Policy Shifts Influence the Functional Changes of the CNH Systems on Mongolian Plateau

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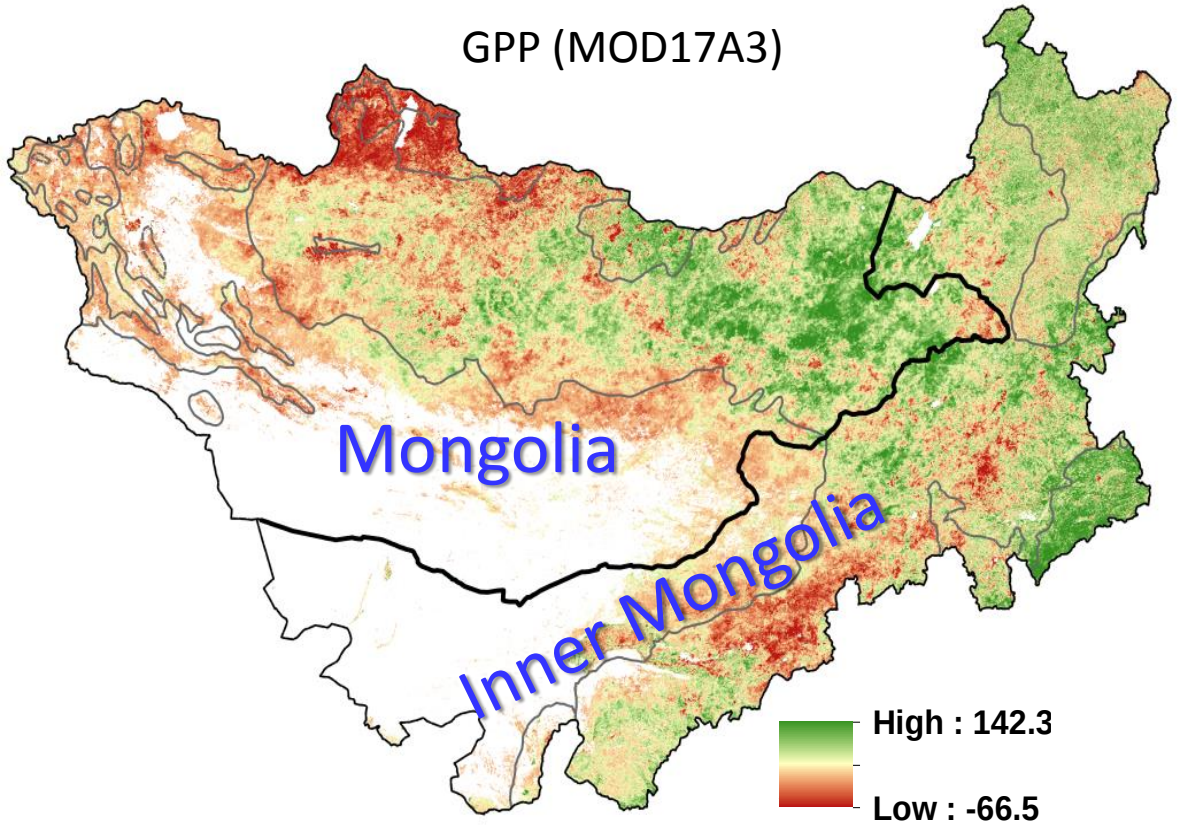
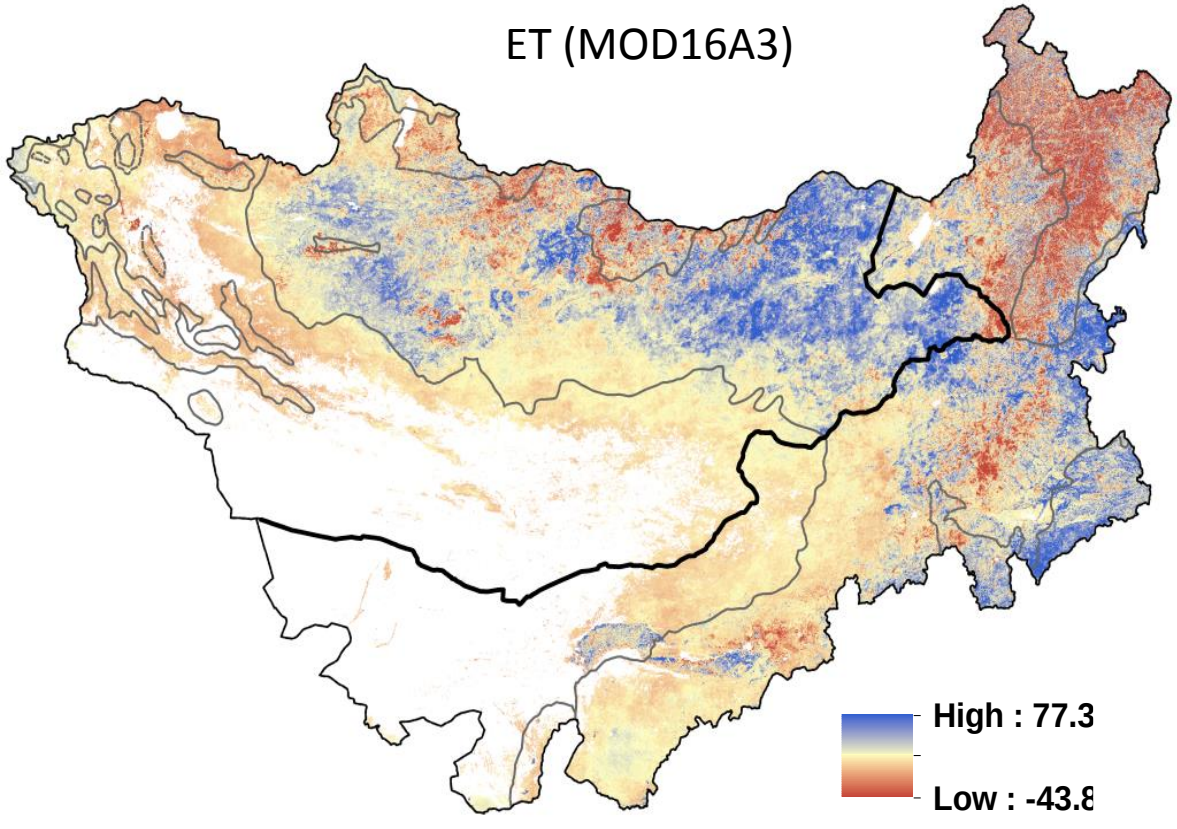
The LCLUC Spring Science Team Meeting

April 18-19, 2016, Maryland

In the very beginning, we were interested in

Spatiotemporal changes (trends) and regulations of CO_2, H_2O, and energy fluxes in a changing climate on the Mongolia Plateau





John et al 2016

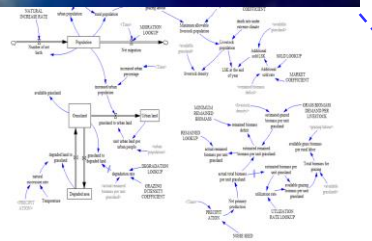
Two contrasting macro-systems on Mongolia Plateau
Inner Mongolia (China) & Mongolia

- High latitude (>40 ^{o}N), high elevation (>1,000 m)
- Nomadic culture, with Mongols dominating the landscape
- Two contrasting societies (IM & MG): after WWII
- The center of atmospheric activities in East Asia for the monsoons
- How do policy shift alter the function of human and natural systems on Mongolia Plateau?

Spatiotemporal changes and regulations of C, H_2O, and energy fluxes in a changing climate on Mongolia Plateau

Satellite

SD Modeling



The mobile flux towers

Eddy-Covariance towers

(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

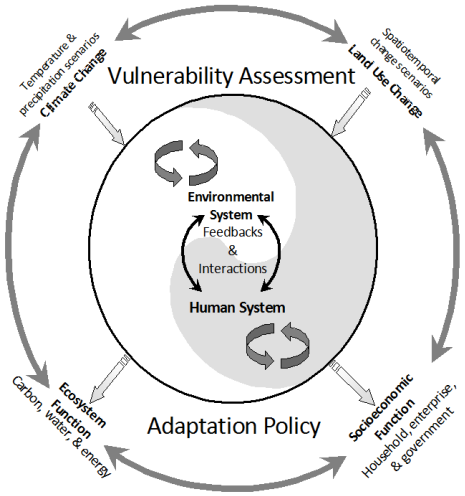
(2) Evapotranspiration (ET)

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

5.77

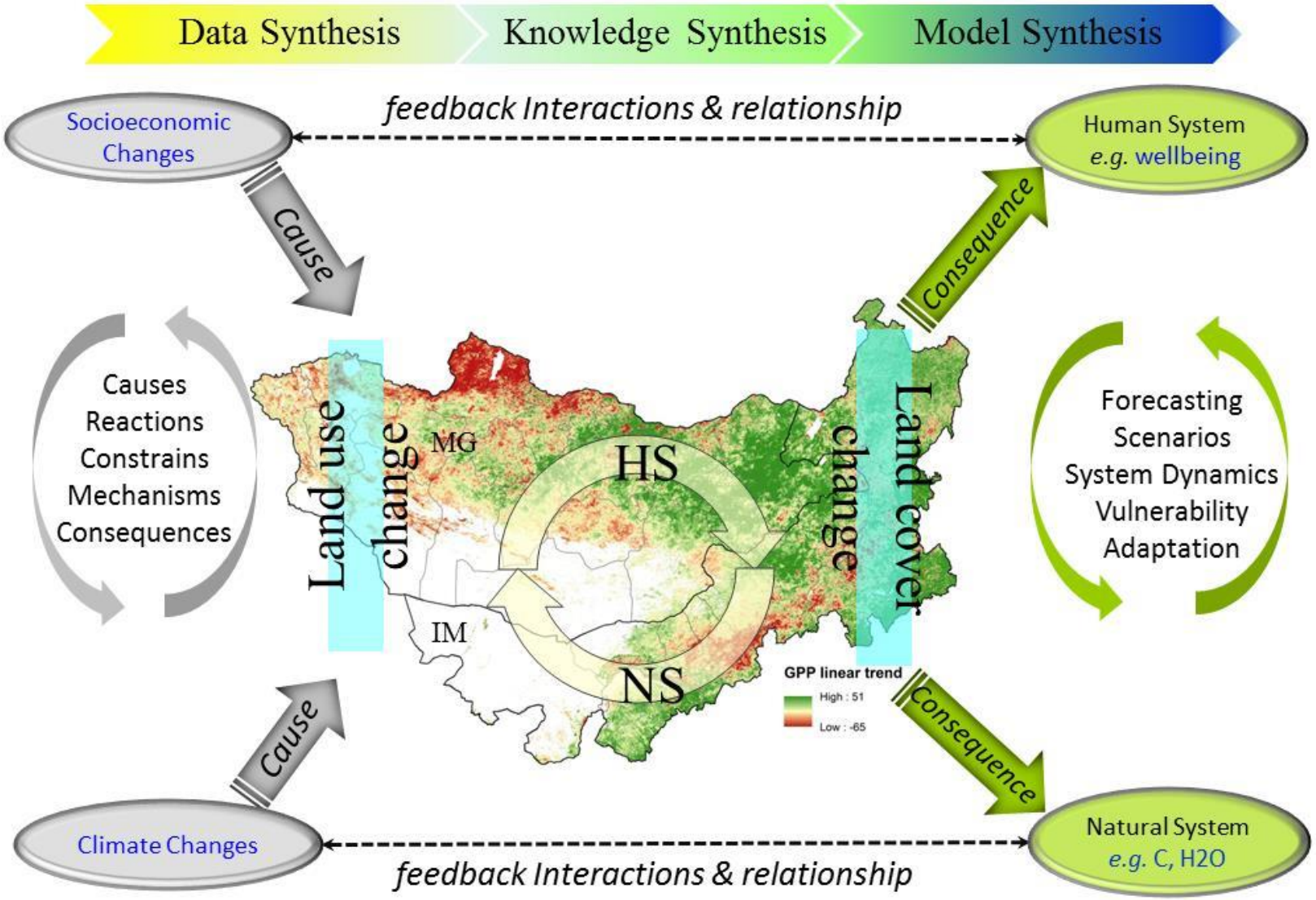
Chen et al. 2013

In sum, it seems that



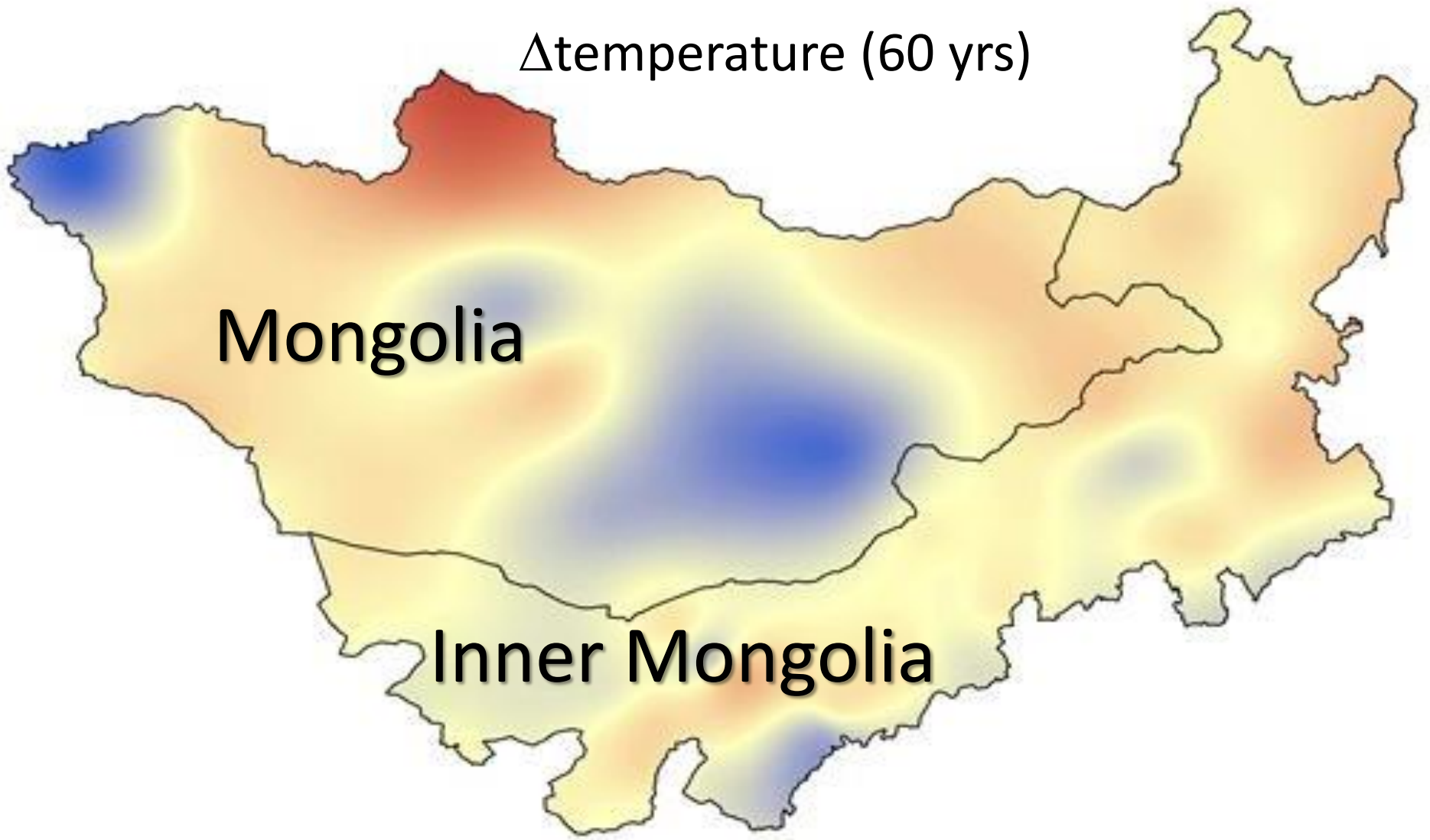
- The systems, **not ecosystems**, are very complex
- Almost **no knowledge** on the interactive feedbacks of human and physical drivers; but it is clear that the system is not driven by climate alone—as ecologists traditionally believe (e.g. temperature, precipitation)
- Feedbacks and interactions among HS/NS elements are **unknown**
- The underlying mechanisms are virtually **unknown**

Divergence of IM & MG as Coupled Human and Natural Systems



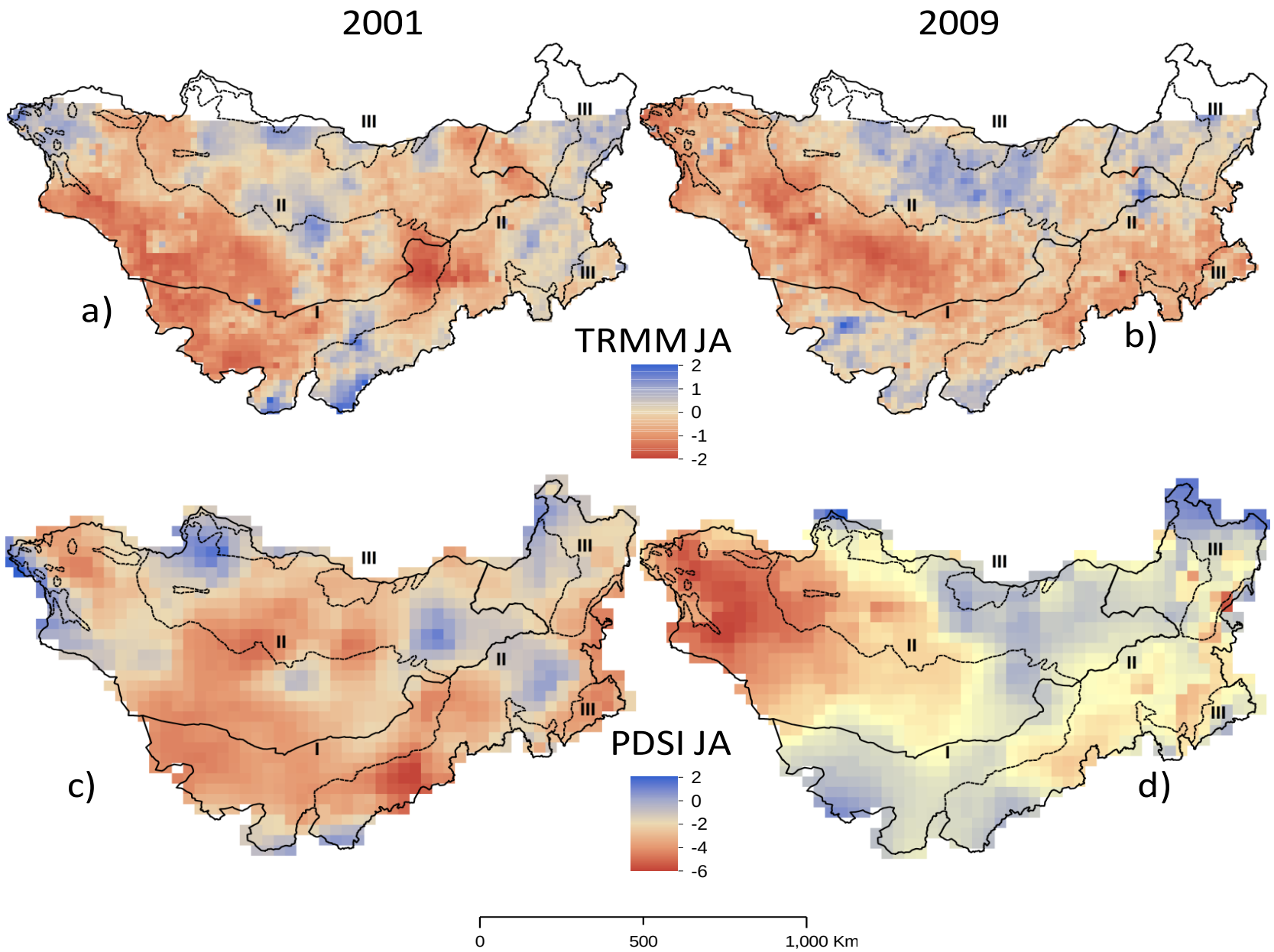
Chen et al. Bioscience, 2015

Spatial mismatches among the elements of human systems (HS) and natural systems (NS)



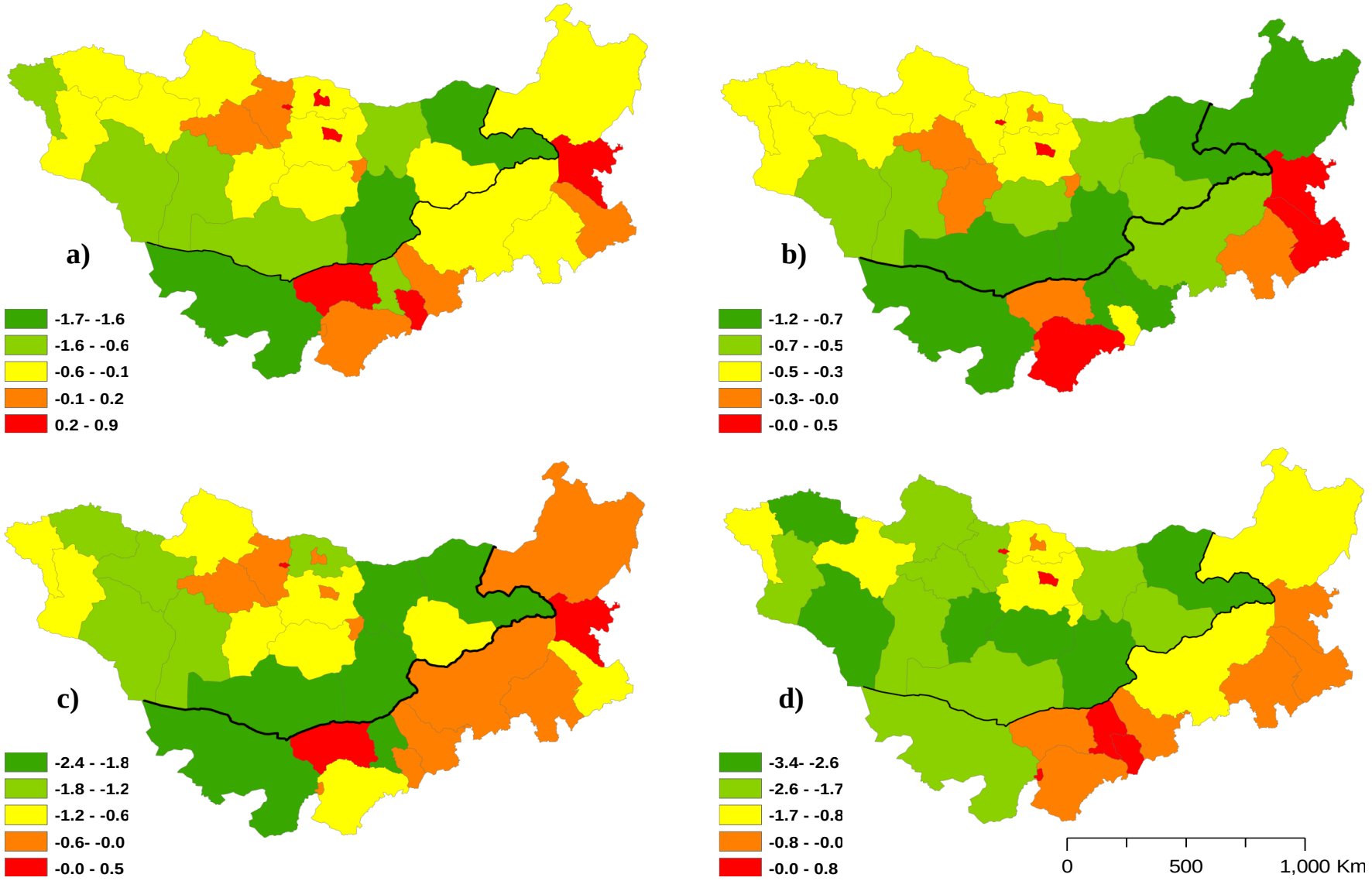
Chen et al 2015

Spatiotemporal changes in precipitation and drought on the Mongolian Plateau



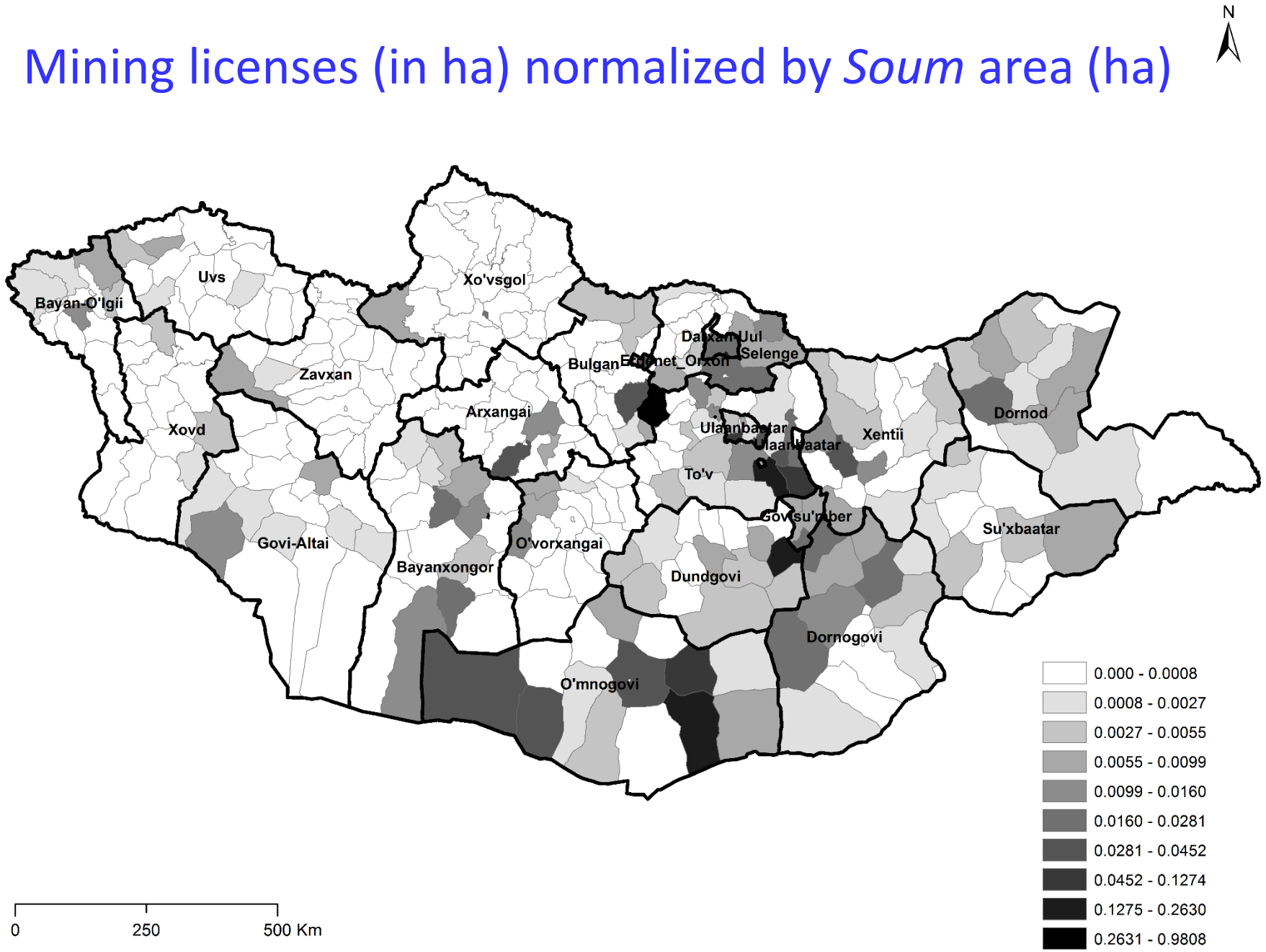
John et al 2013

Mann–Kendall spatial and temporal slope trends of a) total livestock density, b) goat livestock density, c) sheep livestock density, and d) total population density



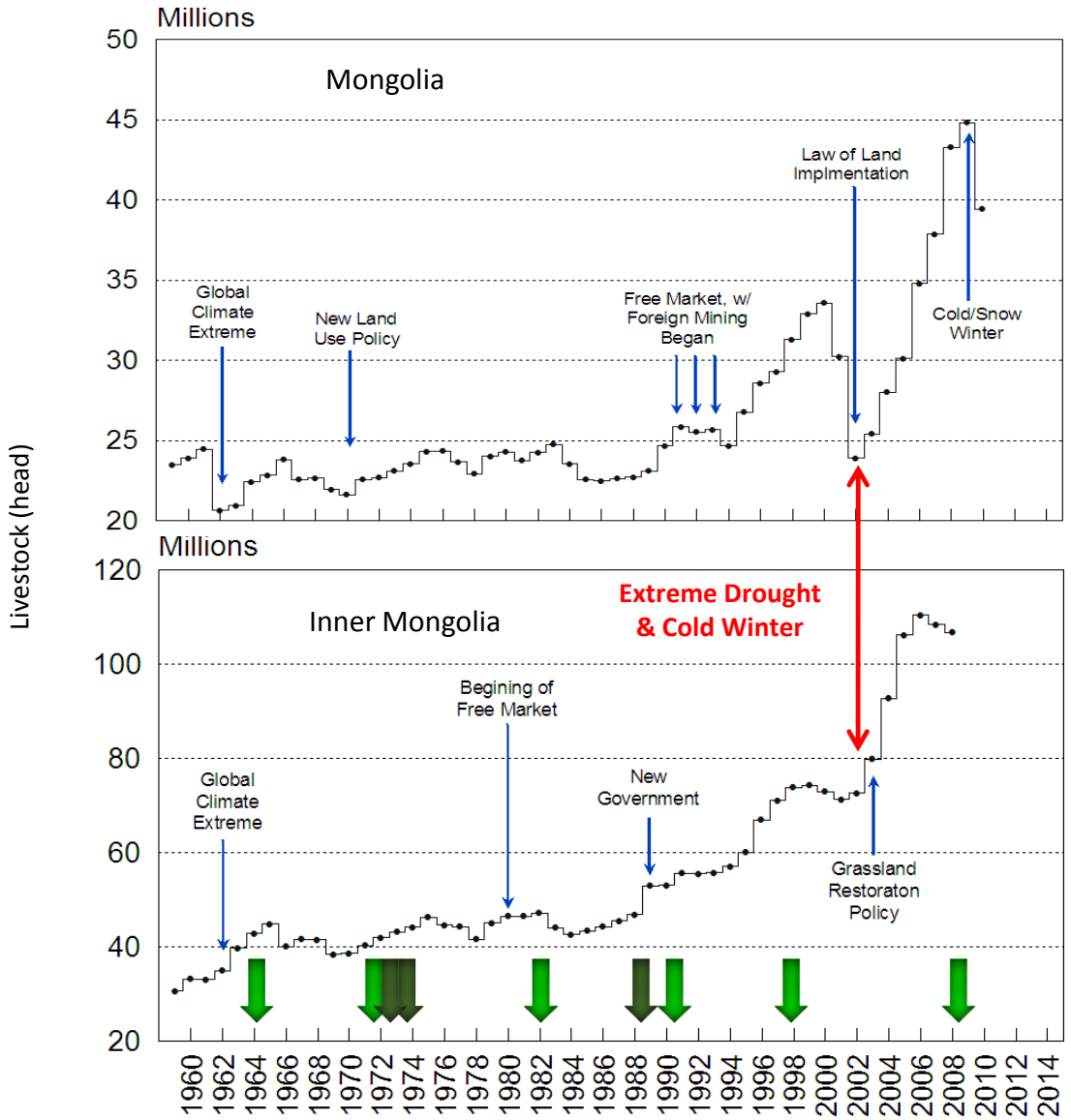
John et al 2016

Mining licenses (in ha) normalized by *Soum* area (ha)



Amartuvshin et al. in prep

Changes in livestock, policy, and climate in IM & MG: Policy Dimension

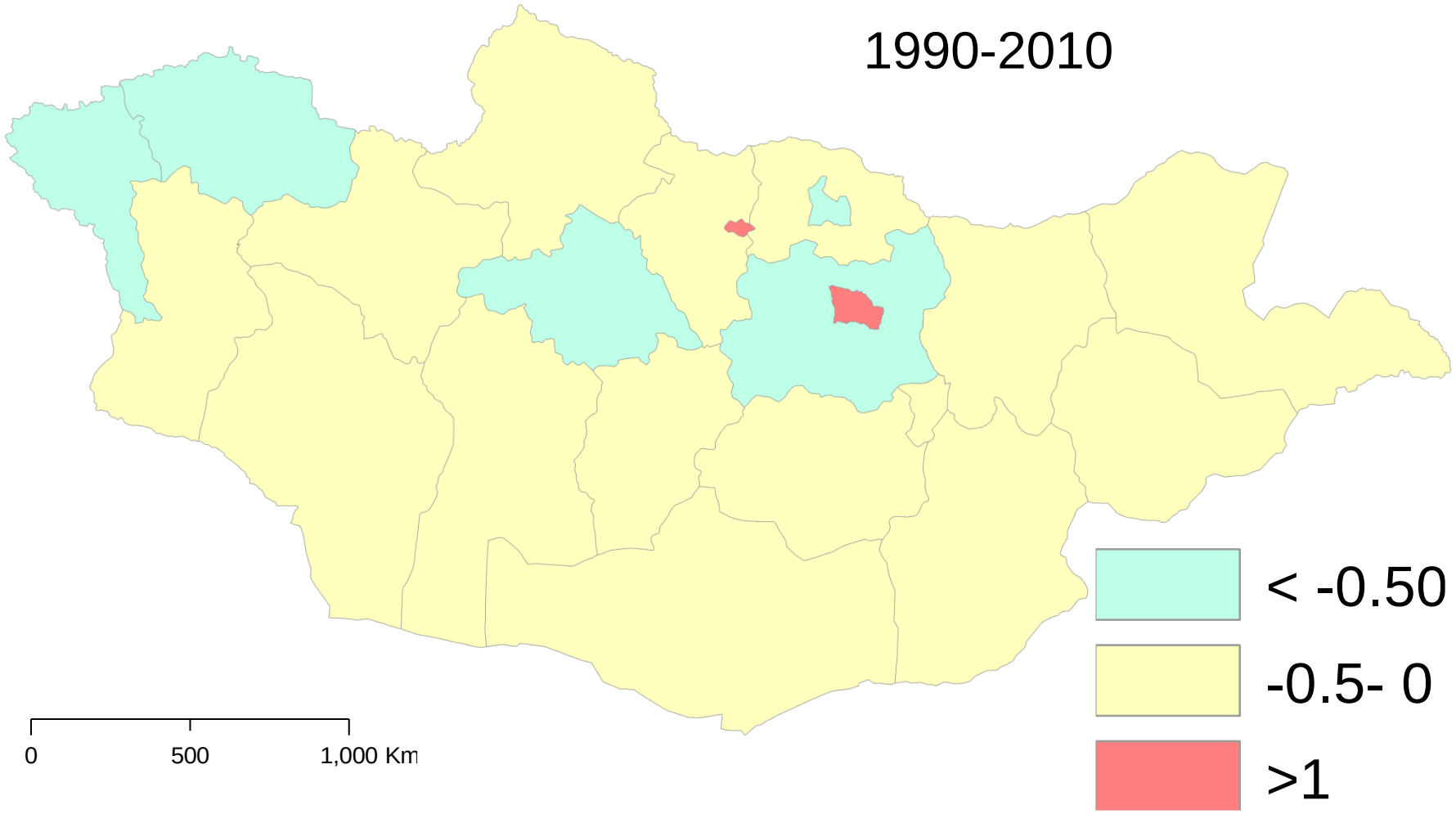


Qi et al. (2012)

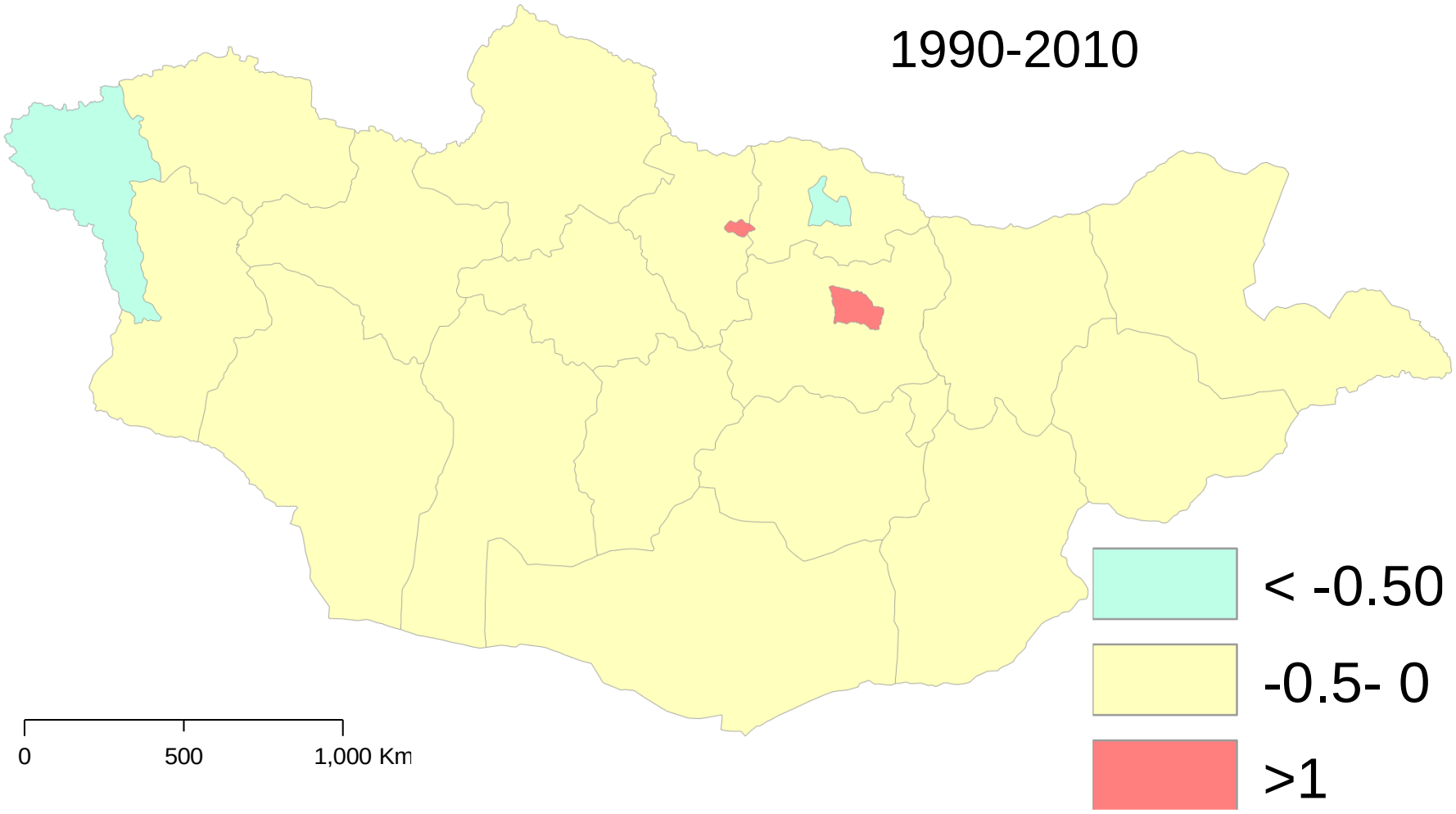
Abandoned village in Inner Mongolia: jobs

Policy-Driven Migration in Mongolia: Atar

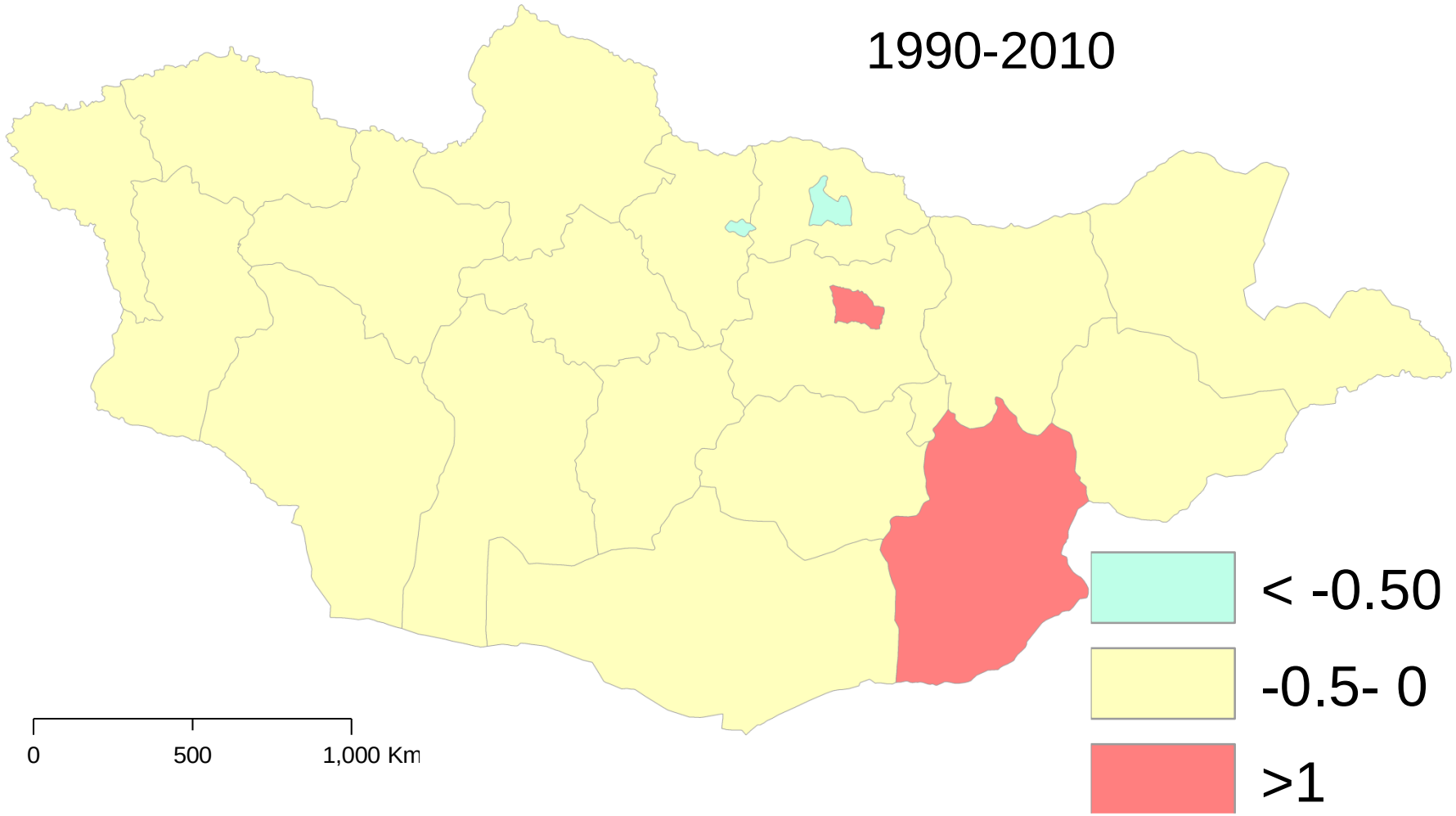
Population migration in Mongolia



Population migration in Mongolia



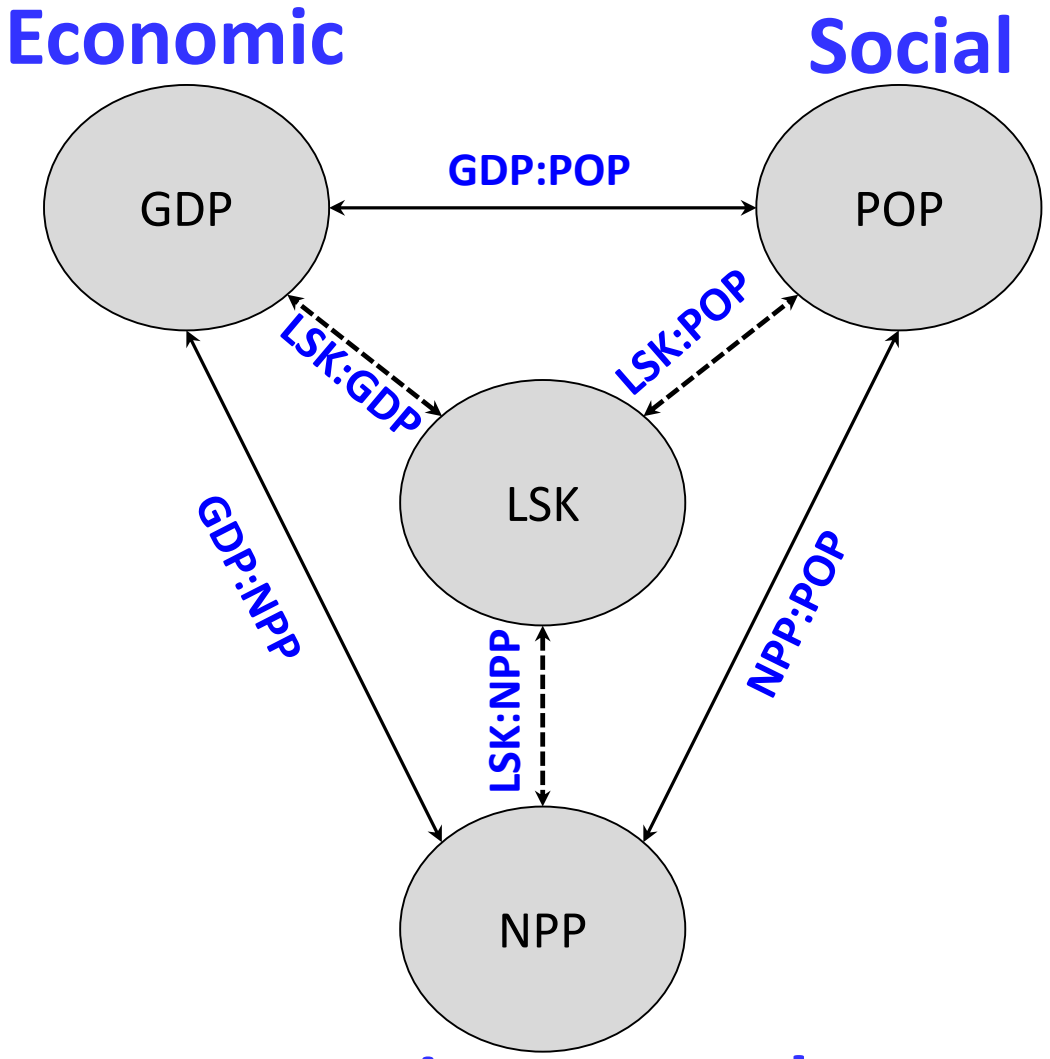
Population migration in Mongolia



Connecting the dots representing social, economic, ecosystem functions, and land use

The three foundational pillars in sustainable science!

POP: population
GDP: gross domestic production
NPP: net primary production
LSK: livestock



Chen et al. Bioscience, 2015

Major Policy/Institution Shifts

Inner Mongolia

WTO 2001: China became a member of the World Trade Organization

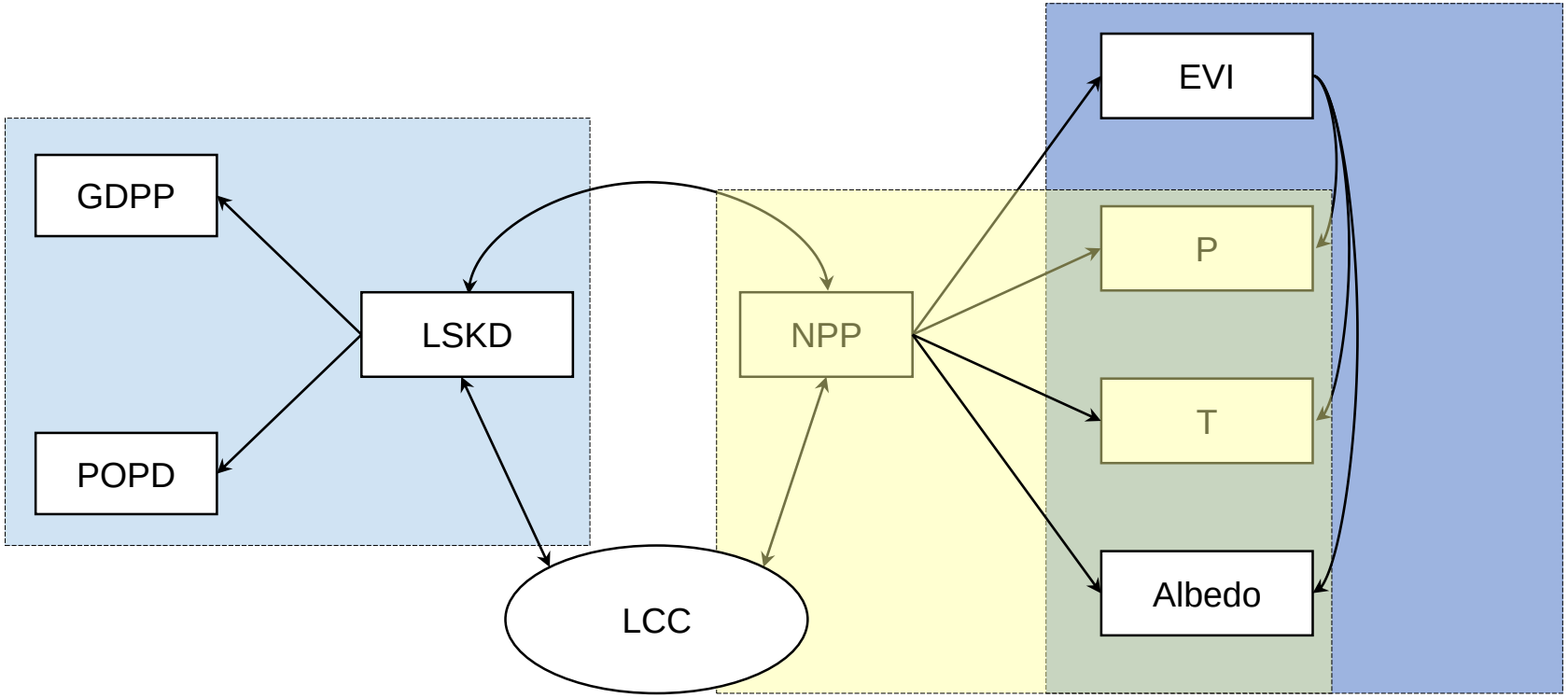
GFG 2008: Grain for Green program

Mongolia

CSU 1991: Collapse of the Soviet Union

Atar 1995: Several shifts

Hypothesis tests using Structural Equation Modeling (SEM)

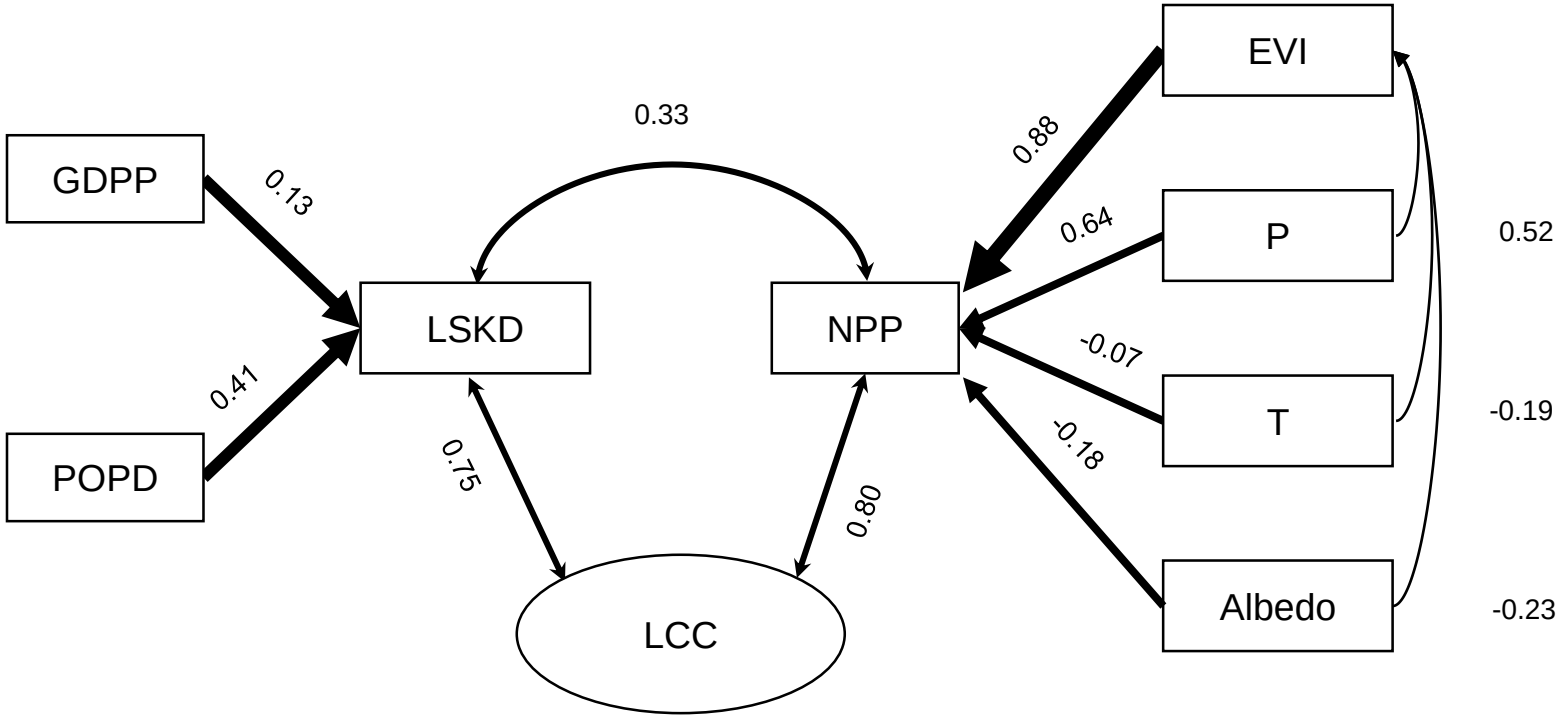


Chen et al. 2015. Environ. Res. Lett.

Mongolian Plateau

The Structural Equation Modeling of the CNH system

The Plateau



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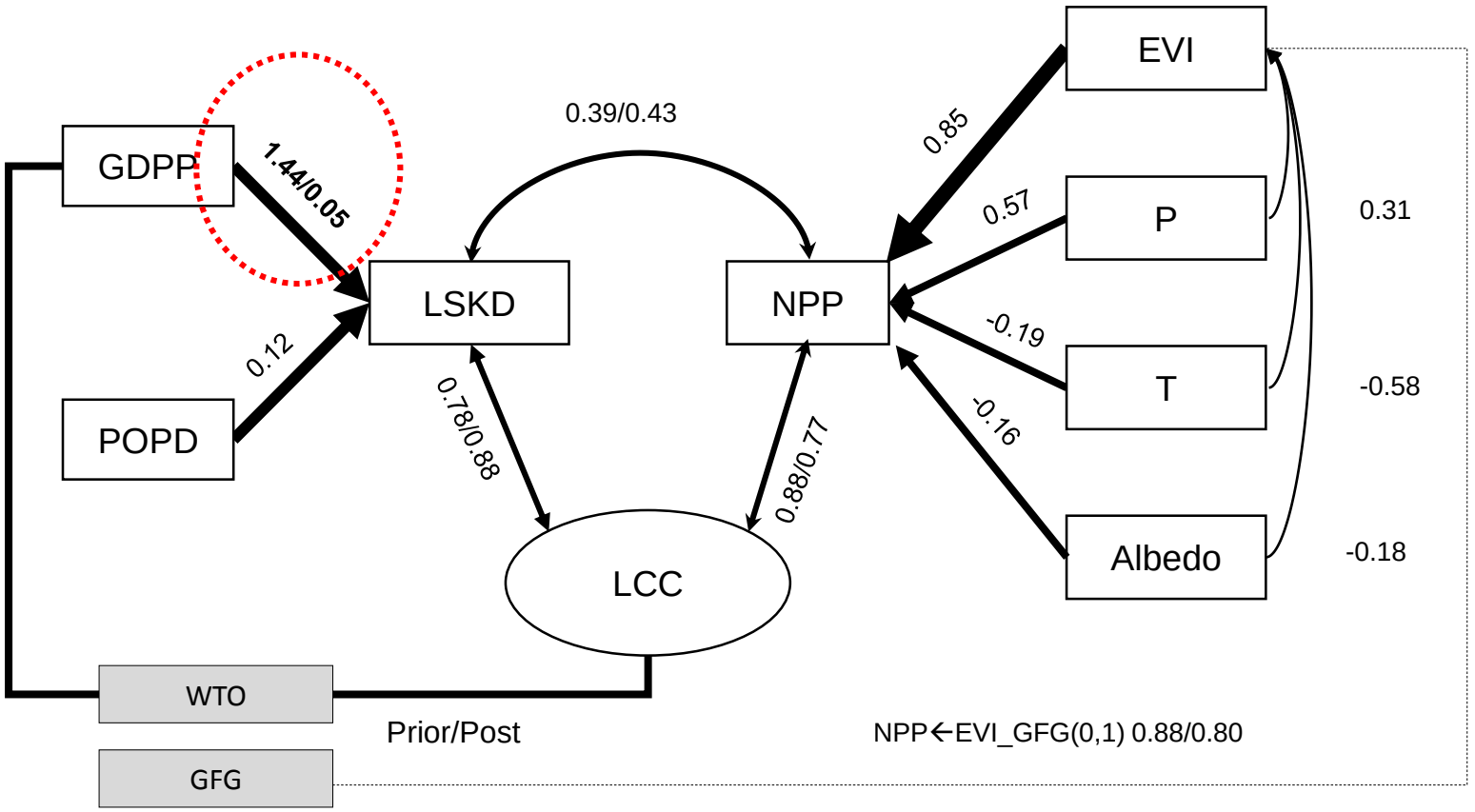
Inner Mongolia



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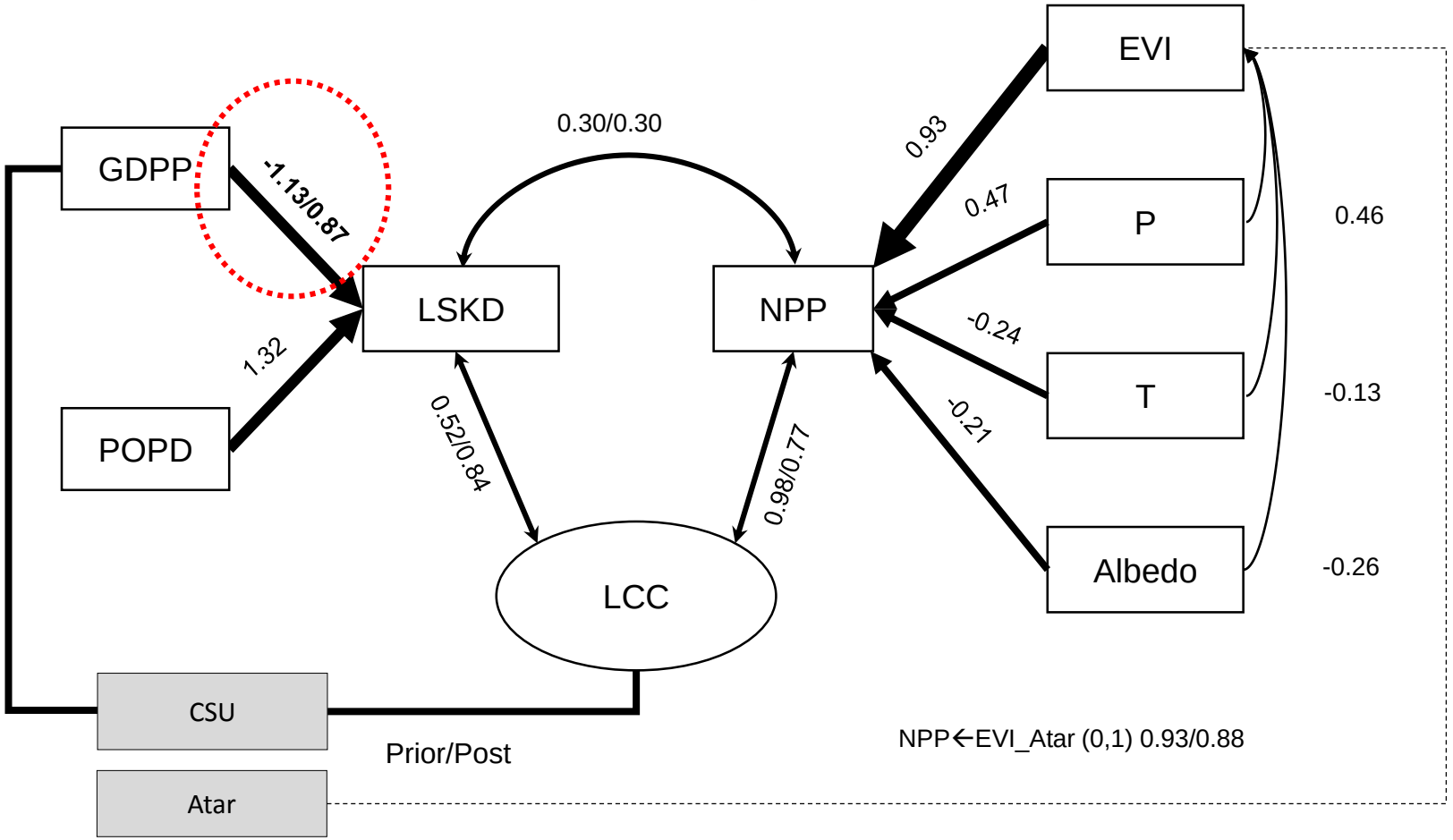
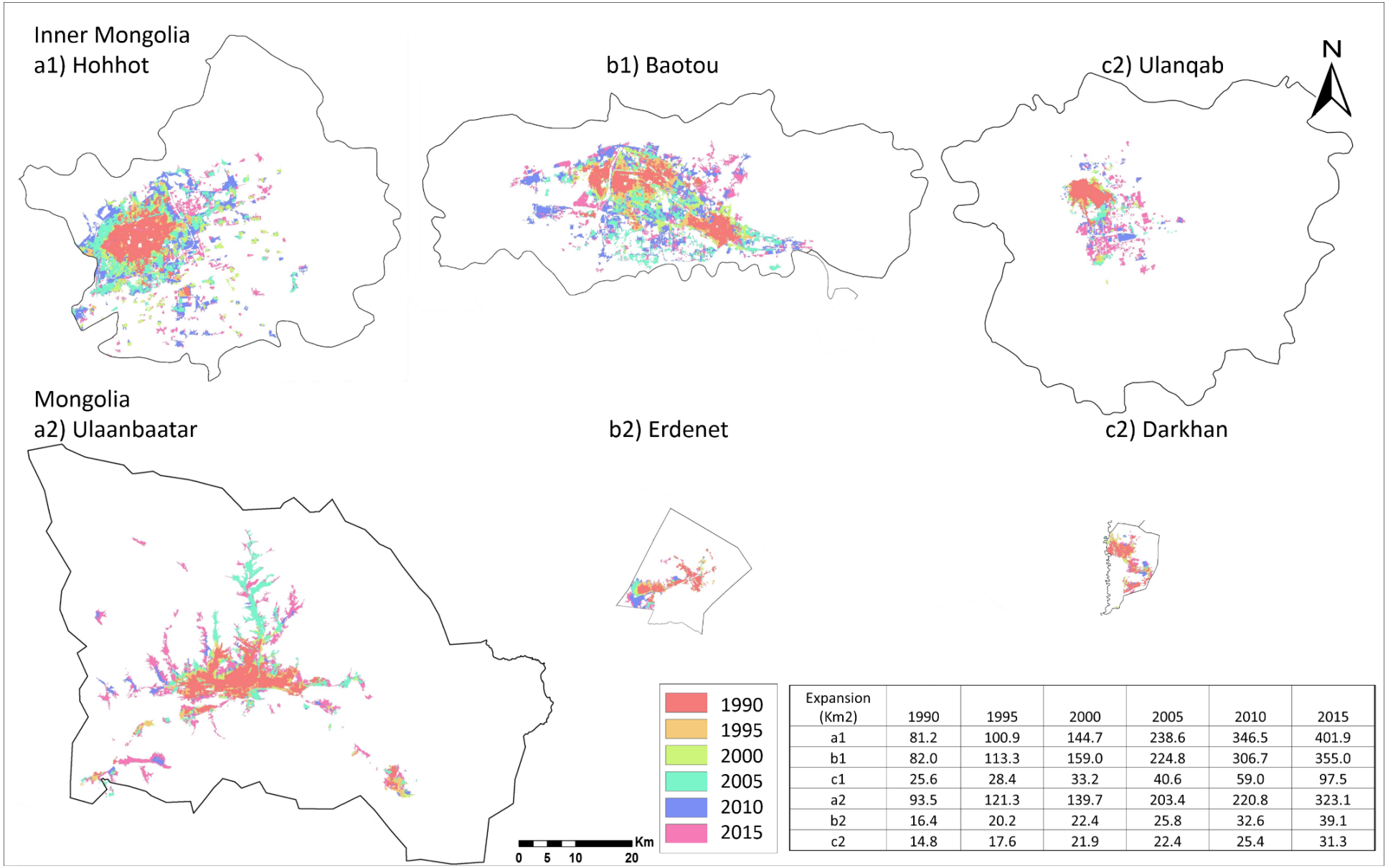


Chen et al. 2015. Environ. Res. Lett.

Urbanization in six different cities in the Mongolian Plateau for 1990-2015



Expansion (Km2)	1990	1995	2000	2005	2010	2015
a1	81.2	100.9	144.7	238.6	346.5	401.9
b1	82.0	113.3	159.0	224.8	306.7	355.0
c1	25.6	28.4	33.2	40.6	59.0	97.5
a2	93.5	121.3	139.7	203.4	220.8	323.1
b2	16.4	20.2	22.4	25.8	32.6	39.1
c2	14.8	17.6	21.9	22.4	25.4	31.3

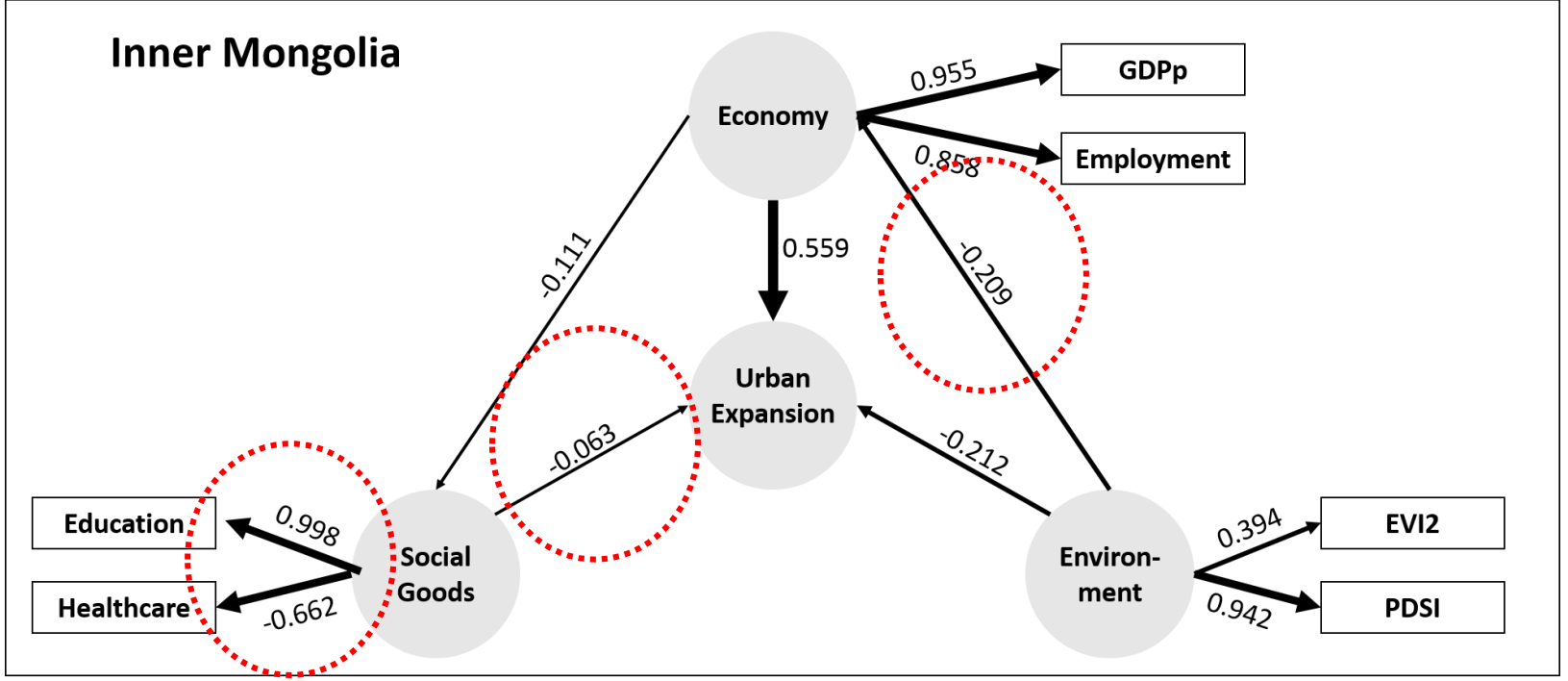
Park et al., in prep (see poster)

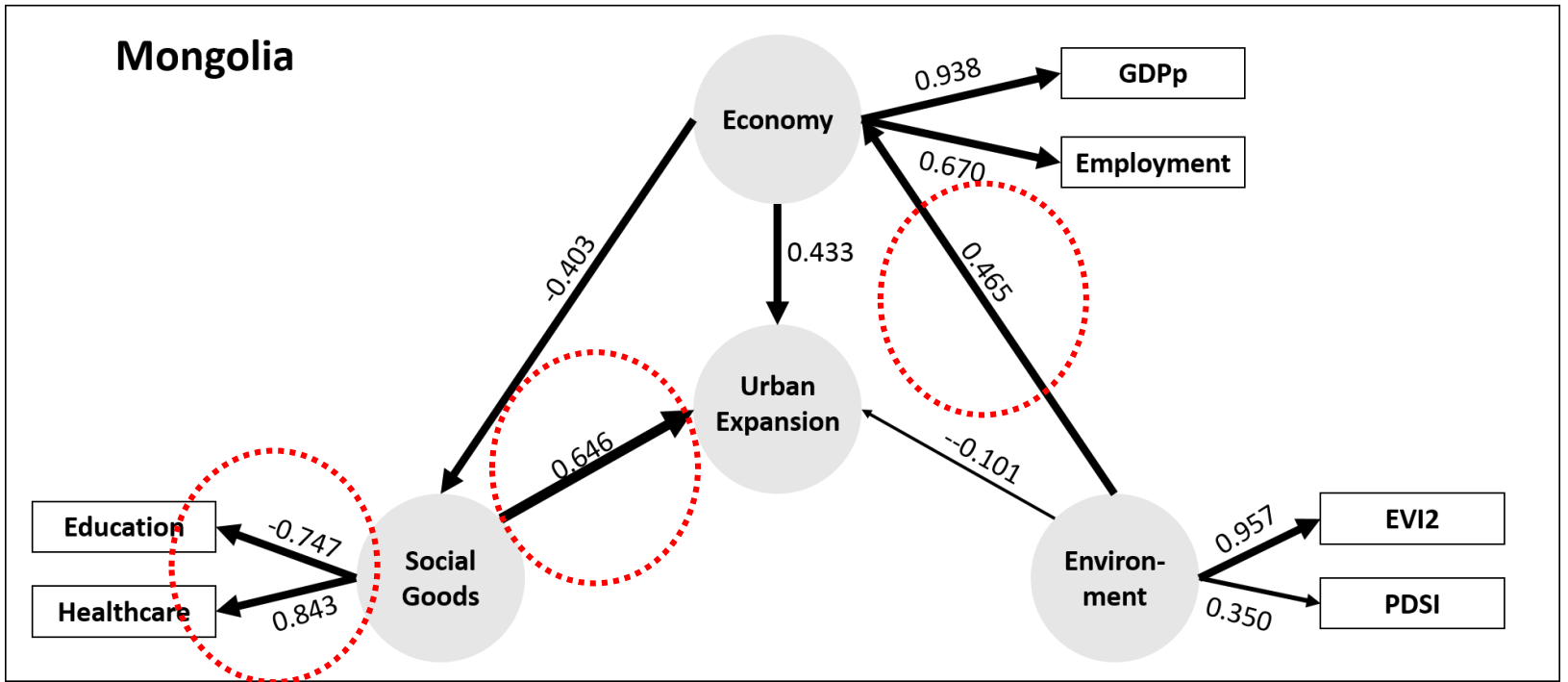
Preliminary results (local scale)

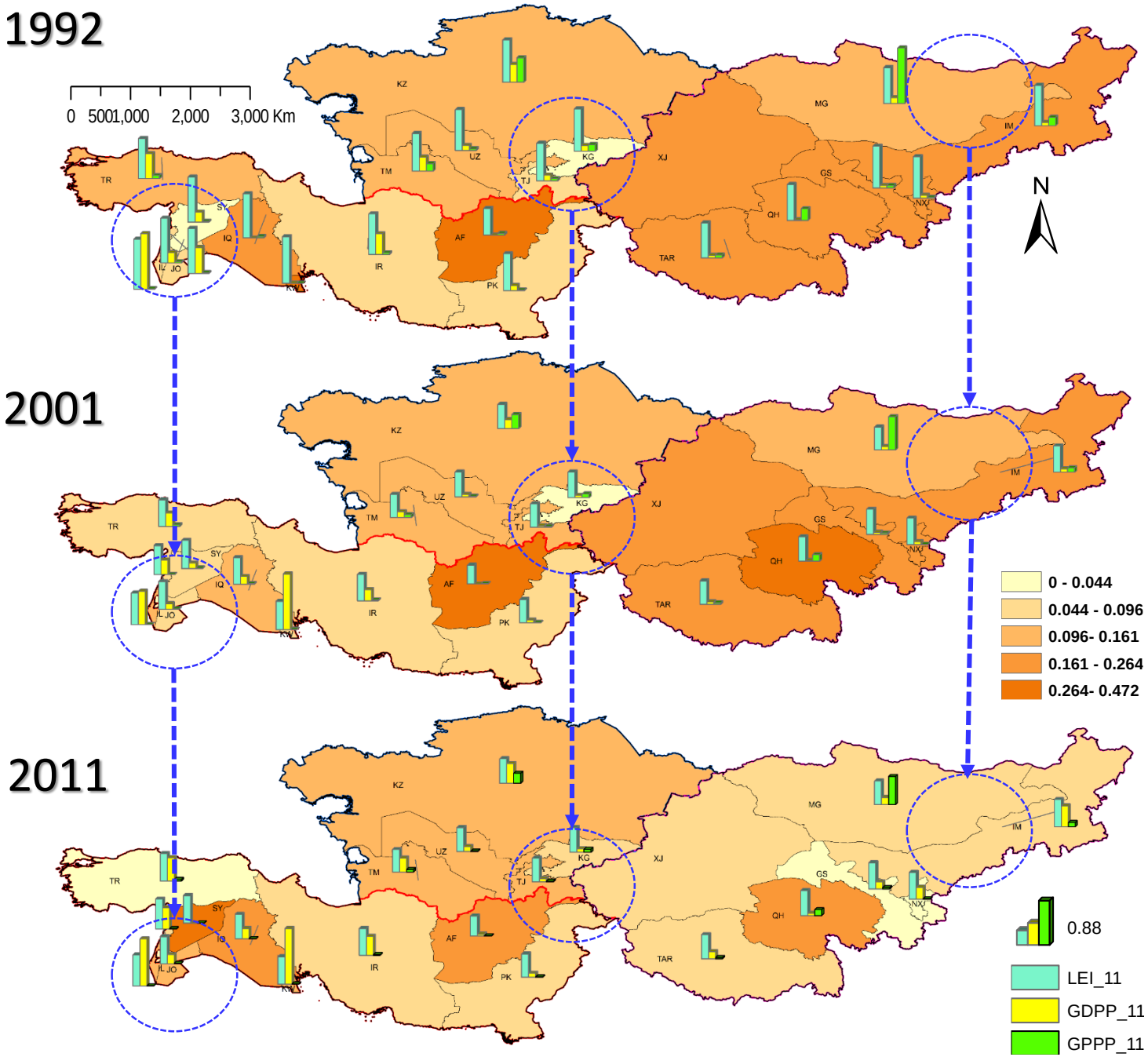
PLS-SEM in IM and MG

for the relationship of urban expansion, economy, social goods and environmental conditions in cities of IM and MG (1990-2015). The collinearity statistics of latent variables of two models are high (VIF > 0.2), and the latent variables of two models have higher convergent validity (average variance extracted , AVE > 0.5).

Park et al., in prep (see poster)







Preliminary results (regional scale)

Dynamics of macrosystems (Sustainability Index, SI) over a 20-year period along the Silk Road. Light color indicates a more sustainable system.

- Largest dryland on the Earth
- 22 juristic units (countries/Provinces)
- 3 clusters: East Asia, Central Asia, and the Middle East
- Major events: The Operation Desert Storm in 1991, Invasion after 9/11 in 2001, The WTO in 2002, etc.

Chen et al, in prep

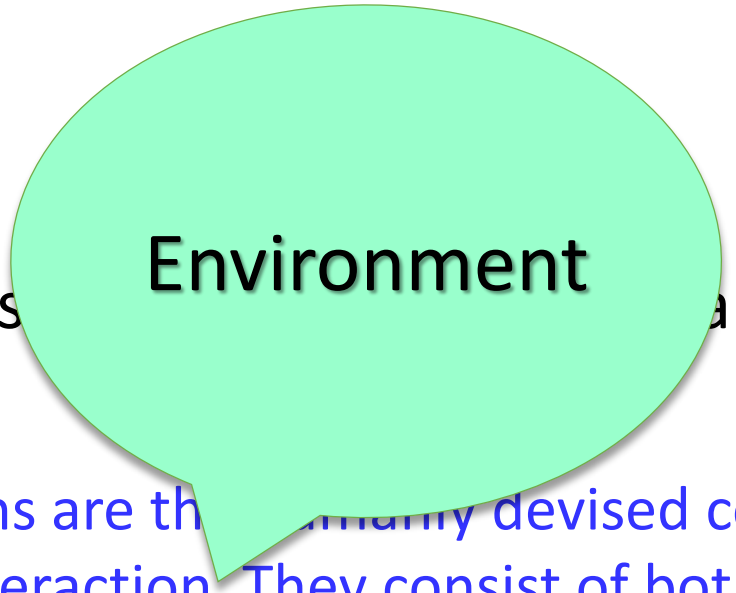
Take-home Messages

- Institution (e.g., policy) plays … aining the sustainability of a system: How?

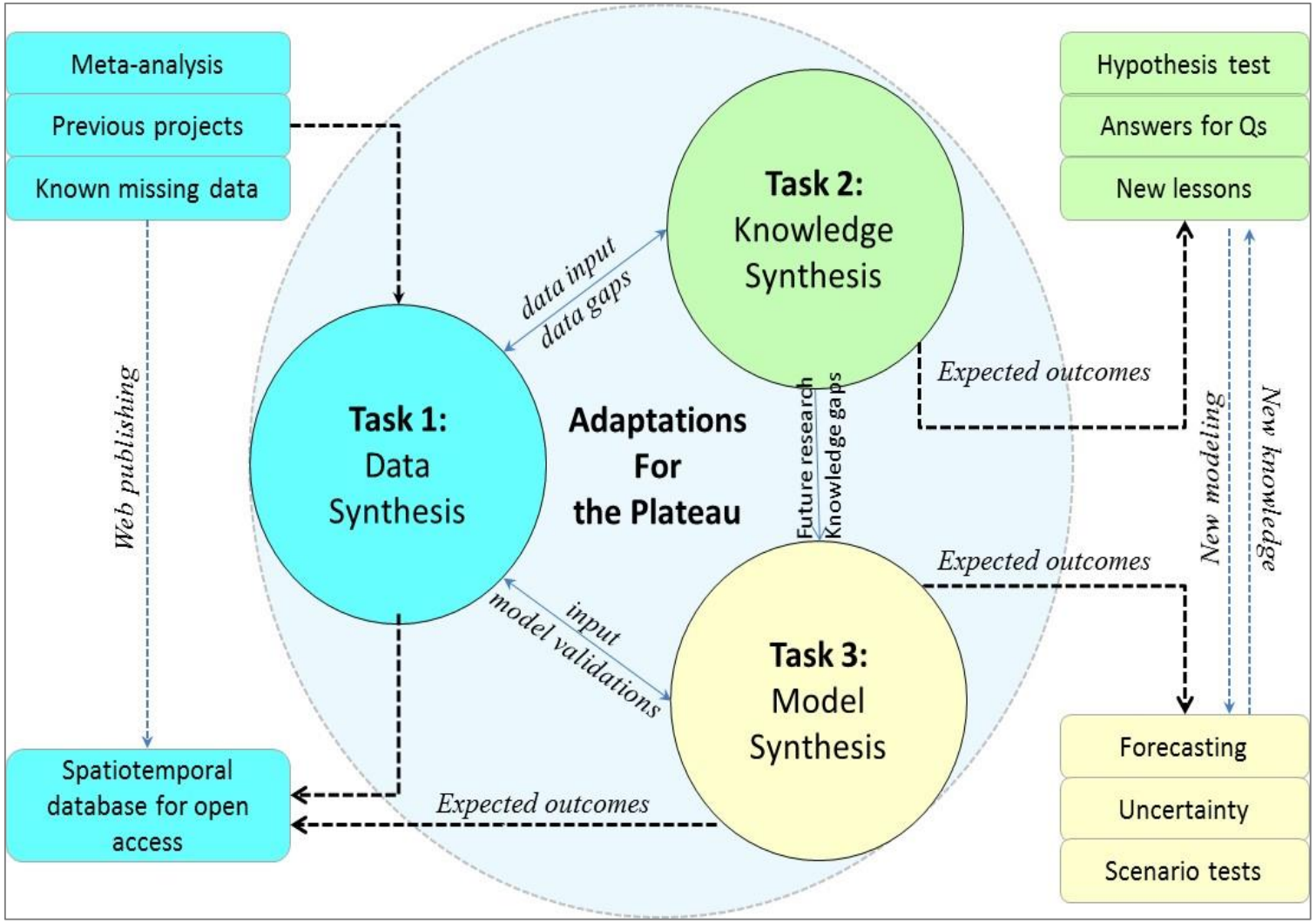
  Douglas North (1991): Institutions are th… humanly devised constraints that structure political, economic and social interaction. They consist of both informal constraints (sanctions, taboos, customs, traditions, and codes of conduct), and formal rules (constitutions, laws, property rights).

- Resource-rich region: tower clusters (LEES Lab), multi-teams on paleoecology (*Amy Hessl*), cross-scale RS modeling (*Martin Kappas*-Germany), livestock (*Maria Fernandez-Gimenez*), urbanization (*Peilei Fan*), modeling (*Qianlai Zhuang*), synthesis (*Dan Brown*; *Dennis Ojima*), other unkowns.

- **Others**? Our synthesis workshop in Ann Arbor (May 12–13, 2016)



In the end, there remains much work to do,
with a central focus on the role of institution through syntheses of data, models, and knowledge (Chen & Brown, LCLUC Synthesis Project, 2015-2017).



Thank You!

Data, publications, updates, contacts, questions, etc. can be accessed through project webpage at http://lees.geo.msu.edu/research/cnh_mongolia.html