forest	39%
Agriculture	30%
Barren area	10%
Snow/Glaciers	8%

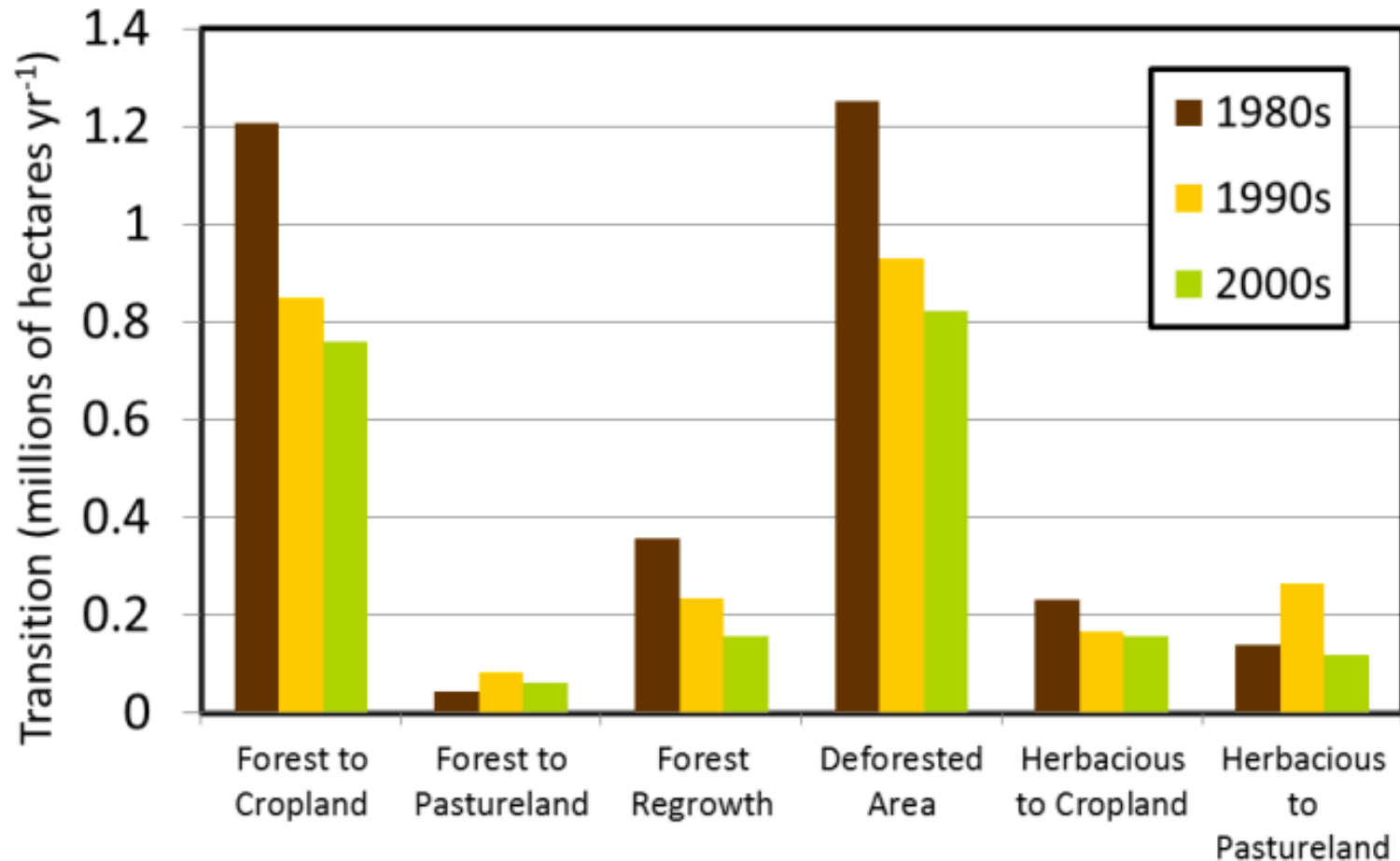
Agriculture	49%
Forest	22%
Fallow land	7%
Shrub land	5%

Dynamics of LCLUC (1860-2013)

- Major changes include:
 - increase in cropland
 - decrease in primary forest
 - Increase in secondary forest

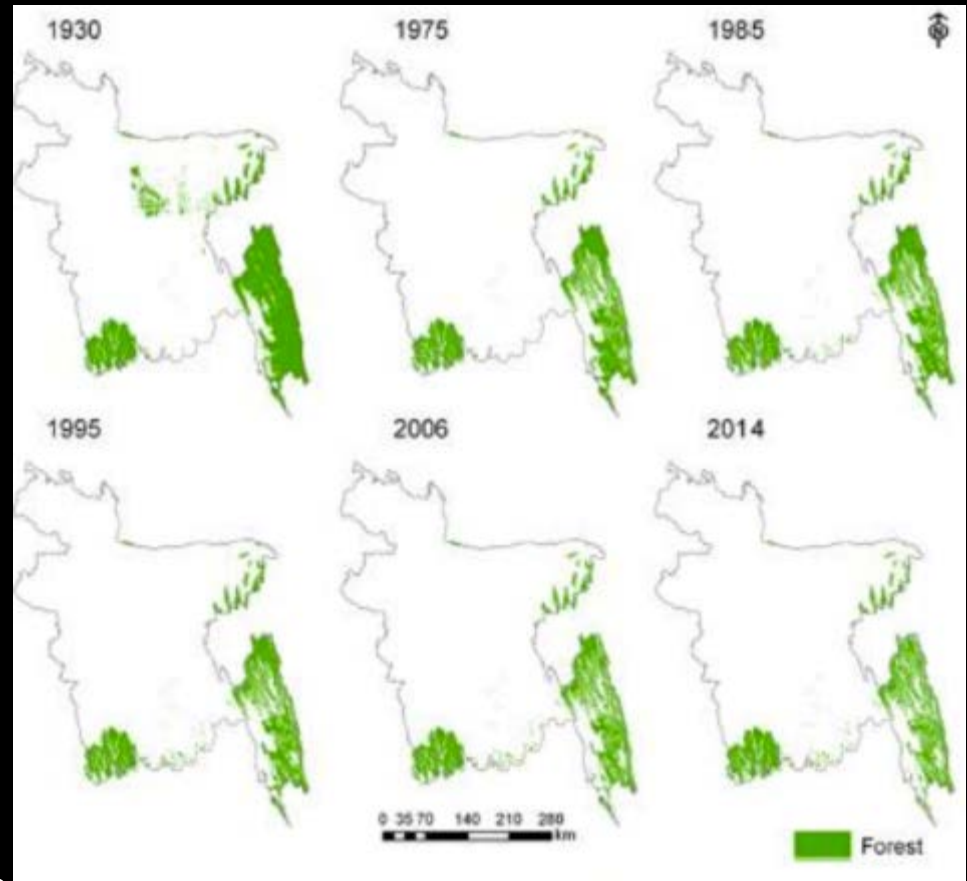


Dynamics of LCLUC in SSEA (1980s, 1990s, 2000s)



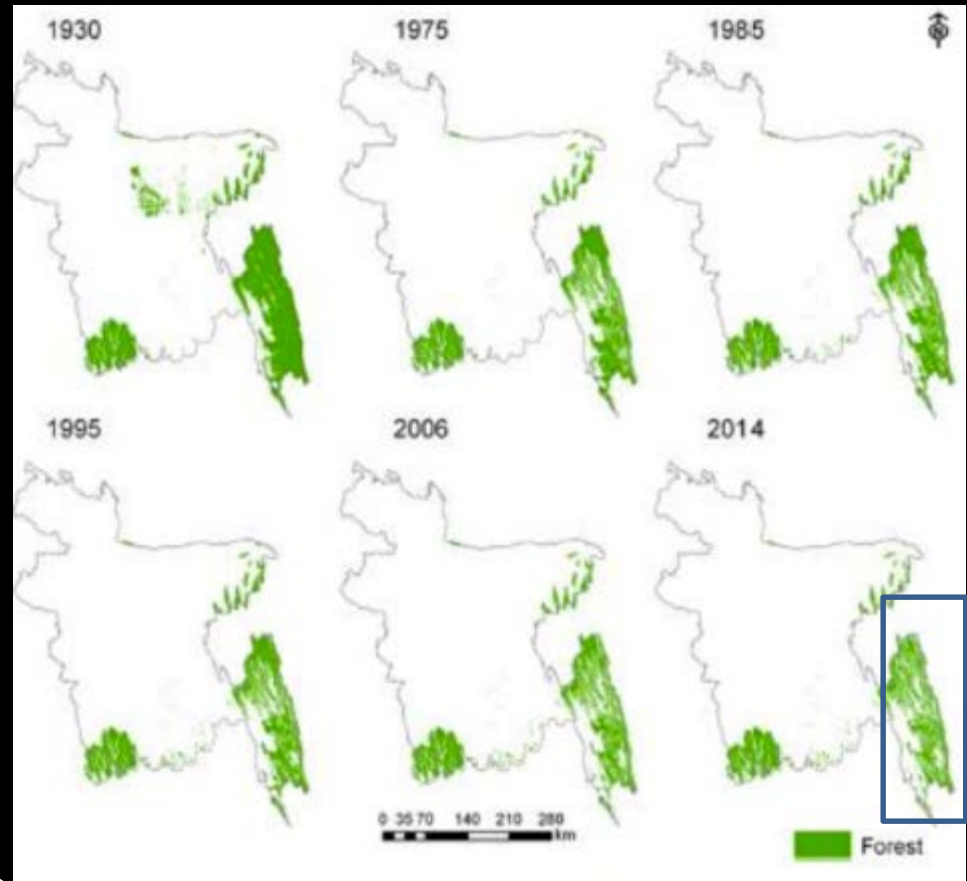
Dynamics of LCLUC - Bangladesh

- About 40% forest is lost over the period 1930-2014
- Highest net annual rate of deforestation occurred during 2006-2014 (0.75%)
- Annual deforestation rate is 1-3%, (2-5 times higher than the deforestation rates in SSEA)

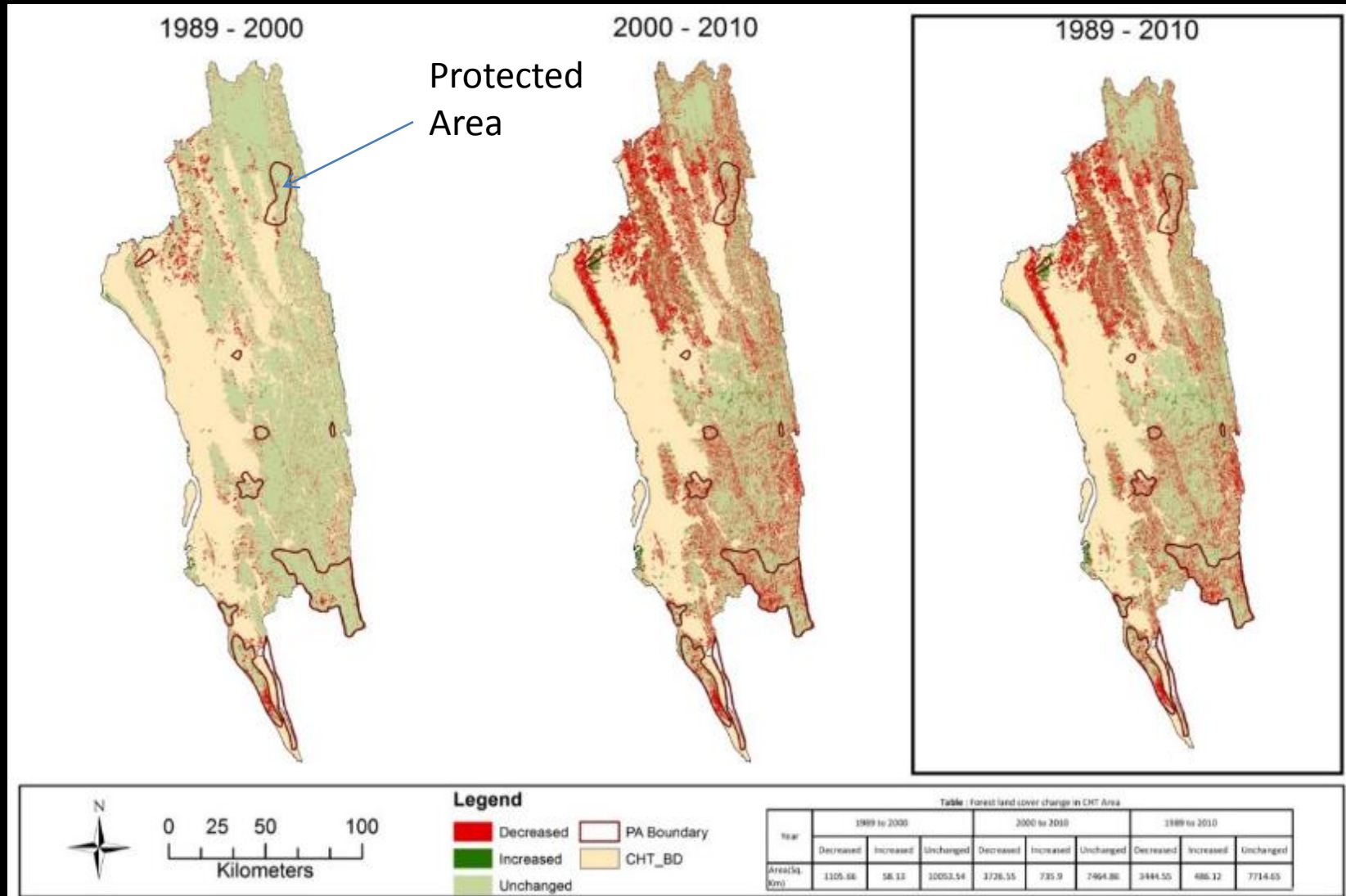


Dynamics of LCLUC - Bangladesh

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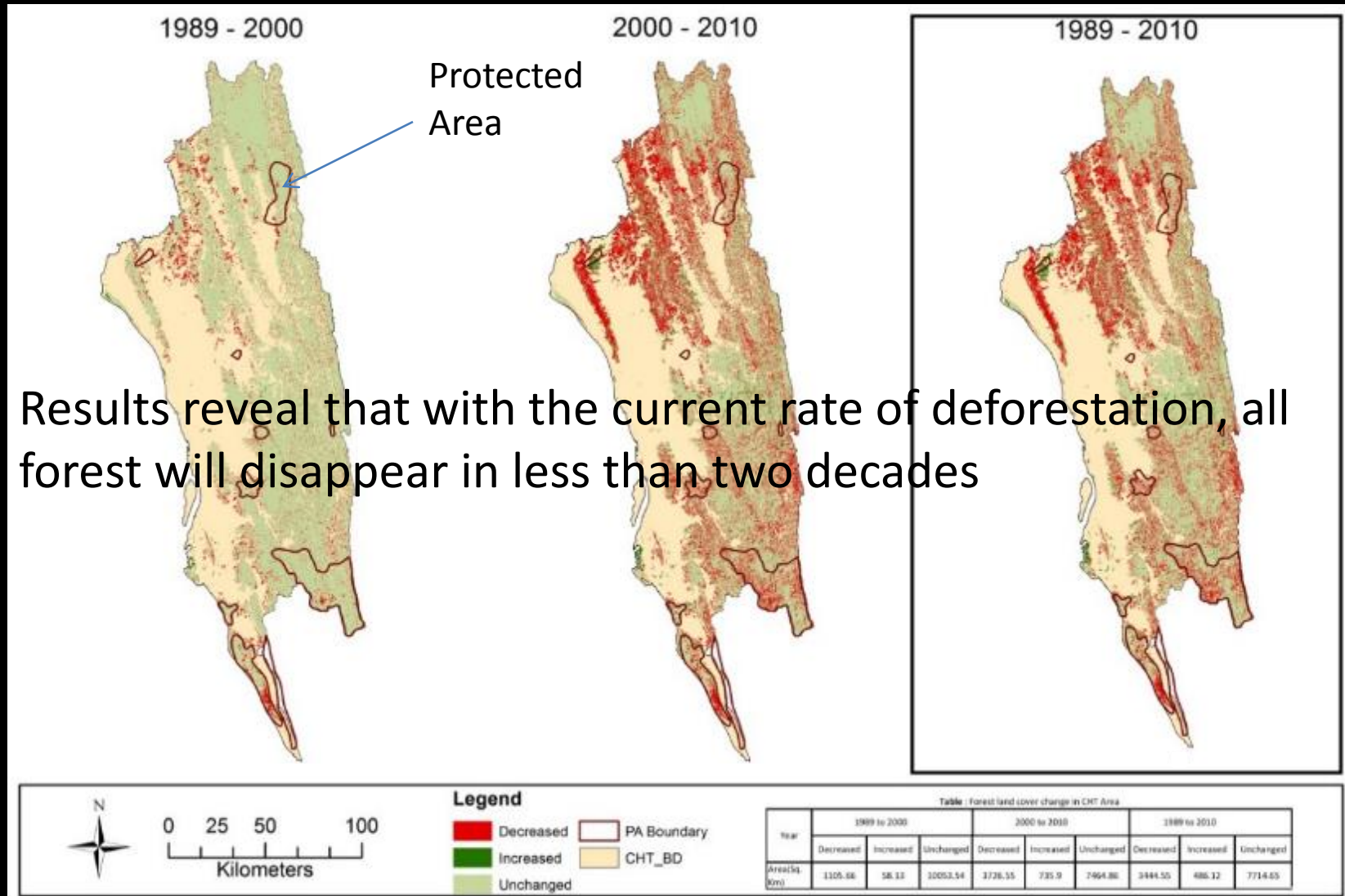


Dynamics of LCLUC - Bangladesh



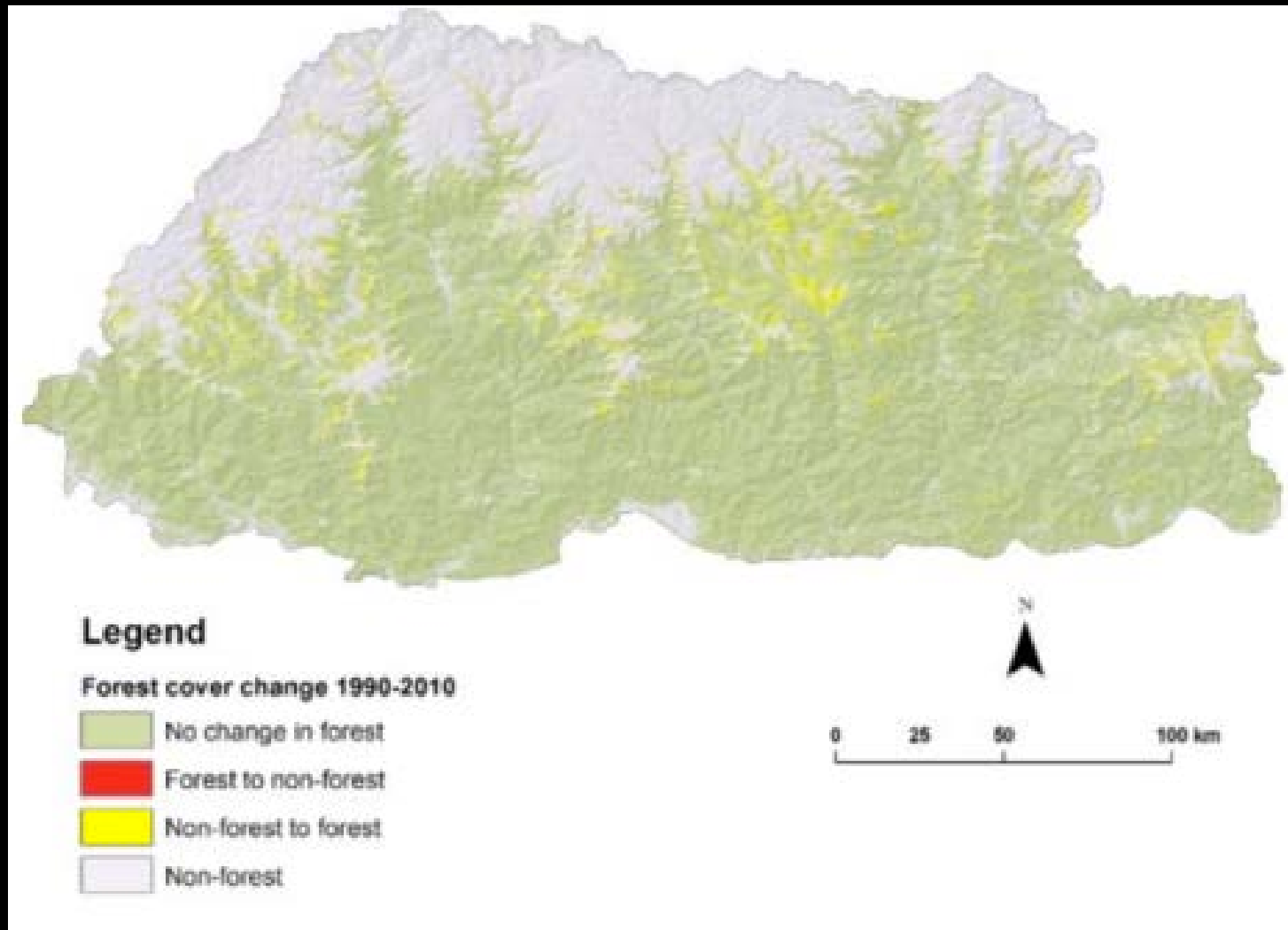
Change in forested area in Southeastern part of Bangladesh (1989-2010).
 The area shown in polygons are the PA boundaries
 (Courtesy: Hammad Gilani of ICIMOD)

Dynamics of LCLUC - Bangladesh



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Dynamics of LCLUC - Bhutan



Dynamics of LCLUC - Bhutan

Over the period 1990-2010, there is an overall increase in forest area from 67 to 70% of total land

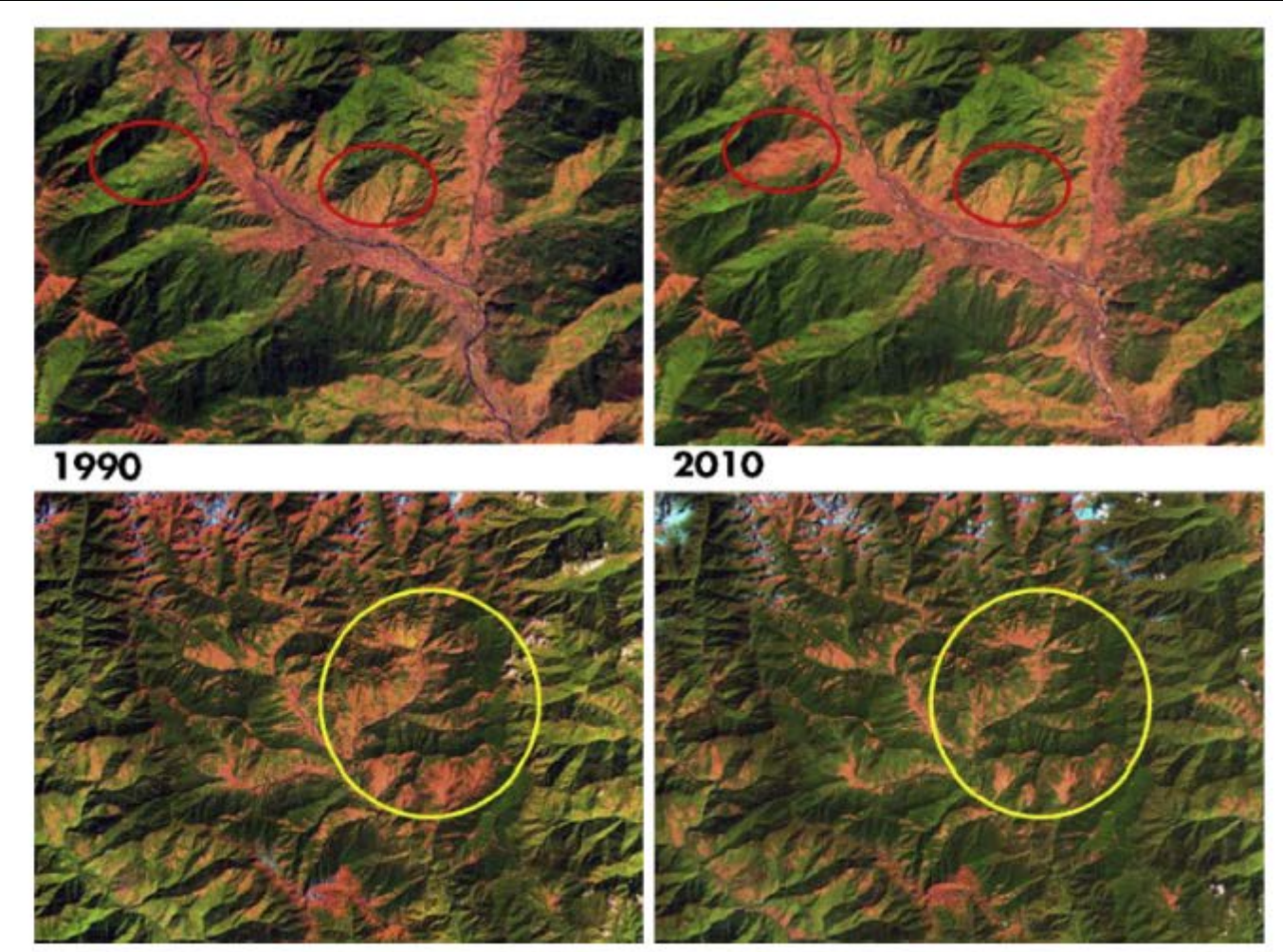
Legend

Forest cover change 1990-2010

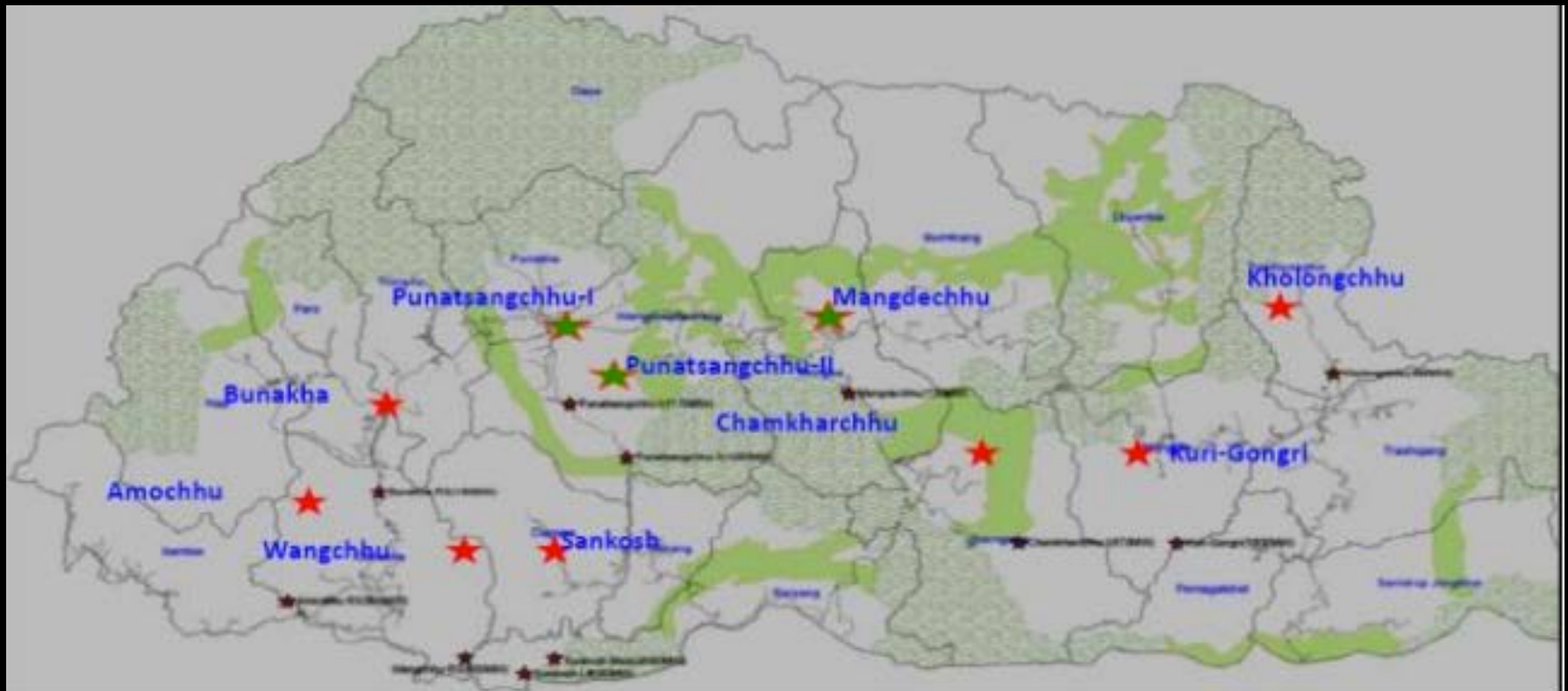
-  No change in forest
-  Forest to non-forest
-  Non-forest to forest
-  Non-forest



Forest Loss and Gain between 1990 & 2010



The Government of Bhutan aims to build 10,000 MW of hydropower



Courtesy: Lobjang Dorji of Bhutan Forest Services

Conversion of Forest to HP



Courtesy: Lobjang Dorji of Bhutan Forest Services

Conversion of Forest to HP



Courtesy: Lobjang Dorji of Bhutan Forest Services

440kV

220kV

132kV

Conversion of Forest to Transmission Lines

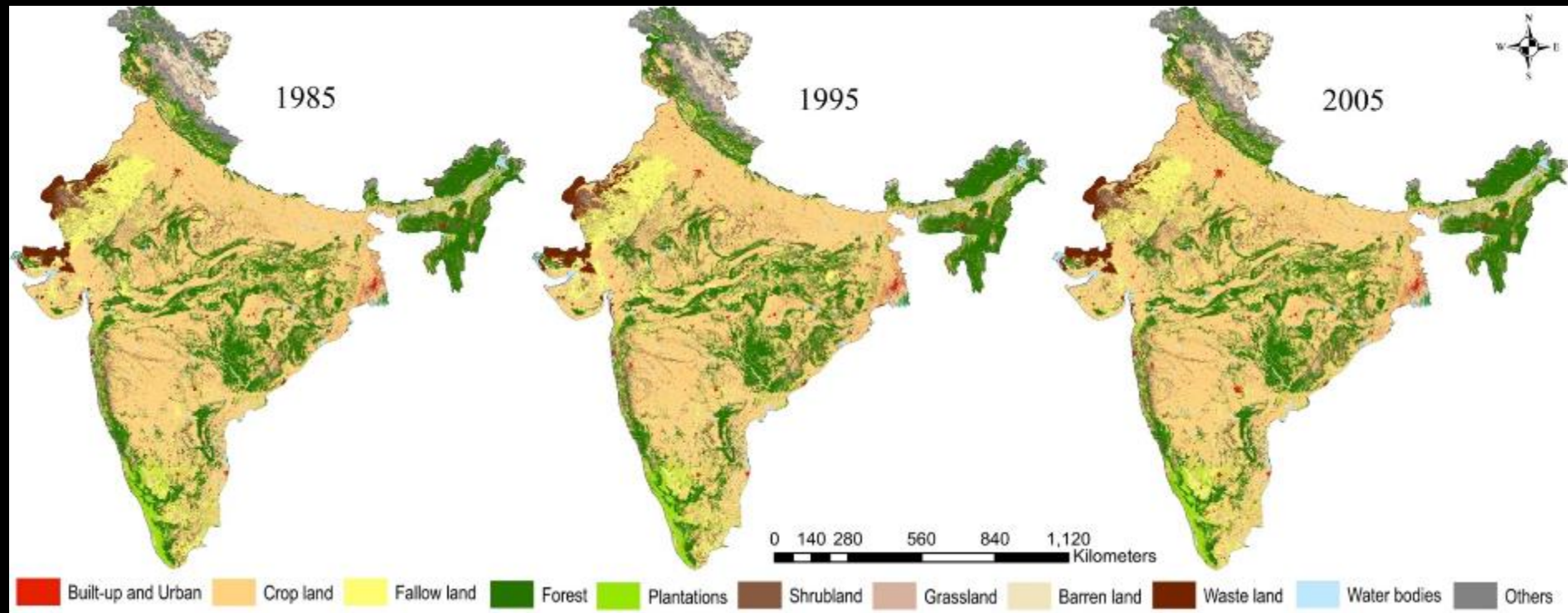


Courtesy: Lobjang Dorji of Bhutan Forest Services

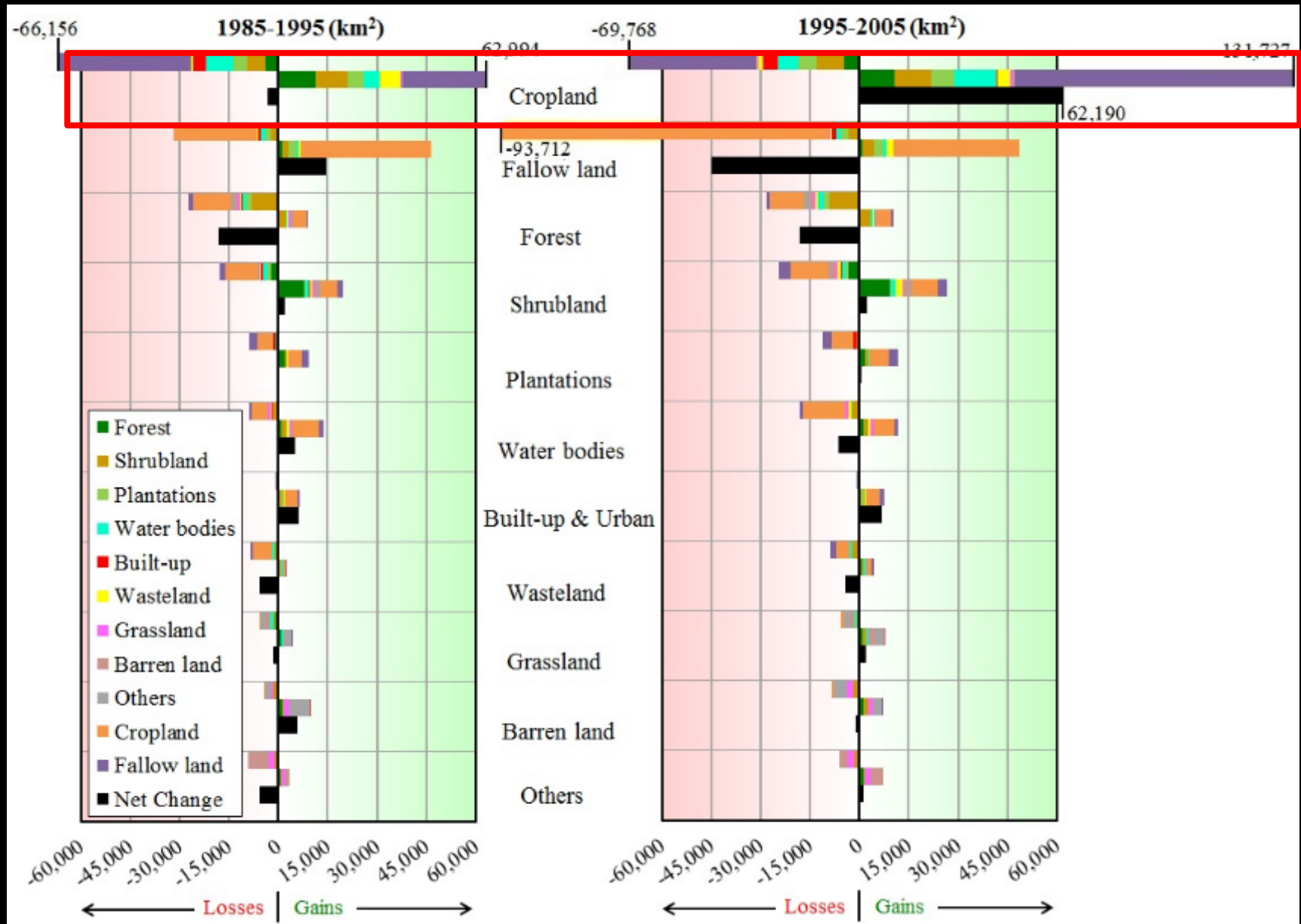
Dynamics of LCLUC - India

Wall-to-wall Landsat Analysis (30m)

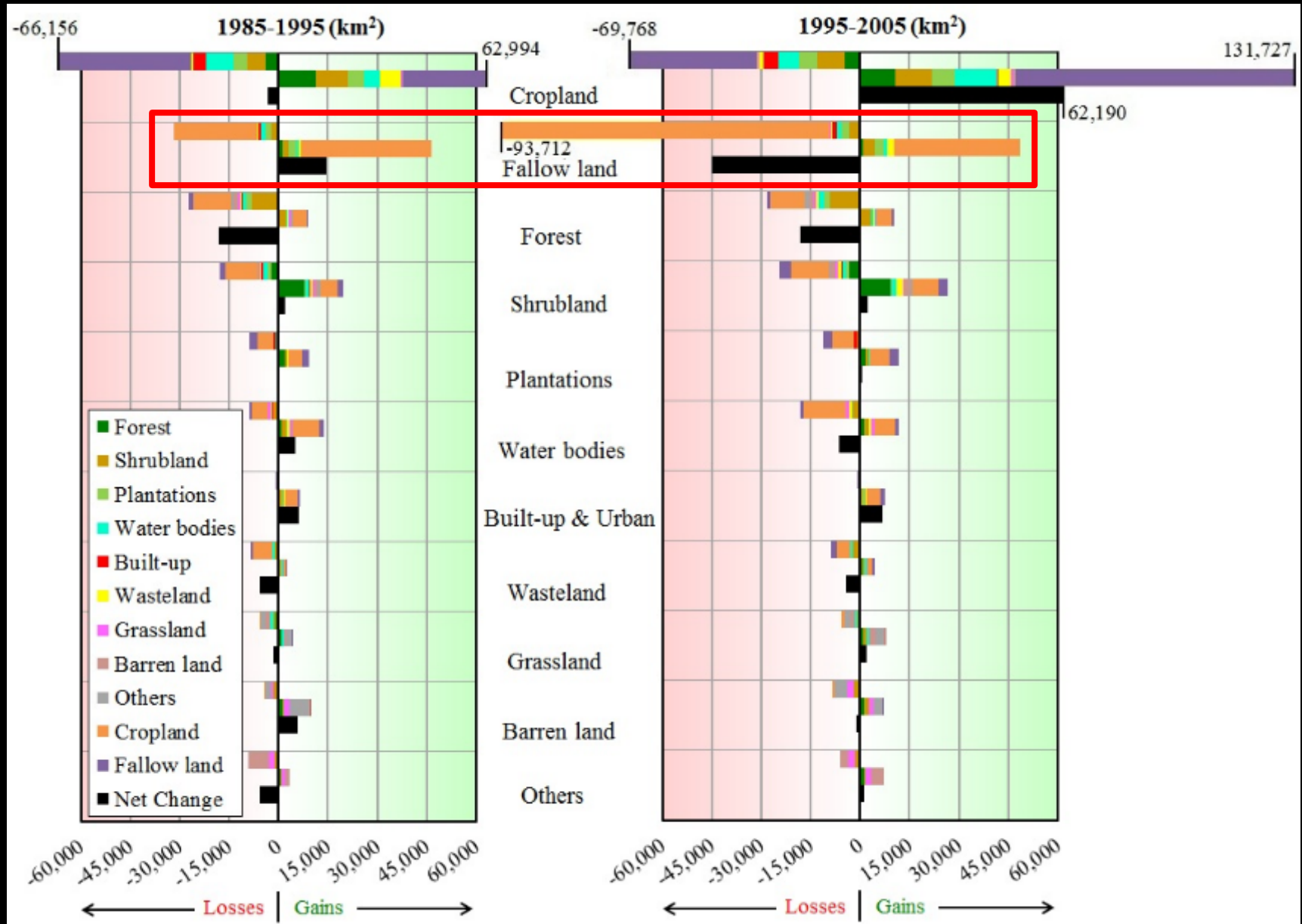
- Covers Longer Time Period: Decadal (1985-1995-2005)



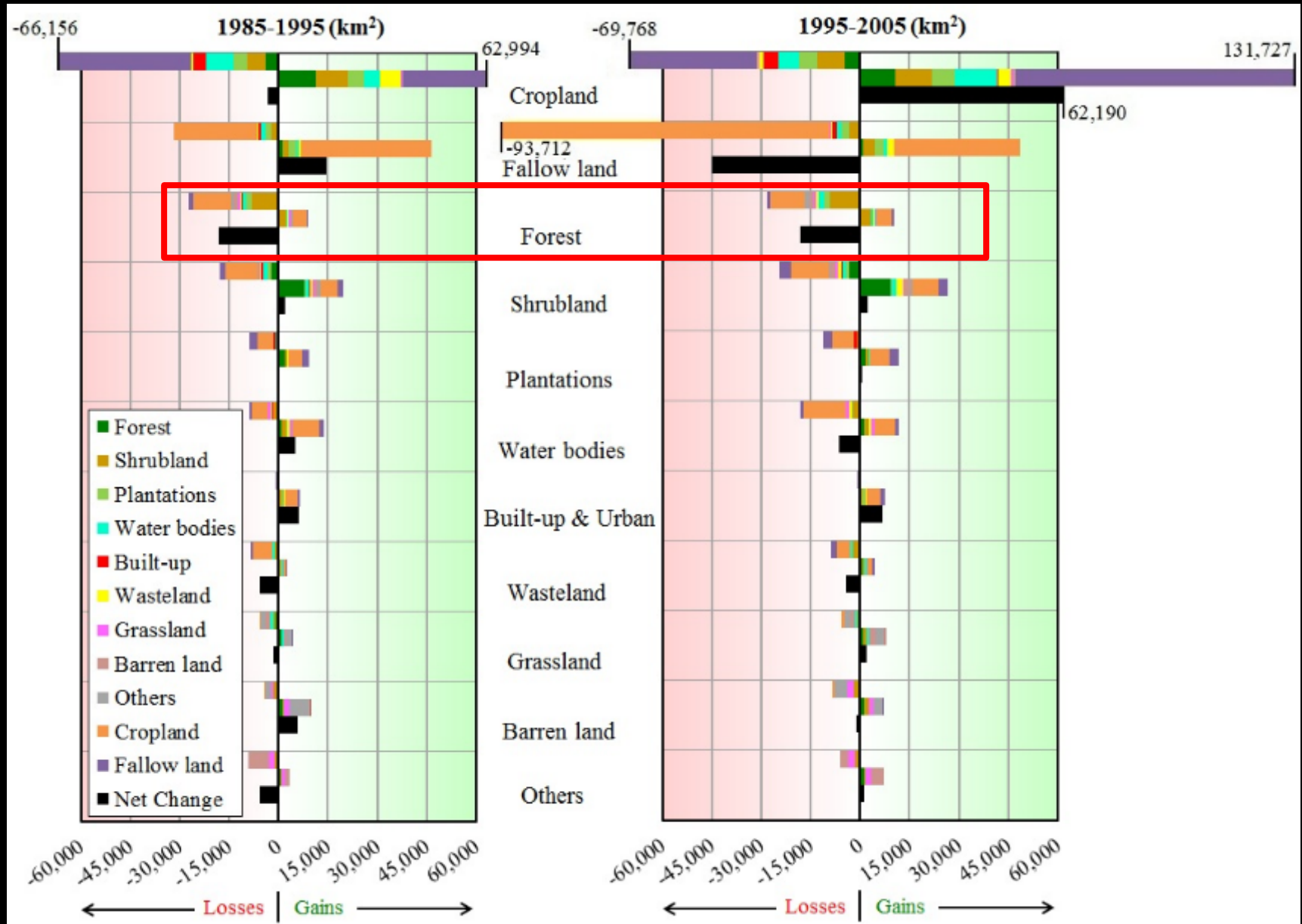
LCLUC Dynamics at National Scale



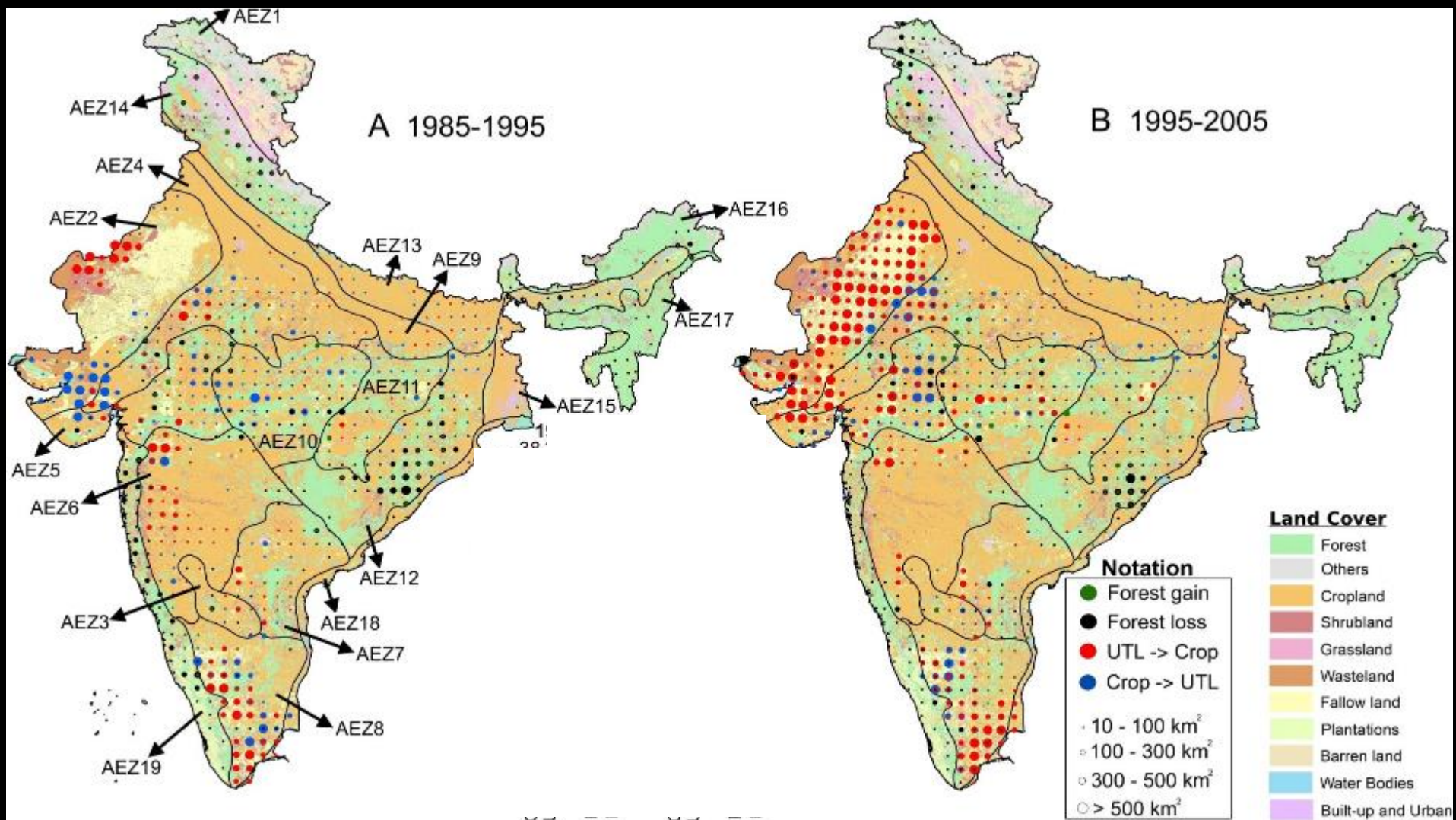
LCLUC Dynamics at National Scale



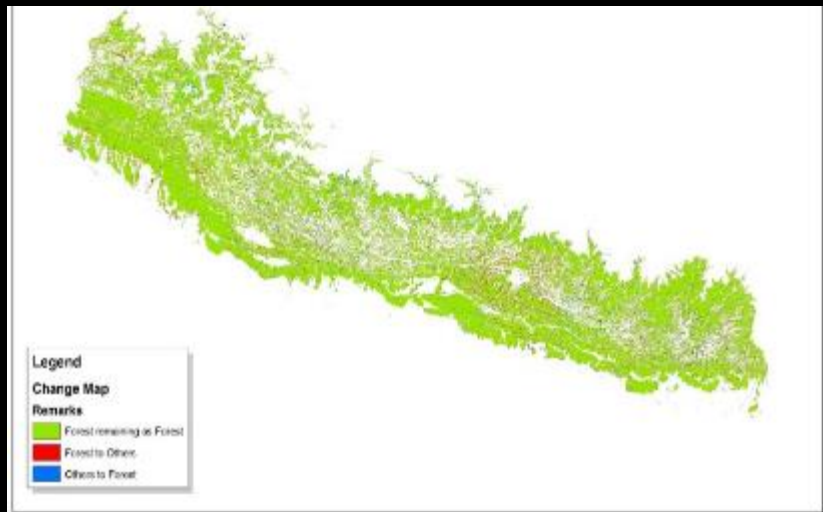
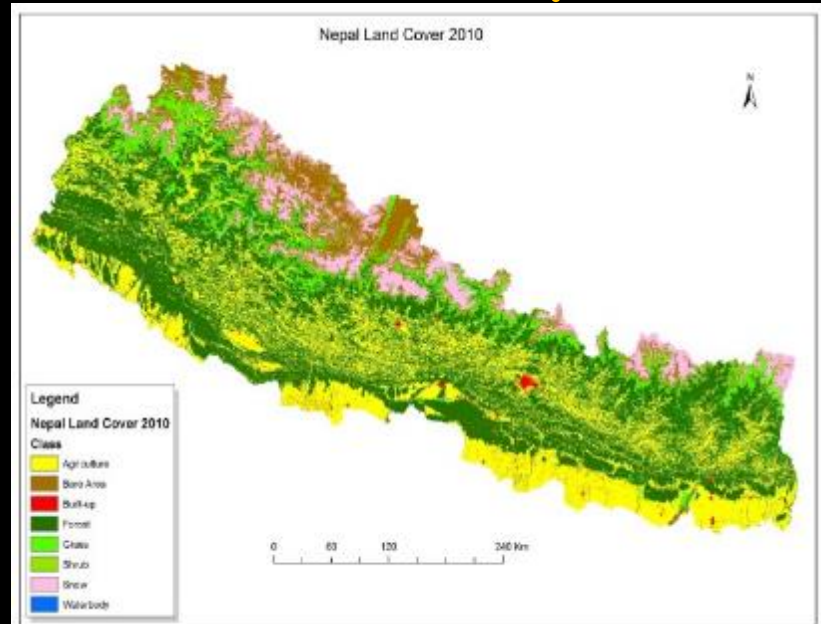
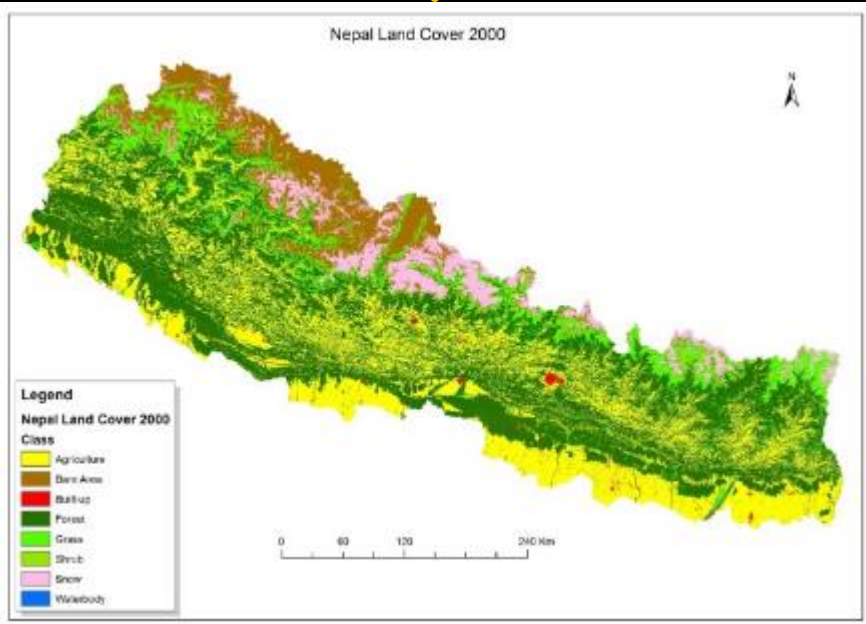
LCLUC Dynamics at National Scale



Regional LCLUC Dynamics -India



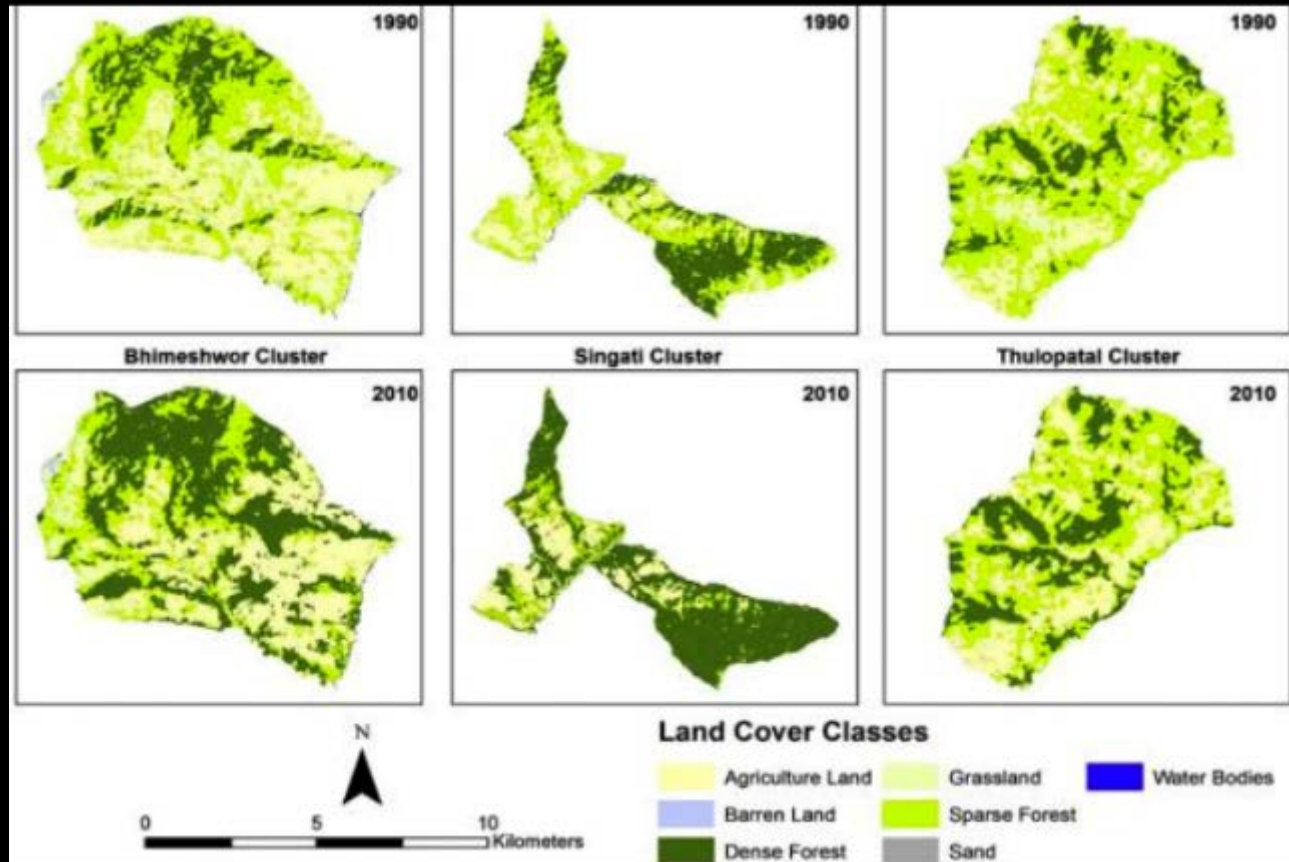
Dynamics of LCLUC - Nepal



	LC 2000	LC 2010	Change 2010-2000
Class	Area (km ²)	Area (km ²)	change Area (km ²)
Forest	61363	60984	-369
Shrub	3542	3616	74
Grass	13825	11818	-2007
Agriculture	40973	41990	1017
Bare Area	17000	15474	1526
Waterbody	726	758	32
Snow	9730	12568	2838
Built-up	475	547	72

Gilani et al. (2016)

Nepal has set an example in implementing innovative forest conservation policies through community forestry programs



Land cover changes in Dolakha District in Nepal (Mbaabu et al., 2014)

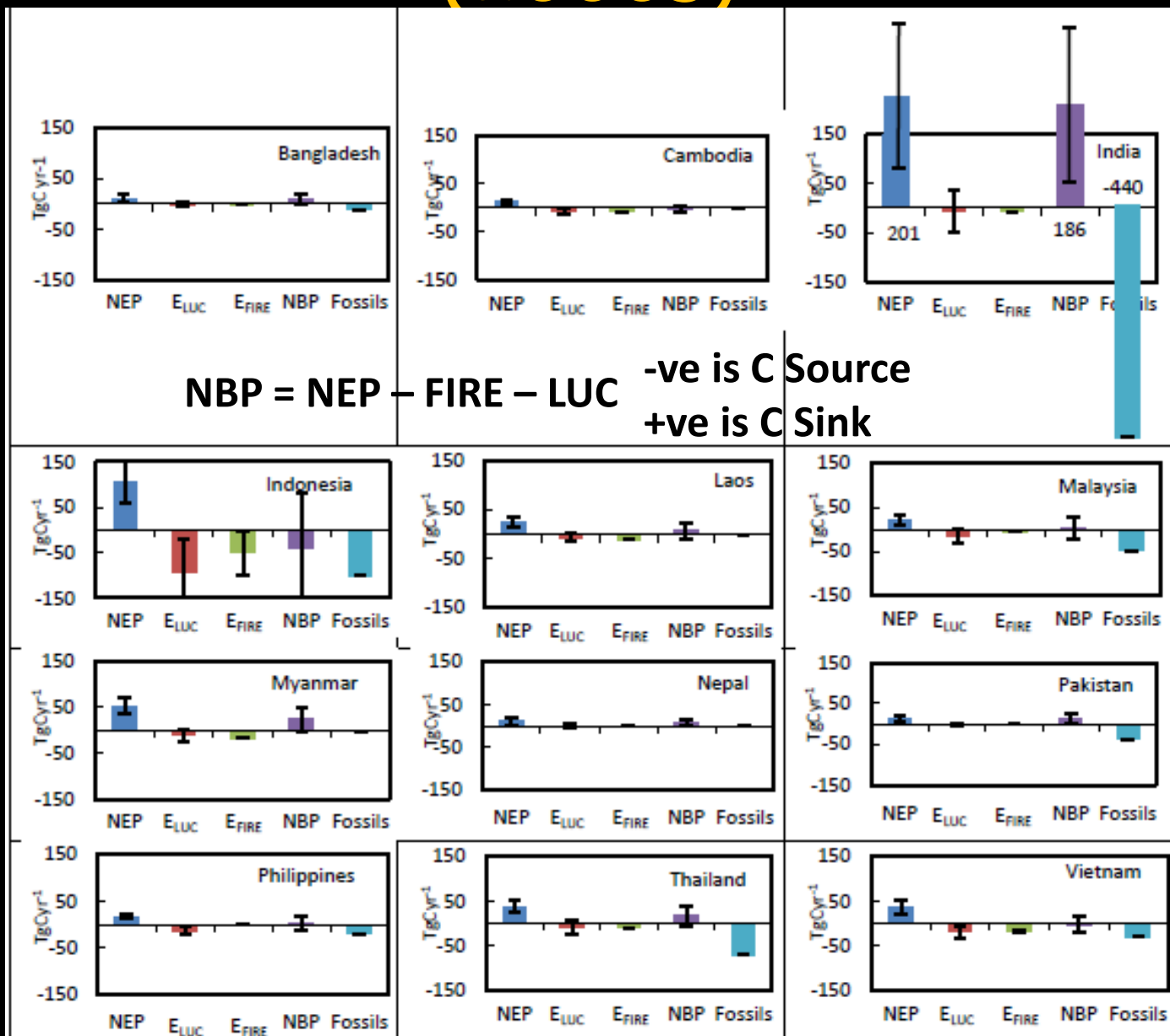
Carbon Dynamics in SSEA

The Terrestrial Carbon Budget of South and Southeast Asia

Matthew Cervarich¹, Shijie Shu¹, Atul K Jain¹, Almut Arneeth², Josep Canadell³, Pierre Friedlingstein⁴, Richard Houghton⁵, Etsushi Kato⁶, Charles Koven⁷, Prabir Patra⁸, Ben Poulter⁹, Stephen Sitch¹⁰, Beni Stocker¹¹, Nicolas Viovy¹², Andy Wiltshire¹³, Ning Zeng¹⁴

Cervarich et al. (ERL, 2016)

Carbon Budget for SSEA countries (2000s)



Global Carbon Project (GCP)

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Global Carbon Budget 2015

Global carbon budget 2014

Global carbon budget 2013

Thank You