Harmonizing Human and Nature for the Changing Globe

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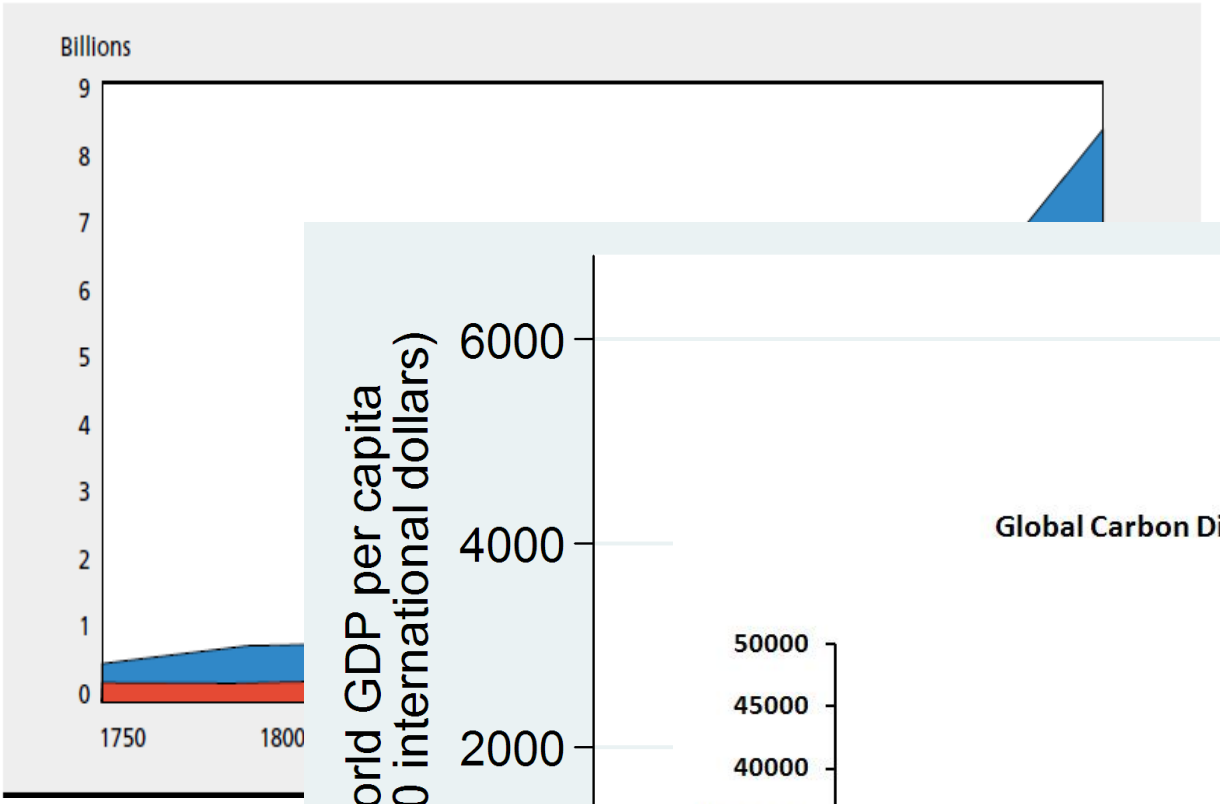
Lake Erie Center Public Lecture
April 18, 2013

Increasing in emission of GHG and air pollution

Figure 3.1 **World population, 1750–2050**



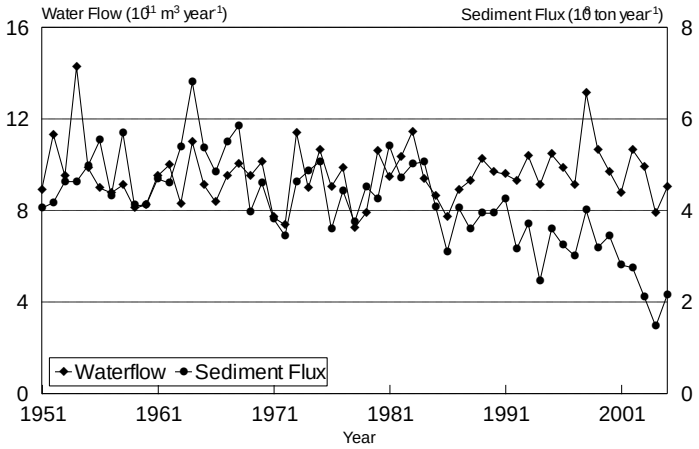
Pressing Issues facing the globe

- Cultural, religion, and other conflicts: wars
- Population increase & living stand[illegible] resources
- Pollution (water
- Climate chang
  etc.): life quality
- Energy crisis & renewable ener[illegible] quality
- Biodiversity & Species invasions: economy, ecosystem services
- Inflectional diseases and may others: healthy/economy

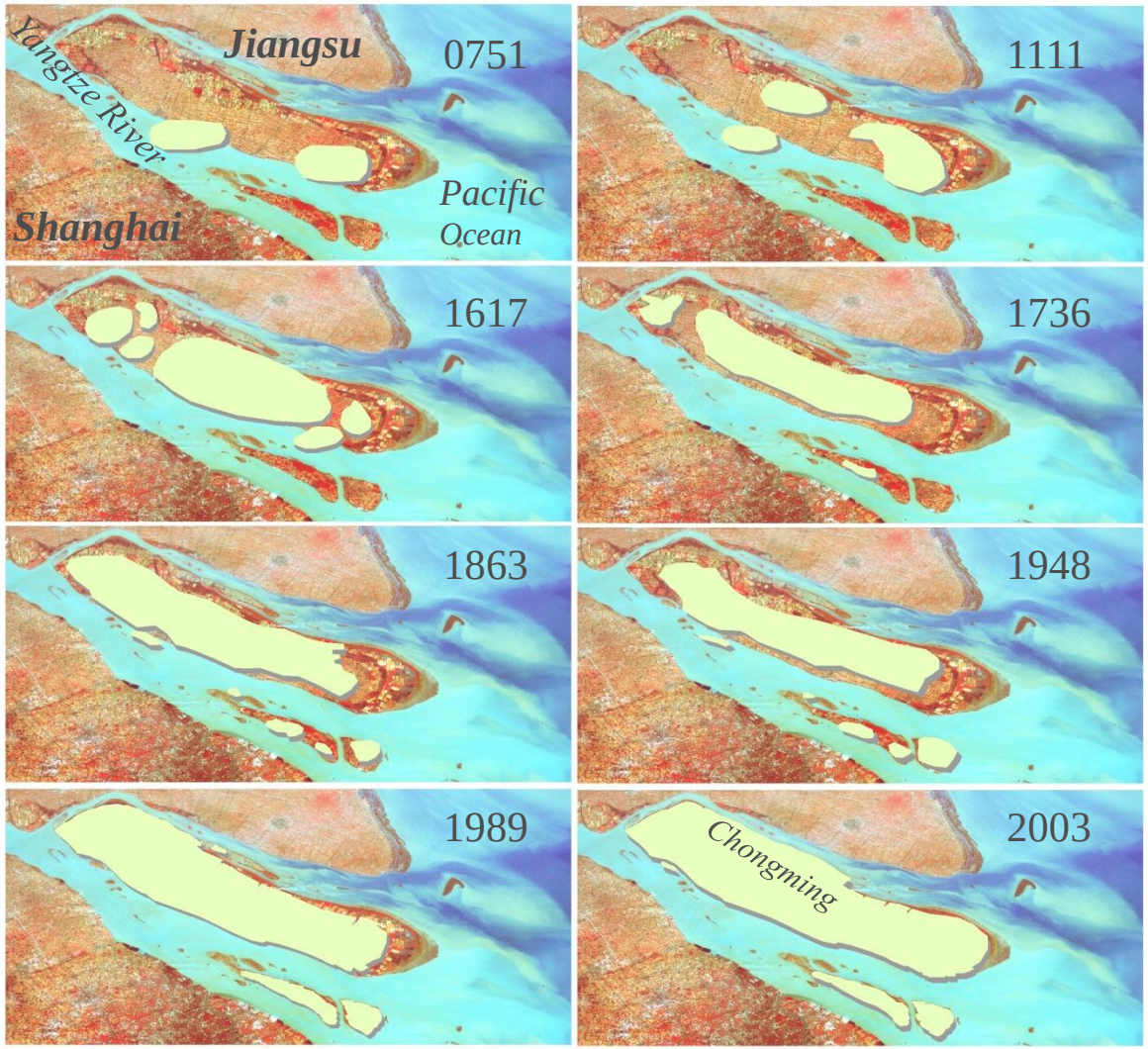
Human beings

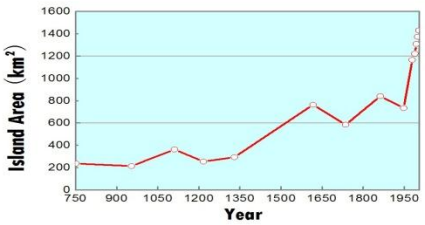
Example 1

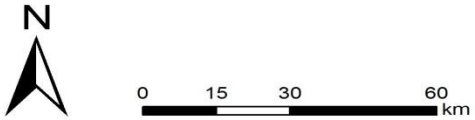
Growing islands (120/year) were measured because of large amount of sediments carried down from >2000 km polluted Yangtze River.



Chen et al. 2008

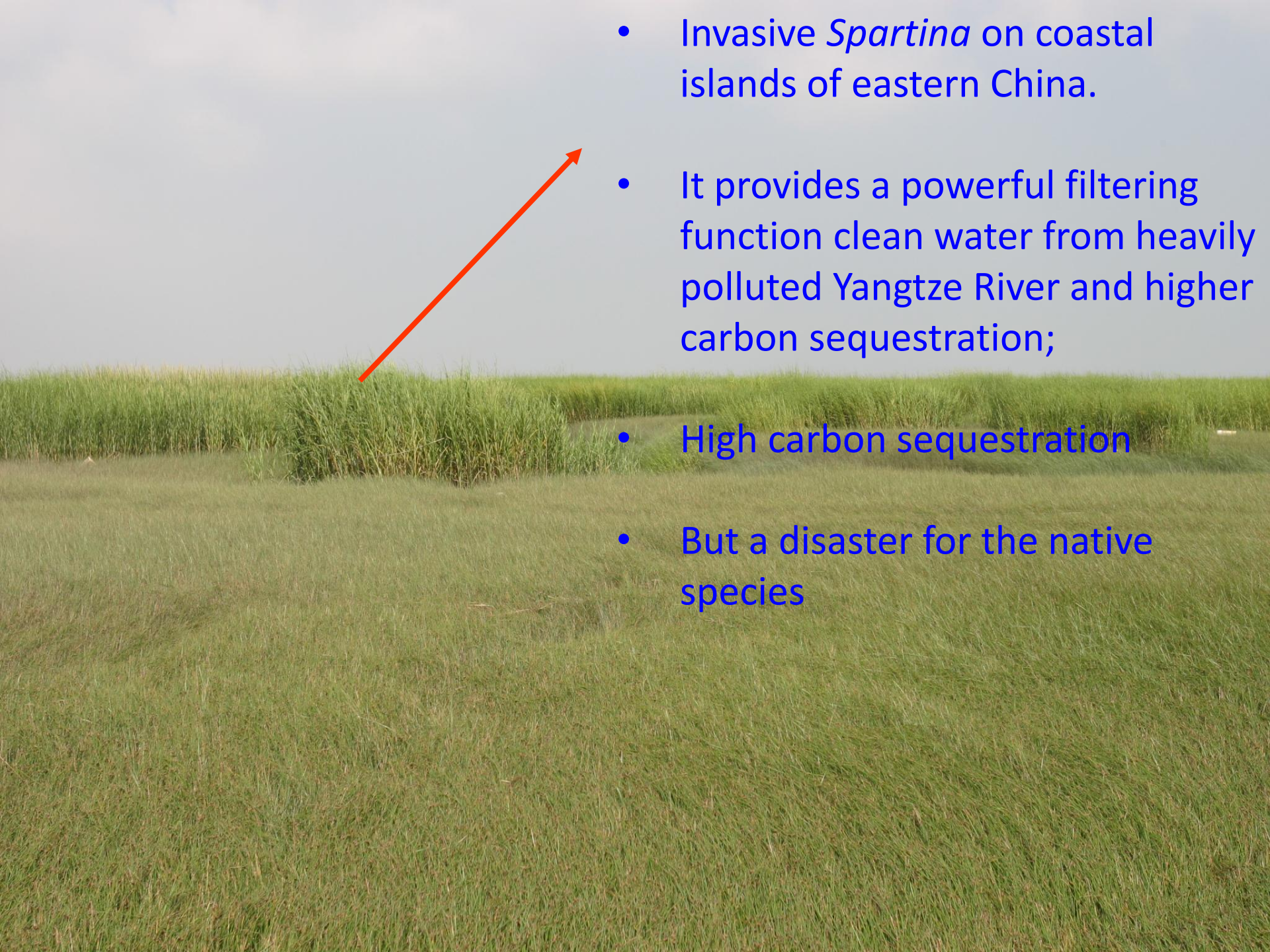

Yangtze River
Jiangsu
0751
Pacific
Ocean
Shanghai
1111
1617
1736
1863
1948
1989
Chongming
2003


Island Area (km²)
1600
1400
1200
1000
800
600
400
200
0
750
900
1050
1200
1350
1500
1650
1800
1950
Year


N
0
15
30
60
km

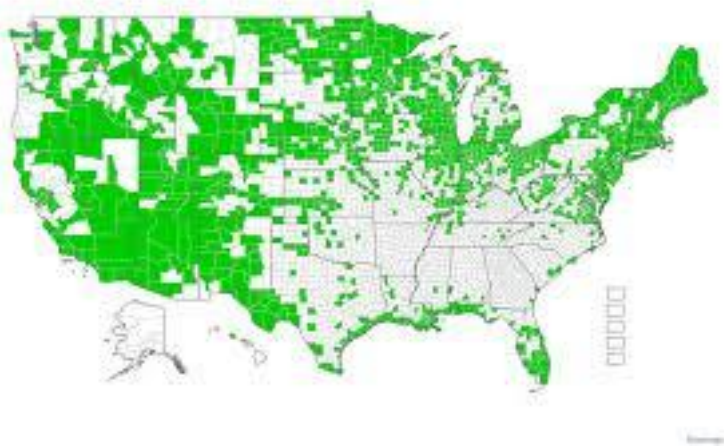
Spartina plantation and expansion

Chen et al. 2008. JI



- Invasive *Spartina* on coastal islands of eastern China.
- It provides a powerful filtering function clean water from heavily polluted Yangtze River and higher carbon sequestration;
- High carbon sequestration
- But a disaster for the native species

Invasive *Phragmites australis* in North America



Example 2

GLBRC
Great Lakes Bioenergy Research Center

GLBRC: support the biomass-to-bioenergy pipeline by developing ecological, agricultural, & life cycle practices that are economically viable & environmentally responsive

High Input, Low Diversity

Continuous Corn

Corn-Soybean-Canola

Switchgrass

Miscanthus

Native grasses + Legumes

Poplars

Early successional

Restored prairie

Low Input, High Diversity

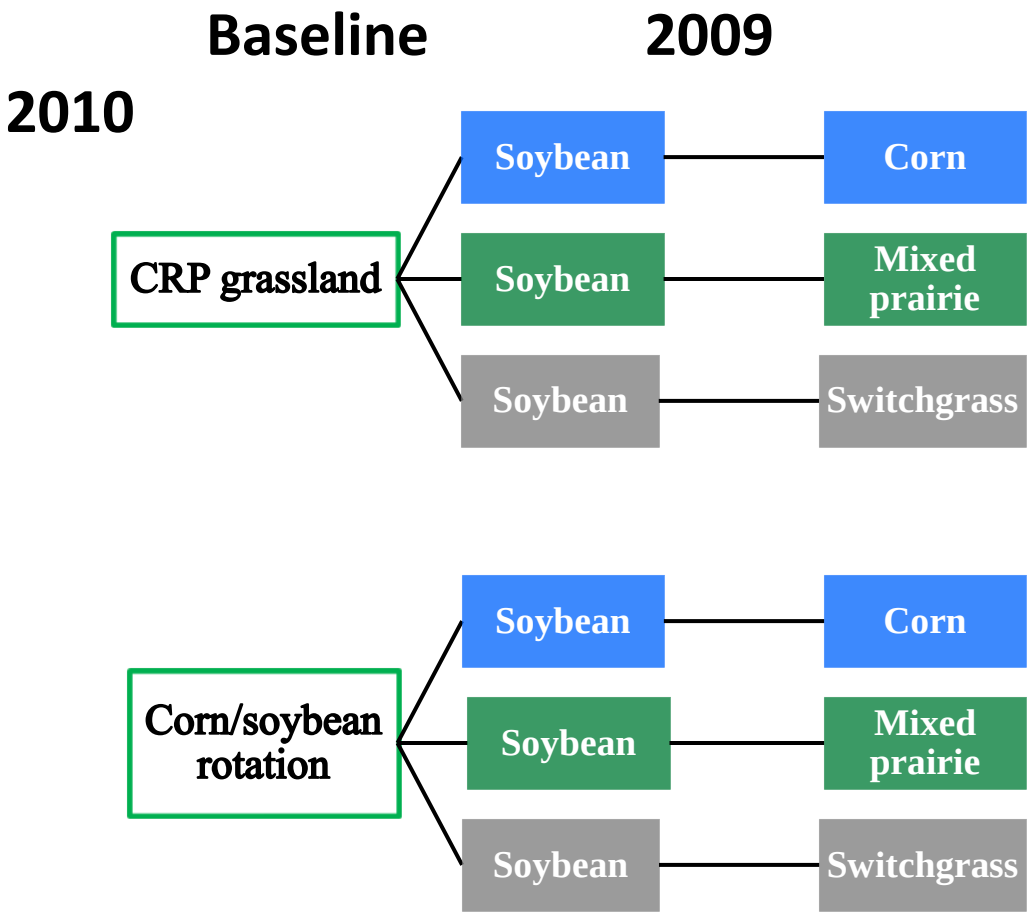
Gelfand et al. 2011

Do we have the lands for these bioenergy systems?

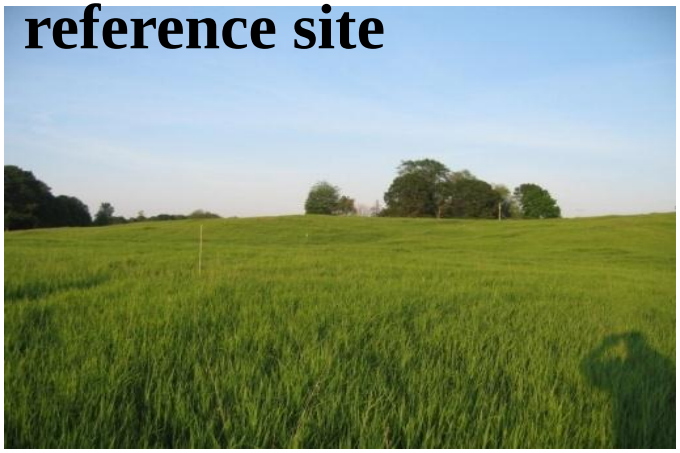
Is it sound to convert forests or other types of land into biofuel systems?

Clean Energy: Biofuels

Experimental design



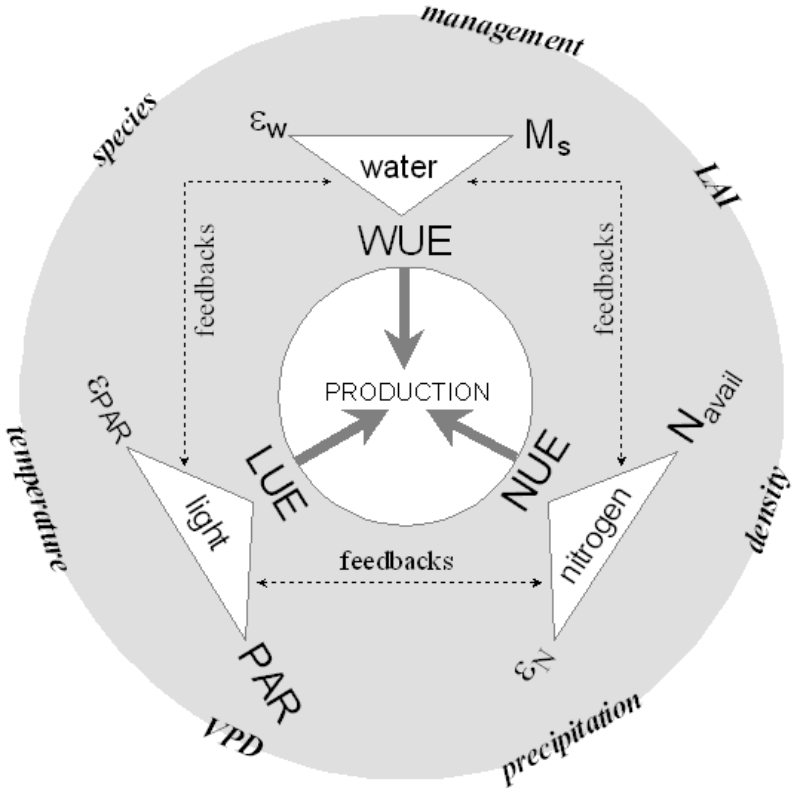
CRP Grassland reference site

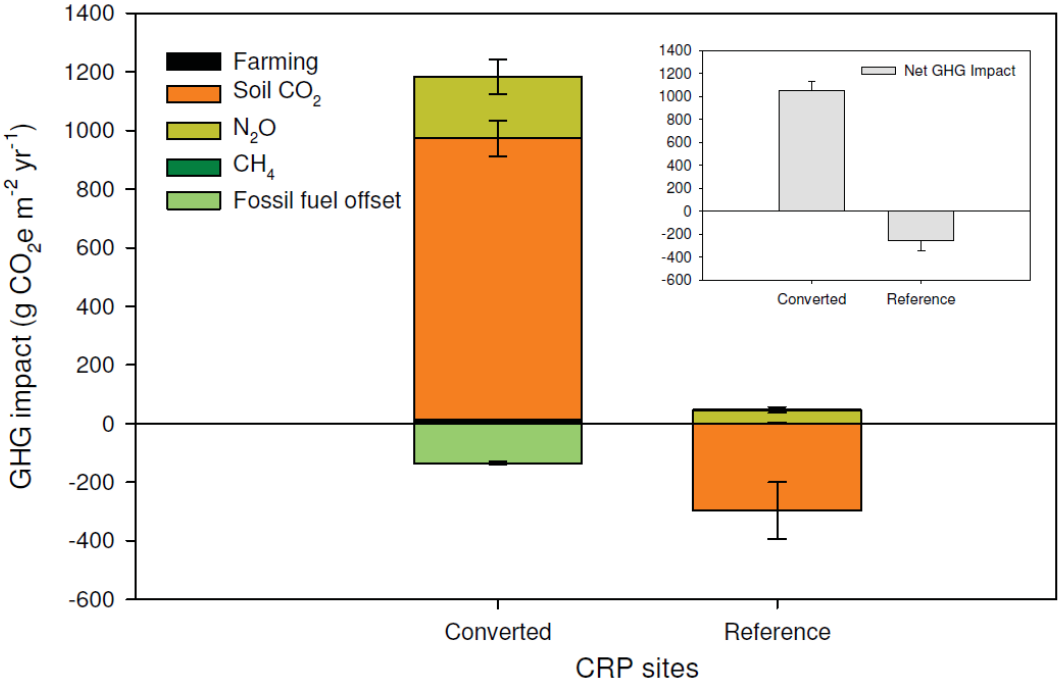


GLBRC scale up fields: sustainability

A new conceptual model on multiple resource use (MRU) as

$$NEP = (\varepsilon_1 \cdot \varepsilon_2 \ldots \varepsilon_n)^{1/n} \bullet (RUE_1 \cdot RUE_2 \cdot \ldots RUE_n)^{1/n} \bullet (R_{avail1} \cdot R_{avail2} \ldots R_{availn})^{1/n}$$

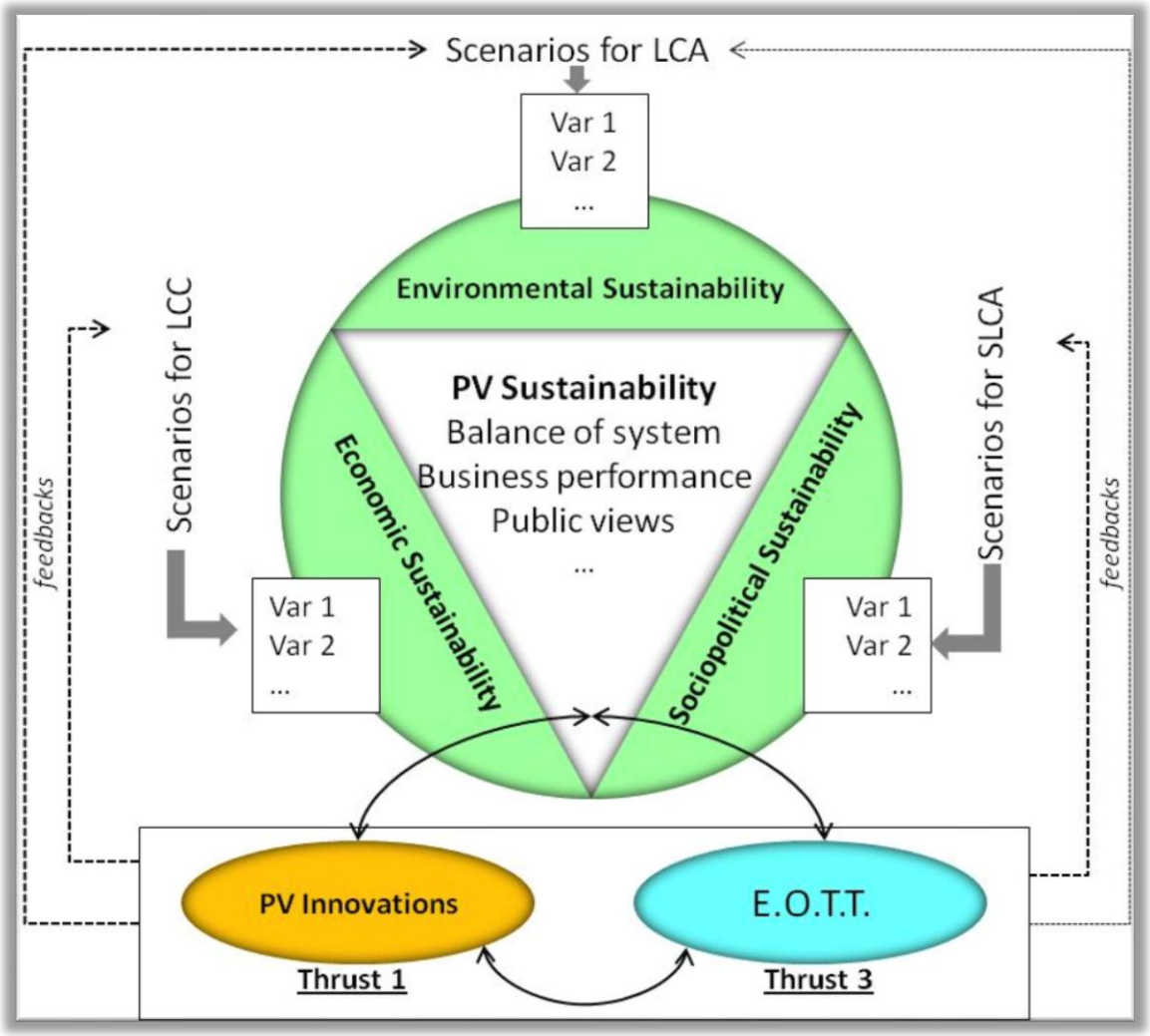




Carbon debt of a CRP grassland converted to bioenergy production. 76 yr would be required to repay a debt of 106±1 Mg CO_2e ha^{-1} were the subsequent system continuous corn under permanent no-till. If tilled, repayment would require ~172 yr because of additional soil carbon loss that balloons total debt to 259±55 Mg CO_2e ha^{-1}. Were the subsequent system corn-soybean, repayment would require 88 (permanent no-till) or 196 (tilled) yr.

(Gelfant et al. 2011. PNAS)

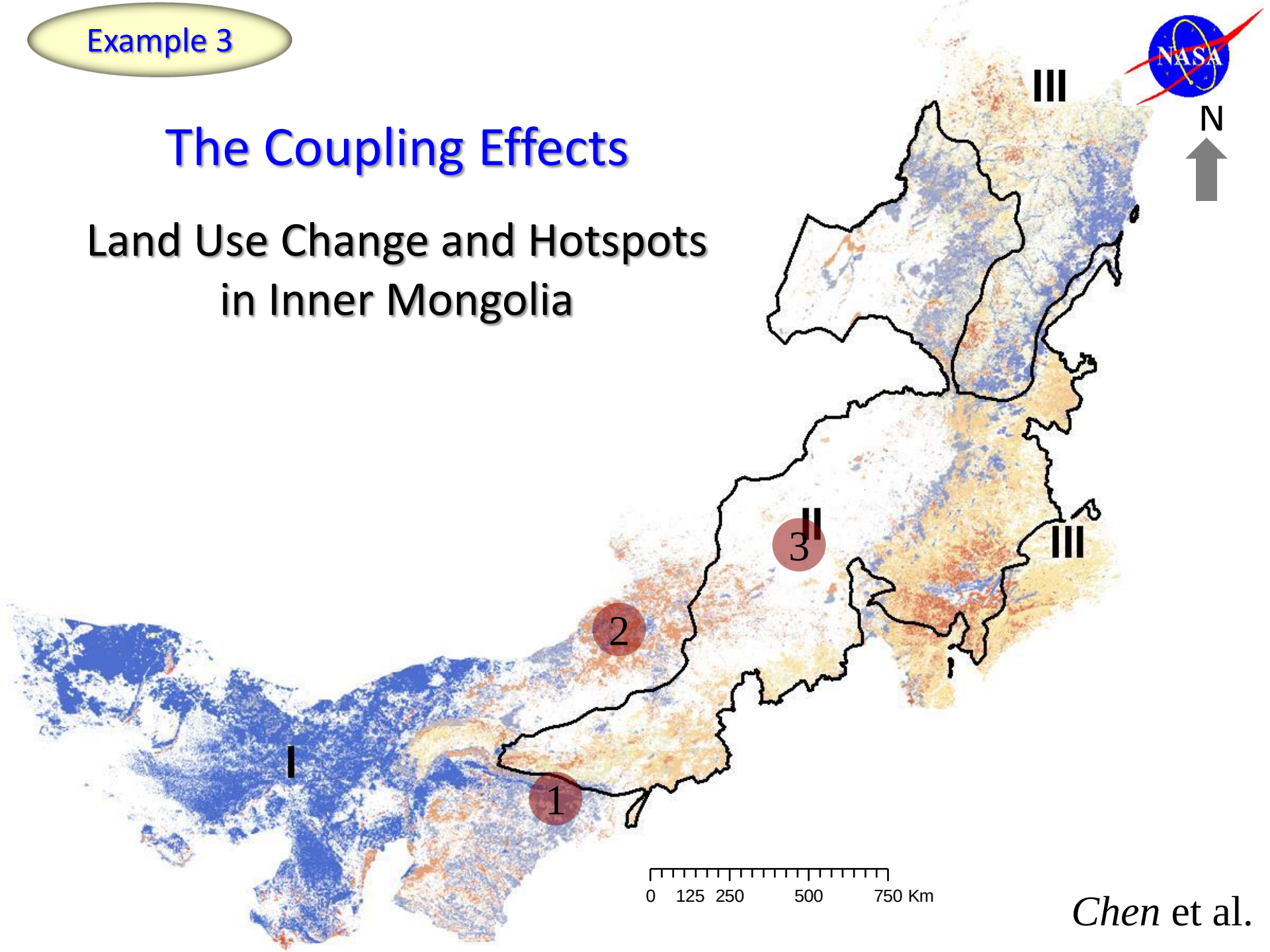
CURRENT THRUST II FOCUS



Example 3

The Coupling Effects

Land Use Change and Hotspots in Inner Mongolia



Chen et al.

Repeated ANOVA tests: Coupled Effects of Climate and Landuse on GPP & ET

(1) Gross Primary Production (GPP)

	SSE	%
Type	2.8924	64.3
Year	1.20423	26.8
Year*type	0.40085	8.9
total	4.49748	

2.4

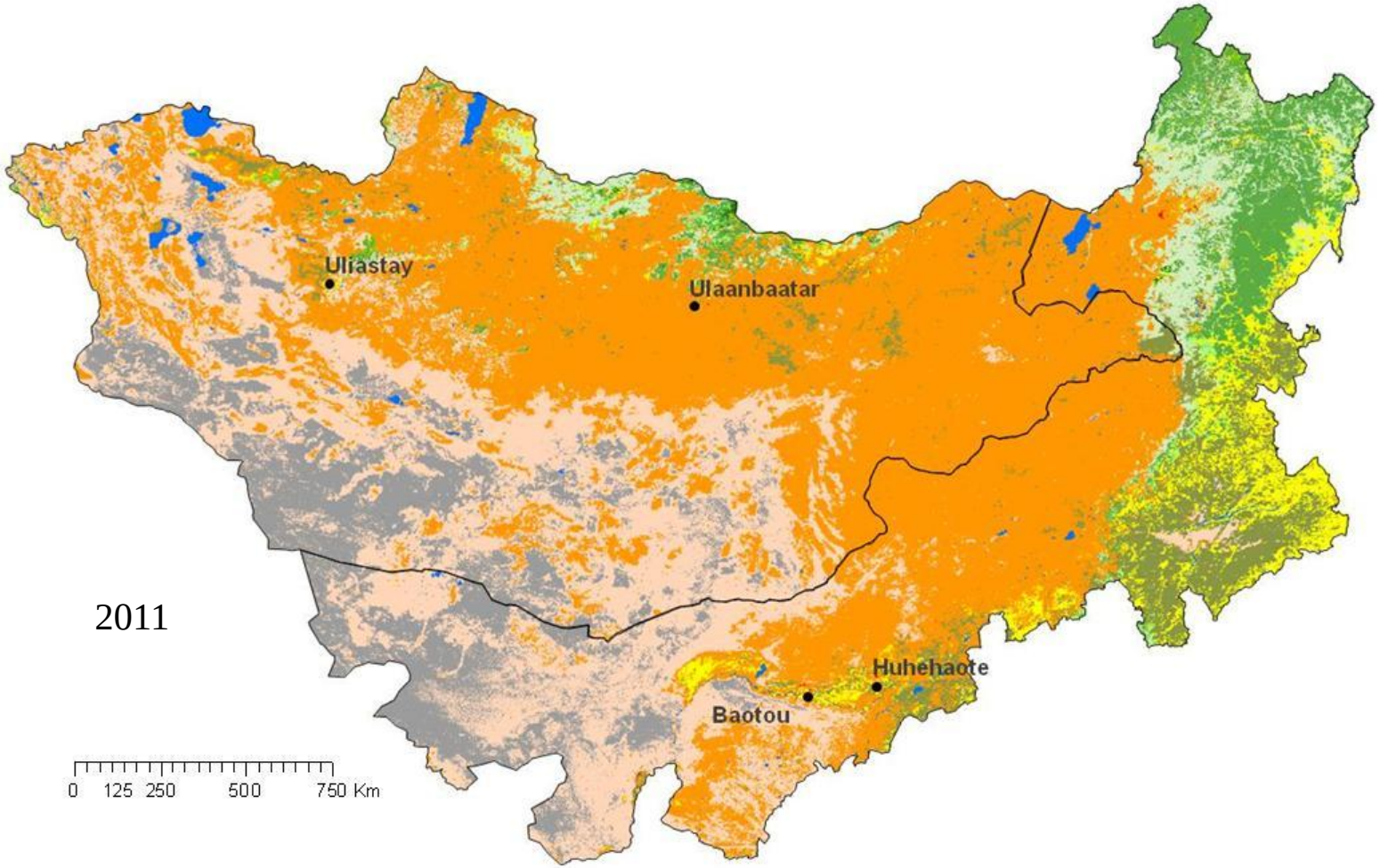
(2) Evapotranspiration (ET)

	SSE	%
Type	11425.4	83.6
Year	1981.1	14.5
Year*type	257.1	1.9
total	13663.6	

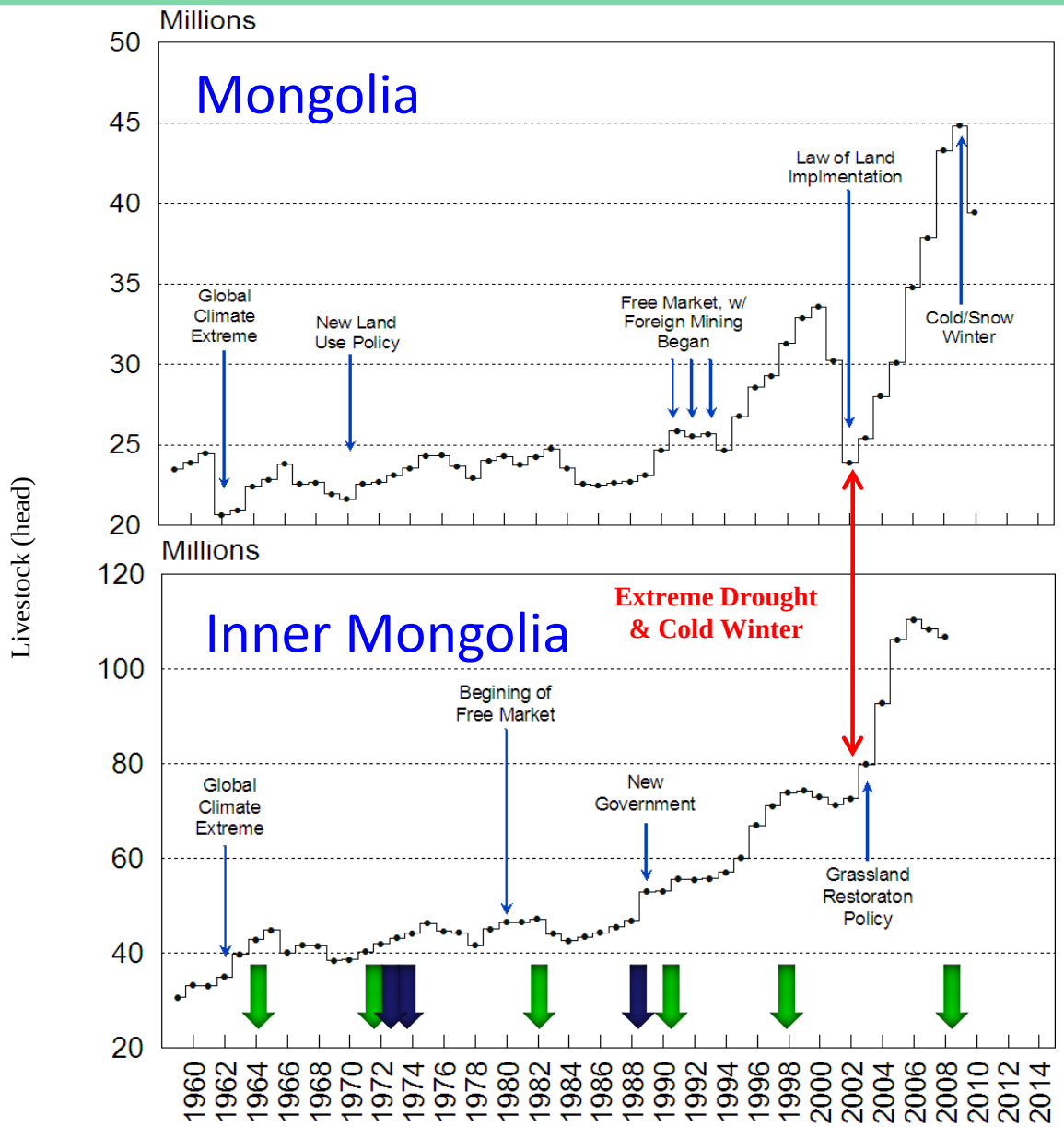
5.77

Chen et al. in prep

Mongolia Plateau: interactive changes of natural and human under similar climate but different land-use conditions



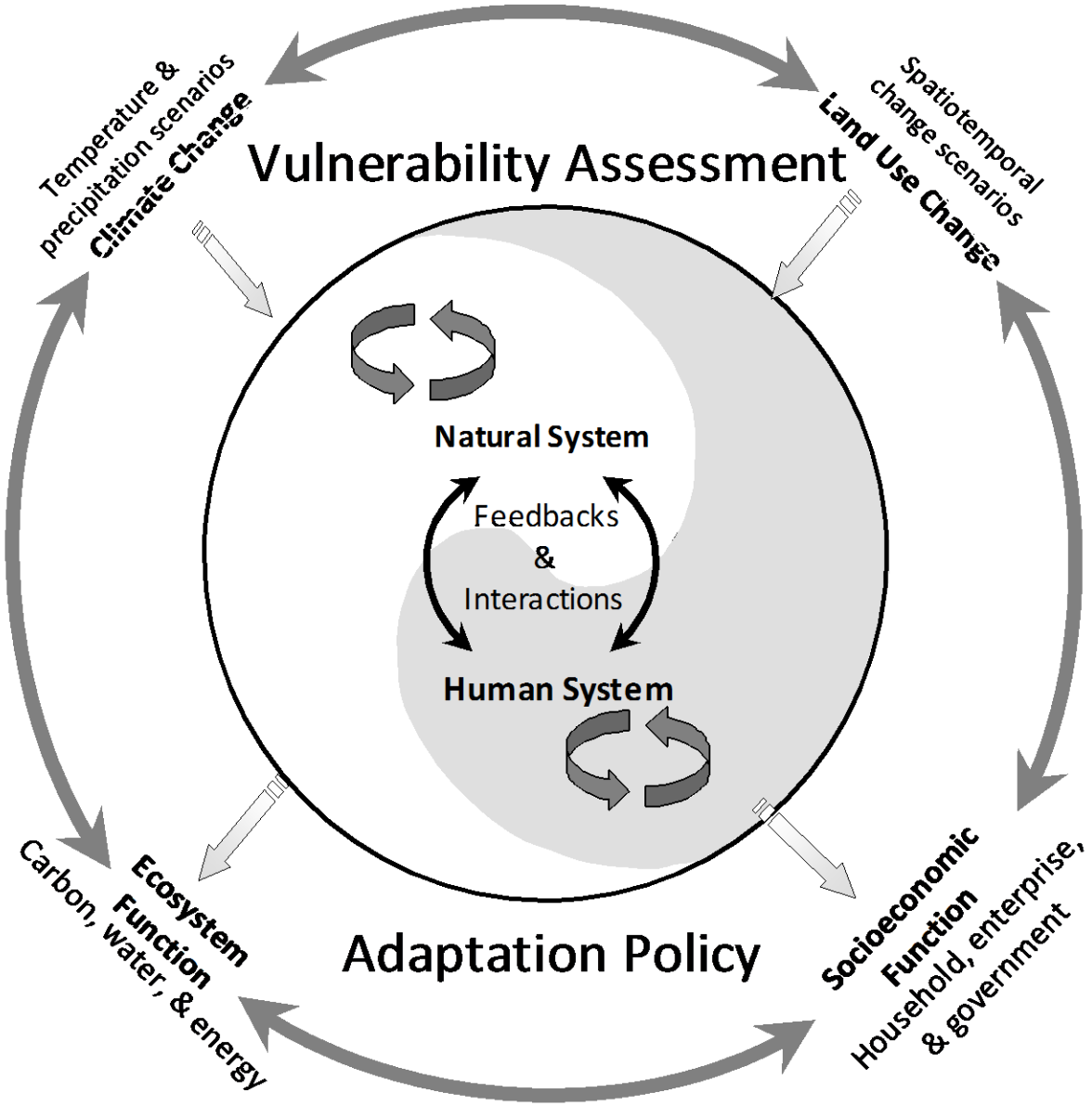
Changes in livestock, policy, and climate in IM and MG



Qi et al. (2012)

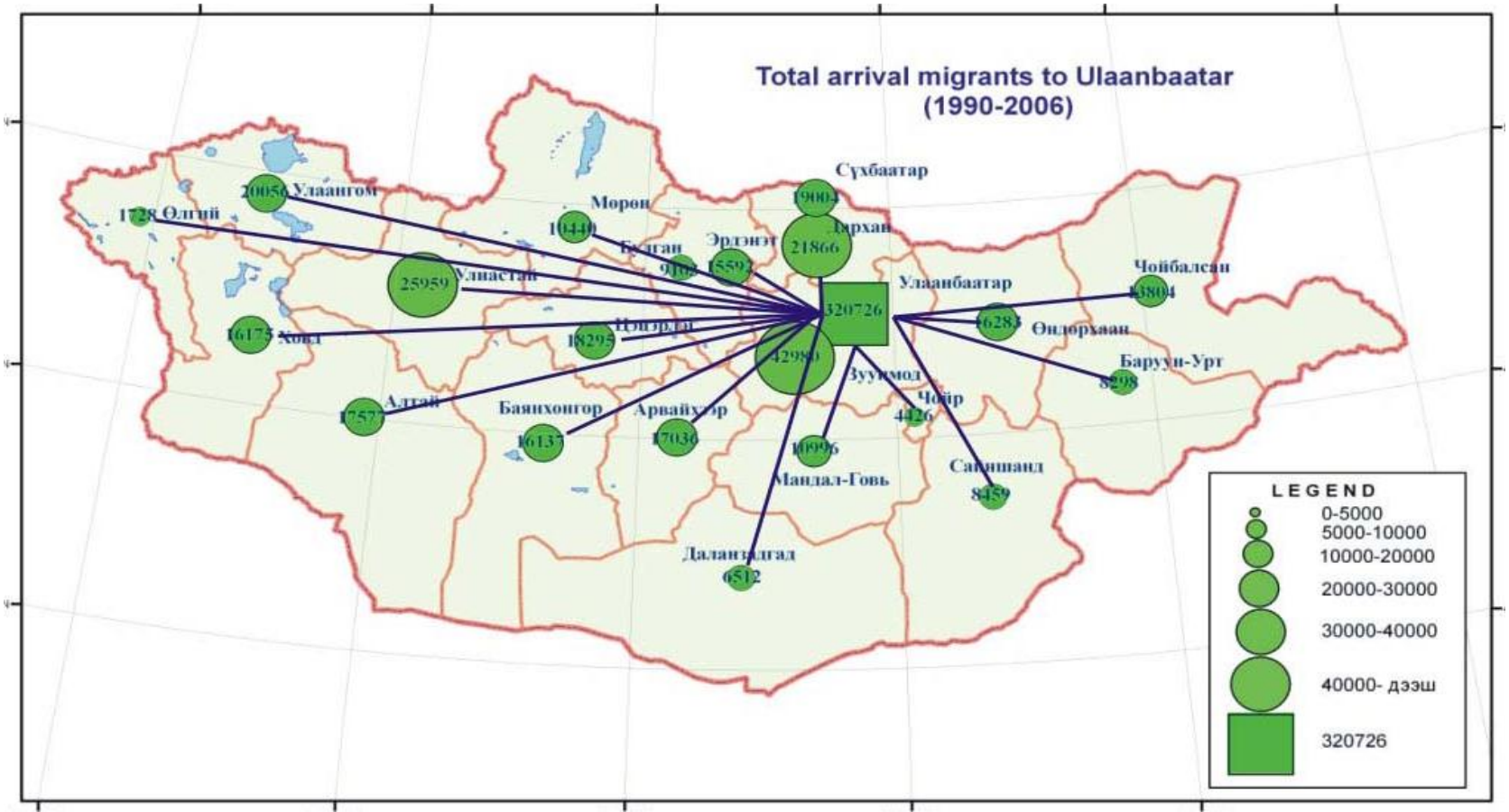
Concept

Macro-System Concept & CHN



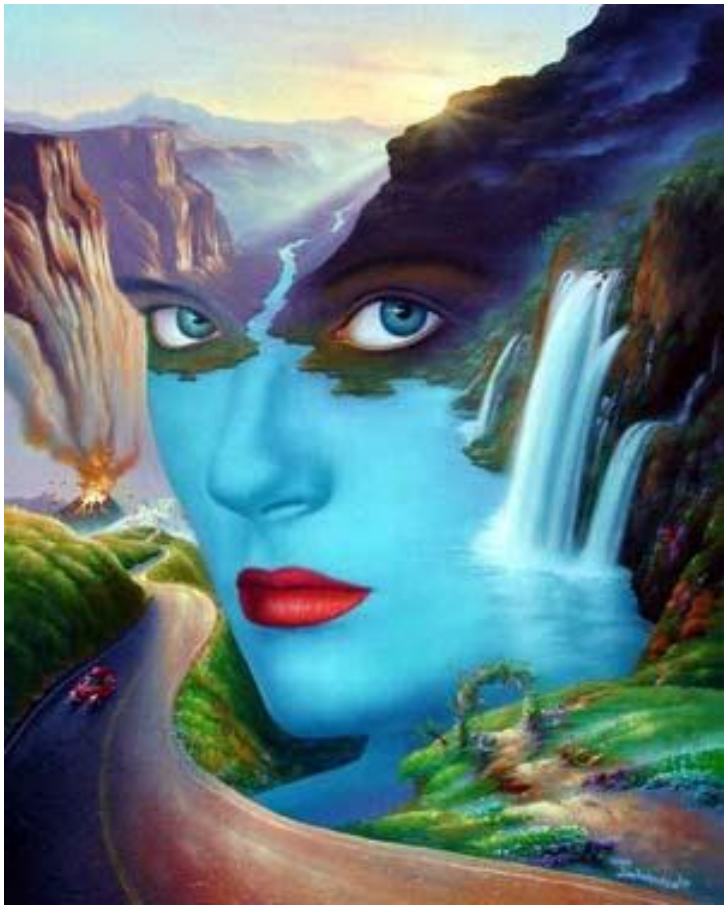
Population migration in Mongolia

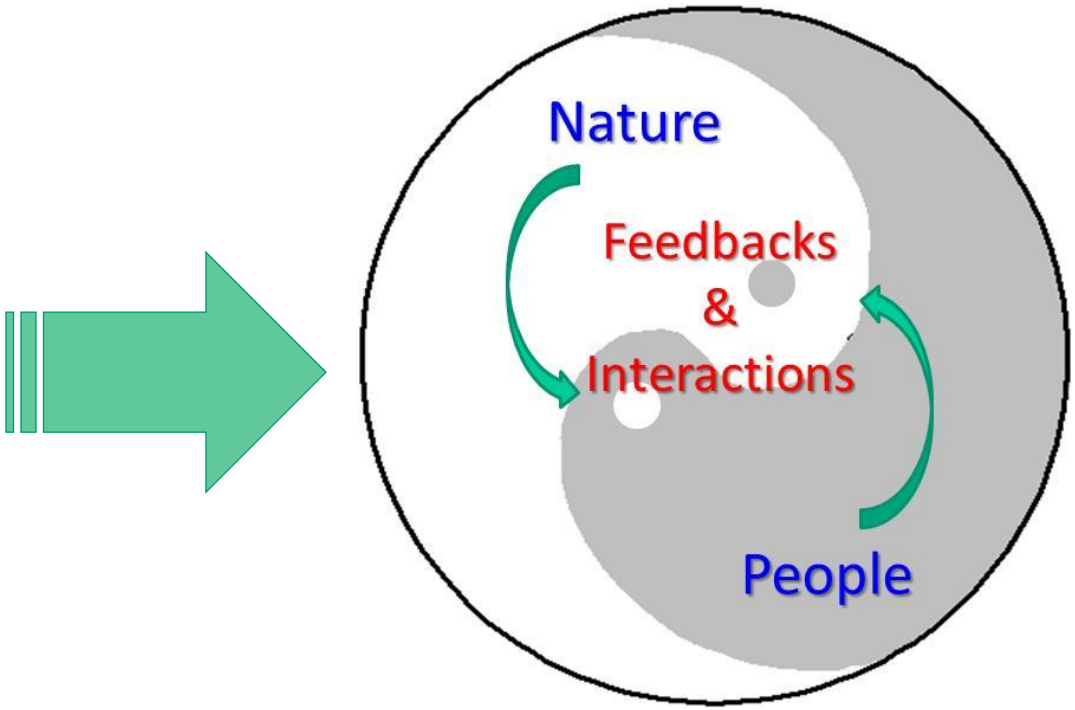
The internal migration where the flow is oriented toward to Ulaanbaatar and the central region of MG has been a trend. Nearly 70% of the migrants is concentrated in such cities area as Ulaanbaatar, Darkhan, Orkhon and Selenge *aimags* or along the general roads and railway lines. Since 1990, 320 thousand have migrated from rural areas to Ulaanbaatar city and 34 thousands from cities to the countryside (J. Oyungerel, Mongolian Academy of Sciences, 2008).



One Thing in Common among These Examples

People ~ Nature

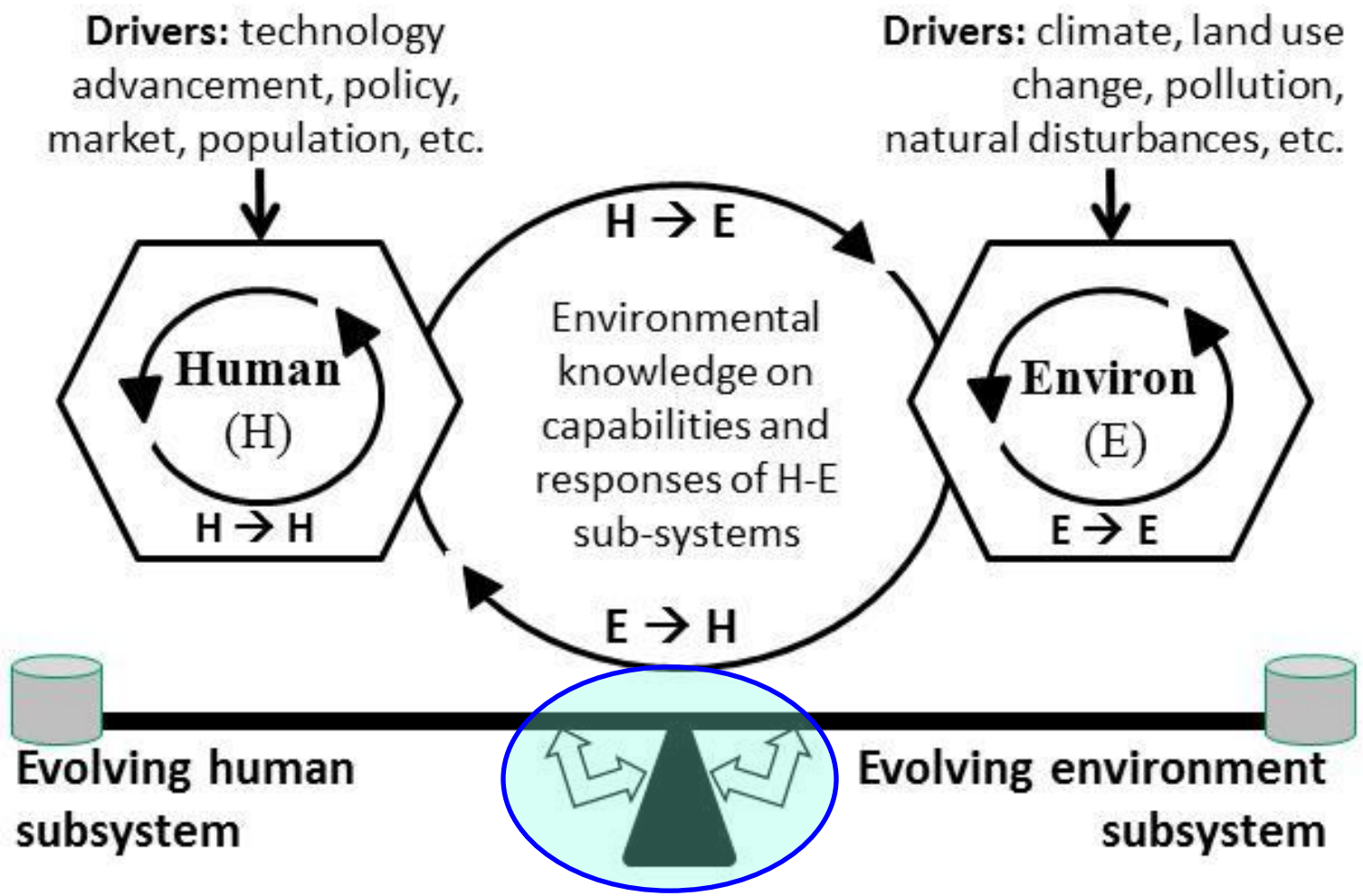




Coupled Human & Natural System (CHANS)

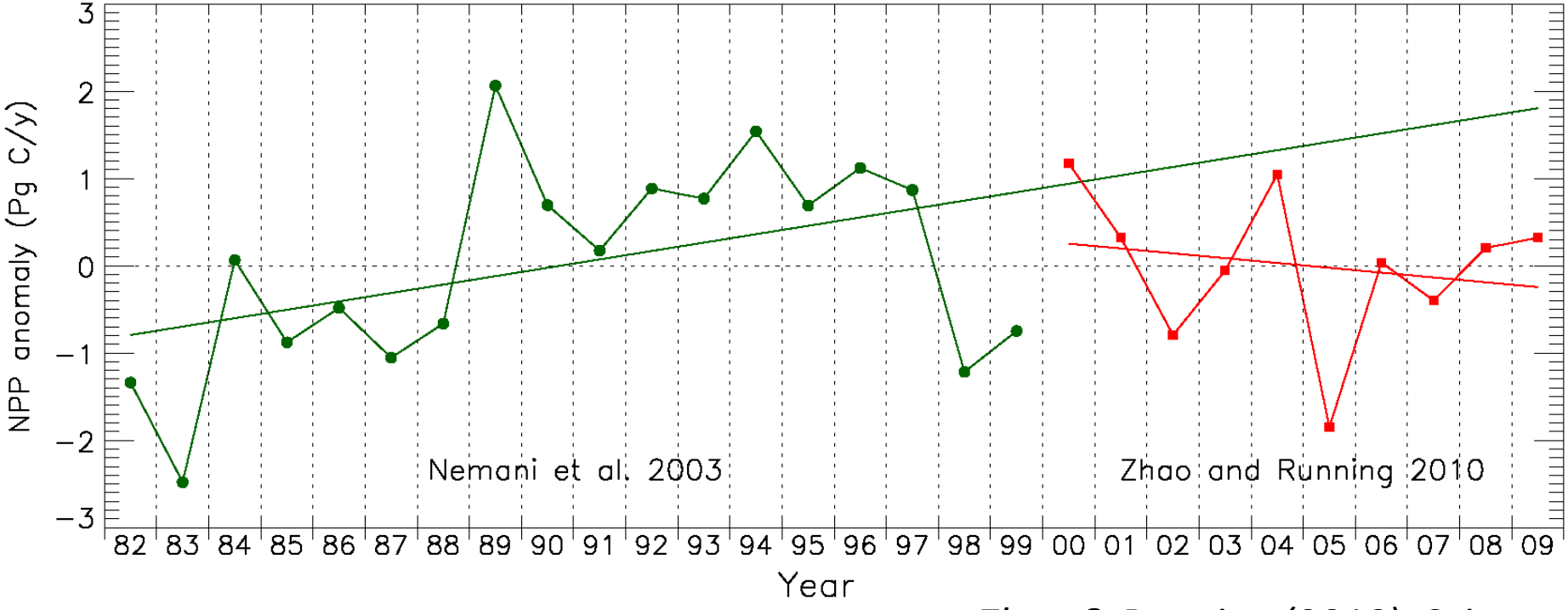
Concept

Coupled Human & Natural System (CHANS)



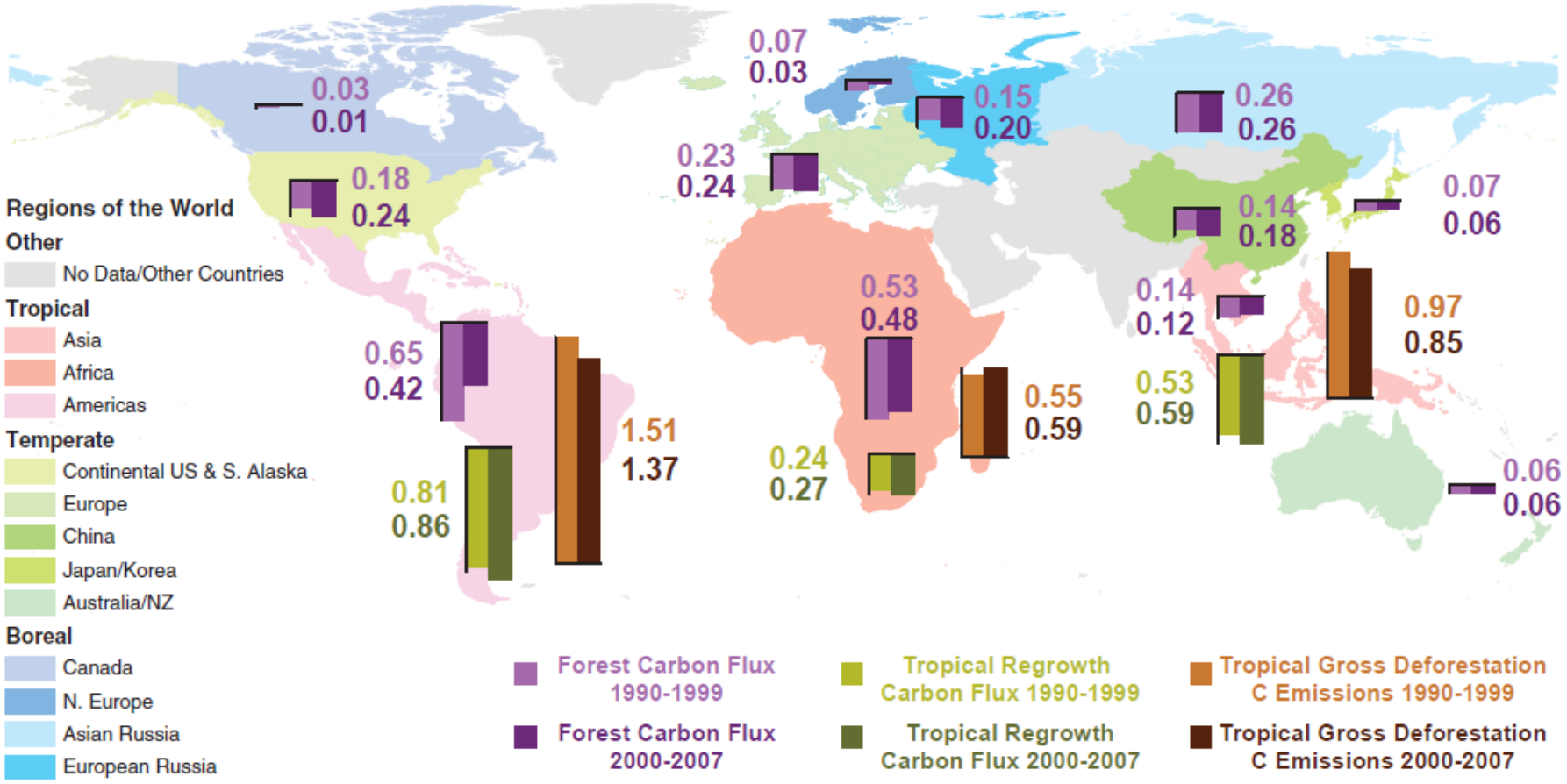
Global NPP decreased from 2000 to 2009, with NPP over North Hemisphere continued increasing (winner) and over South Hemisphere decreased; Recent drying trend caused the reduction in NPP in SH.

What are the consequences?



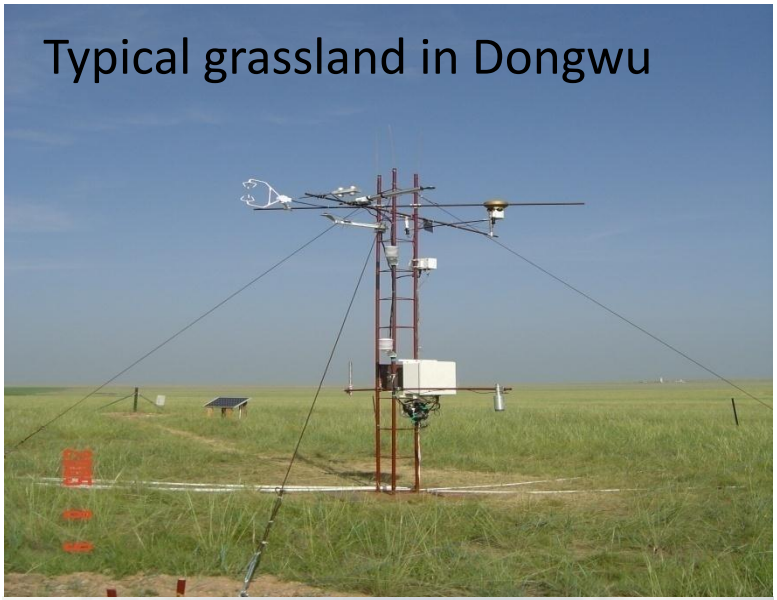
Zhao & Running (2010). Science

Carbon Sinks and Sources (Pg C yr^{-1}) in the World's Forests

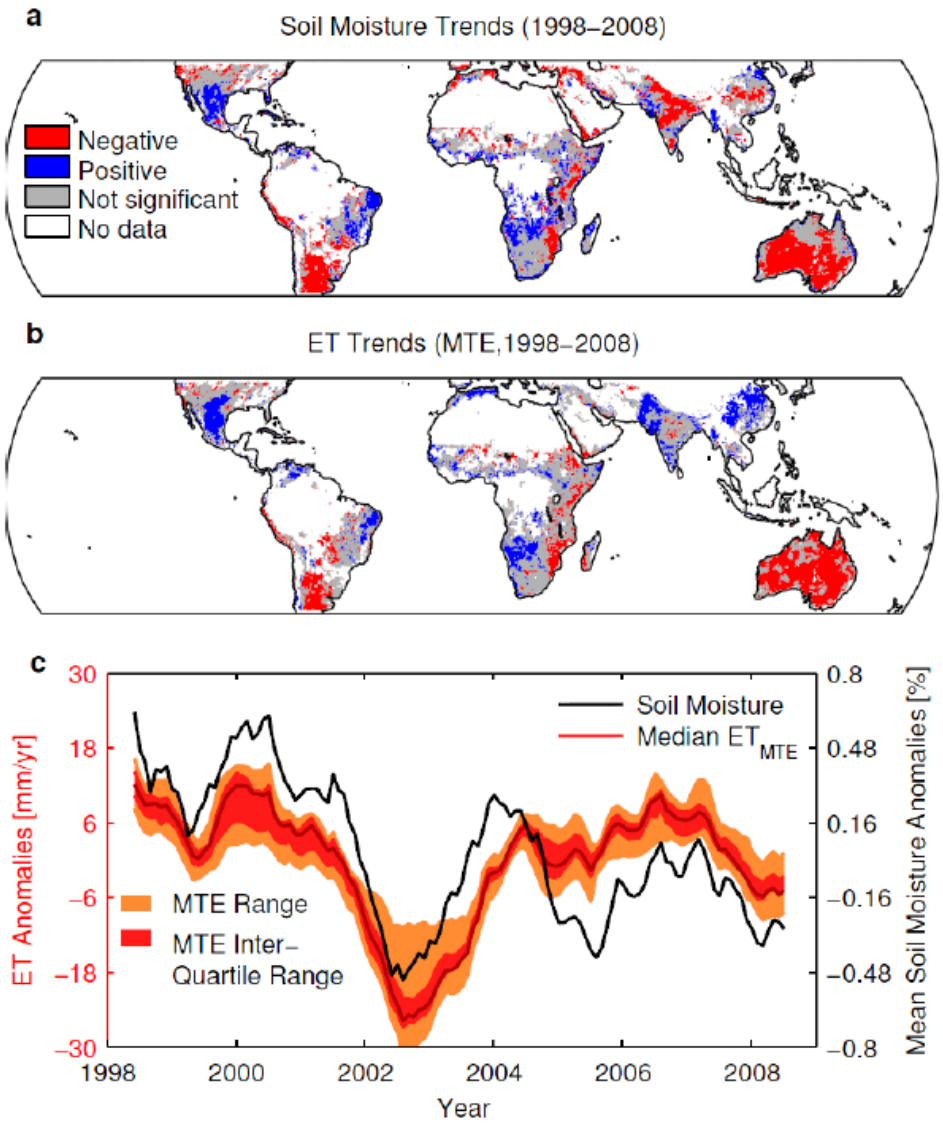


Pan *et al*. (2011) *Science*

FLUXNET for direct measurements of greenhouse gases (GHG). Several thousands site-year data are available.



Global annual evapotranspiration (ET) increased on average by 7.1 mm/yr per decade from 1982 to 1997. After that, coincident with the last major El Nin˜o event in 1998, the global ET increase had ceased until 2008. This change was driven primarily by moisture limitation in the Southern Hemisphere, particularly Africa and Australia.

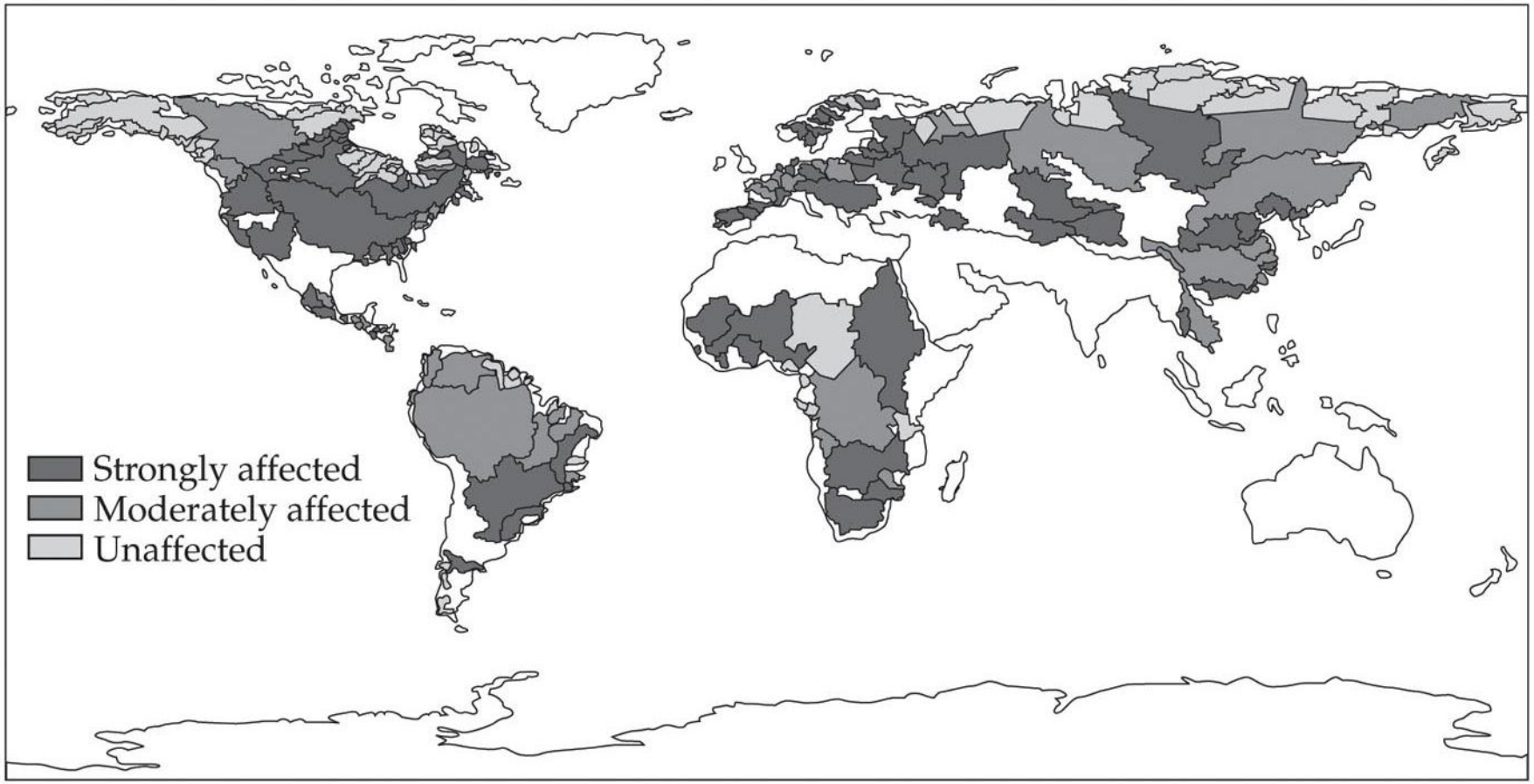


Jung et al. (2010).

Forest fragmentation is one of the greatest environmental issues worldwide because of its significant impacts on biological diversity, disrupts the integrity of stream network (e.g., water quality), etc.

FIG. 1. A Pacific Northwest forest landscape fragmented by clear-cutting.

Degree of fragmentation of major river basins of the world



PRINCIPLES OF CONSERVATION BIOLOGY, Third Edition, **Case Study 7.2, Figure A**

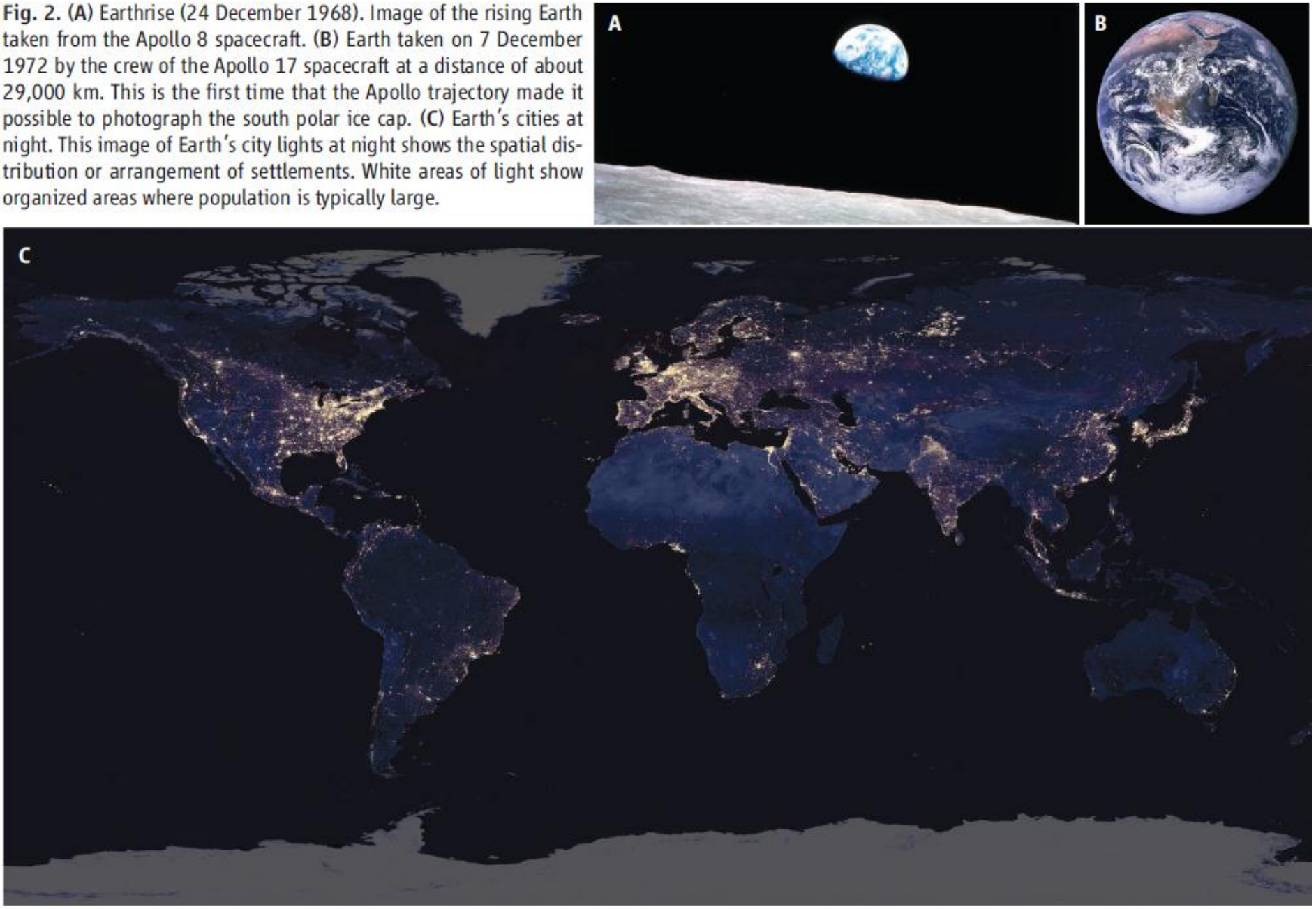
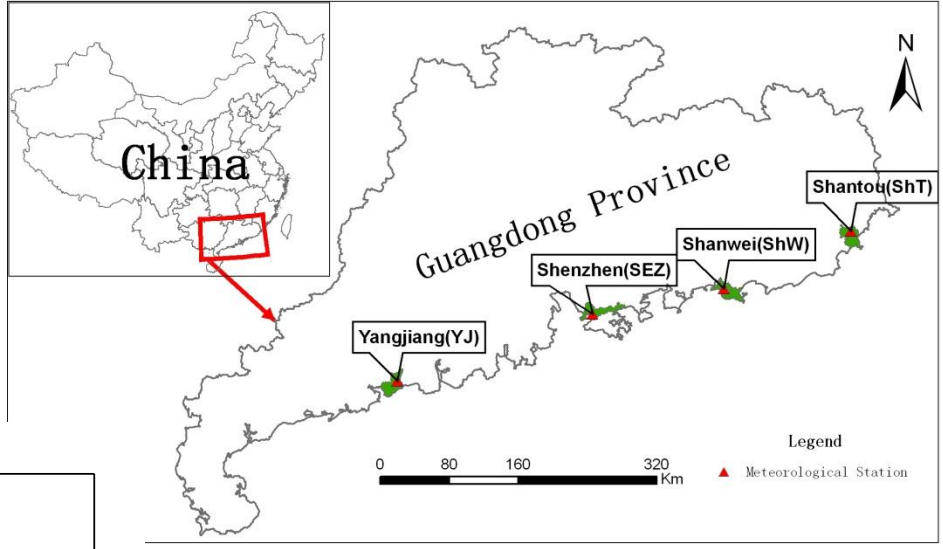


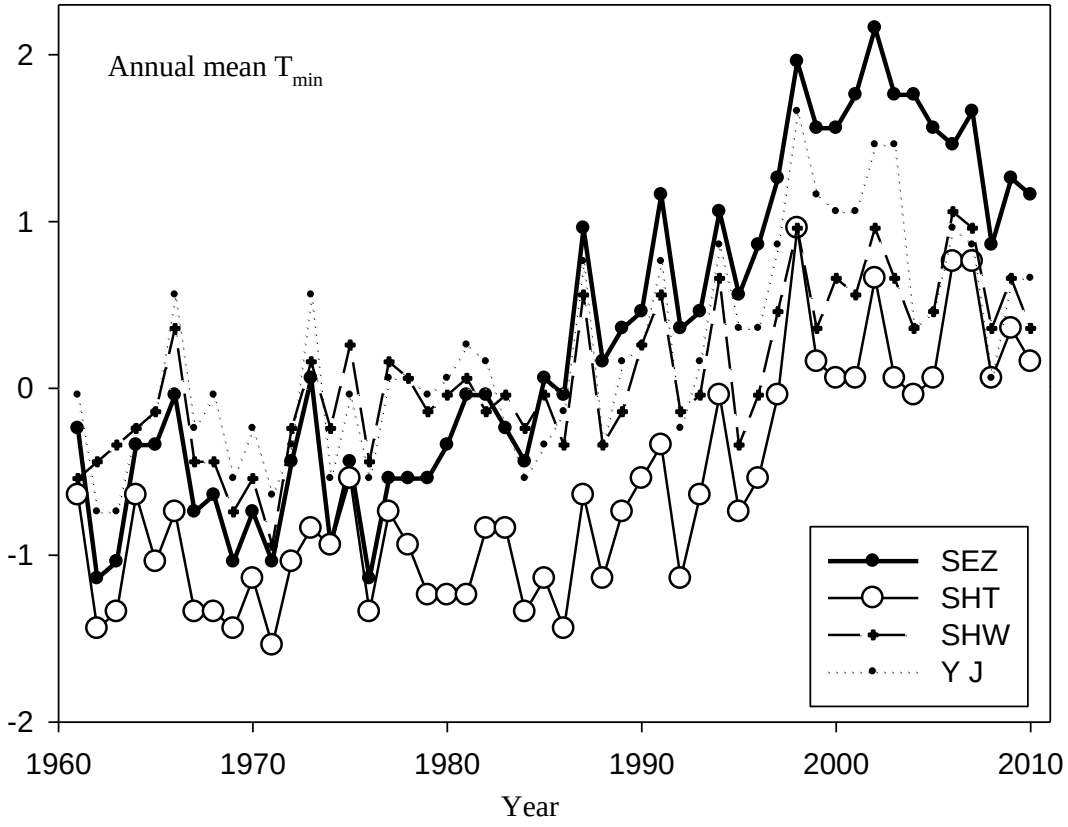
Fig. 2. (**A**) Earthrise (24 December 1968). Image of the rising Earth taken from the Apollo 8 spacecraft. (**B**) Earth taken on 7 December 1972 by the crew of the Apollo 17 spacecraft at a distance of about 29,000 km. This is the first time that the Apollo trajectory made it possible to photograph the south polar ice cap. (**C**) Earth's cities at night. This image of Earth's city lights at night shows the spatial distribution or arrangement of settlements. White areas of light show organized areas where population is typically large.

Urban heat island in 4 coastal cities in Southern China

Case Study From ShenZhen

Urban heat island in 4 coastal cities in Southern China



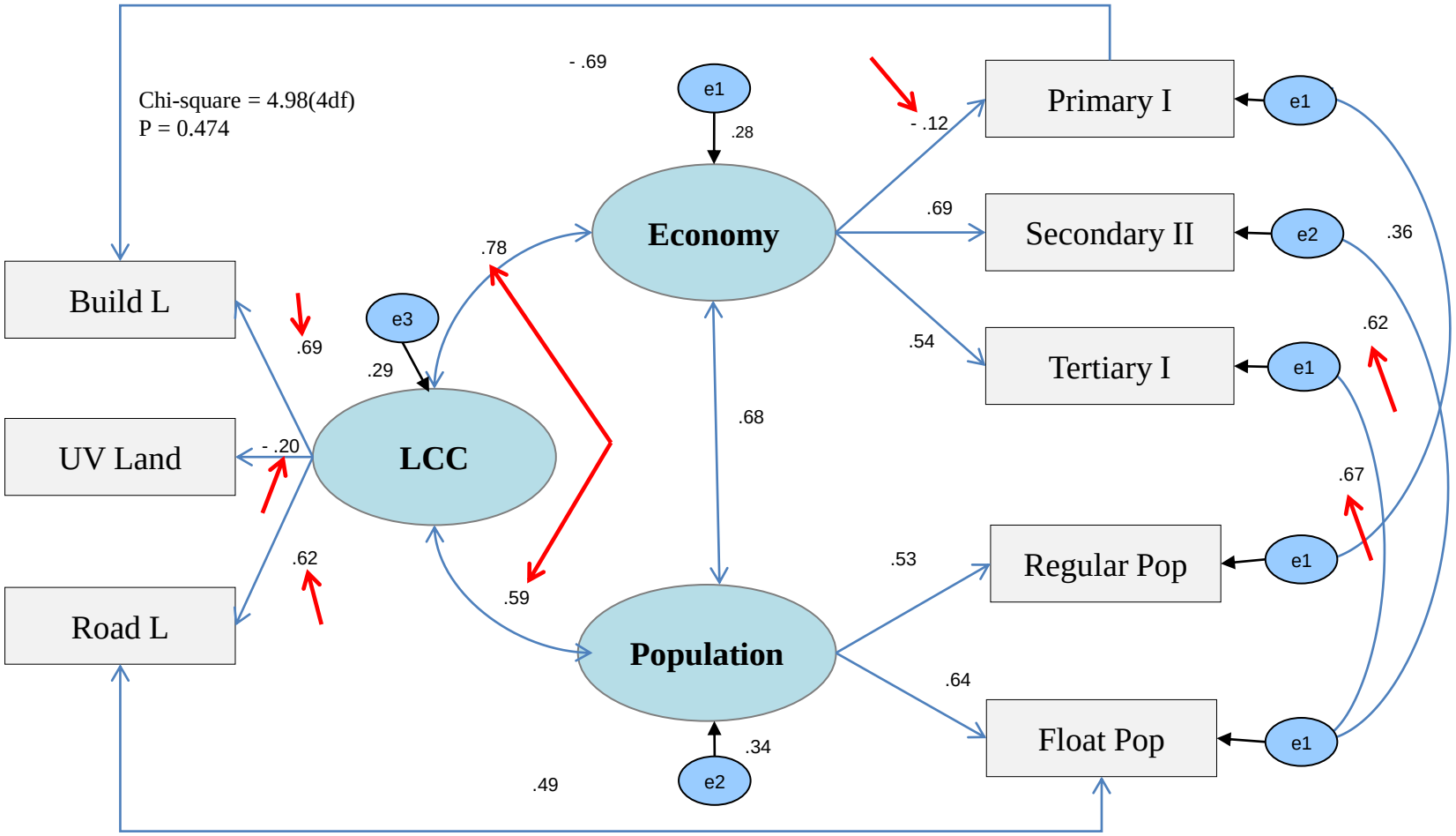


$$Ratio = T_{\min_{i,n}} - \frac{1}{4} \times \frac{1}{n} \sum_{i=1}^{4} \sum_{n=1}^{50} T_{\min_{i,n}}$$

Where *i* is the cities (SEZ,ShT,ShW,YJ);
n is the time, from 1961to 2010

Tian, Chen, Yu. (in press)

Connecting nature, land use change (LCC), economy, and population in Shenzhen (Tian et al. In preparation).



What to do?

Ecosystem Management for Maximizing the Services

Sierra Nevada, CA

Landscape Level (Four Landscapes)

Pine Barrens

Large-Block Pine Oak

Do differences among landscape-level disturbance regimes influence patterns of understory plant diversity or composition?

Small-Block Pine

Pine-Oak-Aspen Forest

An agricultural landscape pattern

Needs from managers and policy makers

Each management option is accompanied with some expectations and many surprises

Lacks of theoretical and empirical bases remain frustrations for landscape managers

Managers need "cook books": available information is too abstractive, not specific. Products need to be simple, straightforward.

Education holds the key for tomorrow

- Students decides the landscapes of future cities
- Explored students' preferences toward natural and wild versus clean and neat residential landscapes.

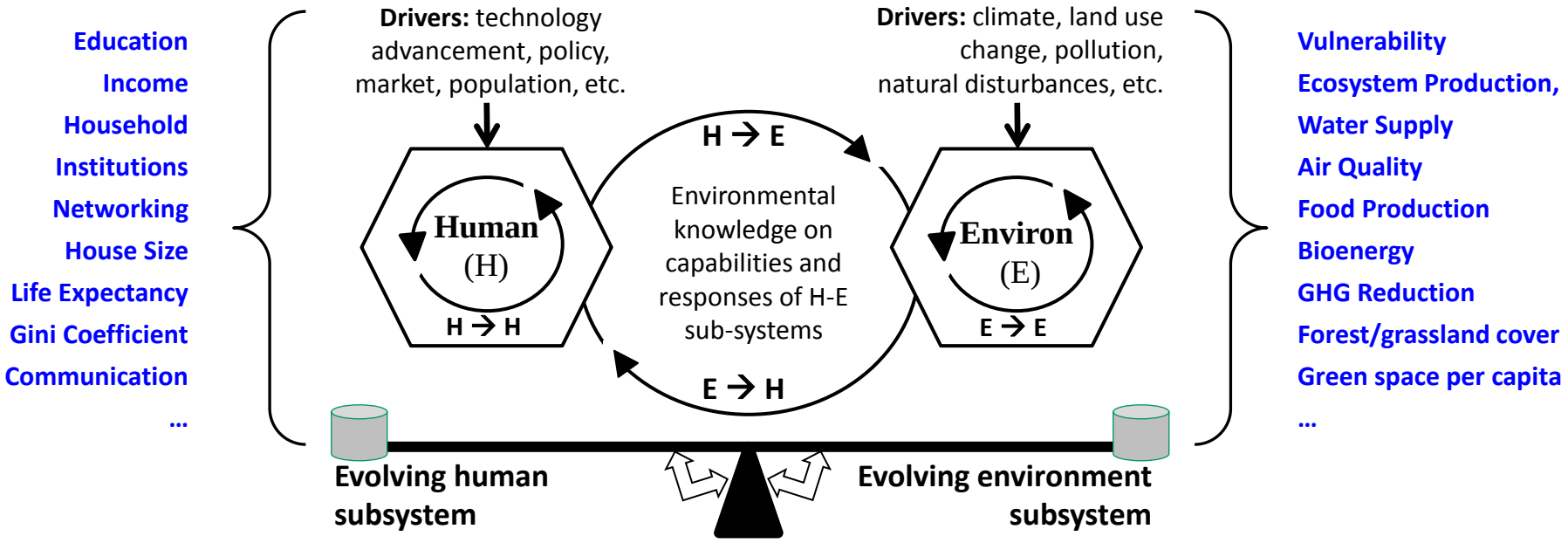
(c) Landscape design H3

(d) Landscape design H4

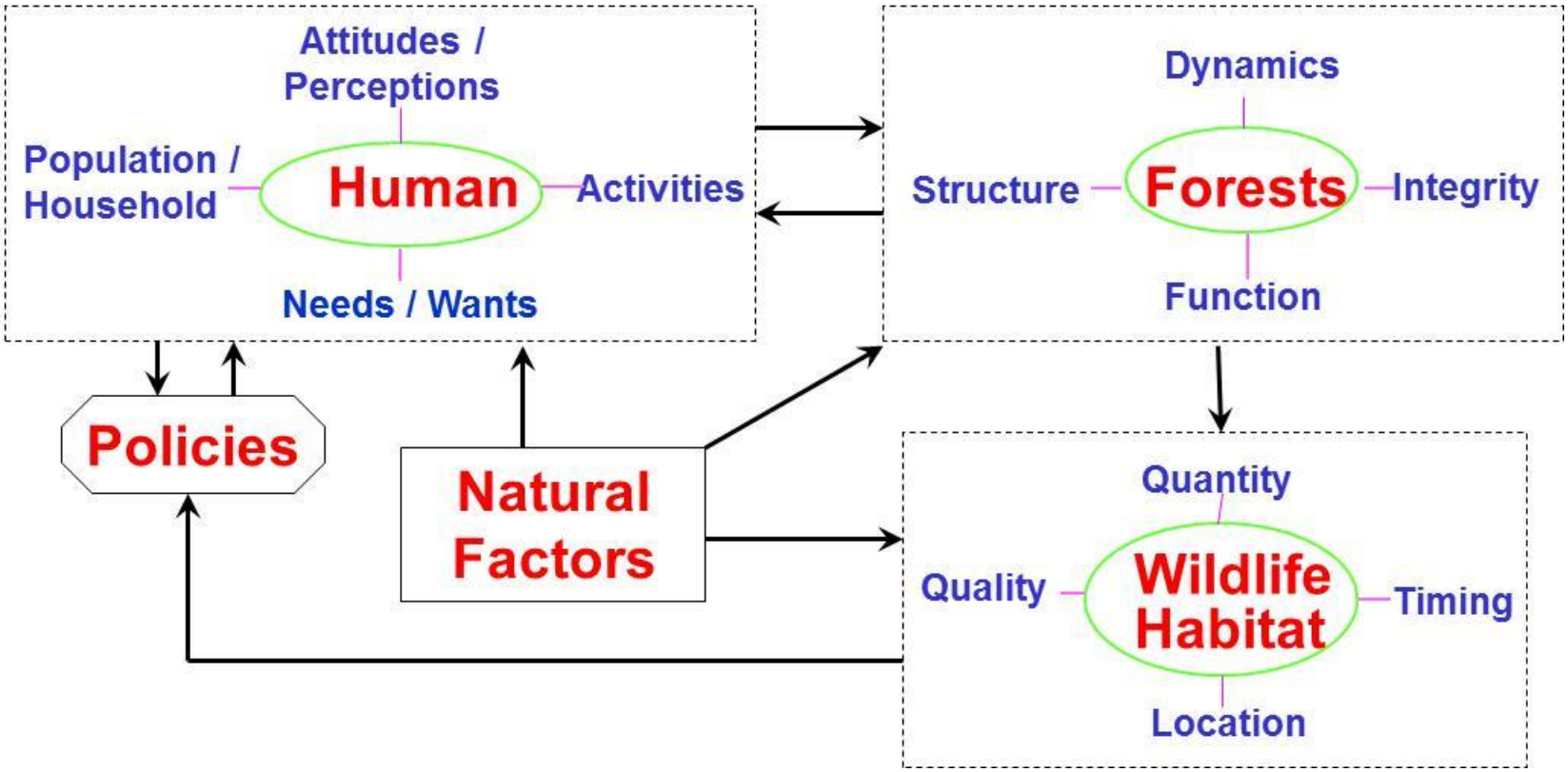
Zheng, B., Y. Zhang, and J. Chen. 2011. Preference to home landscape: wilderness or neatness? *Landscape and Urban Planning* 99:1-8.

Education holds the key for tomorrow

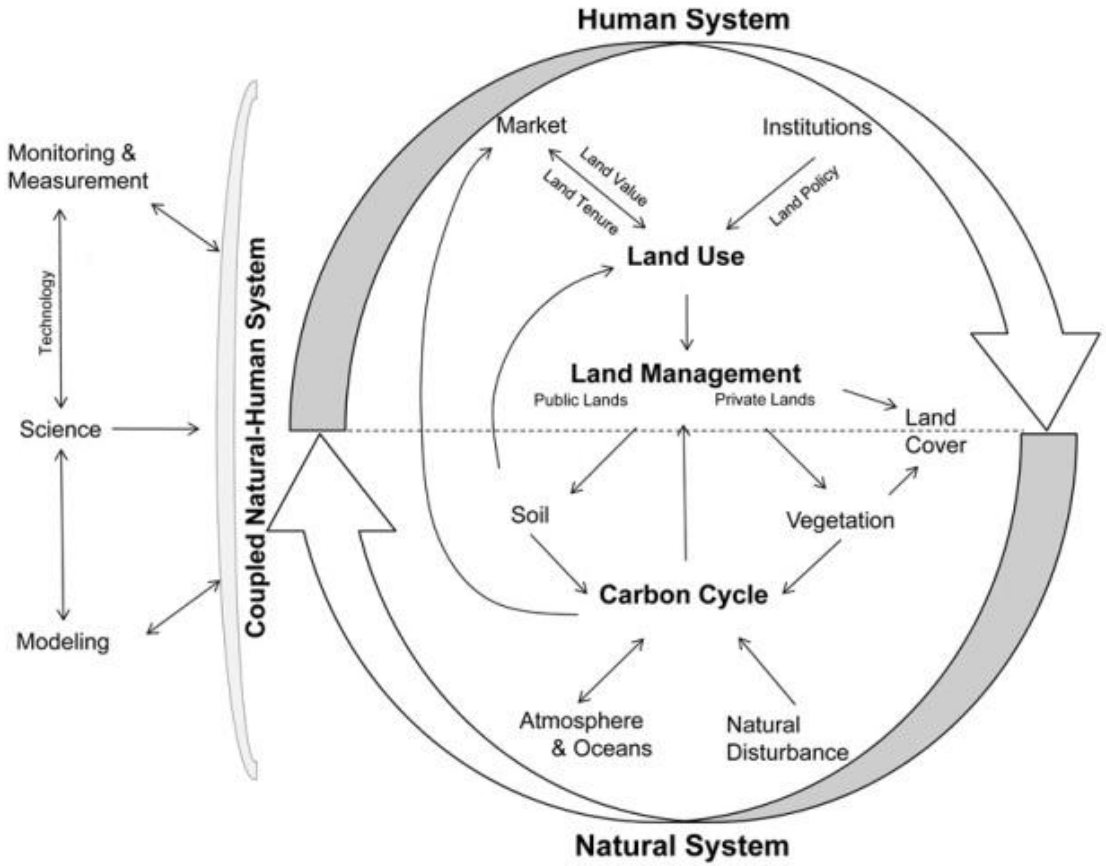
- Based on the rating scores of four housing landscape designs, we explore the potential influential factors on people's preferences, especially the wildness or neatness of the home landscape.
- Students in agricultural economics, horticulture, and social sciences are more inclined to choose a neat, well-kept environment around their homes.
- In contrast, wildlife science students prefer more natural landscapes.
- Senior students and students from large cities also prefer well-maintained and artificial landscapes.
- Students who are members of an environmental group, and those whose parents have a better education, are more likely to choose a more natural landscape.


Education
Income
Household
Institutions
Networking
House Size
Life Expectancy
Gini Coefficient
Communication
…
Drivers: technology advancement, policy, market, population, etc.
Drivers: climate, land use change, pollution, natural disturbances, etc.
Human (H)
H → H
H → E
Environmental knowledge on capabilities and responses of H-E sub-systems
E → H
Environ (E)
E → E
Evolving human subsystem
Evolving environment subsystem
Vulnerability
Ecosystem Production,
Water Supply
Air Quality
Food Production
Bioenergy
GHG Reduction
Forest/grassland cover
Green space per capita
…

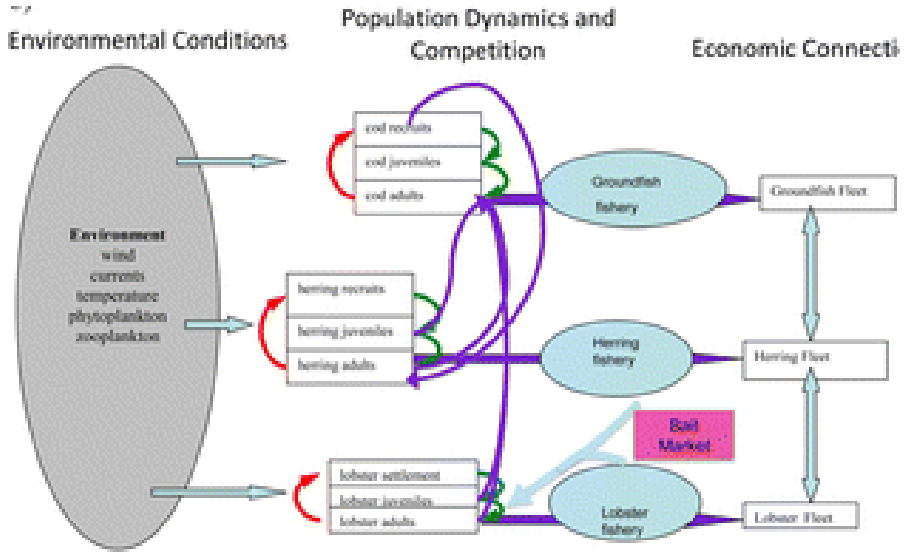
Other applications



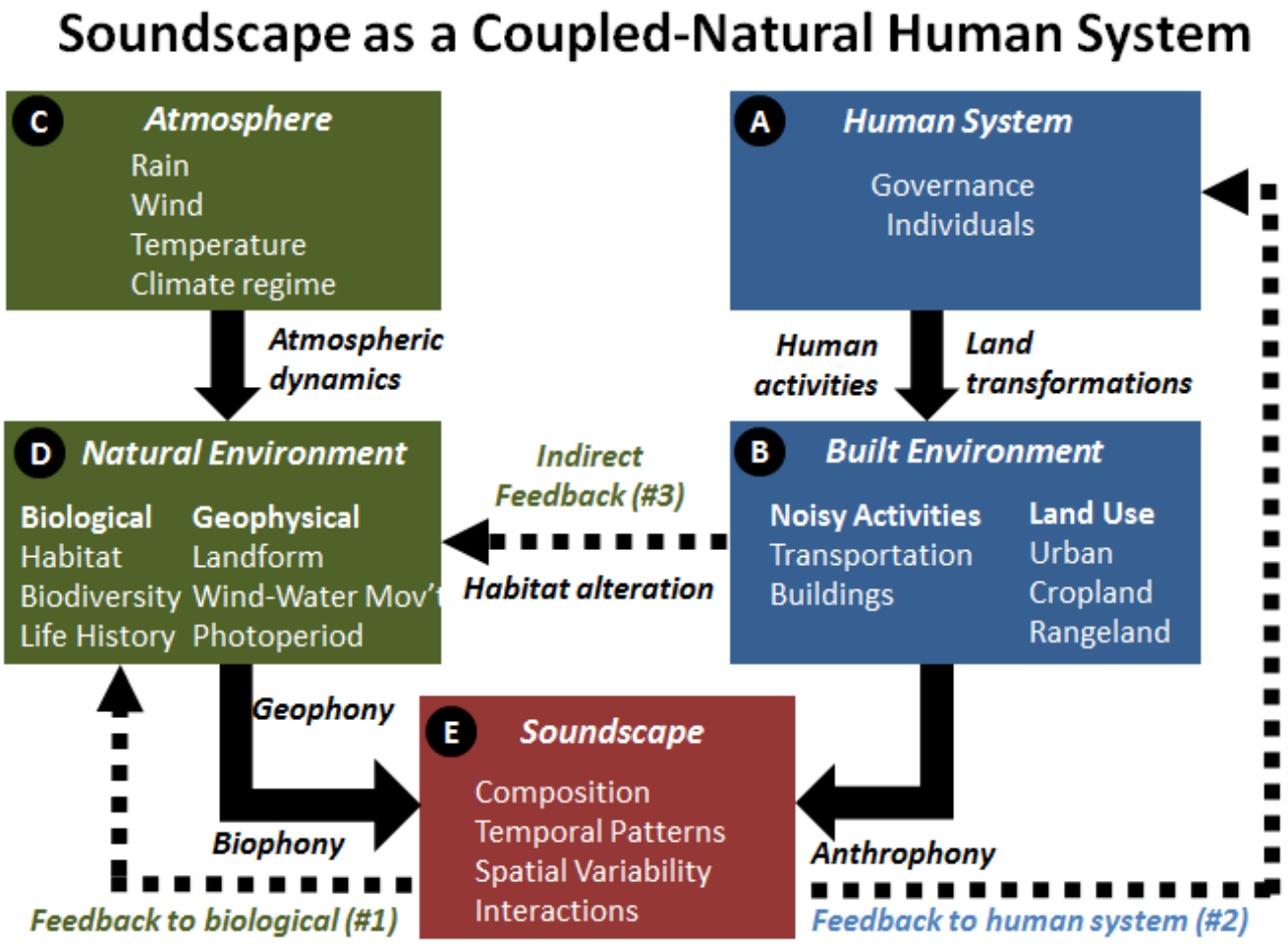
Liu et al. 1999. Panda conservation.



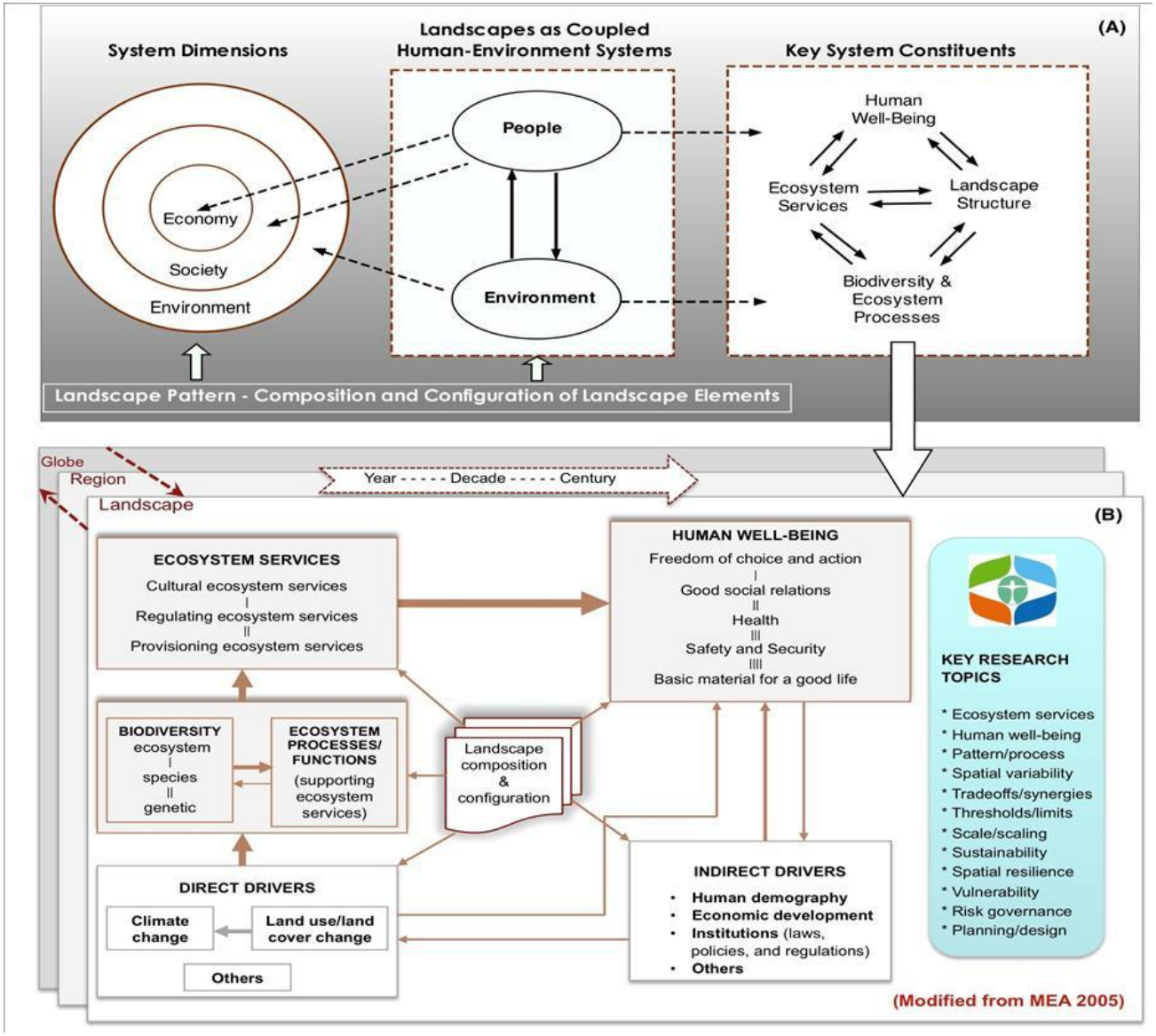
Brown et al. 2013. Land use and carbon cycle. Springer



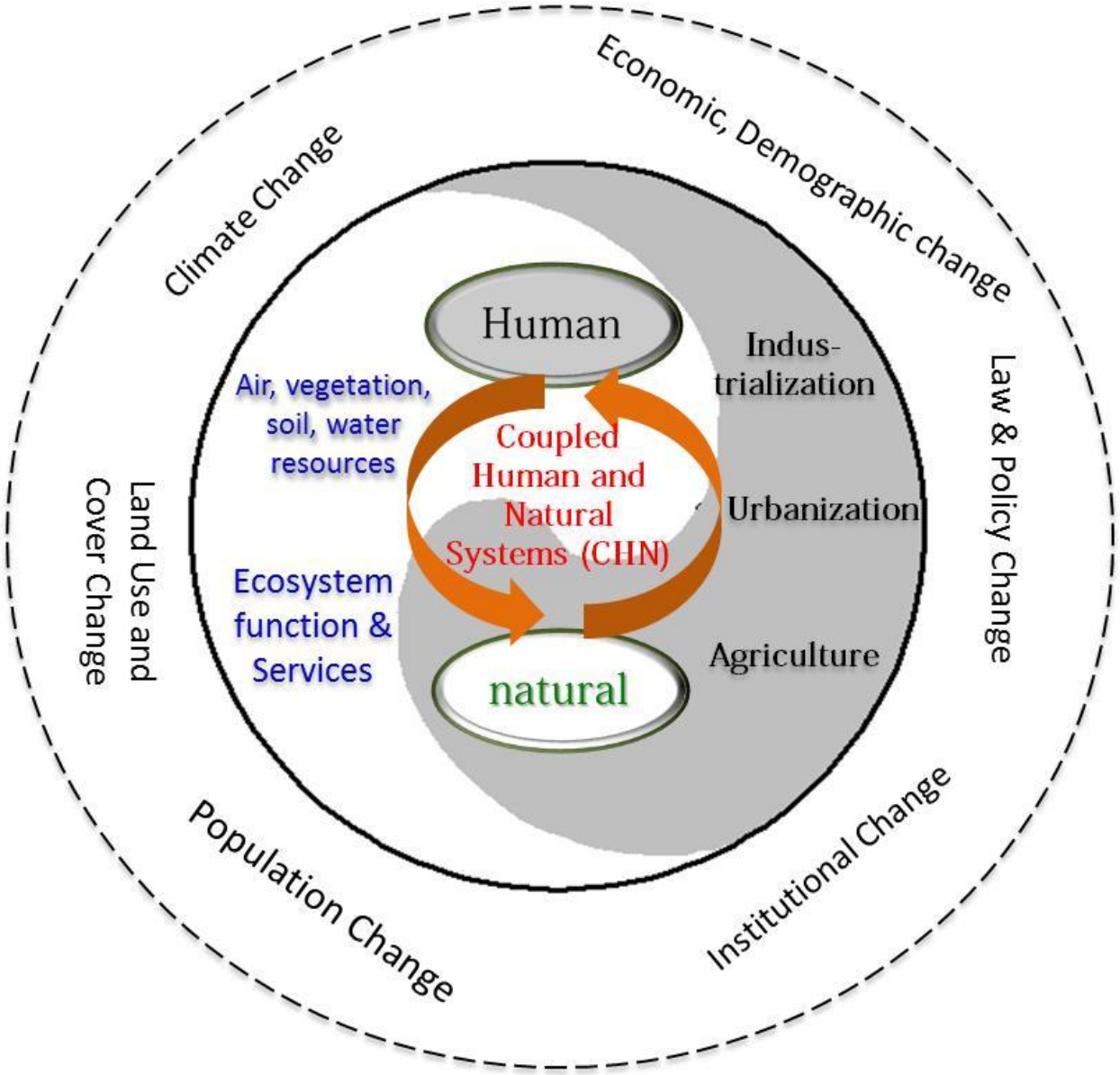
Alberti et al. 2011. Bulletin of the Ecological Society of America 92:218–228.



Pijanowski et al. 2011. What is soundscape ecology? *Landscape Ecology* 26:1213-1232.



Wu et al. in press. Landscape Ecology.



Chen et al. IceMe initiative at NUIST

LEES Lab

http://research.eeescience.utoledo.edu/lees/index.html

Questions?