20 YEARS OF LCLUC PROGRAM: A RETROSPECTIVE AND UPDATE

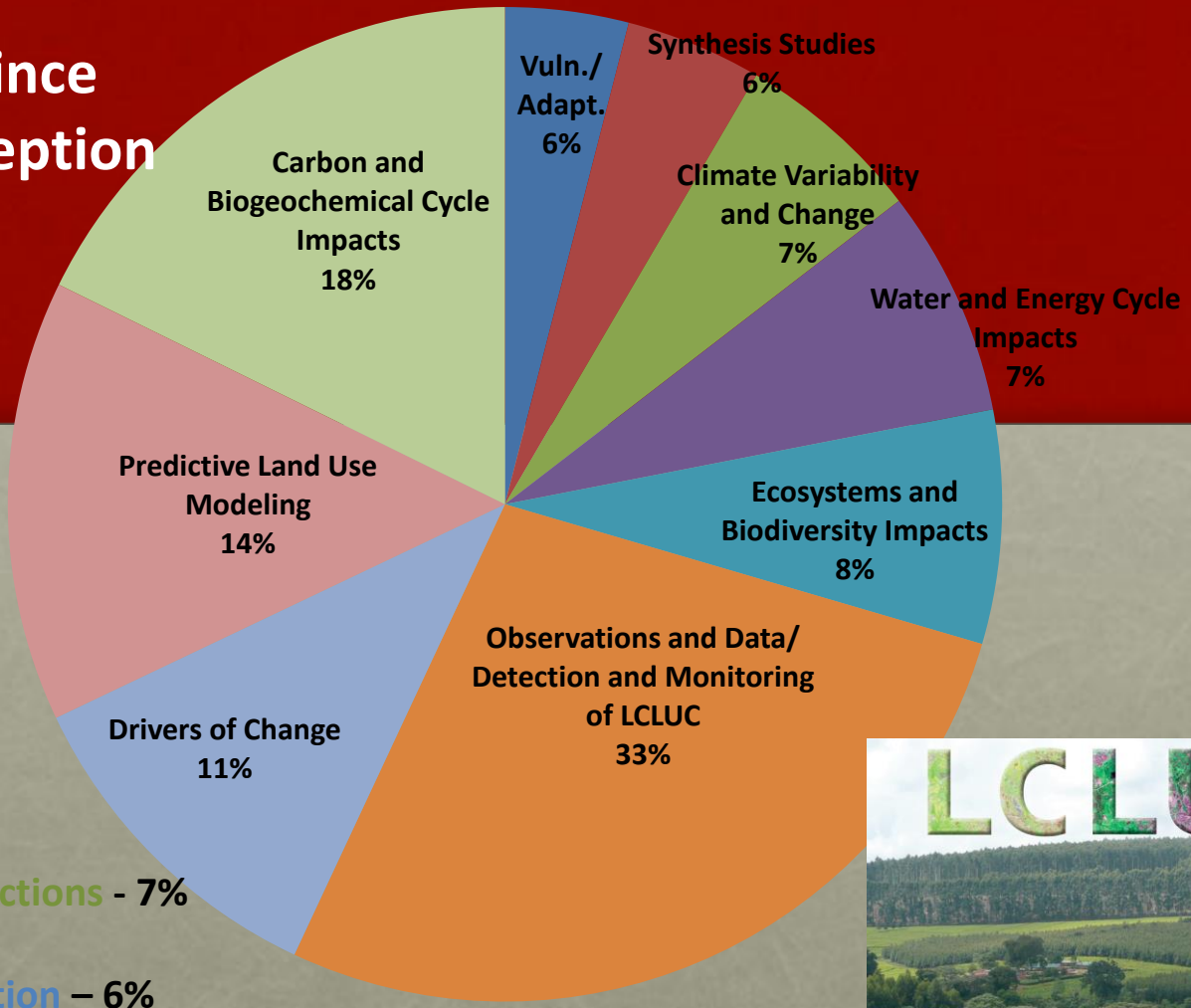
Garik Gutman,
NASA Headquarters
Manager, LCLUC Program

20th Anniversary Celebration

April 2016

LCLUC Program Content

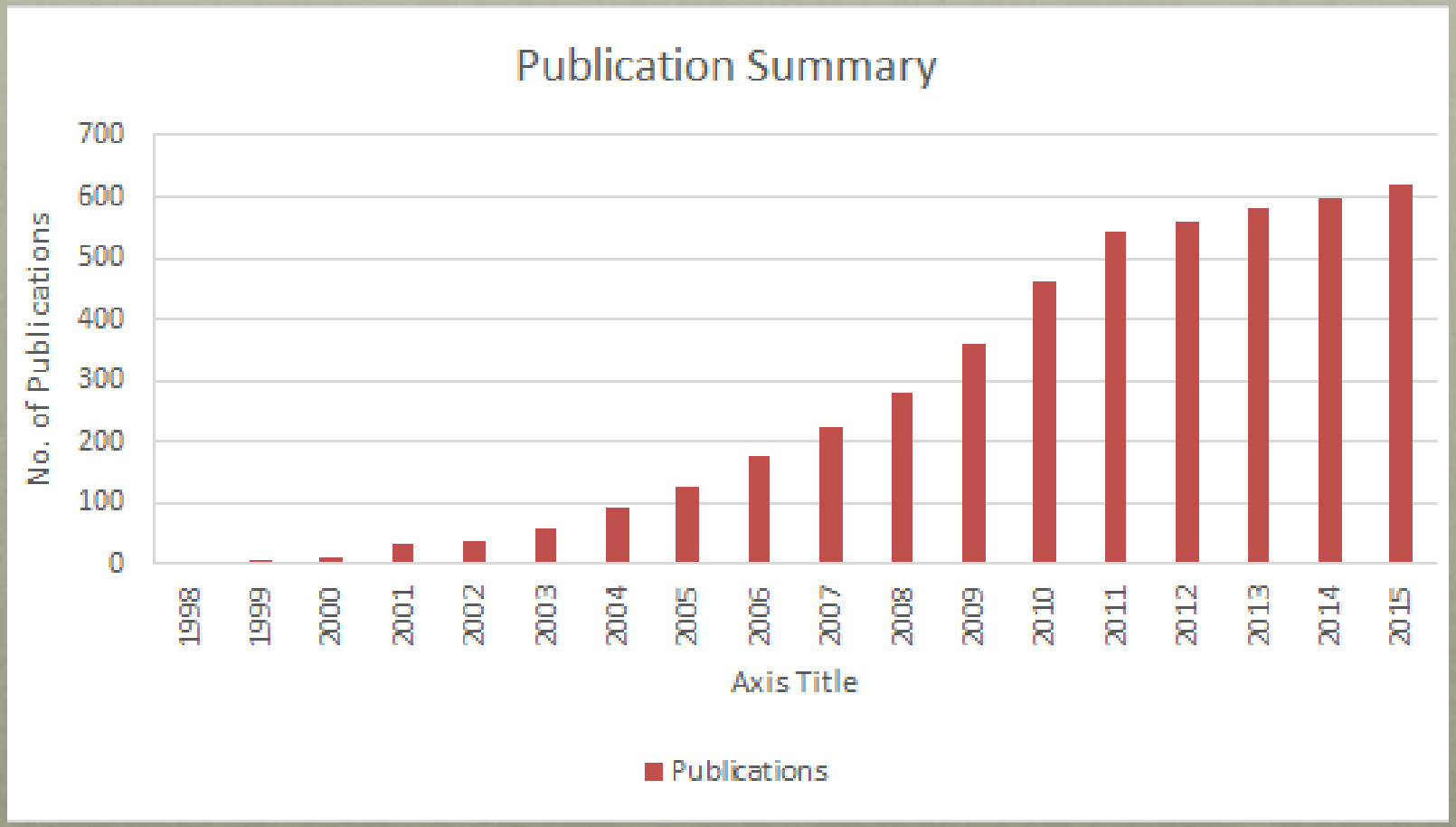
250 projects since Program's inception
Each year ~40 3-yr projects
Total in the Program >260 researchers



Impacts - 34%
(Carbon+Water+Eco)
Monitoring – 33%
LU Modeling – 14%
LCLUC- Climate interactions - 7%
Synthesis – 6%
Vulnerability/Adaptation – 6%

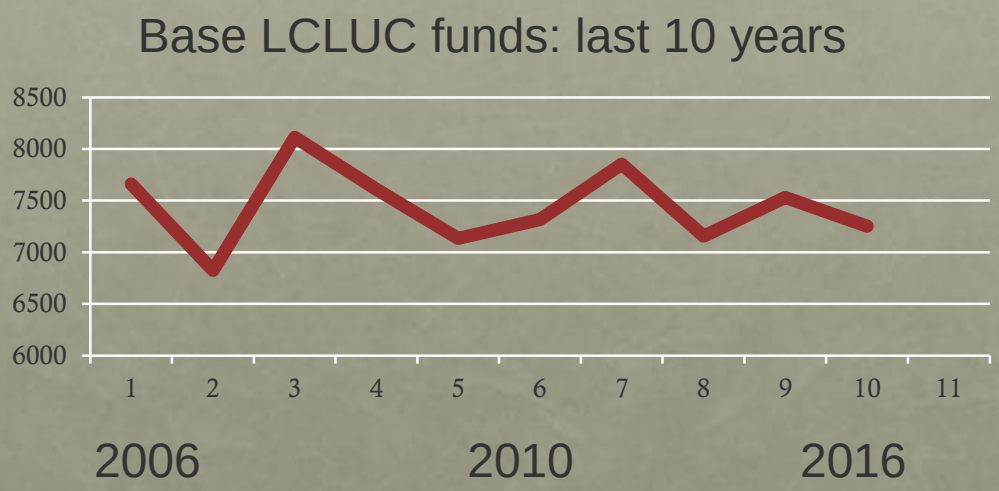
http://lcluc.hq.nasa.gov

NUMBER OF PUBLICATIONS



LCLUC BUDGET "STABILITY"

- **About the same as 20 years ago**
- **Inflation, sequestration, harvesting – "I will get by/I will survive…"**
- **Growing demand, community**
- **Balancing processes and geography**



GROWING BY "COALESCENCE"

- Carbon Cycle program
- Interdisciplinary program (IDS)
- USPI (participation in non-US missions)
- Landsat
- TERRA/AQUA
- NPP
- MuSLI
- ACCESS/MEASURES

LCLUC Science Team Meetings

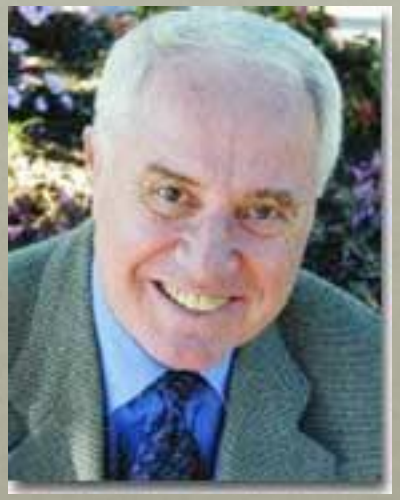
Washington: Spring Blossom

2007: Climate/Carbon
2008: Joint CC&E Focus Area meeting
2009: LCLUC impacts on climate
2010: GLS LCLUC products
2011: 15th Anniversary (review/update)
2011/9: Agriculture (Joint CC&E FA)
2012: Urban
2013: Wetlands
2014: Urban
2015: Early Career Scientists (Joint CC&E FA)
2016: 20th Anniversary/Industrial Forests
2017: Mountains

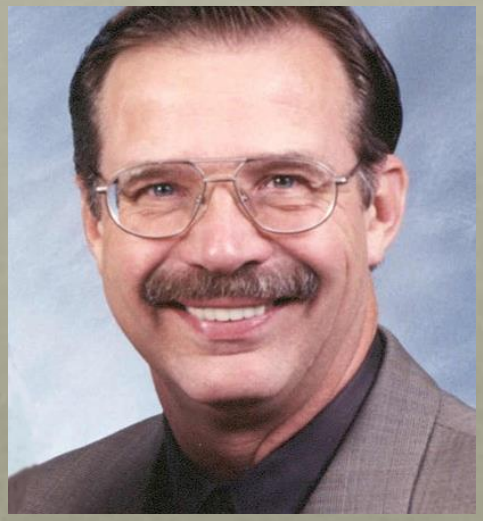
International: Fall-Winter

2007/9: NEESPI/MAIRS Urumqi, China
2009/1: MAIRS Kohn Kaen,Thailand
2009/9:MAIRS/NEESPI Almaty, Kazakhstan
2010/8: NEESPI Tartu, Estonia
2011/11: MAIRS Hanoi, Vietnam
2013/1: MAIRS Coimbatore, India
2013/11: NEESPI/MAIRS Tashkent, Uzbekistan
2014/10: NEESPI: Sopron, Hungary
2016/1: SARI: Yangon, Burma/Myanmar
2017: TBD

In Memoriam



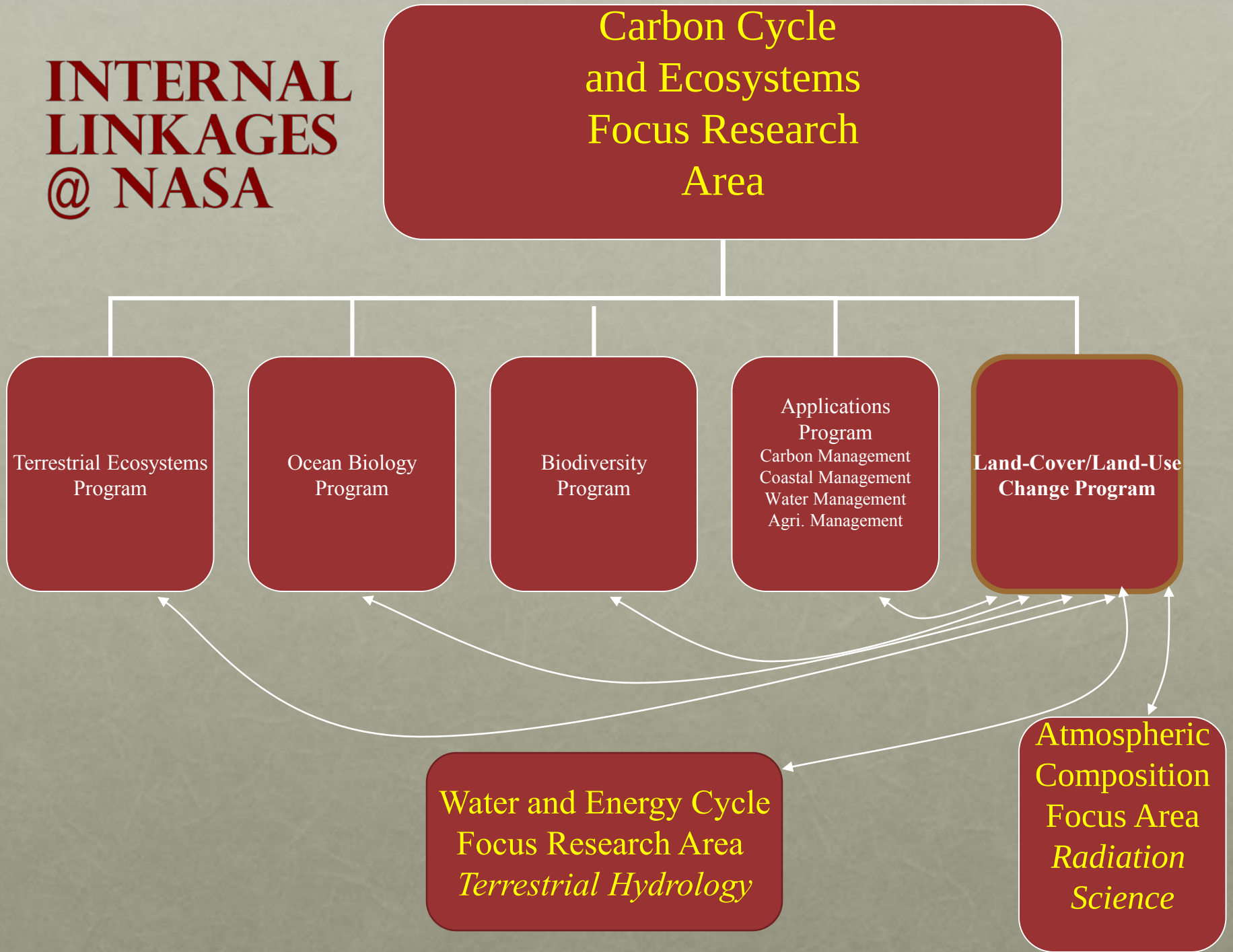
Jack Estes: 2001



Don Deering: 2010

Greg Leptoukh: 2012

INTERNAL LINKAGES @ NASA



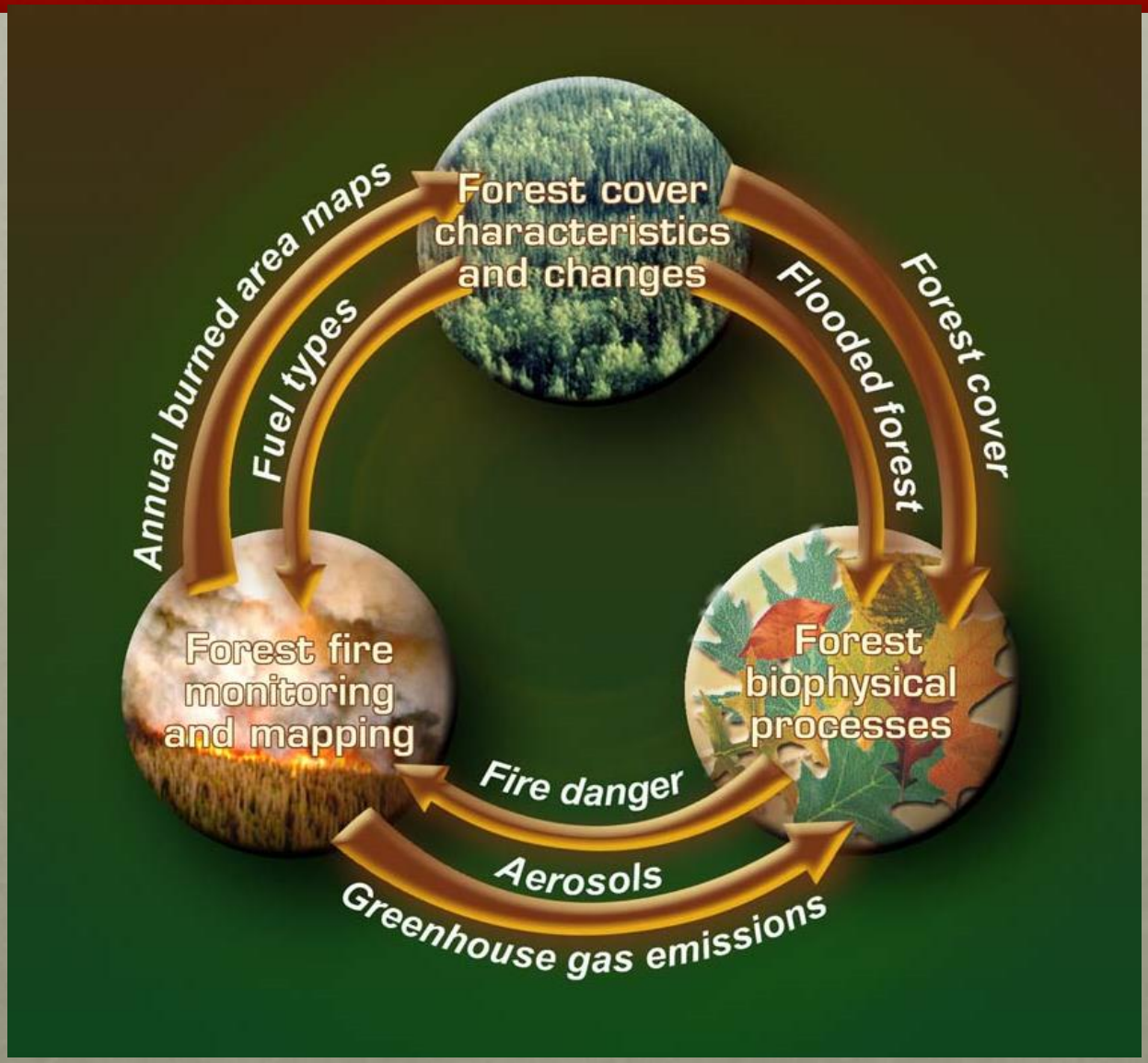
EXTERNAL LINKAGES: NATIONAL

- With U.S. Global Climate Research Program
  - Participated in and supported the LULCC Interagency Working Group
  - Contributed to USGCRP's annual issues of Our Changing Planet
  - NRC review of land use models - NASA LCLUC co-sponsored with USGS
- With USGS
  - Contributed to Landsat program
  - Led and sponsored Global Land Surveys initiative and projects
  - Supported USGS science projects
  - Contributed to "data buys"
- With USAID
  - Supported SERVIR (acronym standing for Mesoamerican Regional Visualization and Monitoring System in Spanish) - coordination with South/Southeast Asia Initiative
  - Participated in PEER (Partnerships for Enhanced Engagement in Research)

EXTERNAL LINKAGES: INTERNATIONAL

- **GOFC-GOLD**
  - **Fire Implementation Team office at UMD funded by LCLUC**
  - **Regional Information Networks (RINs): CARIN (C. Asia), SCERIN (C. Europe), SEARRIN (SE Asia), SARIN (S. Asia), etc.**
- **CEOS/GEO**
  - **International Working Group on Calibration and Validation**
  - **Land Surface Imaging (LSI) Constellation Working Group**
  - **Global Landcover Datasets (SB-02 C1)**
  - **Working Group Land Cover Africa**
- **IGBP/IHDP (transitioning to Future Earth)**
  - **Global Land Project (GLP)**
  - **NEESPI (Northern Eurasia Earth Science Partnership Initiative)**
  - **MAIRS (Monsoon Asia Integrated Regional Study**
- **EARSeL LULC Special Interest Group**
  - **Joint biennial workshops (2nd one in Prague, 6-7 May)**
- **ESA and CNES/CESBIO**
  - **Sentinel-2 products**

GOFC-GOLD COMPONENTS AND LINKAGES



BACK IN TIME: GOFC EARLY YEARS

- **Need to focus on our key objectives and provide ways for us to assess progress**
  - **Making observation systems operational**
  - **Making products more available**
  - **Ensuring use of products**
- **Need to raise profile of GOFC/GOLD**
- **Need to strengthen the regional networks**
- **Need to involve more people**
- **Need to raise more resources**

John Townshend, U.MD, former GOFC-GOLD Chair

BACK IN TIME: LCLUC MAJOR ISSUES 20 YEARS AGO

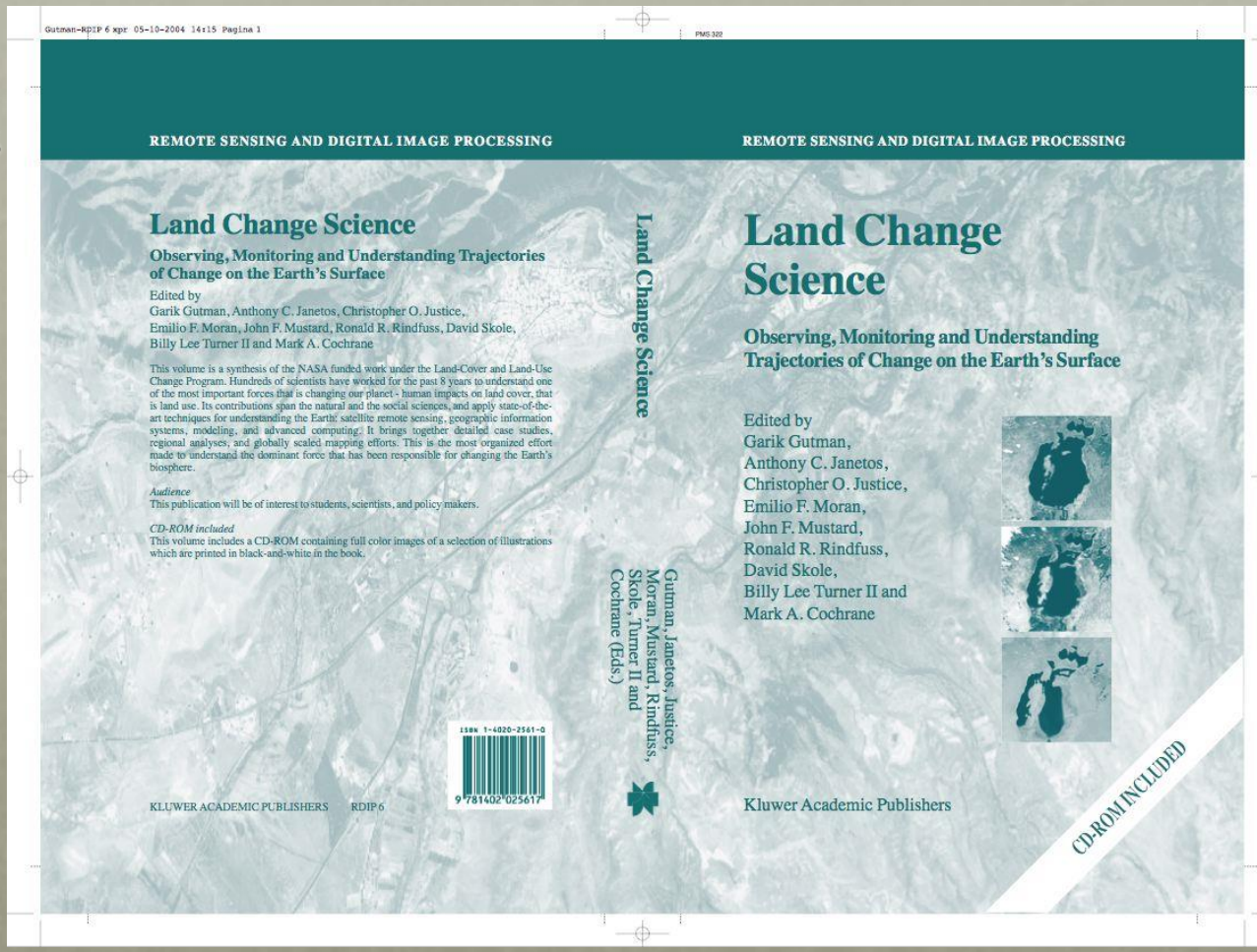
- Food Production and Distribution
- Carbon Sources and Land Use
- Carbon Sinks and Land Use
- Management of Ecosystems for Goods & Services
- Preservation of Unique Places

Tony Janetos (1999)

LCLUC Program Manager 1996-1999
Current GOFC-GOLD Chair

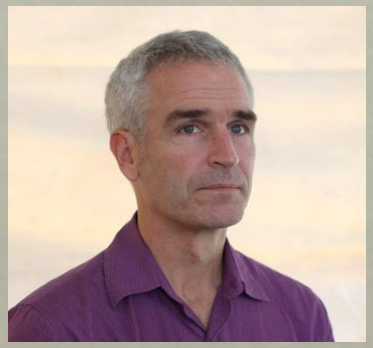
TOWARDS LCLUC SYNTHESIS: THE EARLY YEARS

- Case studies in various areas of the world
- Patterns to processes
- Disturbances and feedbacks
- Trajectories and projections



The major milestone

Early Synthesis by LCLUC Veterans


Mustard


Fisher


Defries


Moran


Hansen

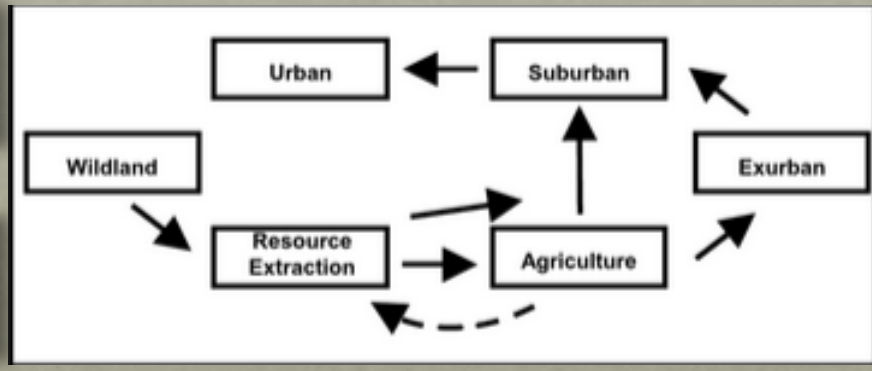

Turner

Undisturbed Wildlands

Frontier Resource Extraction

Agricultural Expansion

Industrialization and Urbanization

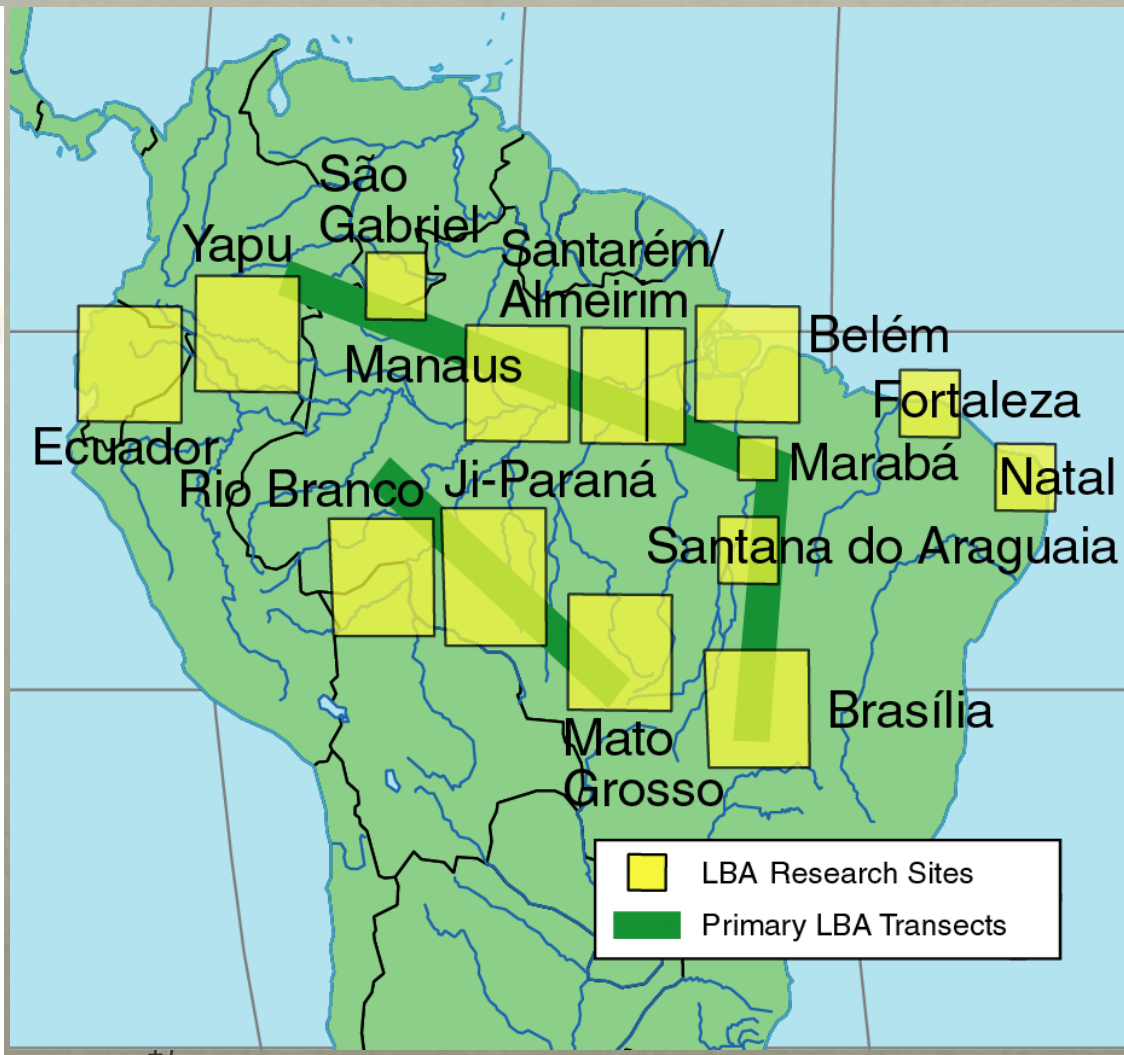


Trajectories of Economic and Land Use Development

THE ROLE OF SOCIAL SCIENCE IN LCLUC PROGRAM

- **Humans play an important role in LCLUC**
- **Social and economic science research includes**
  - **impacts of changes in human behavior on LCLUC**
  - **impacts of LCLUC on society**
  - **adaption to climate change of land-use systems**
- **During the last 8 years, the Social/Economics Science component has been a mandatory part of all LCLUC proposals, unless otherwise stated in the solicitation**

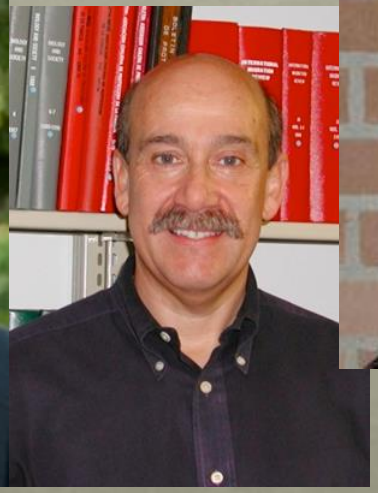
Large-Scale Biosphere-Atmosphere Experiment in Amazonia (LBA)



LBA LCLUCERS



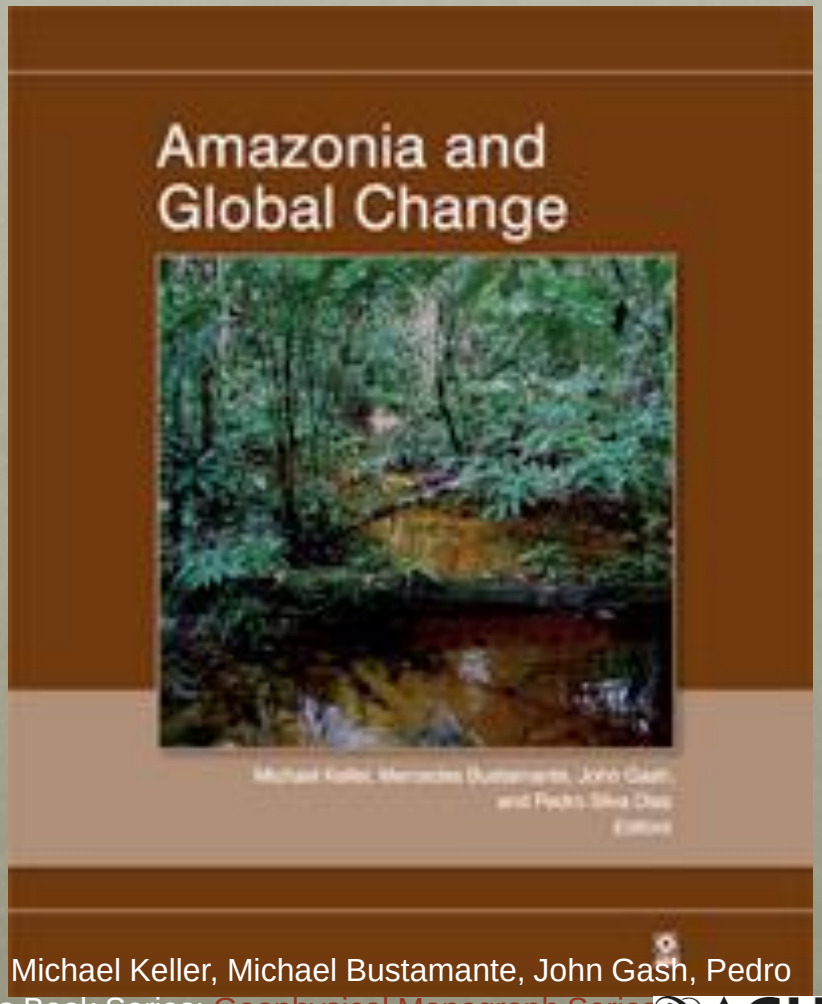



LBA SYNTHESIS

Science Question: How do tropical forest conversion, re-growth, and selective logging, influence carbon storage, nutrient dynamics, trace gas fluxes, and the prospect for sustainable land use in Amazonia?

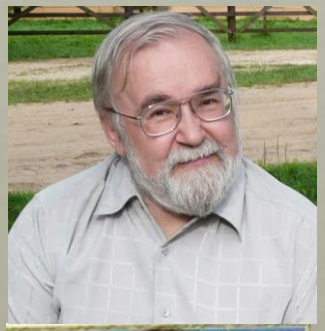
- ***Amazonia and Global Change*** **synthesizes the results of the LBA research**
- **http://onlinelibrary.wiley.com/book/10.1029/GM186**
- **Translated to Portuguese**



Editor(s): Michael Keller, Michael Bustamante, John Gash, Pedro Silva Dias Book Series: Geophysical Monograph Series
Published Online: 21 MAR 2013

International Regional Initiatives

- **Northern Eurasia Earth Science Partnership Initiative (NEESPI)**
- **Monsoon Asia Integrated Regional Study (MAIRS)**
- **Both moving to Future Earth – NEFI and Future Asia**
- **South Asia Regional Initiative (SARI) is getting momentum**
  - **LCLUC-2015 and -2016**
  - **Endorsement by Future Earth under consideration**



Project Scientst
NASA-NEESPI
Pasha Groisman,
NOAA/UCAR

Project Scientist
NASA-MAIRS
Jiaguo Qi, MSU

Project
Scientist
NASA-SARI
Krishna
Vadrevu, UMD

NASA-RAS Interactions in Early 90's

Gen. Korovin,
(Inter. Forest Inst.)
Deputy Dir.
Specialists on Fires

Acad. Aleks. Isaev
(Inter. Forest Inst.)
Led RAS-NASA
interactions before &
during NEESPI era

Bob Murphy (NASA HQ)
Facilitated installation of
AVHRR Receiving Stations
Prior to NEESPI in mid-90's

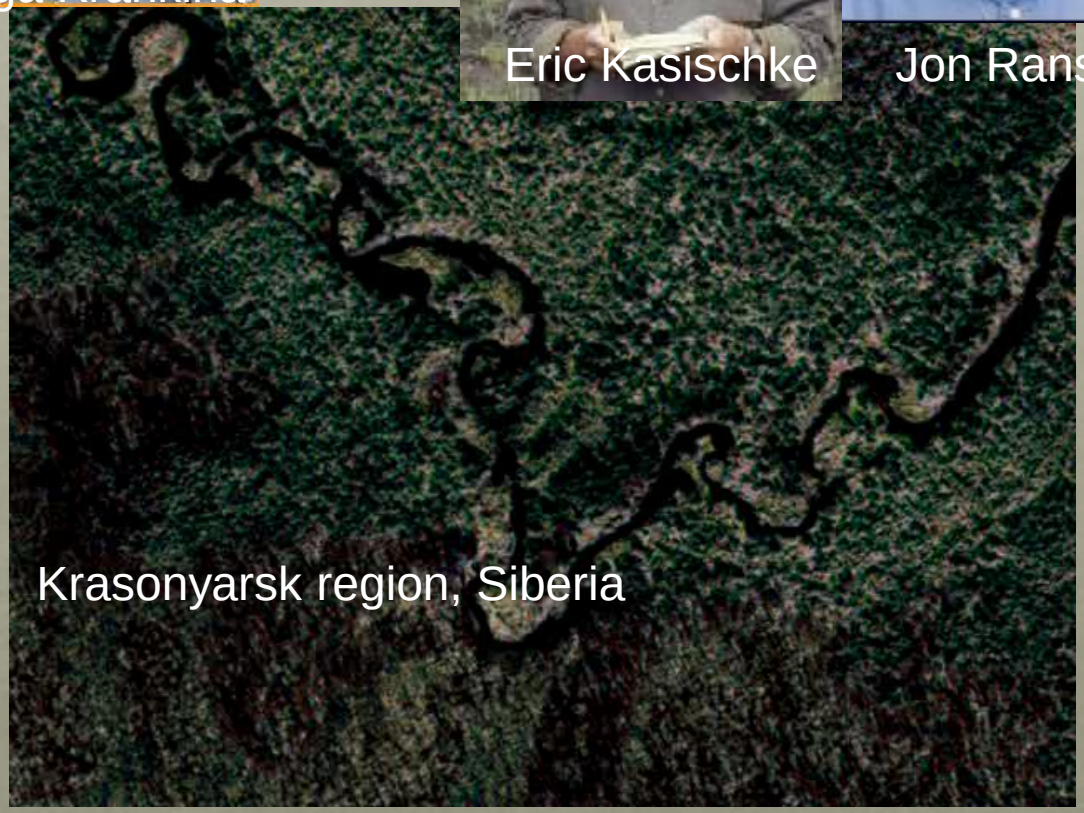
PRE-NEESPI PROJECTS


Olga Krankina


Sue Conard


Eric Kasischke


Jon Ranson


Krasonyarsk region, Siberia


Don Deering

NEESPI SCIENTIFIC NETWORK

2006: >300 SCIENTISTS FROM >170 INSTITUTIONS WITH 47 PROJECTS

Red dots indicate locations of Principal Investigators
Blue dots – locations of Co-Investigators
Green dots - locations of Collaborators
Squares show Focus Research and Science Support Centers.

NEESPI SCIENTIFIC NETWORK

2016: > 750 SCIENTISTS FROM 200 INSTITUTIONS WITH > 170 PROJECTS

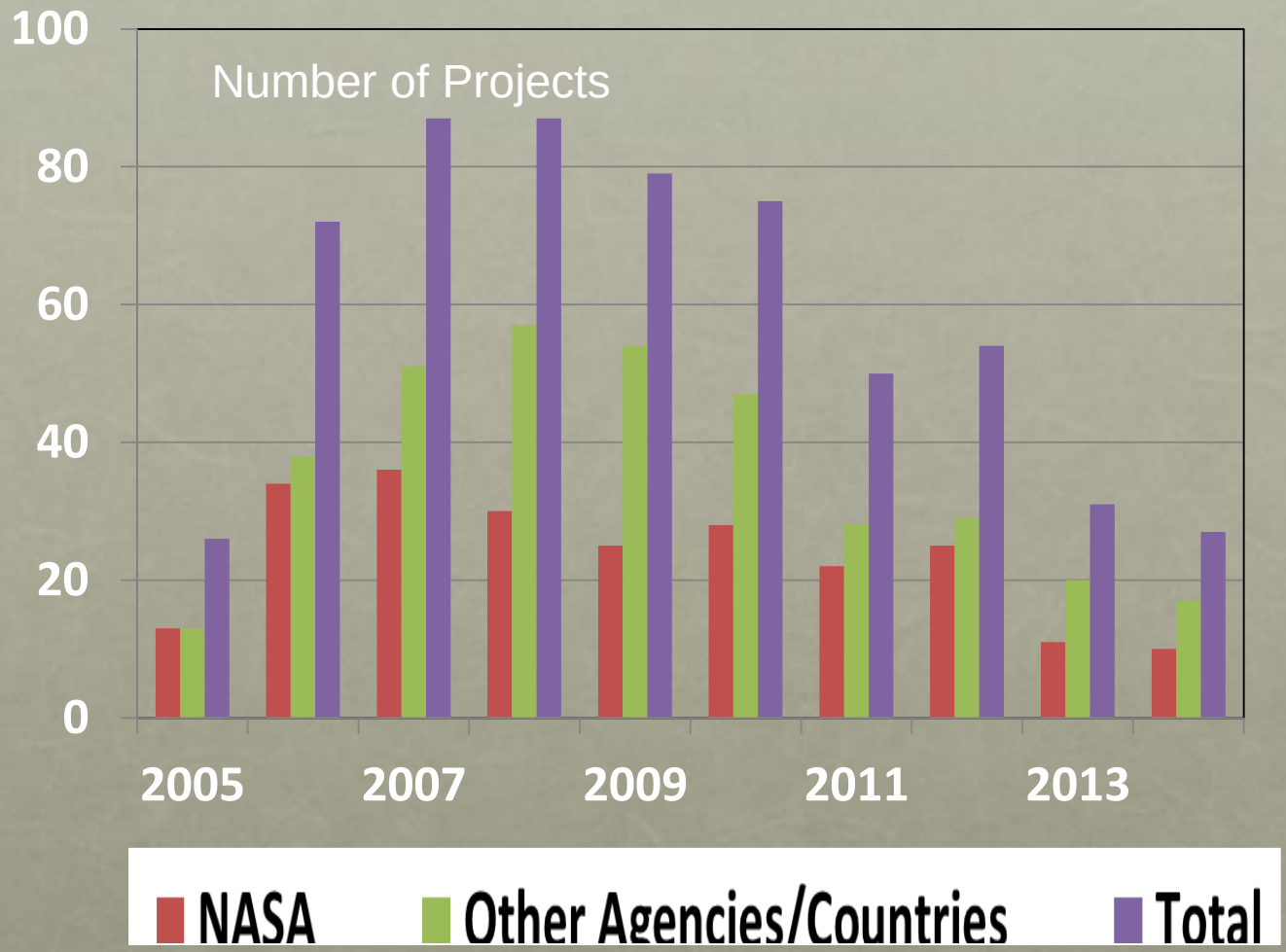
Red dots indicate locations of Principal Investigators
Blue dots – locations of Co-Investigators
Green dots - locations of Collaborators
Squares show Focus Research and Science Support Centers.

NEESPI: 10 YEARS OF SCIENCE

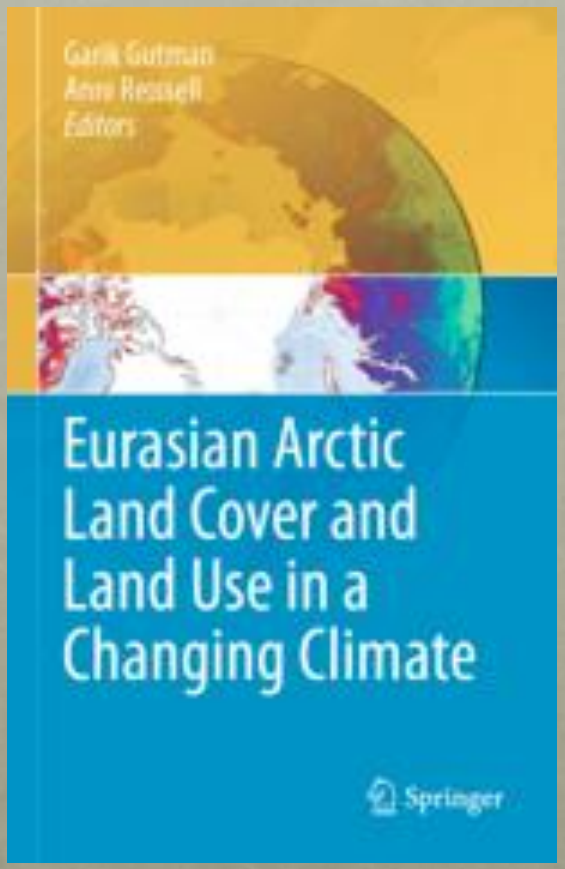
>750 scientists
>200 institutions
>170 projects
30 countries

>80 Ph.D. students

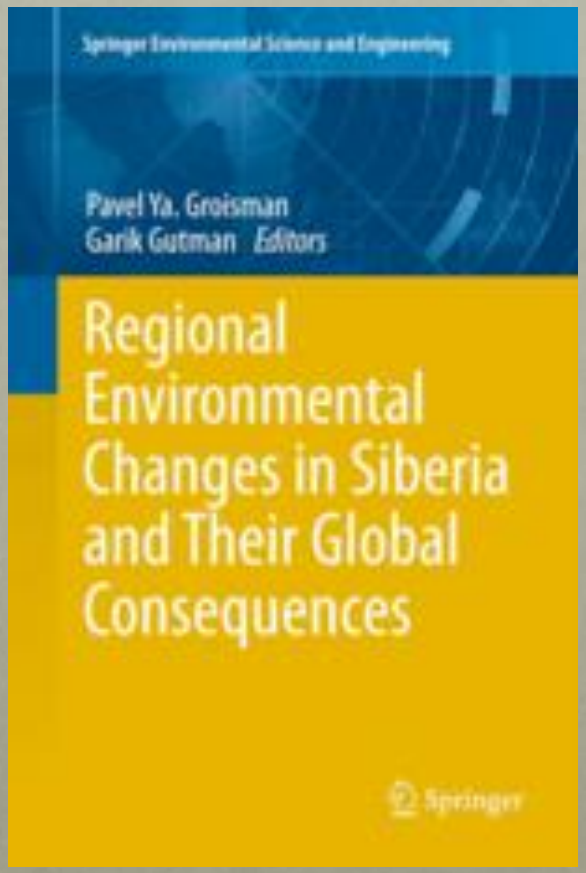
~**1500** papers
and **40** books



NEESPI-LCLUC BOOKS



Springer 2010



Springer 2012

Springer 2013

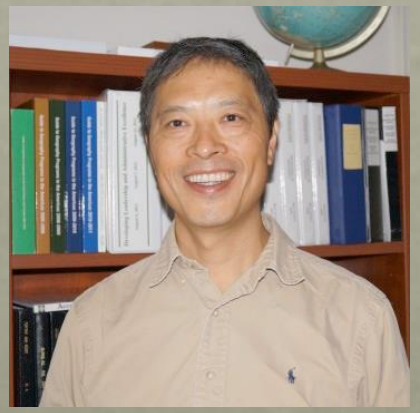
LCLUC in Eastern Europe to be published in 2016
LCLUC in Central Asia to be published in 2017

NEESPI SYNTHESIS









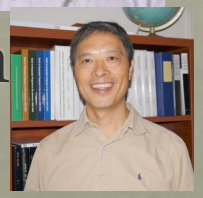


ONGOING NEESPI SYNTHESIS

LCLUC-2012

- Qianlai Zhuang, Purdue U.
  - Regional and Global Climate and Societal Impacts of Land-Use and Land-Cover Change in Northern Eurasia: A Synthesis Study

- Jiquan Chen, Michigan State U.
  - LCLUC Synthesis: Ecosystem-Society Interactions on a Changing Mongolian Plateau



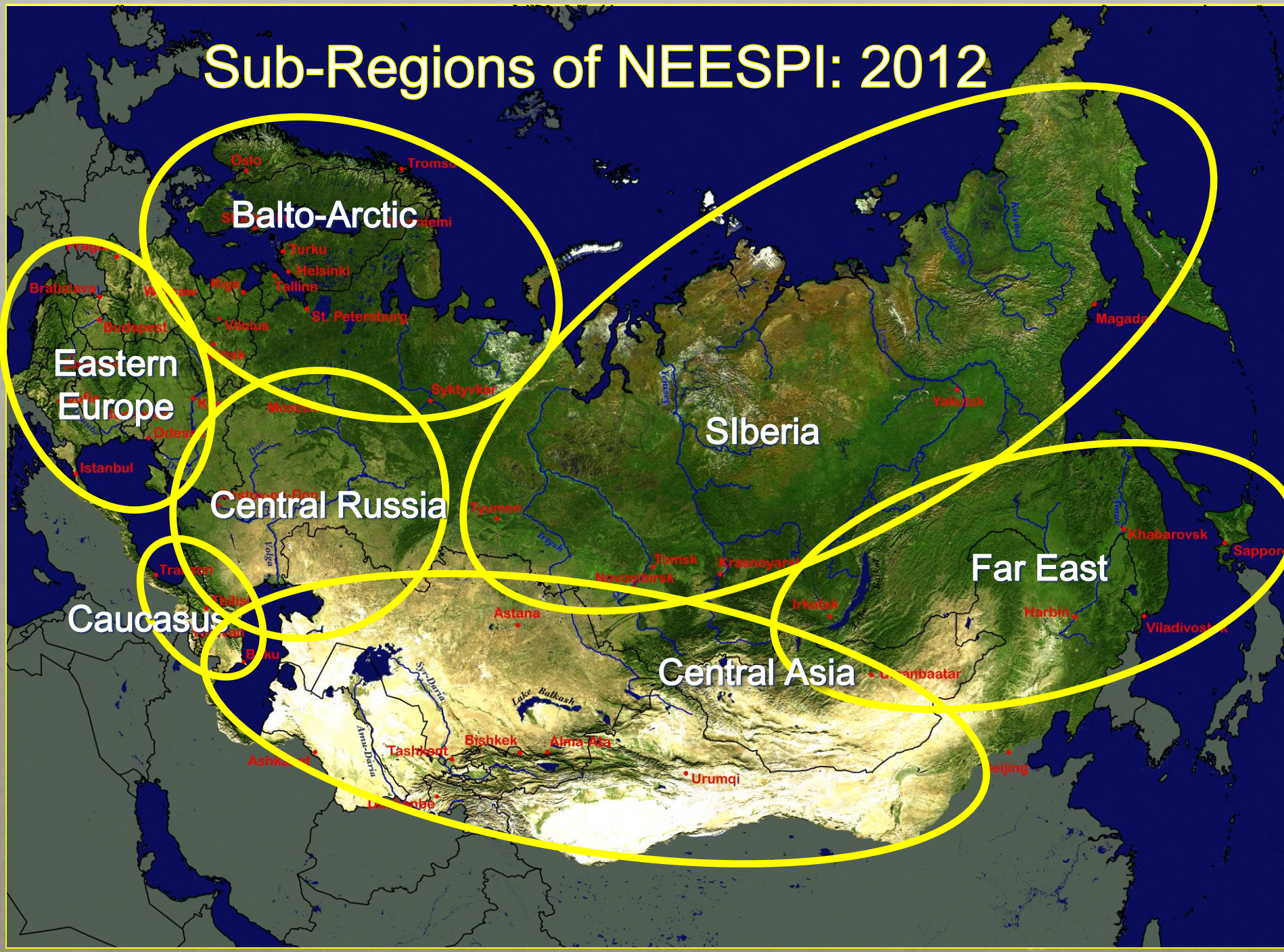
- Irina Sokolik, Georgia Tech.
  - Multiscale synthesis of land cover and land use, climatic and societal changes in drylands of Central Asia
- Skip Walker, U. Alaska, Fairbanks
  - Yamal LCLUC Synthesis

LCLUC-2013

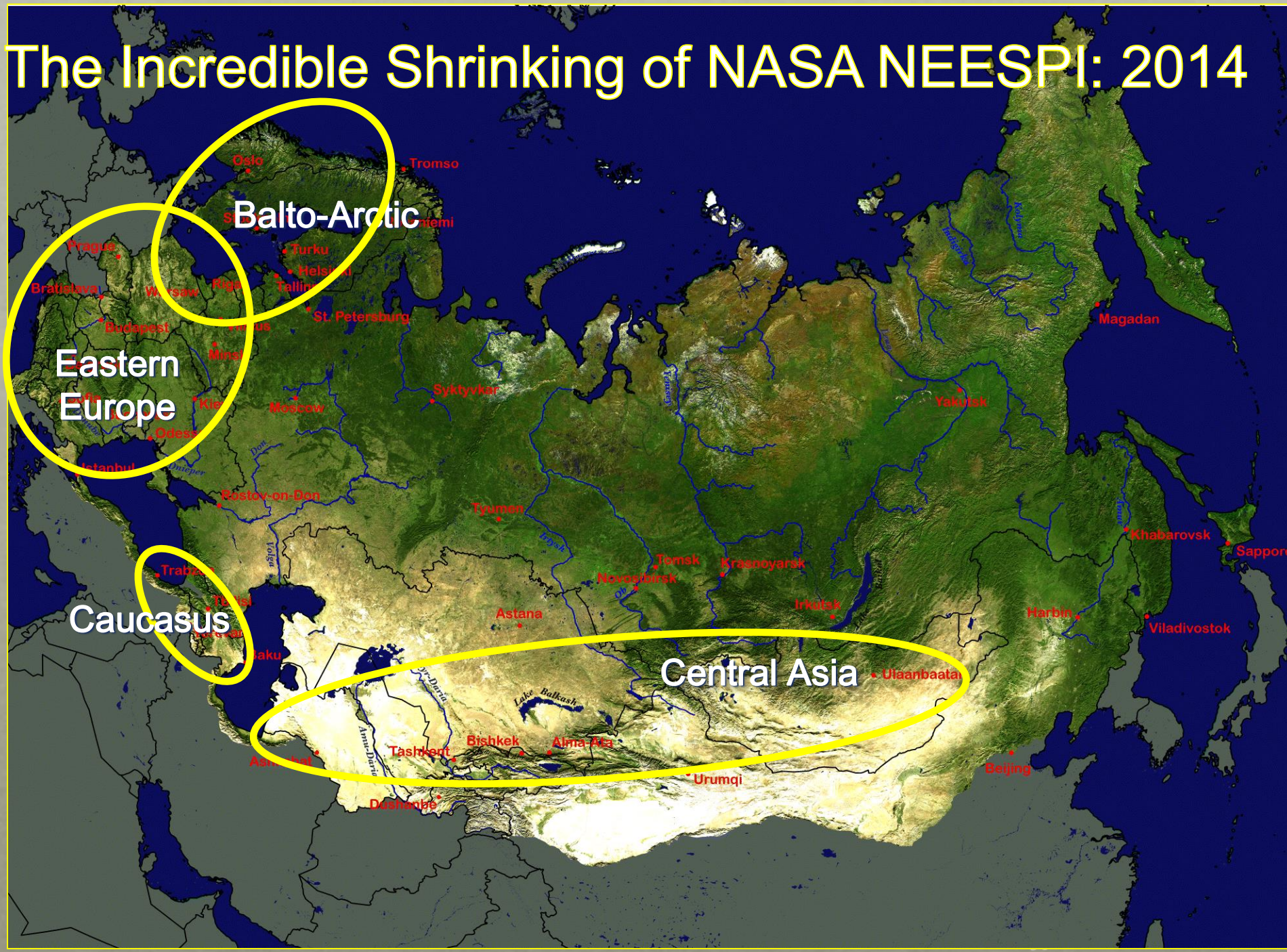
Peilei Fan, Michigan State U

- **Urbanization and Sustainabilit Under Global Change and Transitional Economies: Synthesis from Southeast, East and North Asia**

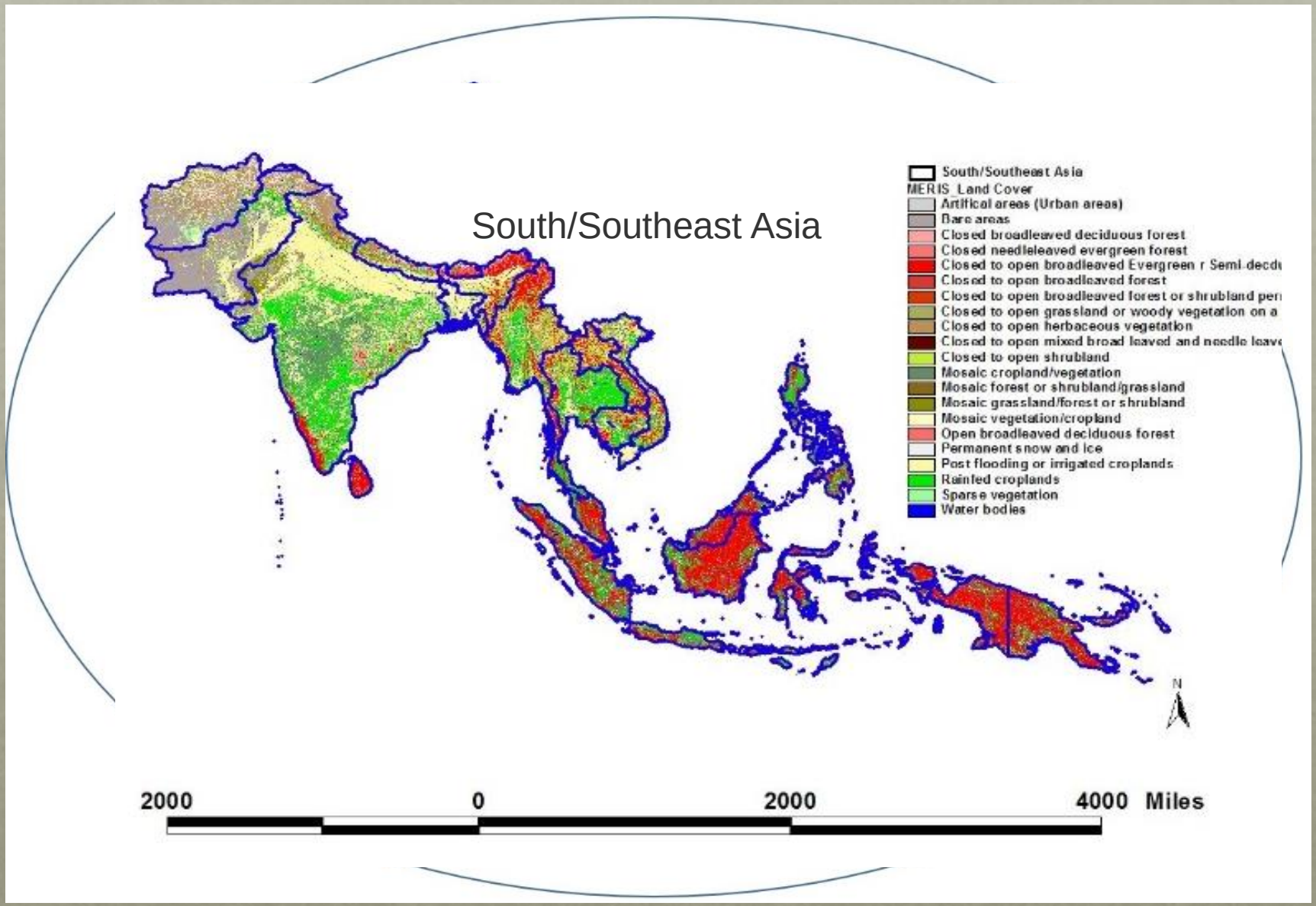
2-Program Synergy


Sub-Regions of NEESPI: 2012
Balto-Arctic
Eastern Europe
Central Russia
Caucasus
Siberia
Far East
Central Asia
Oslo
Tromso
Turku
Helsinki
Tallinn
Riga
St. Petersburg
Vilnius
Budapest
Bratislava
Syktyvkar
Yakutsk
Magada
Istanbul
Odessa
Tyumen
Tomsk
Krasnoyarsk
Novosibirsk
Irkutsk
Khabarovsk
Harbin
Astana
Bishkek
Almia Ata
Tashkent
Urumqi
Lake Balkash
Syr-Daria
Amu-Daria
Volga
Don
Ob
Lena
Yenisei

The Incredible Shrinking of NASA NEESPI: 2014



SARI


South/Southeast Asia
South/Southeast Asia
MERIS Land Cover
Artifical areas (Urban areas)
Bare areas
Closed broadleaved deciduous forest
Closed needleleaved evergreen forest
Closed to open broadleaved Evergreen r Semi-decd
Closed to open broadleaved forest
Closed to open broadleaved forest or shrubland per
Closed to open grassland or woody vegetation on a
Closed to open herbaceous vegetation
Closed to open mixed broad leaved and needle leav
Closed to open shrubland
Mosaic cropland/vegetation
Mosaic forest or shrubland/grassland
Mosaic grassland/forest or shrubland
Mosaic vegetation/cropland
Open broadleaved deciduous forest
Permanent snow and ice
Post flooding or irrigated croplands
Rainfed croplands
Sparse vegetation
Water bodies
N
2000
0
2000
4000 Miles

NASA-MAIRS PRE-SARI STUDIES

PRE-SARI SYNTHESIS PROJECTS

LCLUC-2012

- Atul Jain/U. of Illinois
  - Land Cover and Land Use Changes and Their Effects on Carbon Dynamics in South and South East Asia: A Synthesis Study

- Jeff Fox, East-West Center, Hawaii
  - Forest, Agricultural, and Urban Transitions in Mainland Southeast Asia: Synthesizing Knowledge and Developing Theory

LCLUC-2013

- Peilei Fan, Michigan State U.
  - Urbanization and Sustainability Under Global Change and Transitional Economies: Synthesis from Southeast, East and North Asia

- Seto, Karen , Yale U.
  - Synthesis of LCLUC studies on Urbanization: State of the Art, Gaps in Knowledge, and New Directions for Remote Sensing Science

WHAT WE HAVE LEARNED BY NOW FOR THE SARI REGION

- **Population growth => rapid urban expansion on rural and agricultural lands => further deforestation**
- **Prevalent commodity crops (rubber and palm) prices increase => reduced food production and increased food costs**
- **Large-scale land-cover conversion for agriculture => changes in carbon cycle and air quality degradation (biomass burning)**
- **Economic development initiatives => regional landscape fragmentation**

NASA-SARI SCIENCE

Will be based on the pre-SARI projects and new projects from

- LCLUC-2015 selections for South Asia
- LCLUC-2016 selections for Southeast Asia
- Potentially Carbon Cycle-2016 and IDS-2016

SUMMARY OF ACCOMPLISHMENTS-1

The program has

- **advanced scientific analysis** to areas of the globe where LCLUC is taking place and provided insight into the various impacts of these changes
- **examined the underlying drivers** of land-use change including socio- economic, political, institutional aspects in diverse regions of the globe
- **evaluated the role of satellite data** in initiating projections of future land-use change
- **built broad networks** of international scientists that routinely utilize NASA data to monitor regional land-use change

DATA PRODUCTS THROUGHOUT THE YEARS

- *NASA promotes the free and open sharing of data*
- *USGS - Landsat data for free distribution*
- **LCLUC expects its PI's to make their data and products available to the broader community**
- Data sharing is strongly encouraged
- **Global maps of change in forests and mangroves**
- Landsat GLS-75, -90, 2000, 2005, 2010 and WELD mosaics
- Metadata page on the LCLUC web site – too few projects

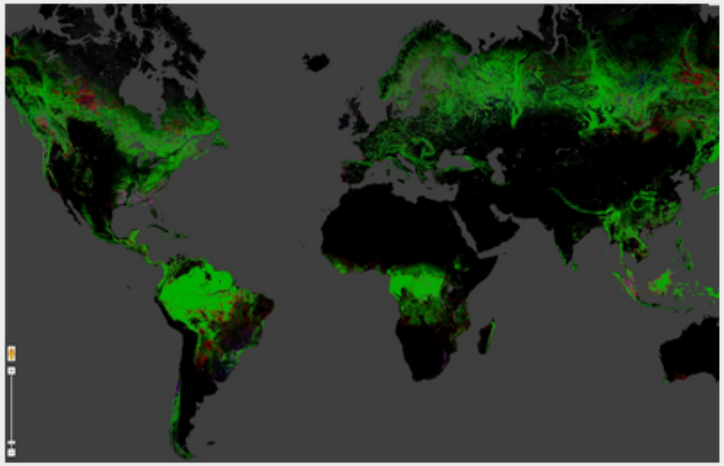
Metadata Page on LCLUC website

Data and Information

Data Initiatives | Satellite Sensing Systems | **Metadata**

Dataset Creator Matthew Hansen

Dataset Global Forest Change



Overview

The Global Forest Change Product provides results from time-series analysis of 654,178 Landsat images in characterizing forest extent and change product. For definitions of Forest extent and change refer to Hansen et al., 2013.

Project Details

PI Details

Products Details

- Spatial Coverage: Global
- Temporal Coverage: 2000-2013
- Resolution: 1 arc-second per pixel (approx. 30m per pixel at the Equator)
- Projection: GCS WGS84 datum
- Data Type: 8-bit unsigned integer
- Data Format: GeoTIFF

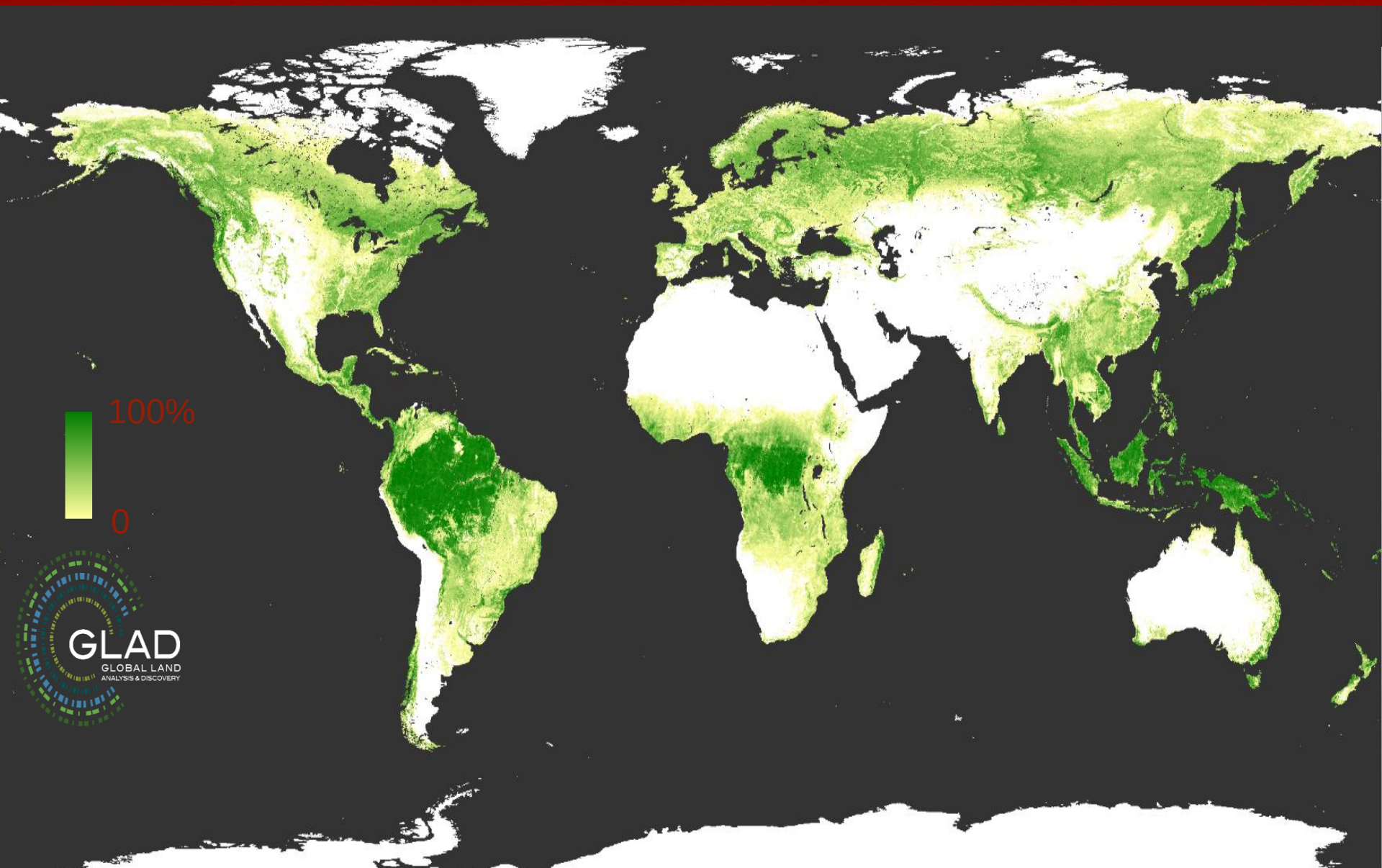
Download

http://earthenginepartners.appspot.com/science-2013-global-forest

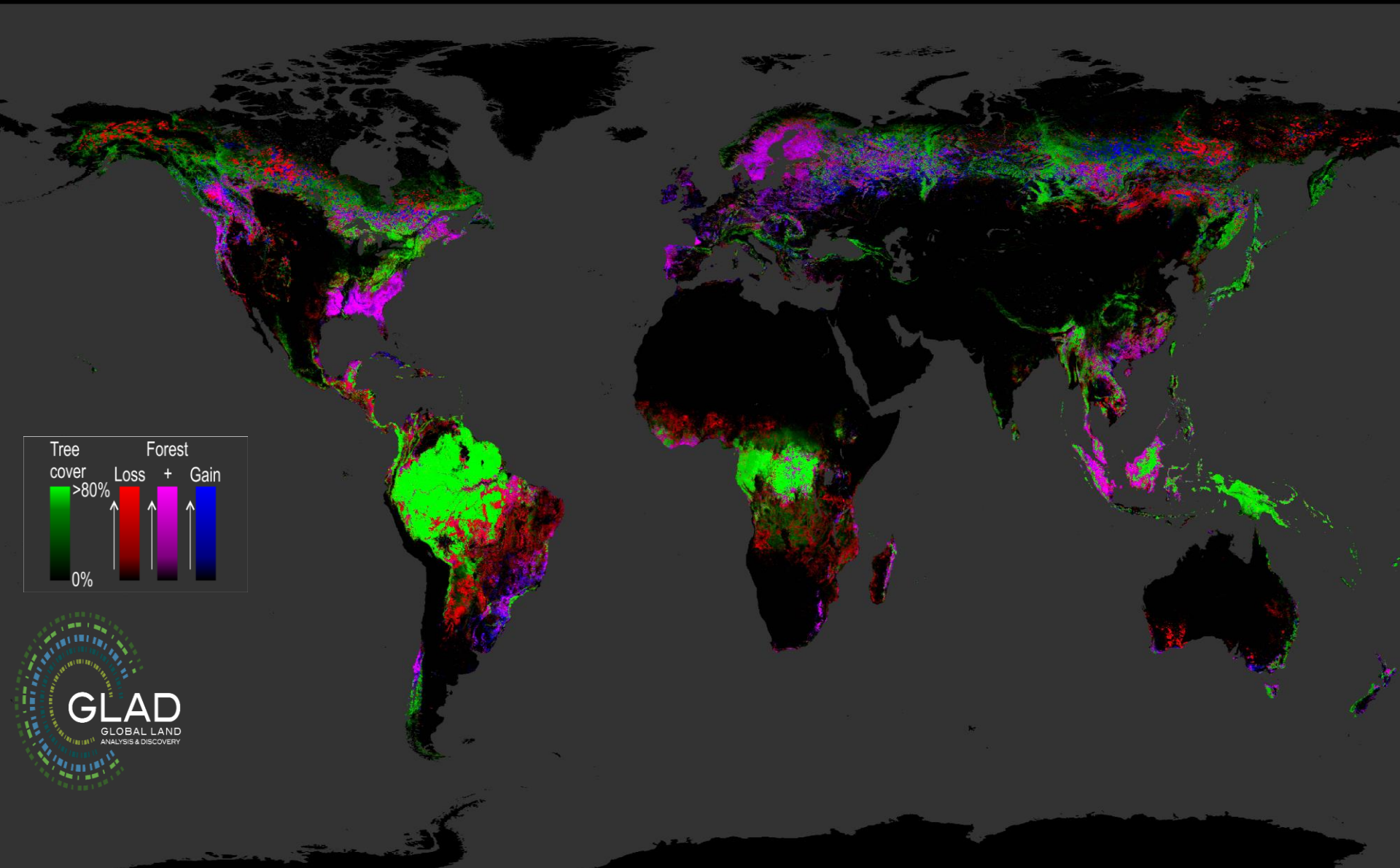
Citation

Hansen, M. C., P. V. Potapov, R. Moore, M. Hancher, S. A. Turubanova, A. Tyukavina, D. Thau, S. V. Stehman, S. J. Goetz, T. R. Loveland, A. Kommareddy, A. Egorov, L. Chini, C. O. Justice, and J. R. G. Townshend. 2013. "High-Resolution Global Maps of 21st-Century Forest Cover Change." Science 342 (15 November): 850-53. Data available on-line from: http://earthenginepartners.appspot.com/science-2013-global-forest.

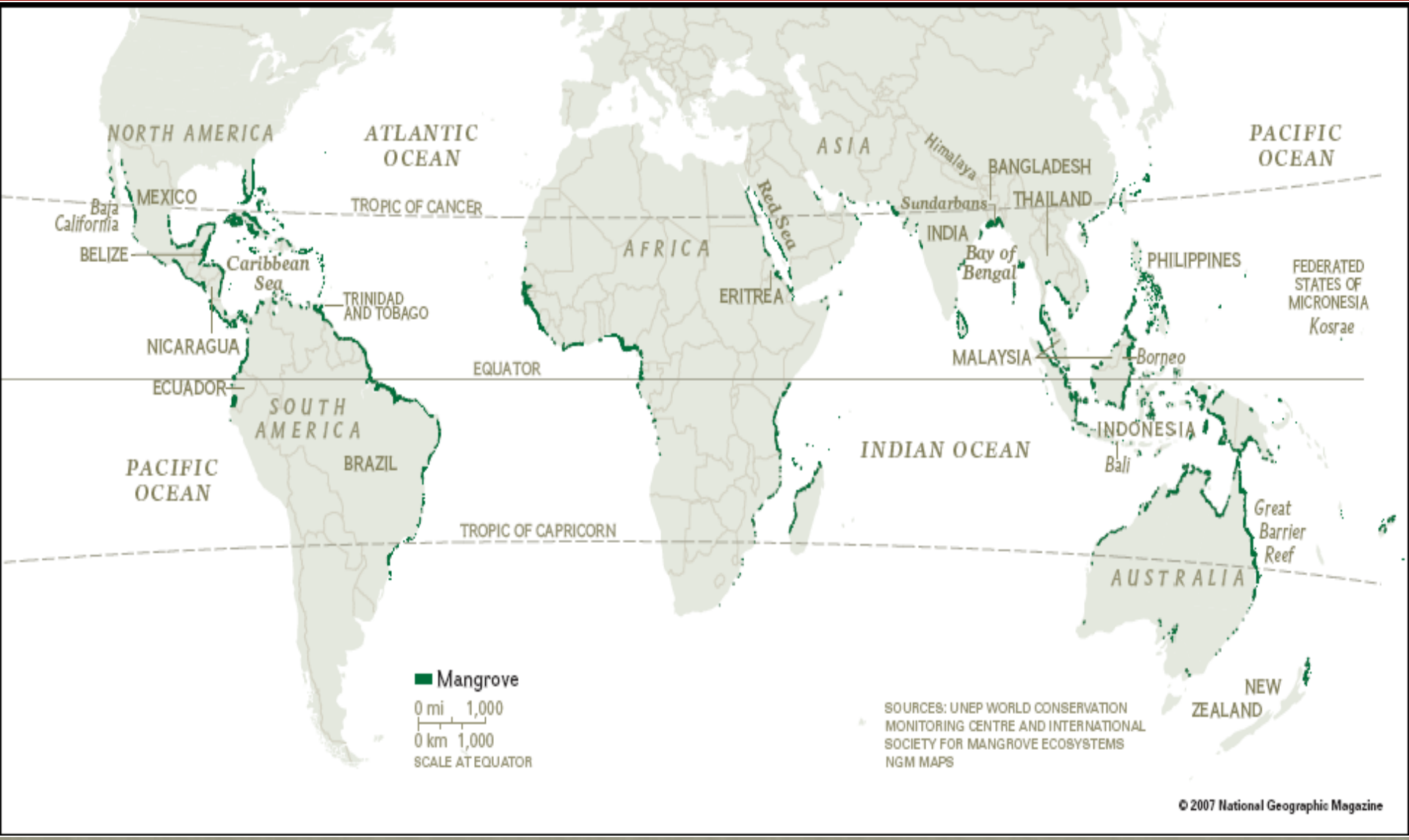
Forest Cover: 2013 percent tree cover



Tree Cover Extent and Forest Loss and Gain: 2000-2014



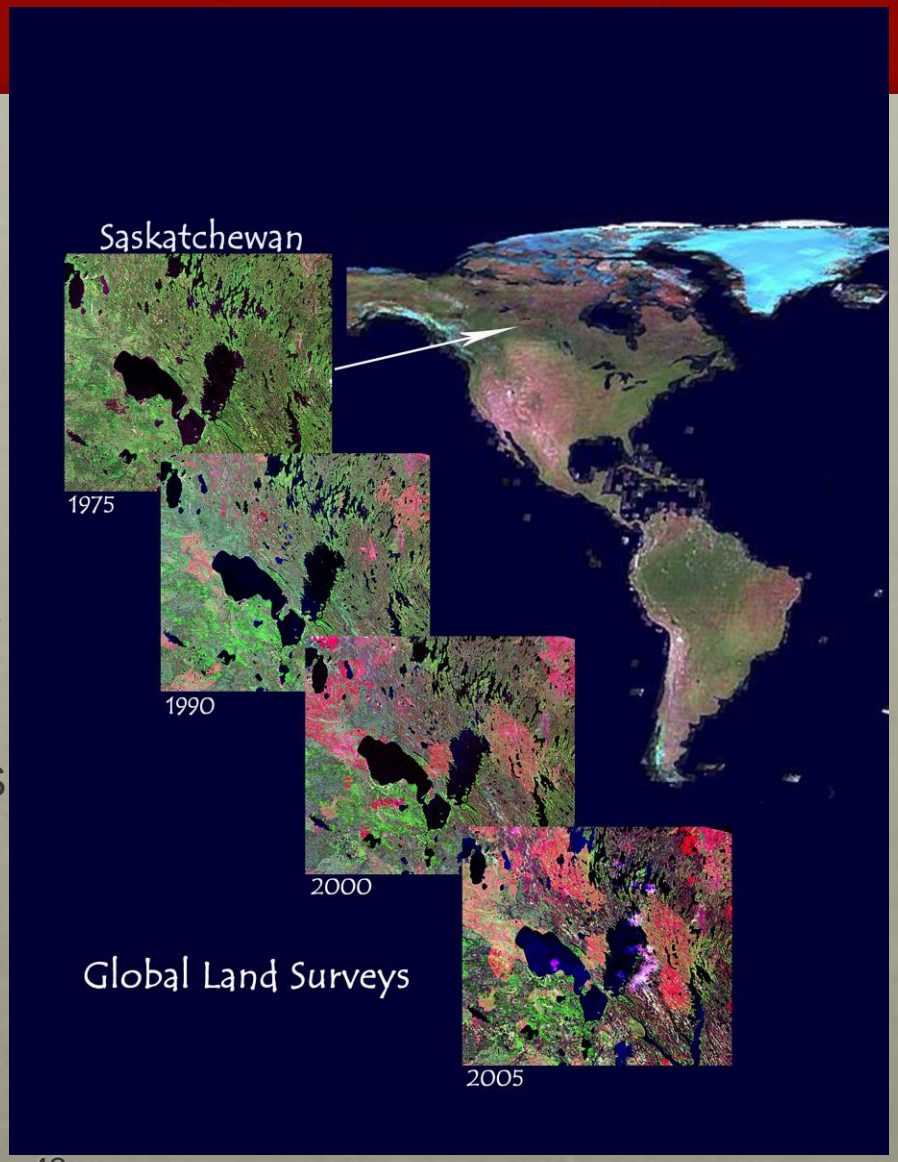
Mangrove forest cover change 1990-2005



NASA-USGS Global Land Survey Data Sets

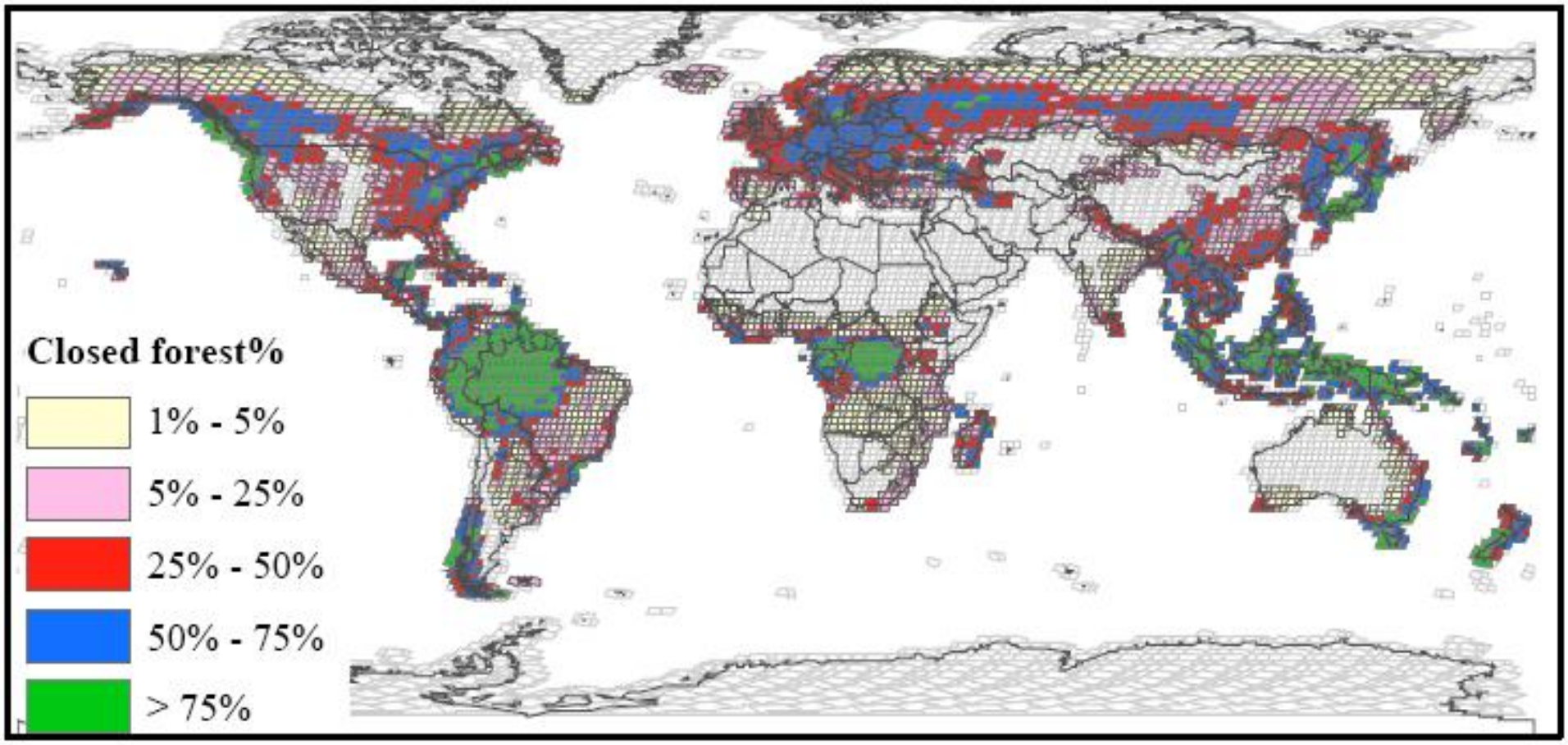
Global cloud-free, geocorrectedd Landsat-based datasets centered on 1975, 1990, 2000, 2005, and 2010. EO-1 ALI data were used for mosaics over small islands.

- 1 scene per epoch at the peak of vegetation
- 30-m global mosaic
- For global assessments of land-cover change
- Paper describing GLS-2005 published in P&RS Journal with a cover image
- GLS datasets are complete and available for download via GLOVIS/EarthExplorer at USGS free of charge
- Remote Sensing of Environment, 2013, ***Assessment of the NASA–USGS Global Land Survey (GLS) datasets***, Gutman et al.
- GLS-2015 ??

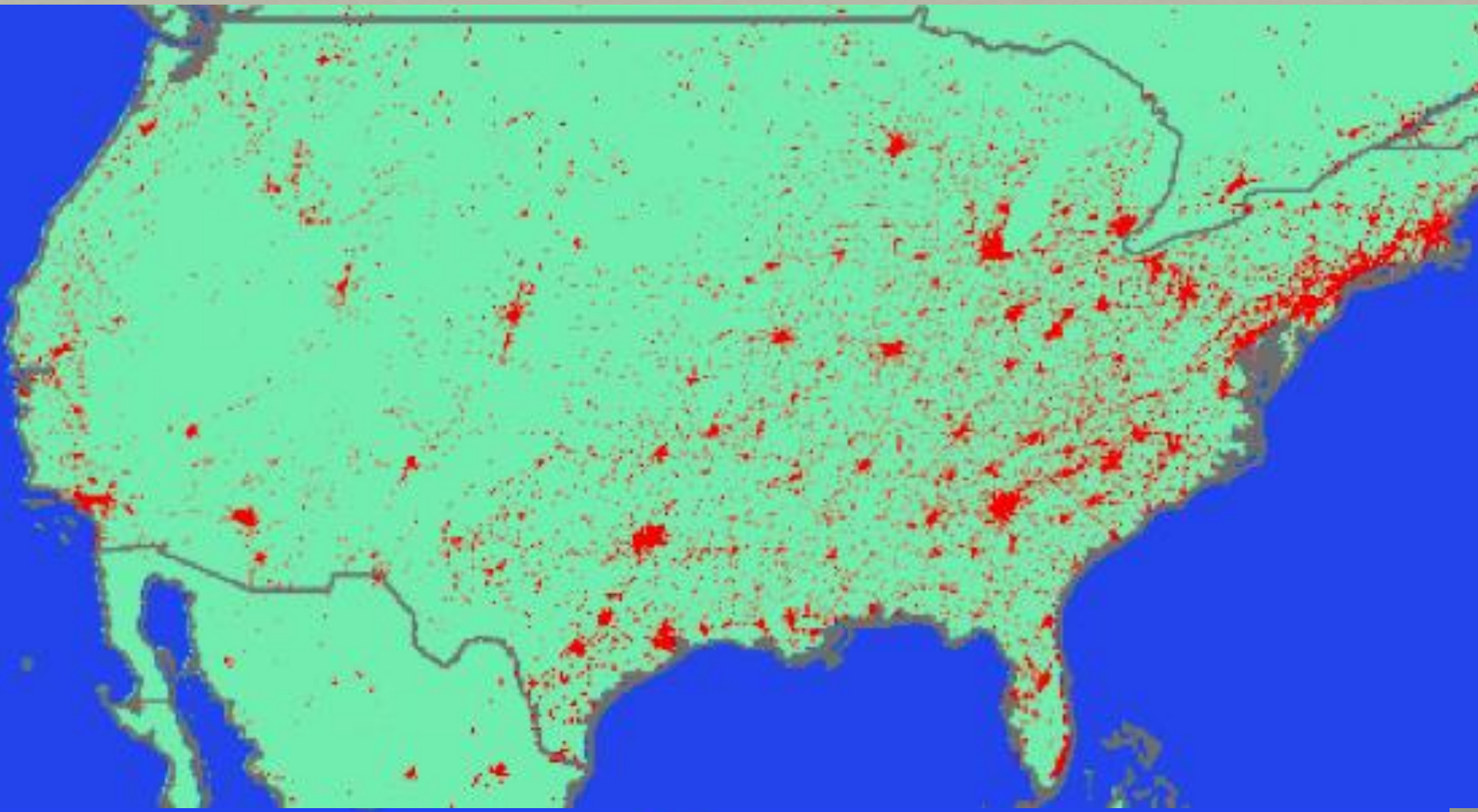


Progression of fires scars in central Canada

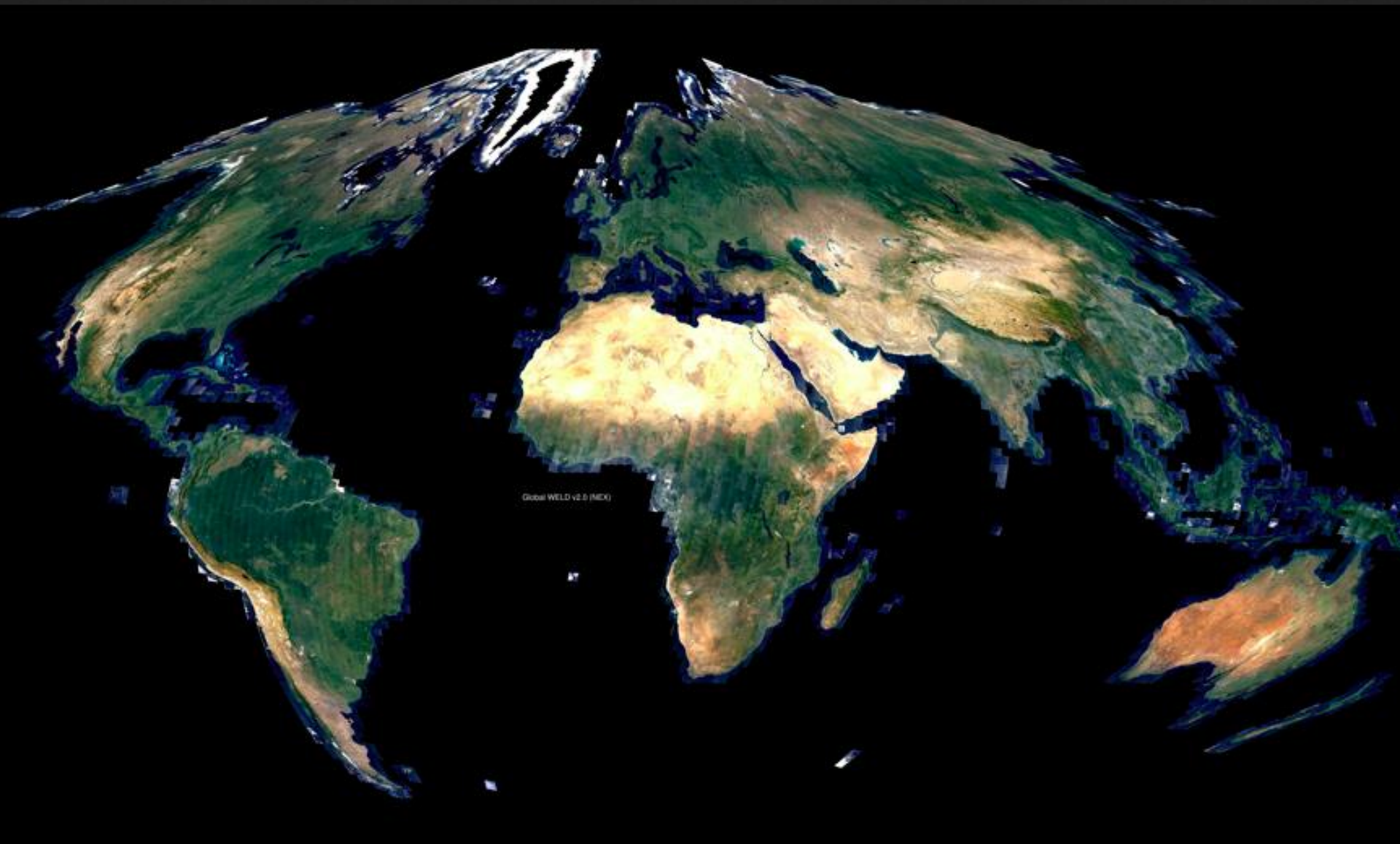
GLS (1990-2005) frames w/ > 1% closed canopy forest: MEASURES



LANDSAT-BASED GLOBAL IMPERVIOUS SURFACES



Prototype of Global Composite Using Landsat-5 and -7



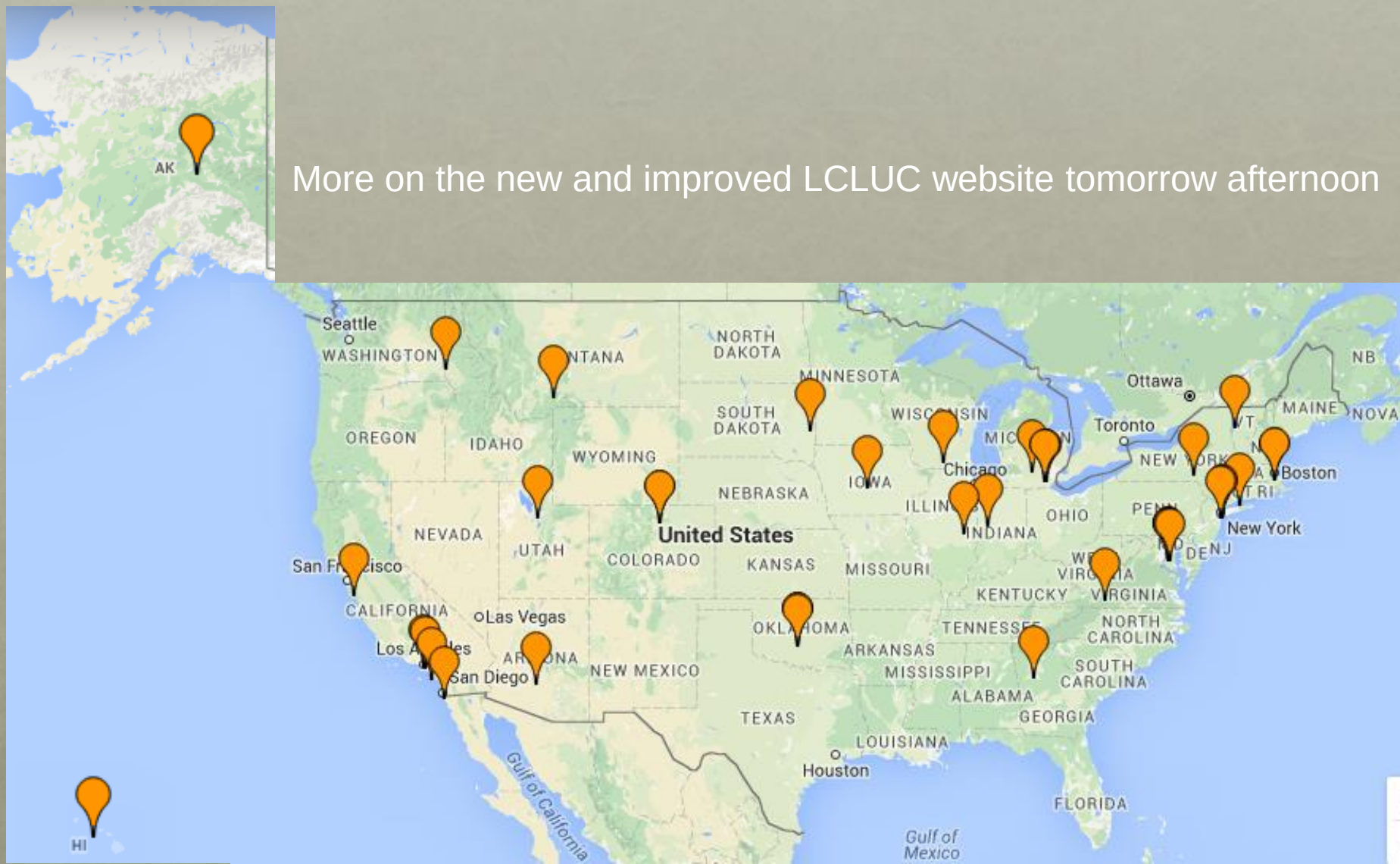
SUMMARY OF THE ACCOMPLISHMENTS-2

The program has

- **provided the basis for monitoring**, reporting and verification of forest-cover change in the context of the implementation of Carbon Treaties
- **created the means** to undertake periodic, continuous global assessments of Land-Cover and Land-Use Change
- **quantified rapid changes** in the urban built environment, forest cover and agriculture around the globe
- **provided the primary science rationale** for the Landsat Mission and, more general, Sustainable Land Imaging

ONGOING PROJECTS: PI LOCATIONS

More on the new and improved LCLUC website tomorrow afternoon



EDUCATION AND OUTREACH

- LCLUC site and Facebook page
  - One month ago we hit 1000 "likes"
- Quarterly e-Newsletter
  - The 2nd issue is out
- One-pagers
- Statistics:
  - Info on grad students needed
  - Info on publications needed

LCLUC Webinars series

- 16 projects have been showcased during 2014-15
- Urban and Urban-Ag transitions were covered
- The Spring 2016 webinar is on Ag monitoring

Educational Component: NASA-MSU IALE

Educational Component: Trans-Atlantic Training (TAT)

LCLUC Training in Latvia - 2010: Czech trainees

More on the new and improved LCLUC website tomorrow afternoon

Agreeing on the TAT: Prague, Dec 2011

NASA-ESA regular training sessions in Eastern Europe for students +3 years
June 2013 in Prague, Czech Rep.
June 2014 in Krakow, Poland
April 2015 in Prague, Czech Rep.
July 2016 in Zvolen, Slovakia

Hands-on Training

IT WOULDN'T HAVE BEEN POSSIBLE WITHOUT THEM DURING THE PAST 20 YEARS

Happy 20th, LCLUC!