



Land Use Change, Hydrology and Climate in Central Asia

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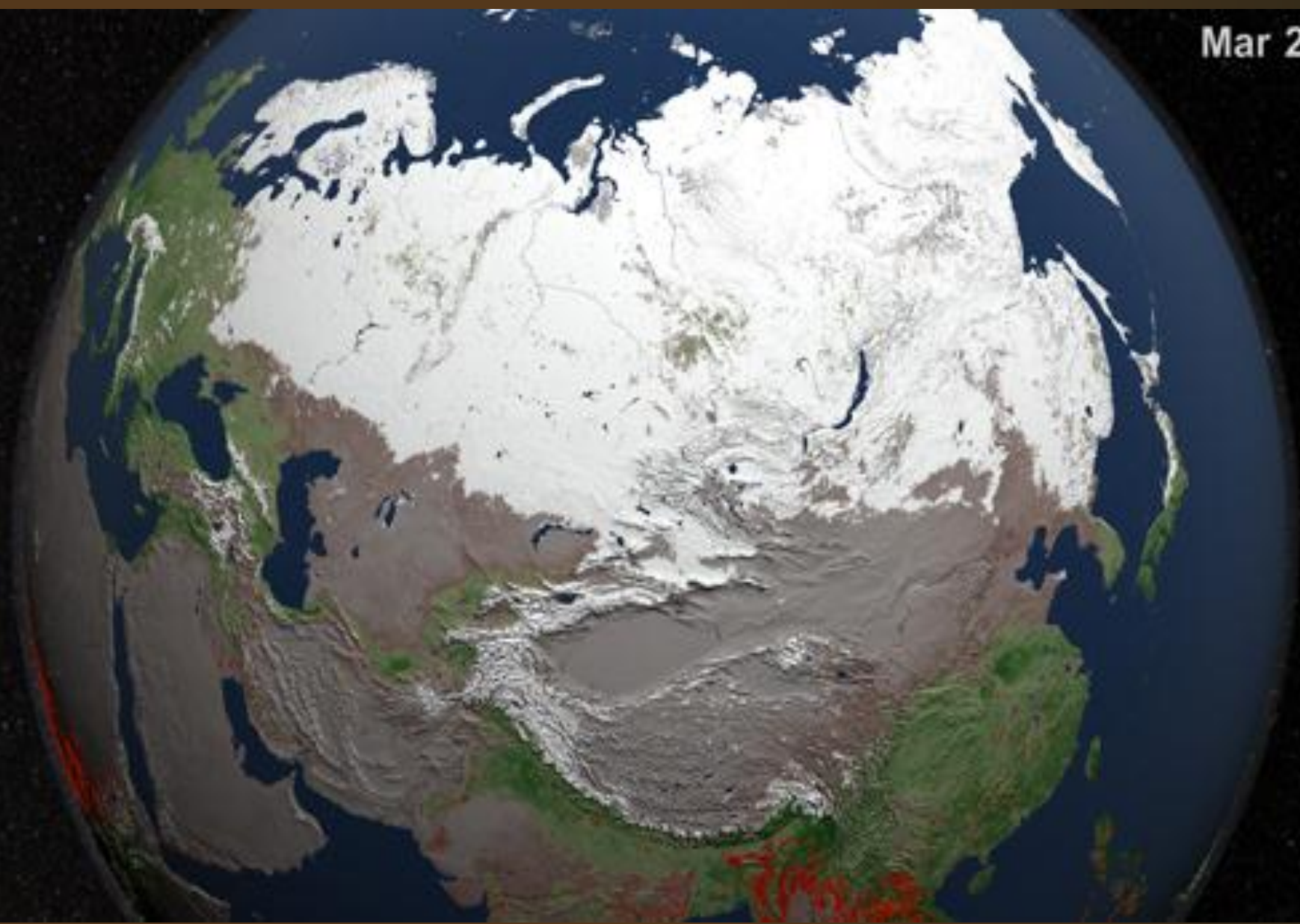
*With contributions from
Dan Brown and Jiquan Chen*

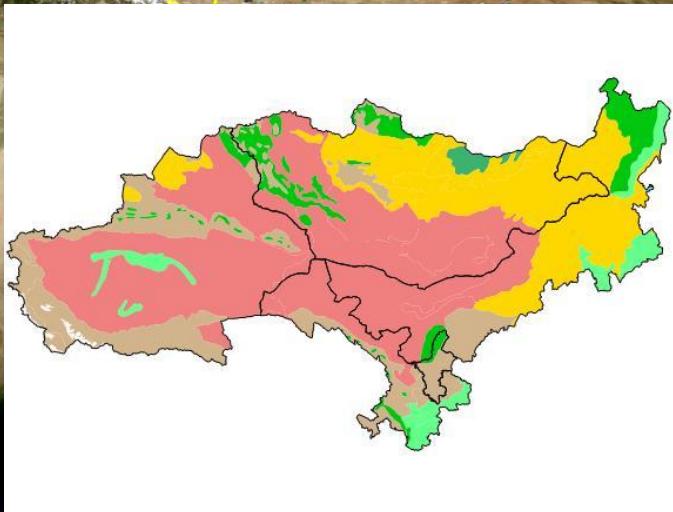
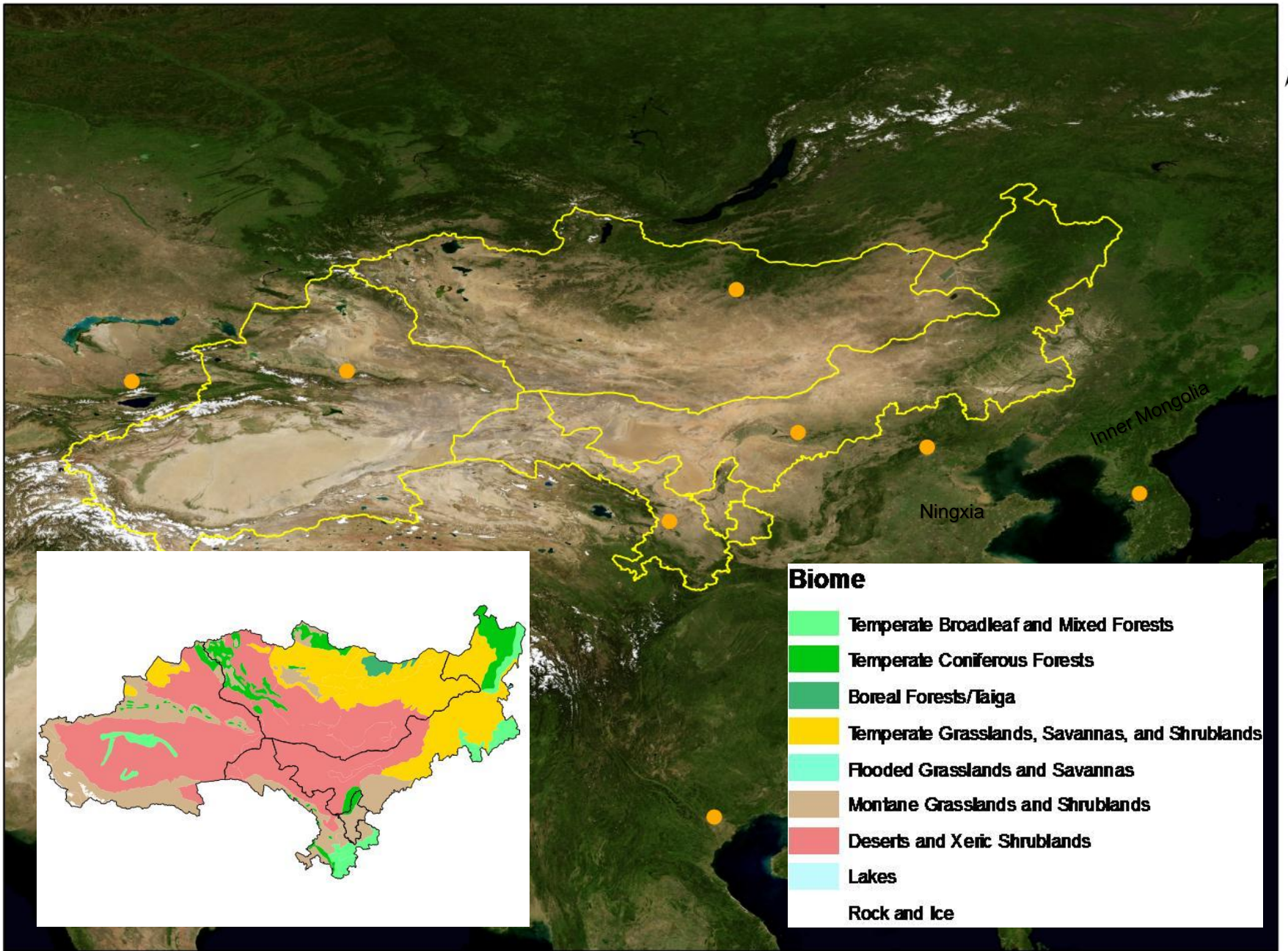
A matter of Geography

Central Asia is a large region of varied geography, including high passes and mountains, vast deserts and especially treeless, grassy steppes

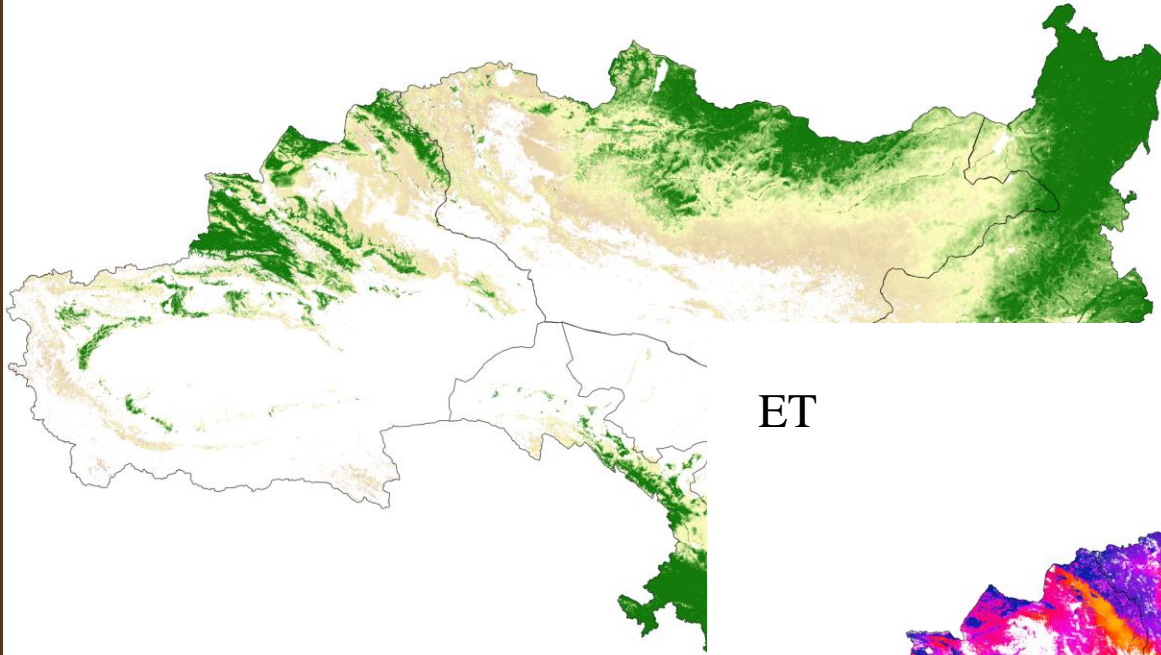
Combined with intense land use activity spanning agriculture and herding and climate divisions, the region is characterized as water limited

Mar 2010

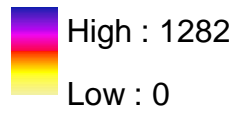
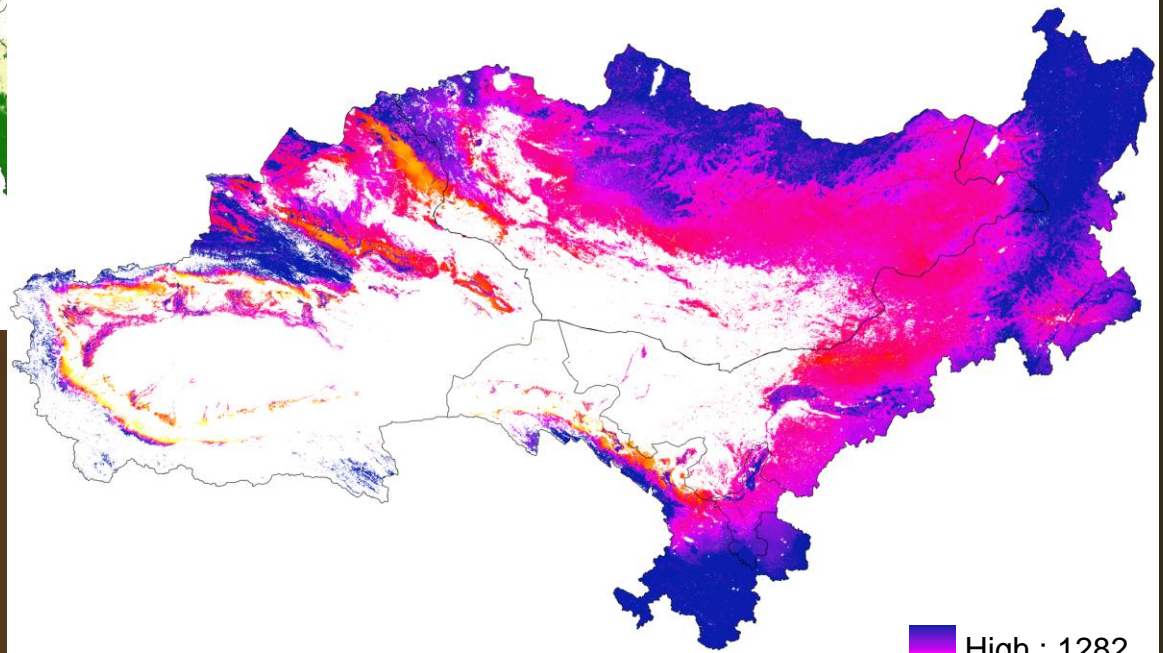




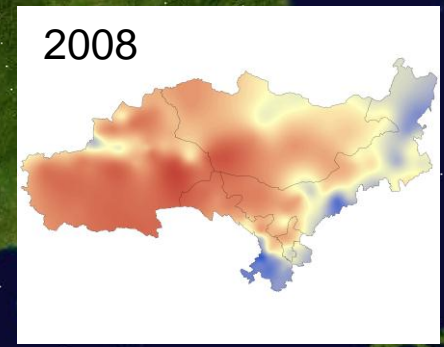
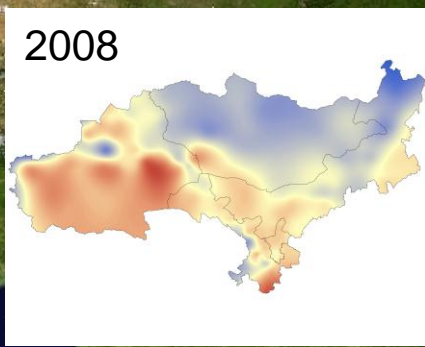
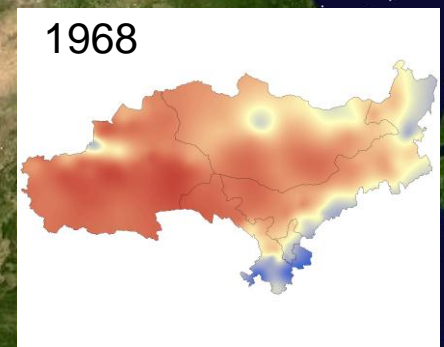
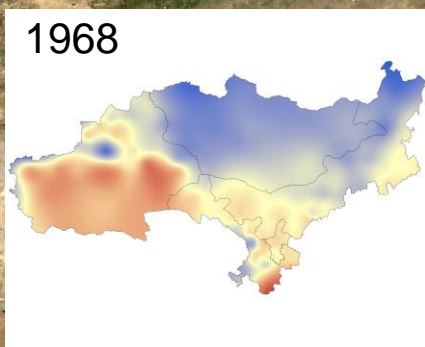
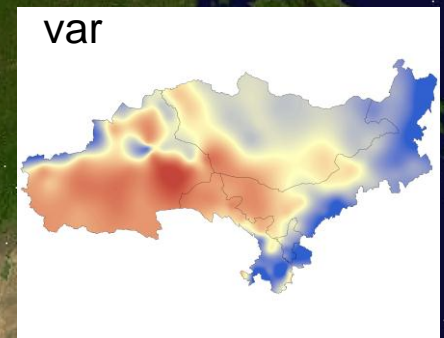
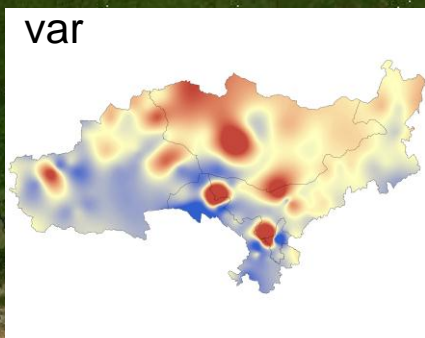
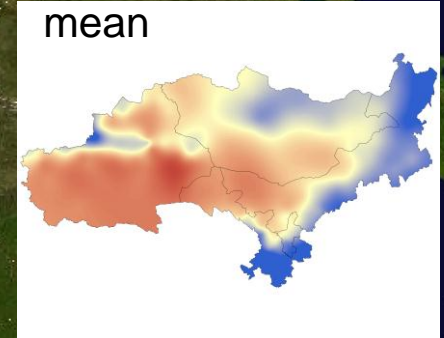
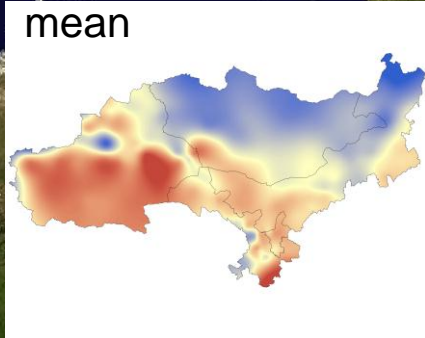
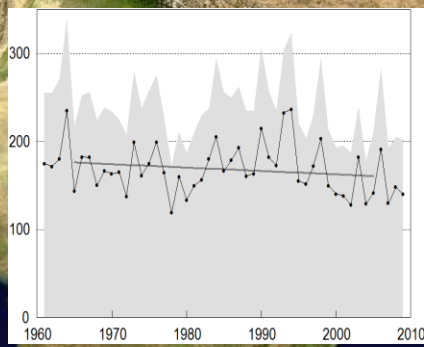
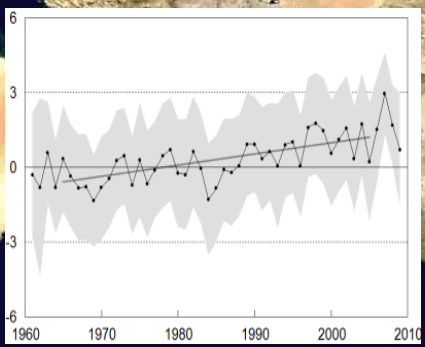
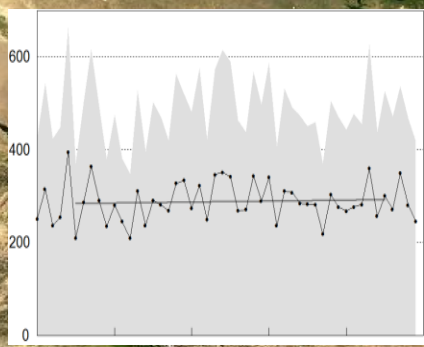
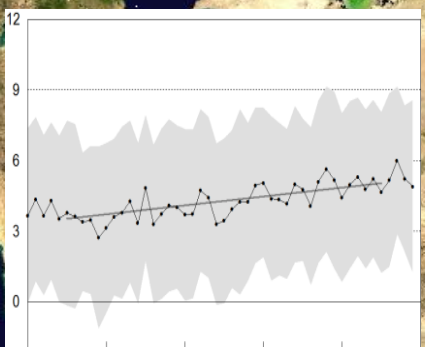
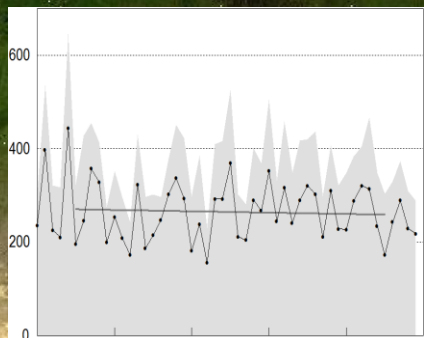
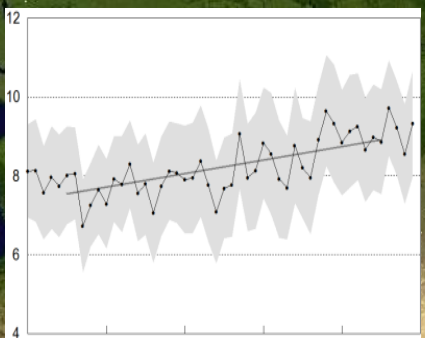
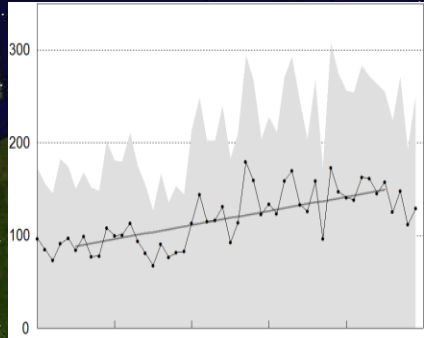
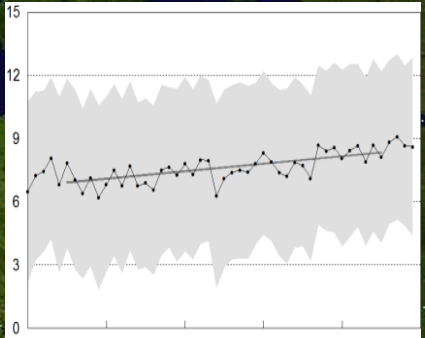
GPP

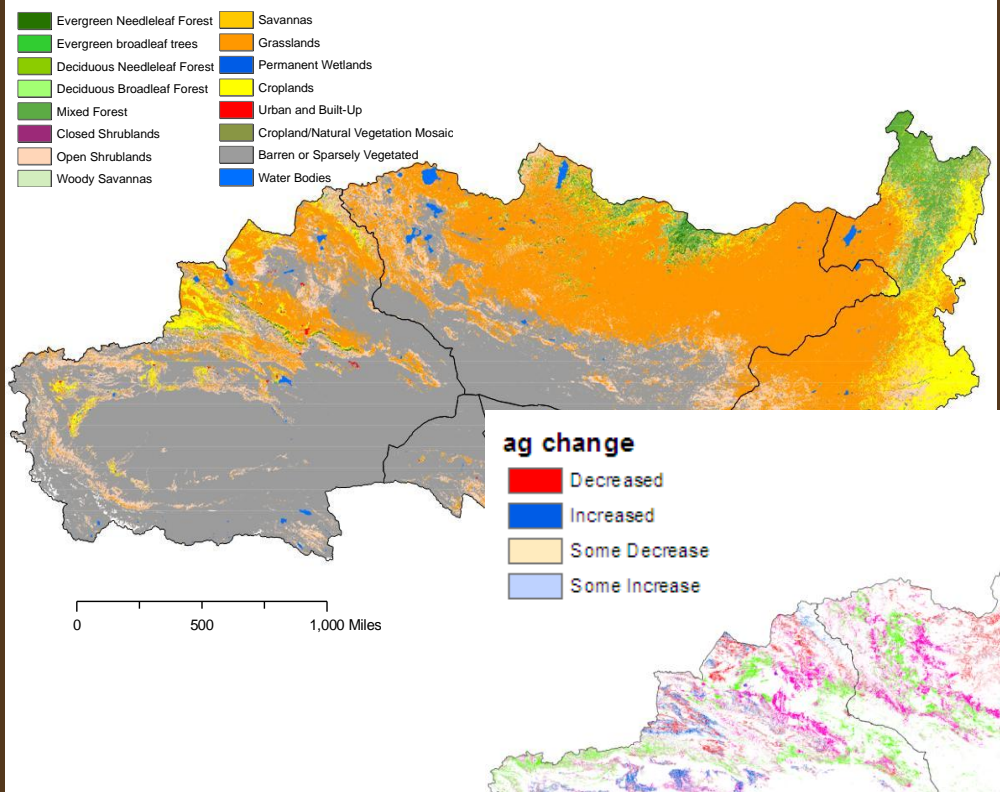


ET

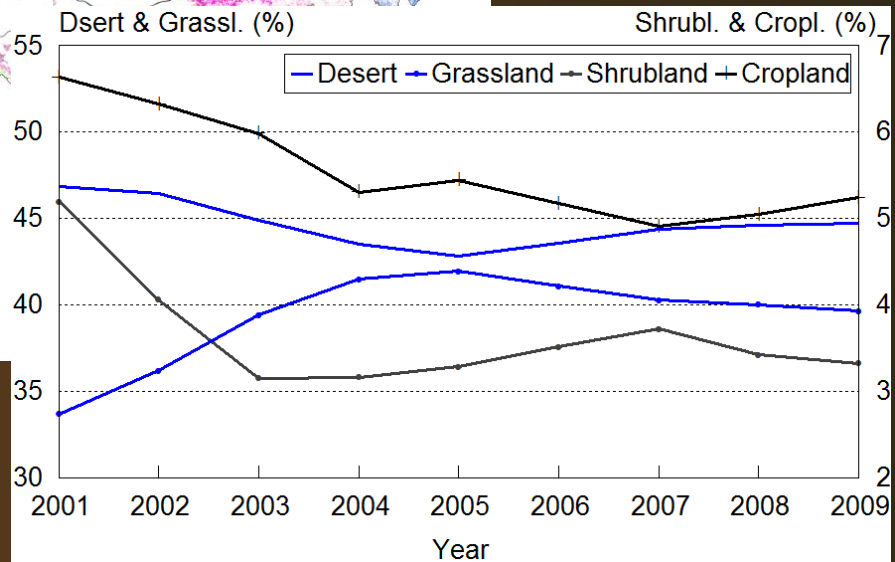
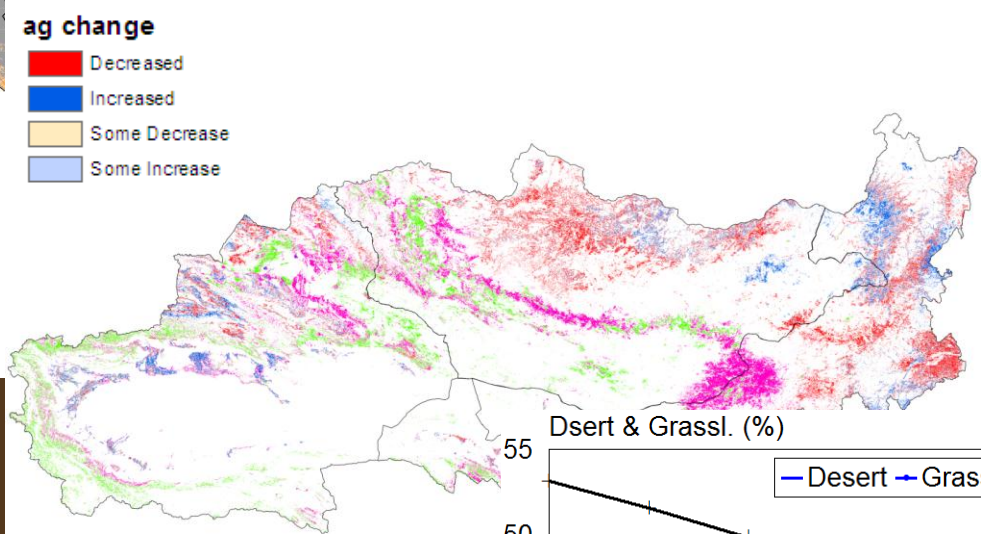


From Jiquan
Chen

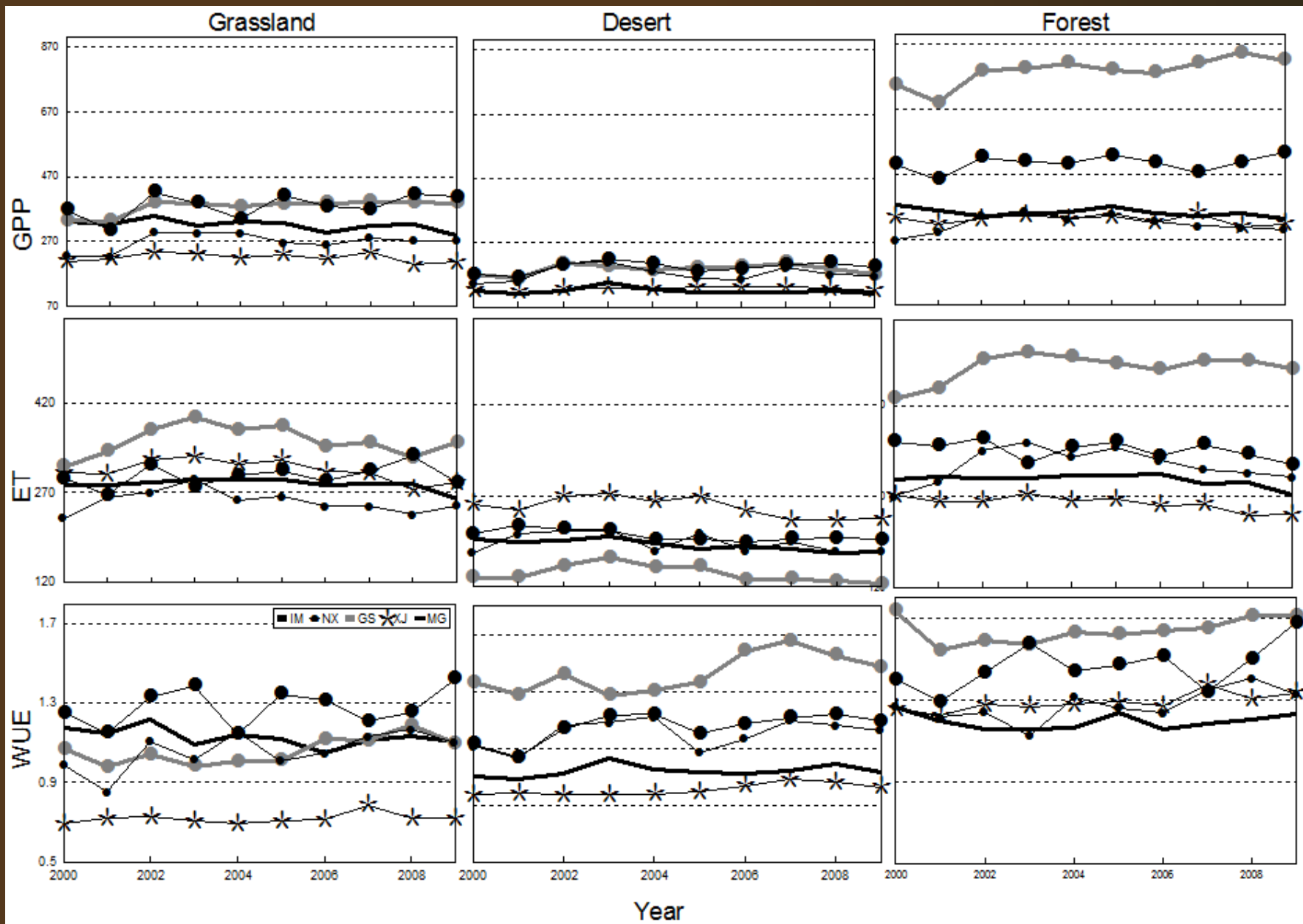




Kyrgyz landscape

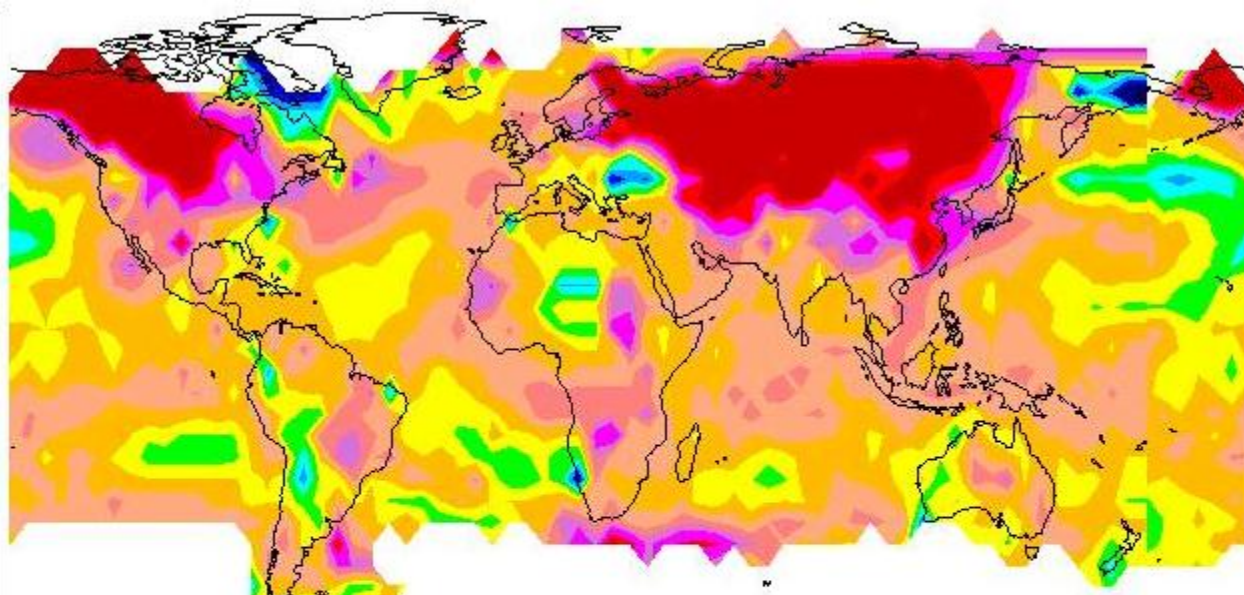


From Jiquan Chen

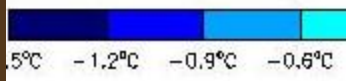


Climate change wildcard!

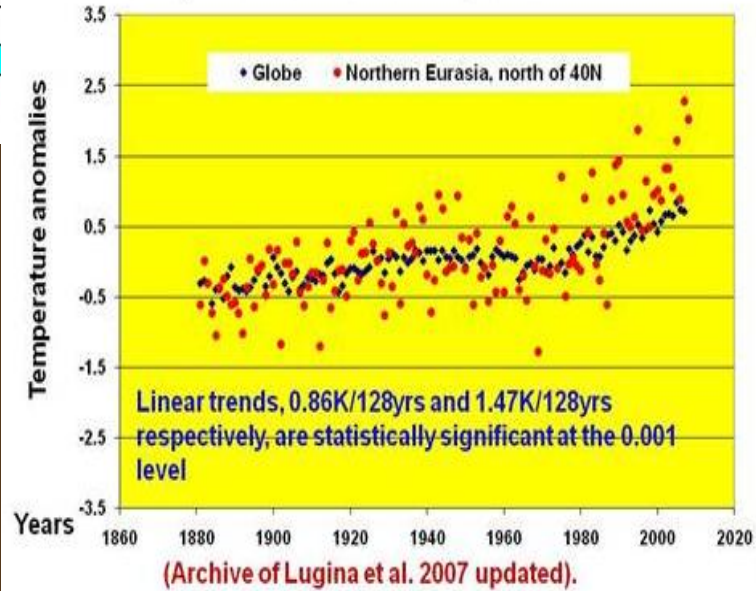
- The region is expected to experience dramatic changes in climate
- Directly linked to water resources (e.g. glacier retreat, decreased surface flow, decreased lake levels, increased ET)
- What is the role of these changes on crop productivity, rate of water depletion, salt accumulation and so on?



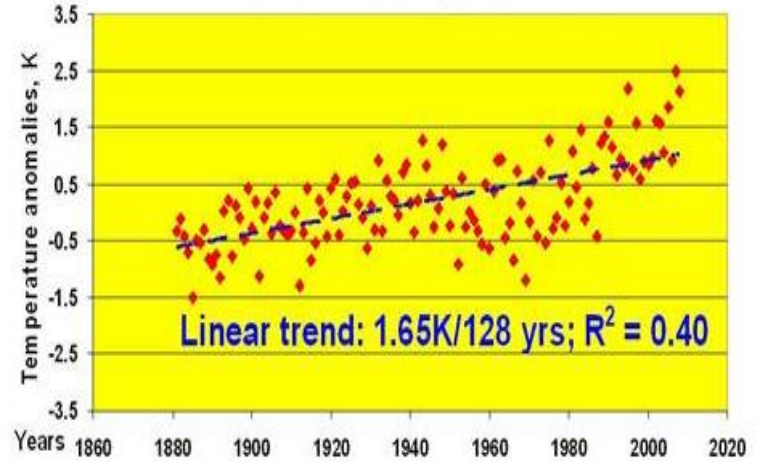
Mean winter



Global (latitudinal zone from 60°S to 90°N) and Northern Eurasia (north of 40° N) surface air temperature anomalies, 1881-2008



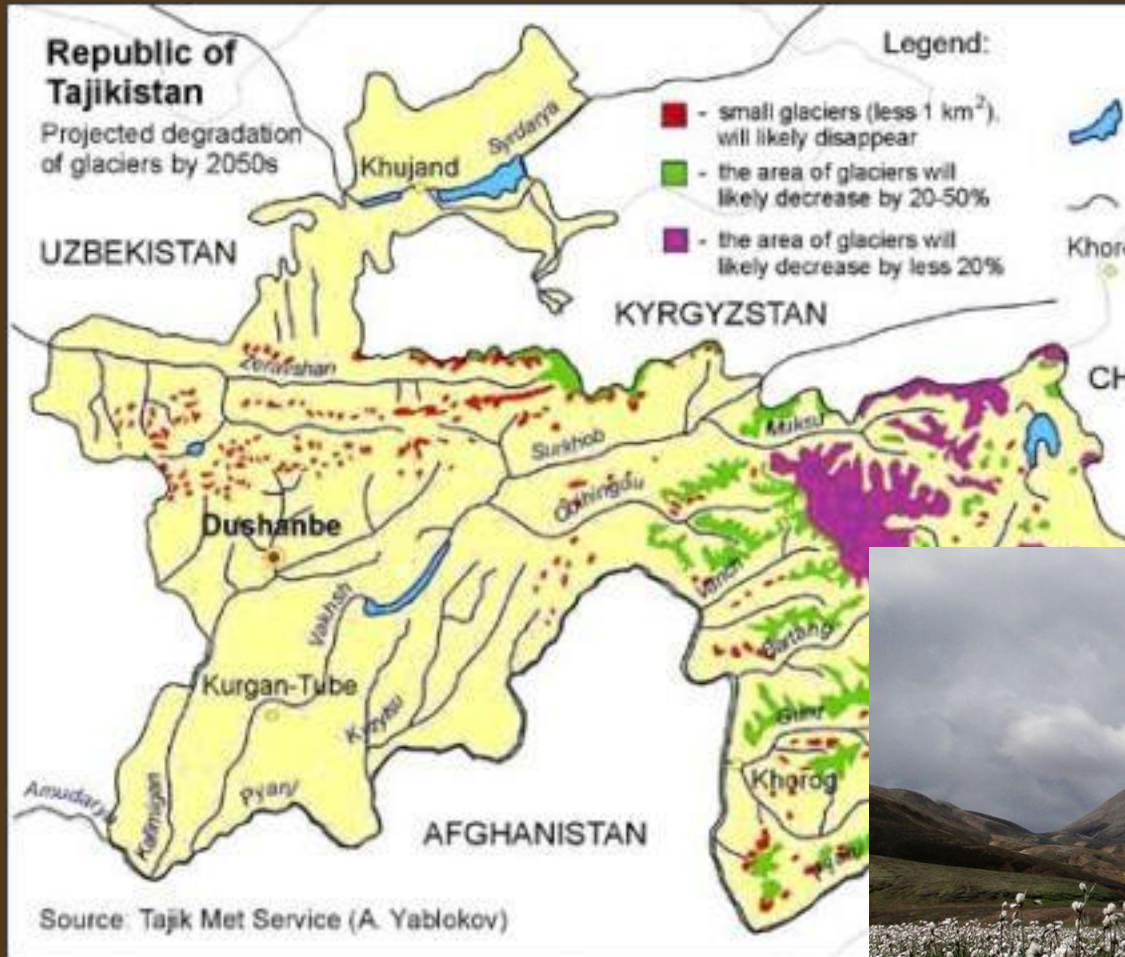
Northern Asia, north of 40°N. 1881-2008. Surface air temperature anomalies from the 1951-1975 reference period



During the past twenty years, all anomalies were above 0.5K and eight of them were above 1.5K. Year 2007 showed a record anomaly of 2.5K.

From Pasha Groisman

Predicted changes in glacier area in Tajikistan

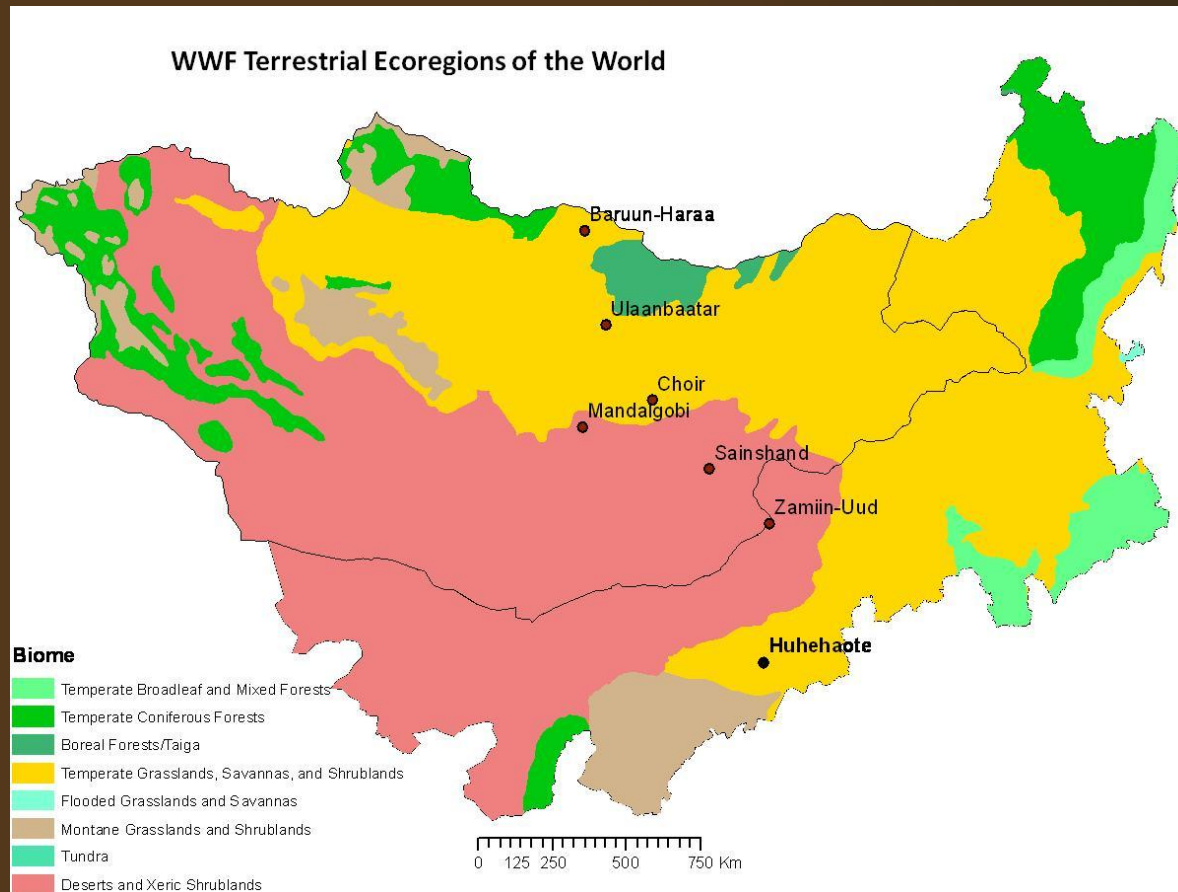


Synthesize research in 3 studies

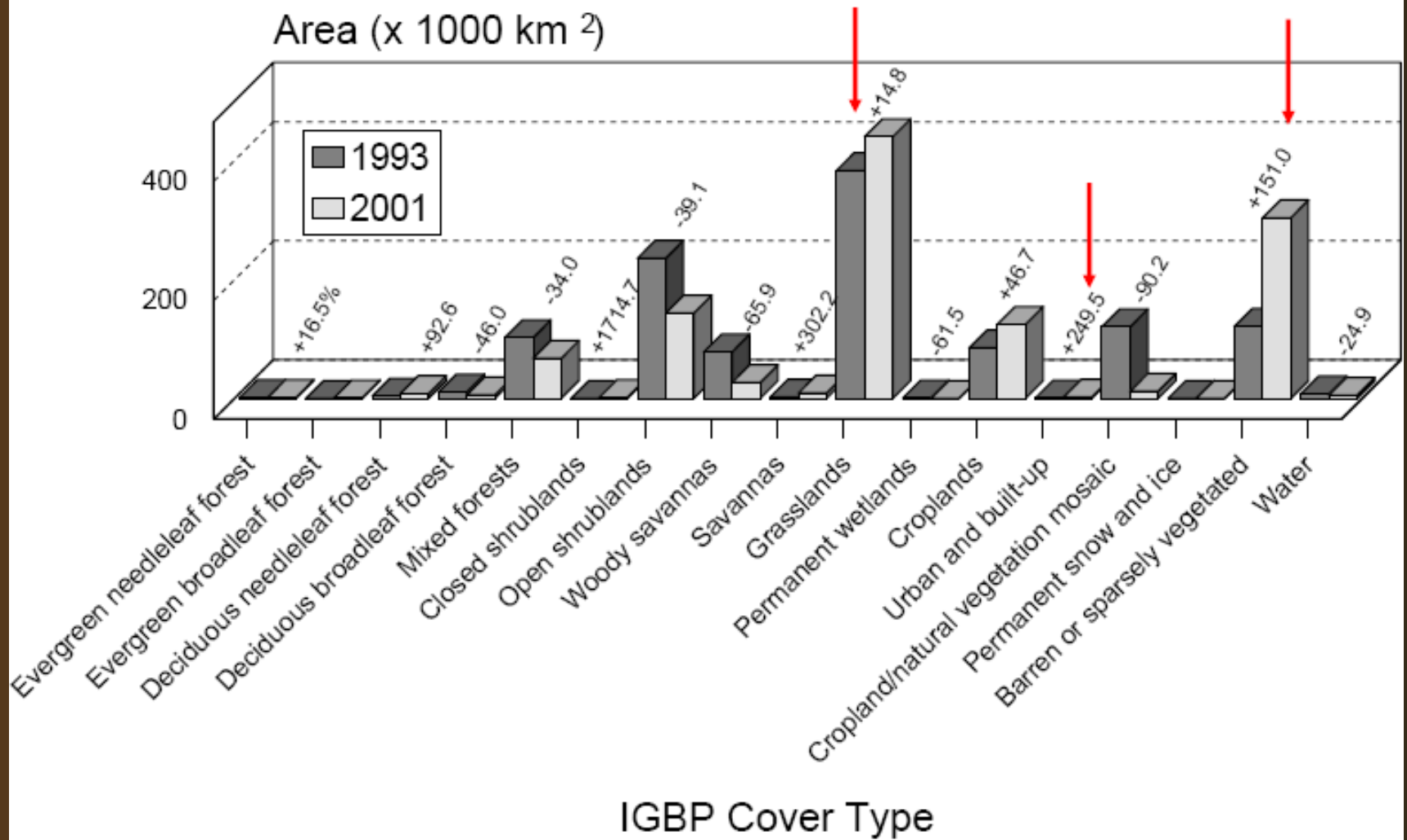
- Land-use change in Mongolia and Inner Mongolia (Chen et al)
- Sustainable Governance of Mongolian Grasslands (Wang and Brown)
- Changes in hydrology of the Tarim basin (Ozdogan et al)

Mongolia Plateau

- Two contrasting counties (IM & MG)
- Adaptation as the central focus
- Natural and Human System as one Unit

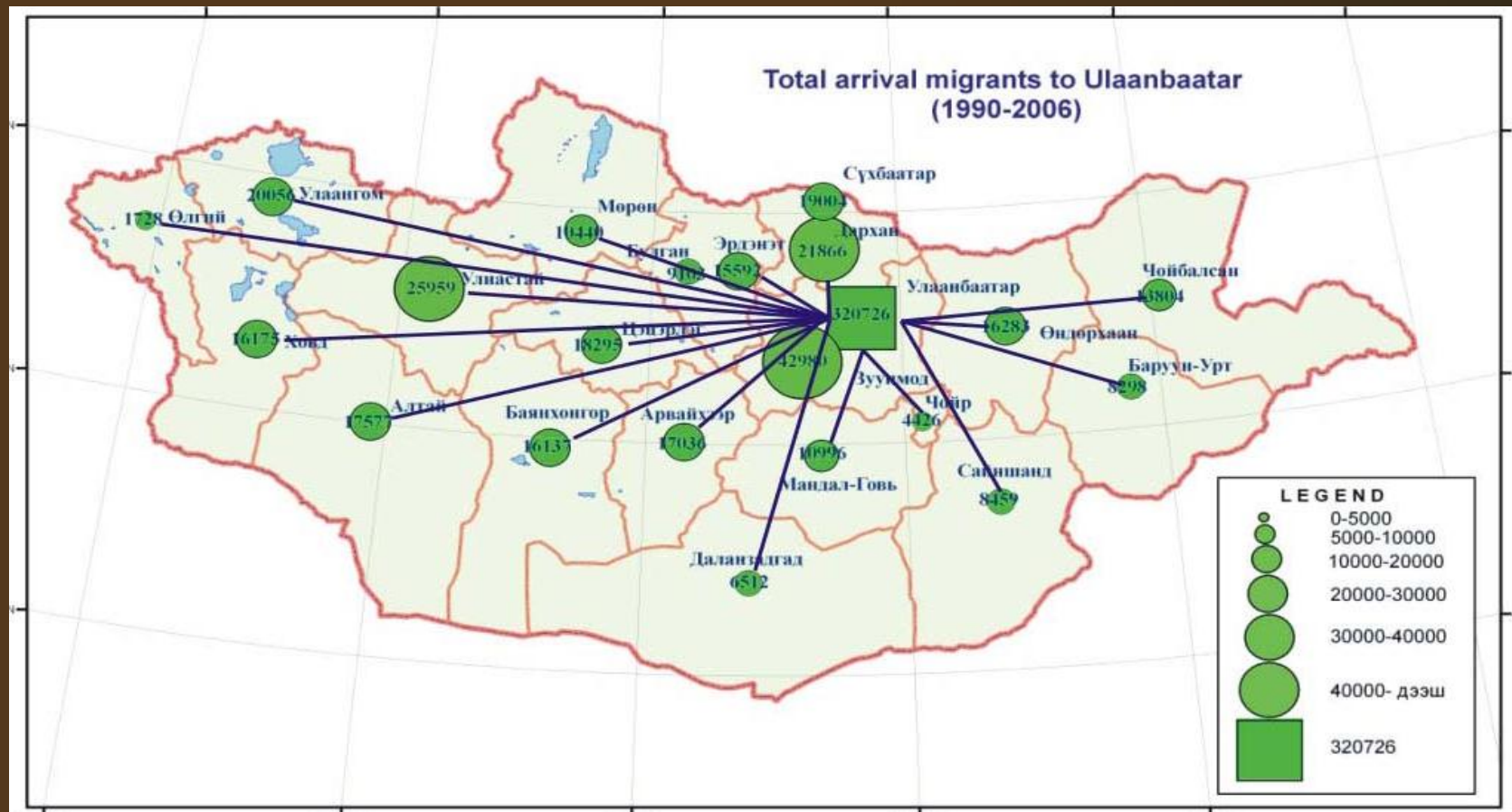


Land cover change between 1993 and 2001 in Inner Mongolia. The numbers are net percent change with negative sign indicating a decrease.

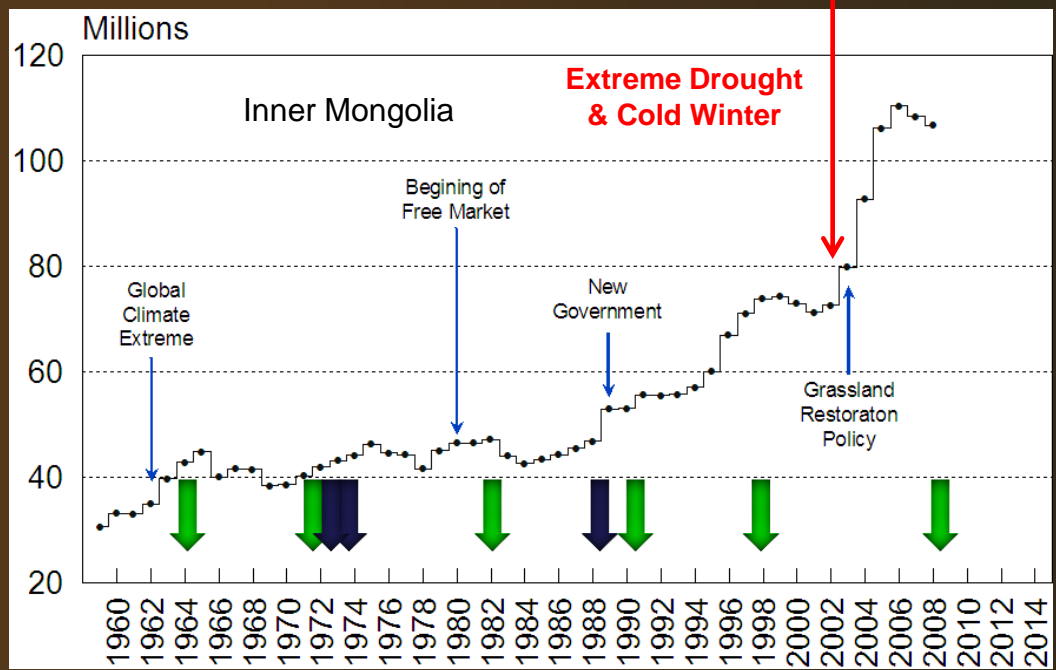
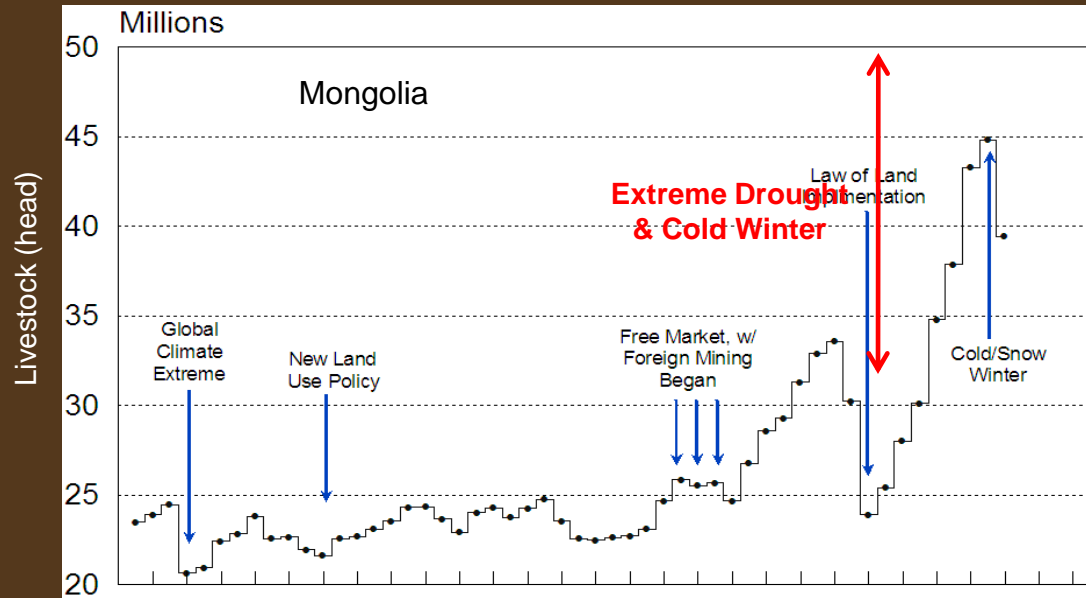


Present situation of population migration in Mongolia

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).

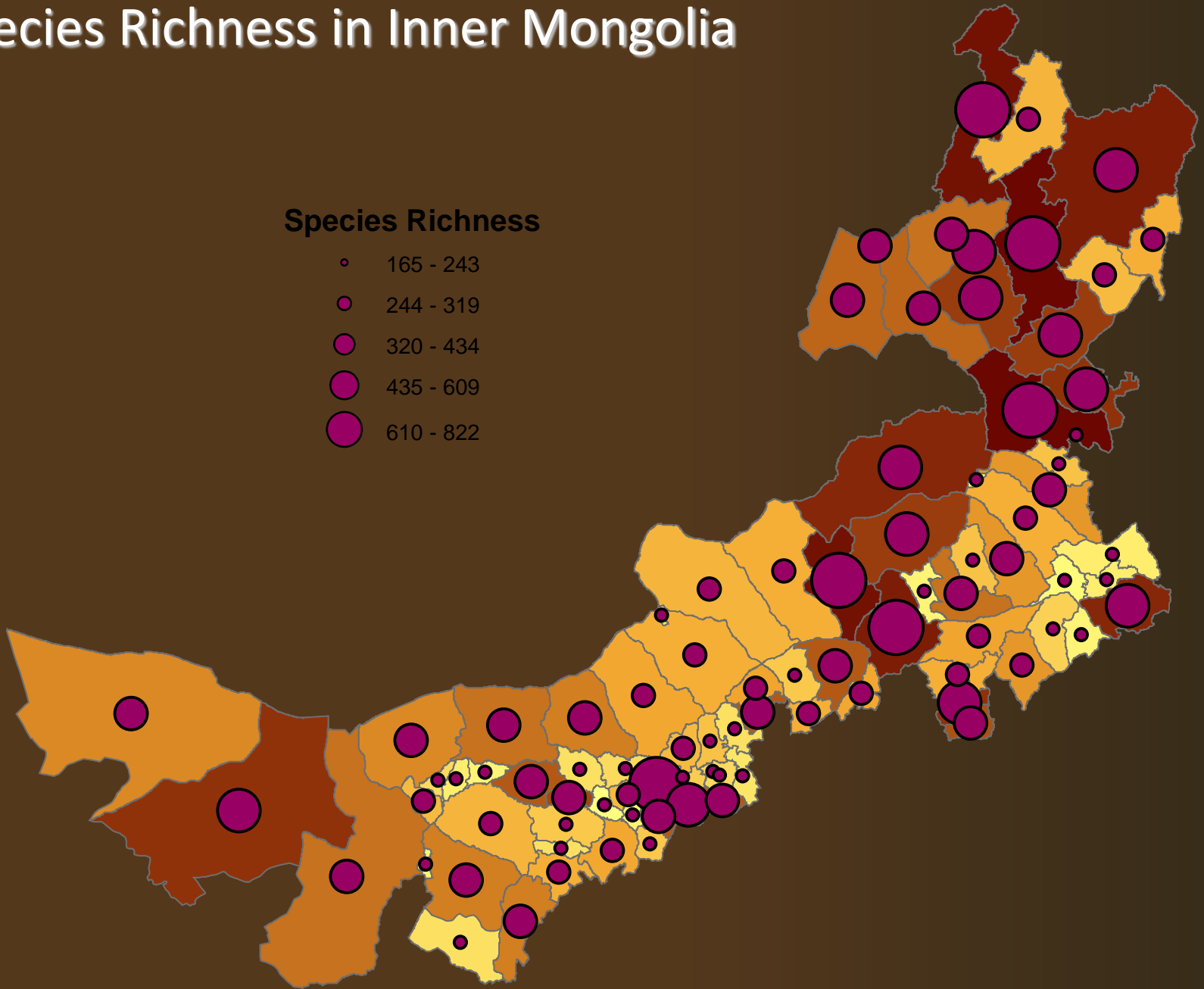


Changes in livestock, policy, and climate in IM and MG



Species Richness in Inner Mongolia

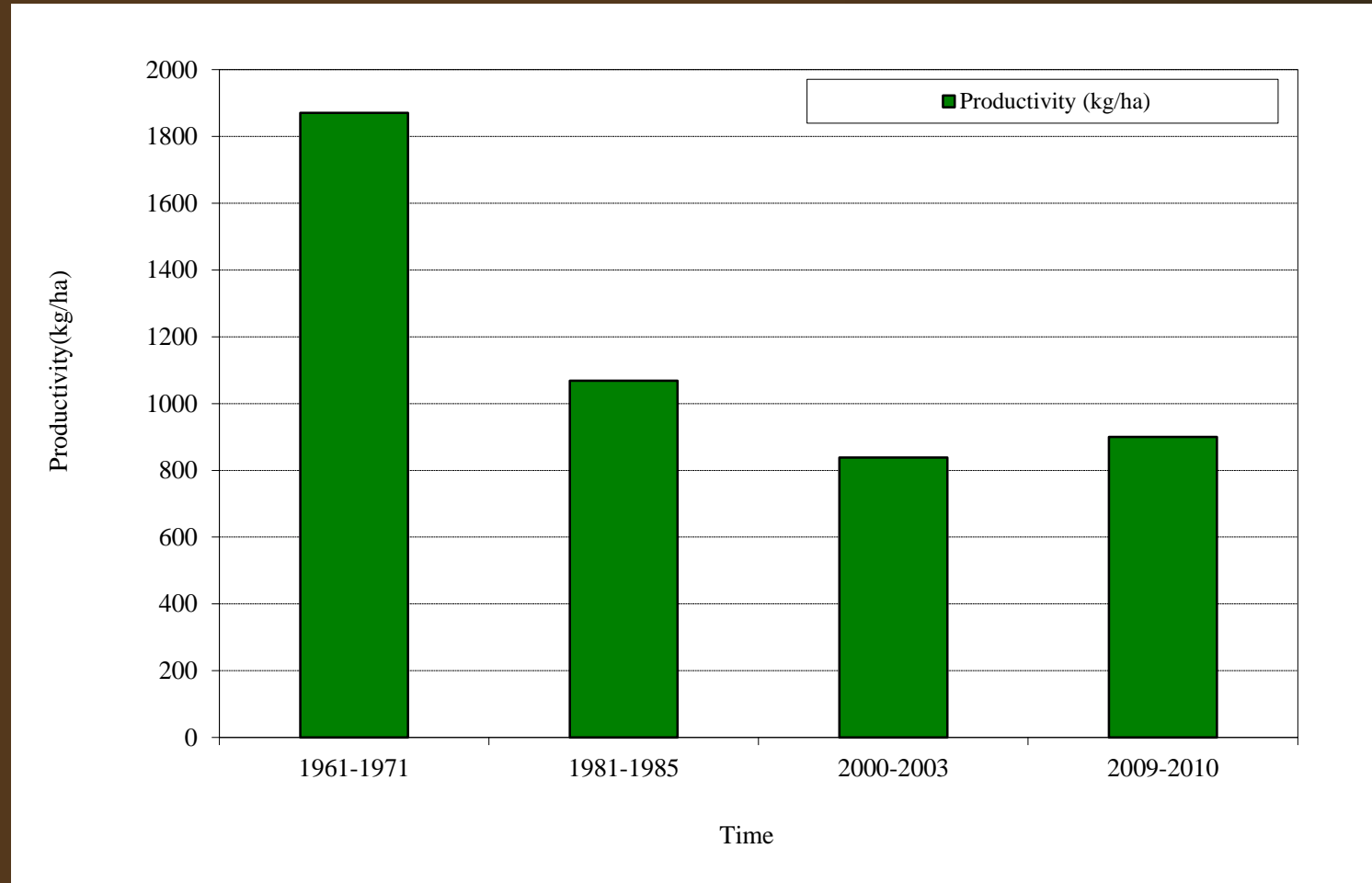
Species Richness



Sustainable Governance of Mongolian
Grasslands: Comparing Institutional, Market,
and Ecological Changes in the Context of
Climate Change in Mongolia and Inner
Mongolia, China

Authors: Jun Wang, Dan Brown, Arun Agrawal

Dynamics of Grassland Productivity in IMAR



Data: four-time province-scale grassland surveys in IMAR, China
(Xing Qi, personal communication)

Socioeconomic Periods in Grassland Dynamics in IMAR

The study period of IMAR can be divided into *three stages* based on *institutional and policy change*:

- *Collective economy period* (1961-1983)

Grassland and livestock were collectively owned by grazing communities.

- *Privatization and market economy period* (1984-1999)

Livestock production and grassland were contracted to herder households.

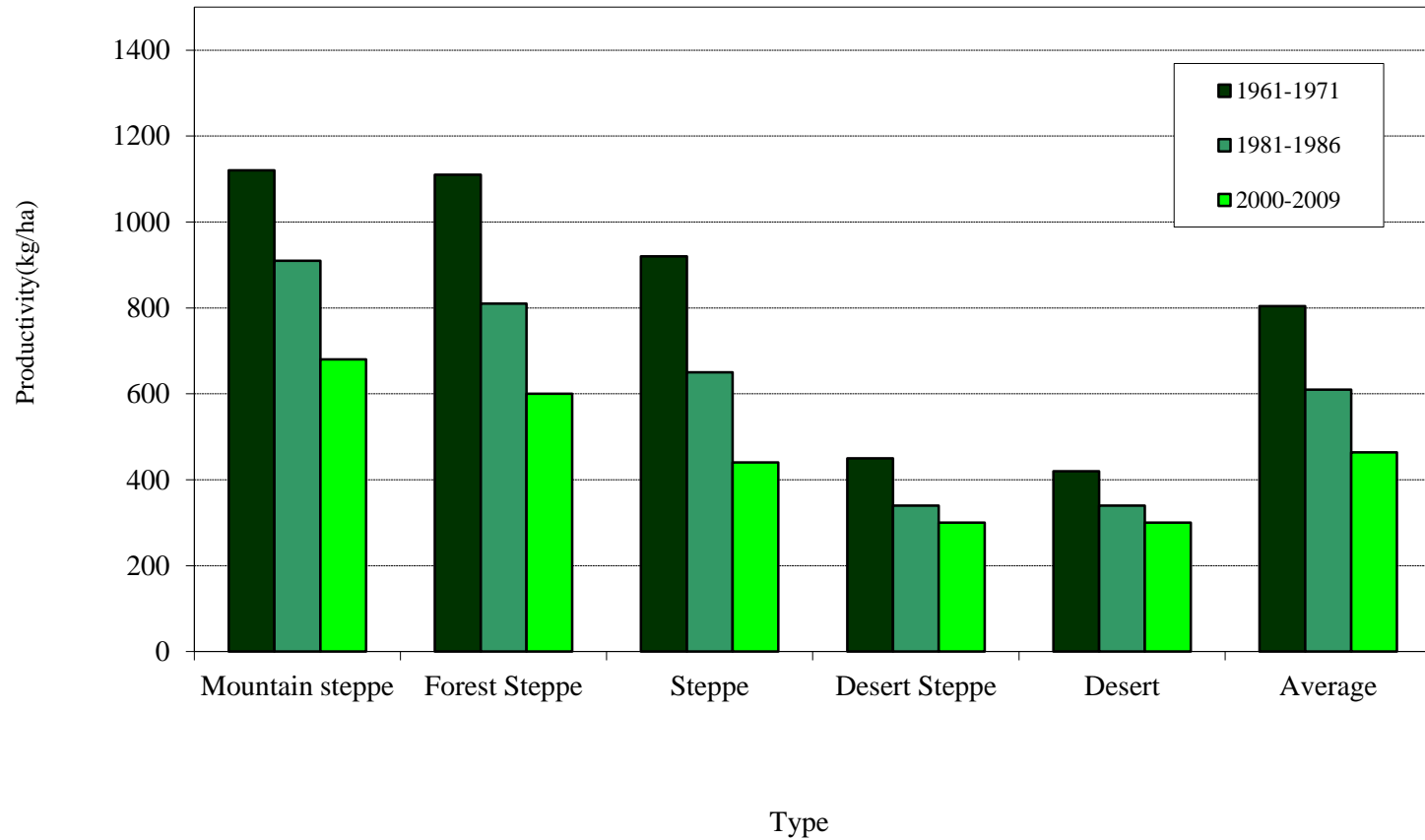
- *Recentralization of grassland management* (2000-present)

The Chinese central government has been implementing a range of policies (“Grain to Green” policy) to recover grassland quality.

Changing Roles of State, Market, and Community (IMAR)

- *In the collective period*, there were no market influences, and the state and local grazing communities play significant roles in governing grassland resources and managing livestock production.
- *Since the middle of 1980s*, China has been transforming to market economy and privatizing livestock and grasslands. Herders' livestock production is linked with global and local market fluctuations. The roles of the state and local communities were relatively deemphasized.
- *Since the year 2000*, the Chinese central government has been trying to recover grassland quality. Grassland management is recentralized to the central government. Herders' livestock production is still market-oriented, while within the institutional and policy constrains. Local communities no longer play important roles in governing grassland resources.

Dynamics of Grassland Productivity in Mongolia



Data: three-time national scale grassland surveys in Mongolia

Socioeconomic Periods in Grassland Dynamics in Mongolia

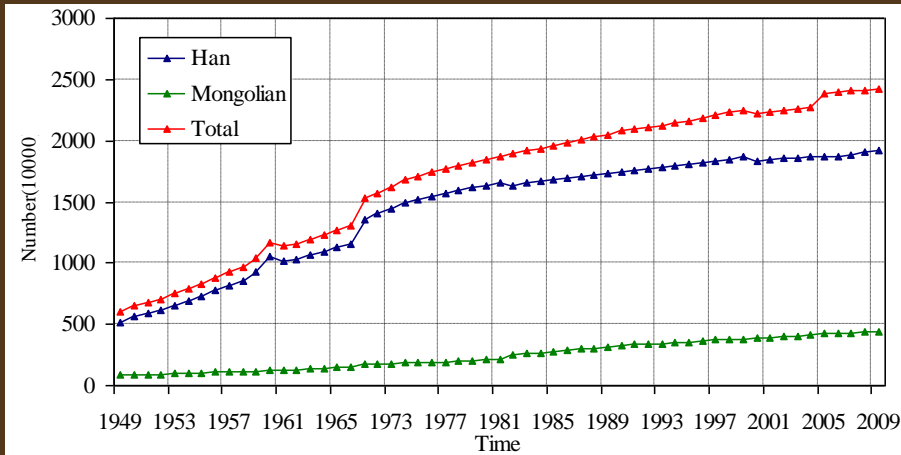
The study period of Mongolia can be divided into *two stages* based on *institutional change*:

- *Collective economy period* (1961-1990)
Grassland and most livestock were collectively owned by the state or its collectives.
- *Privatization and market economy period* (1991-present)
Livestock were privatized to herder households. Grasslands in Mongolia became open-access natural resources.

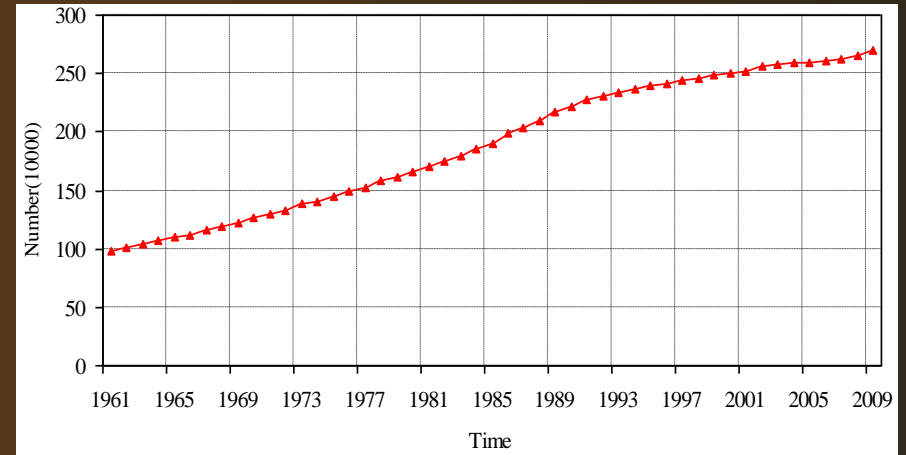
Changing Roles of State, Market, and Community (Mongolia)

- *In the collective period*, the state and local grazing communities (nedgals) play significant roles in coordinate grassland use and managing livestock production. Similar to IMAR, in this period there were also no market influences on livestock production.
- *Since the year 1990*, Mongolia has been transforming to market economy. Herders' livestock production is linked with global and local market fluctuations. In the transforming period, there are no effective legal resource institutions to coordinate grassland use. Local communities also do not play important roles in governing grassland resources and coordinating livestock production.

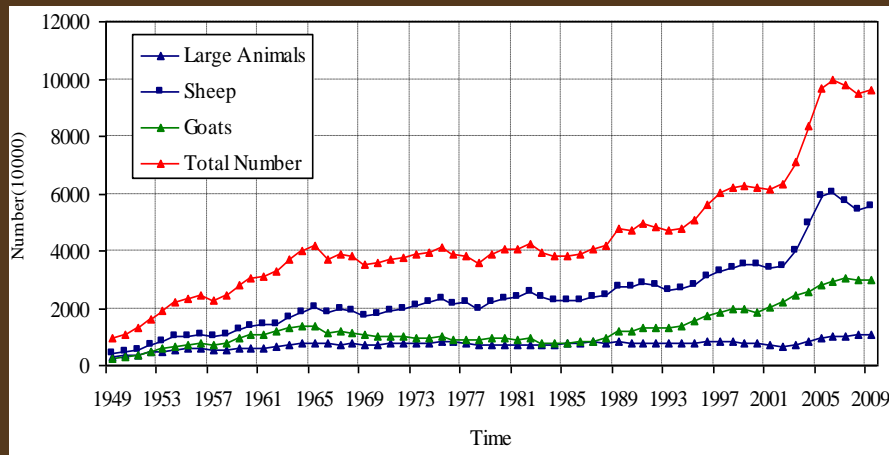
Socio-economic Factors: Populations of Human and Livestock



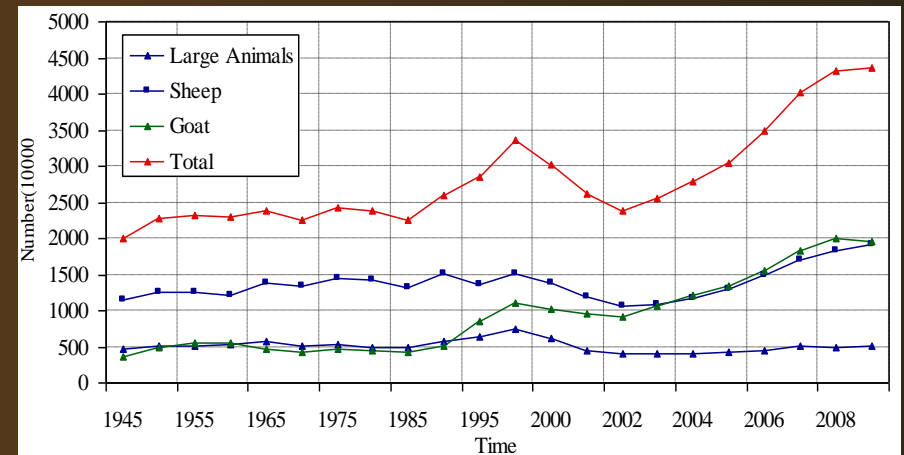
IMAR-Human Population



Mongolia-Human Population

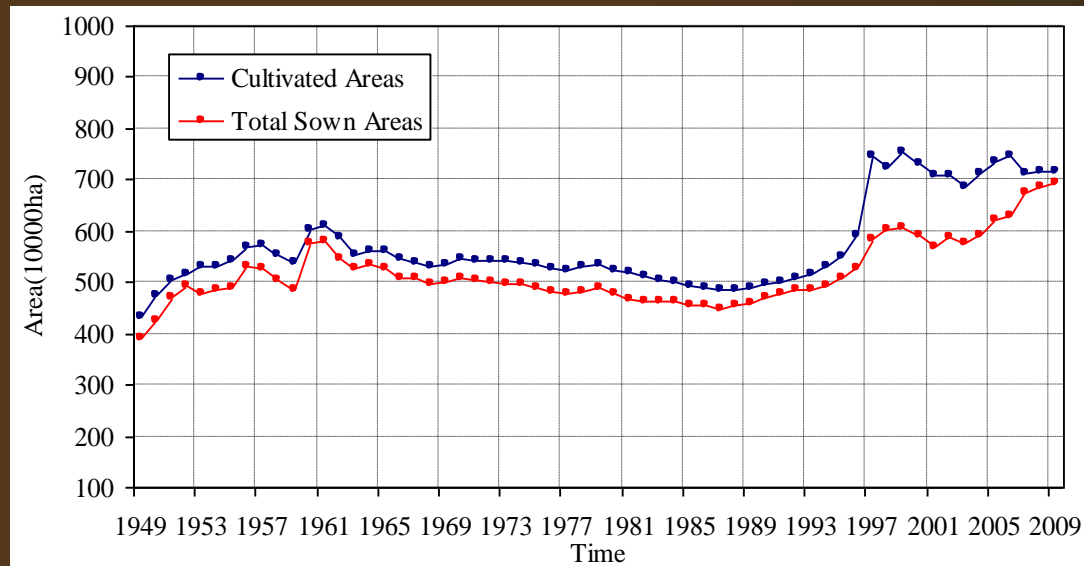


IMAR-Livestock Population



Mongolia-Livestock Population

Socioeconomic Factor: Grassland Conversion

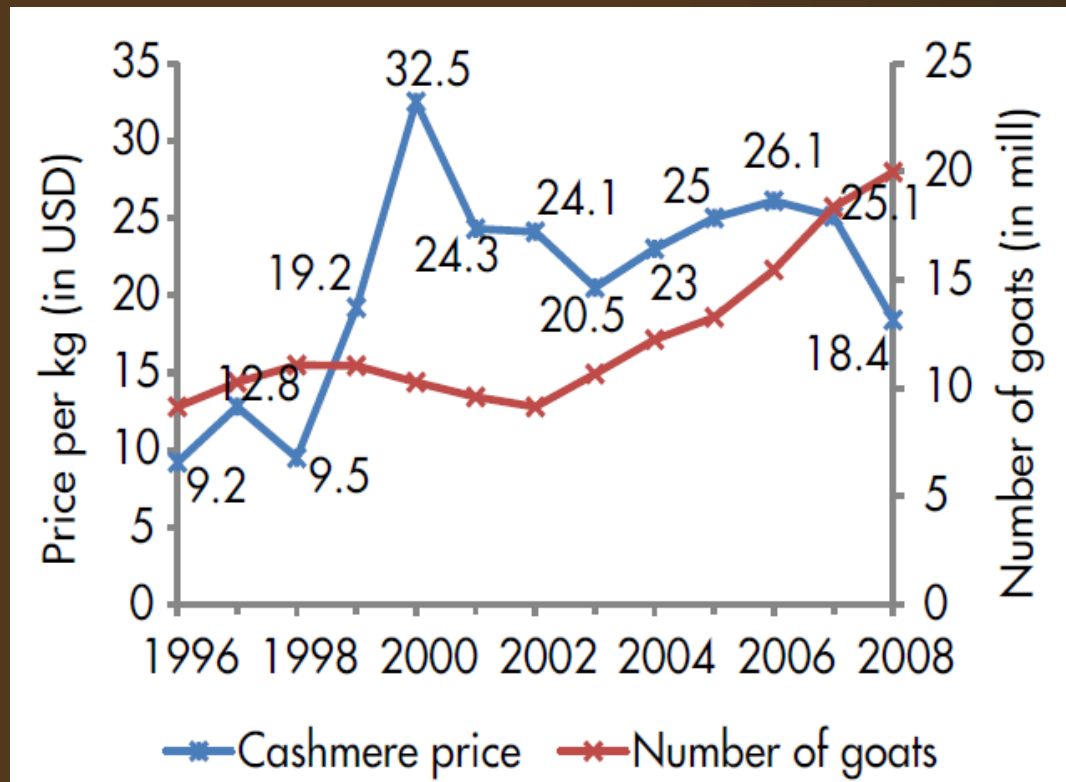


IMAR-Area of Cropland

IMAR: Areas of Grassland Converted by Purpose (Unit: million hectare)

	<i>Grain Production</i>	<i>Fodder Production</i>	<i>Other Uses</i>
1949-1985	9.2	0.0	0.0
1985-2000	6.3	1.4	1.4
2000-2005	0.0	5.6	0.0
Total	15.5	7.0	1.4

Socioeconomic Factor: Market Influence

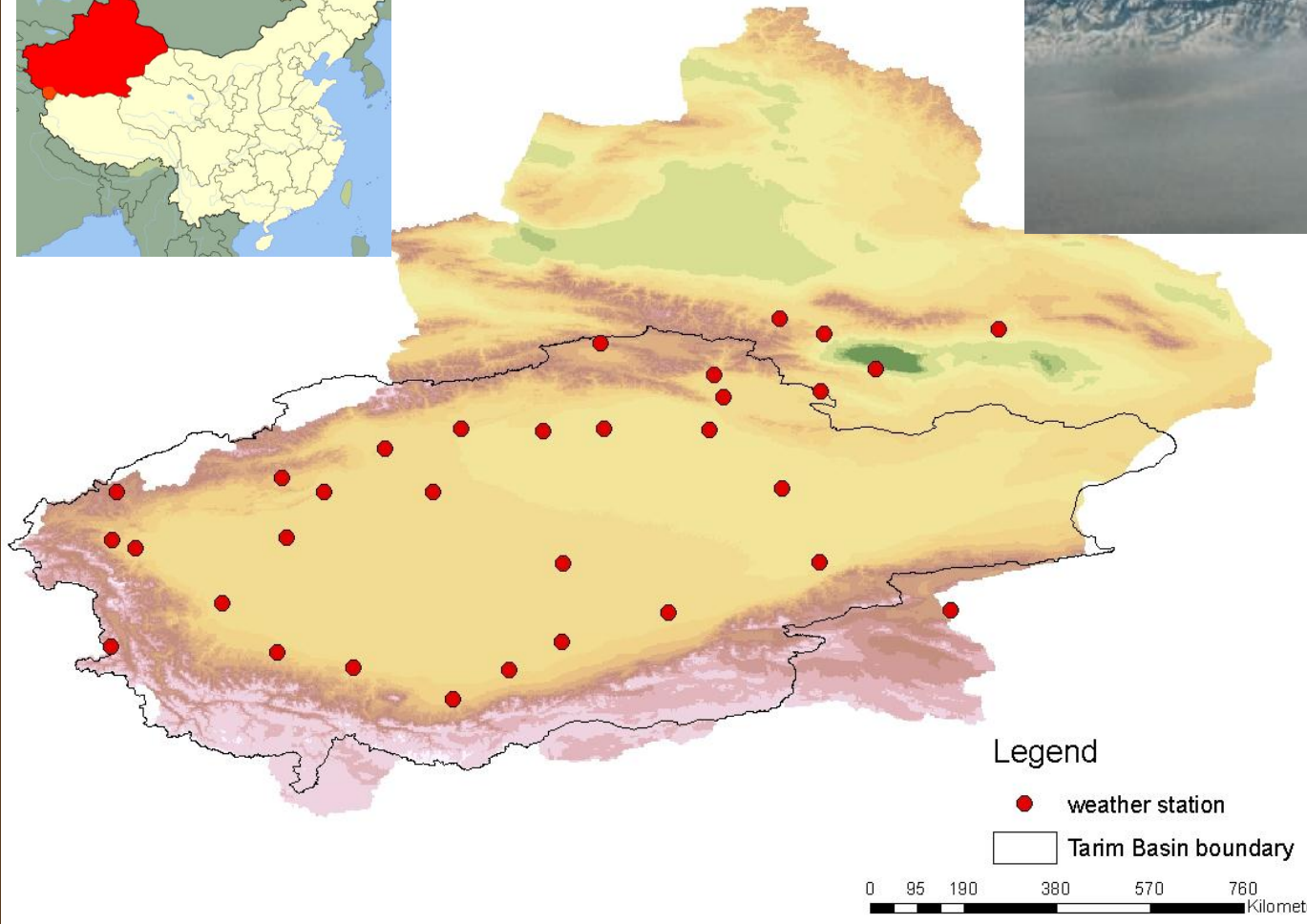


Relationship between the price of cashmere and goat numbers in Mongolia.
Source: National Statistical Office of Mongolia (Olonbayar, M. 2010)

Land-use change and hydrology in the Tarim basin

Mutlu Ozdogan
Yang Yang
Alishir Kurban
Xi Chen

Tarim basin

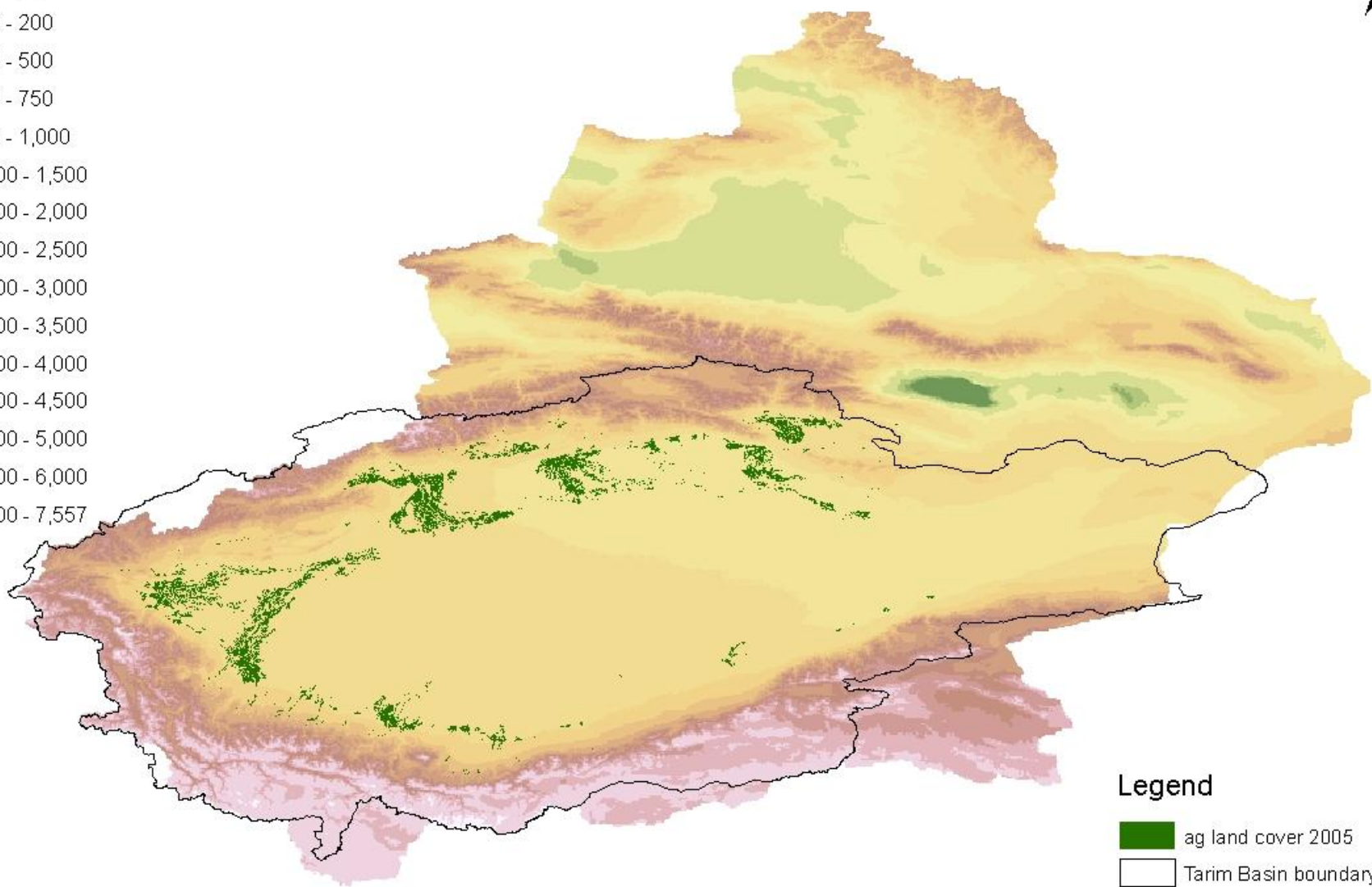
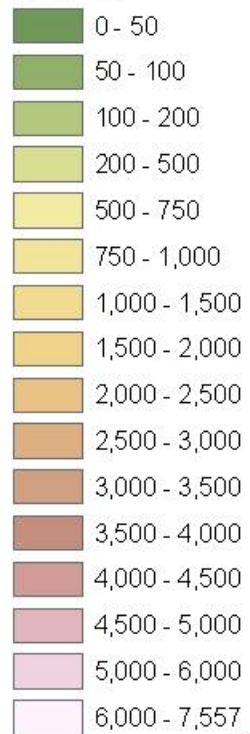




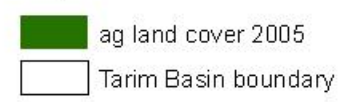




DEM (m)

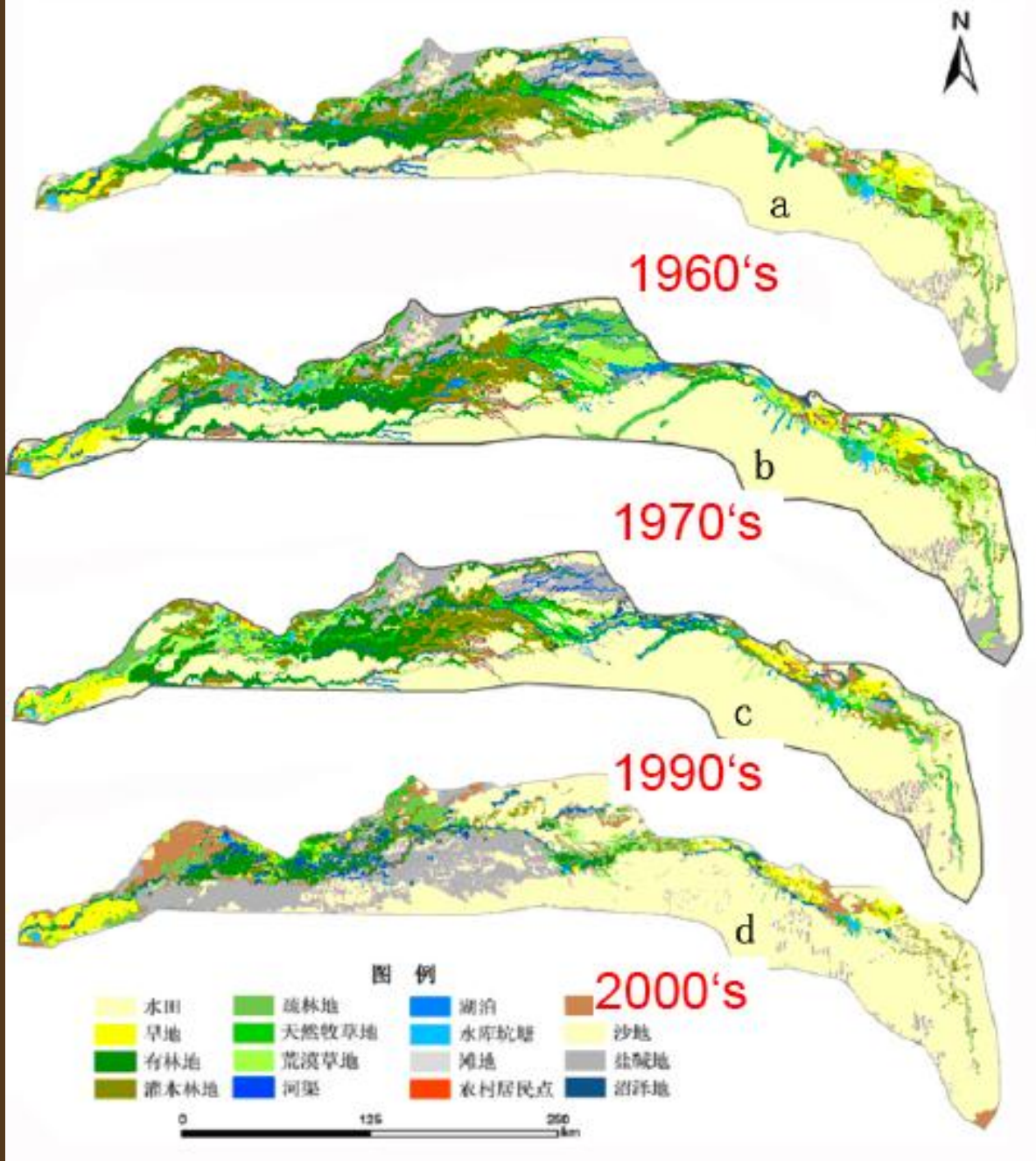


Legend

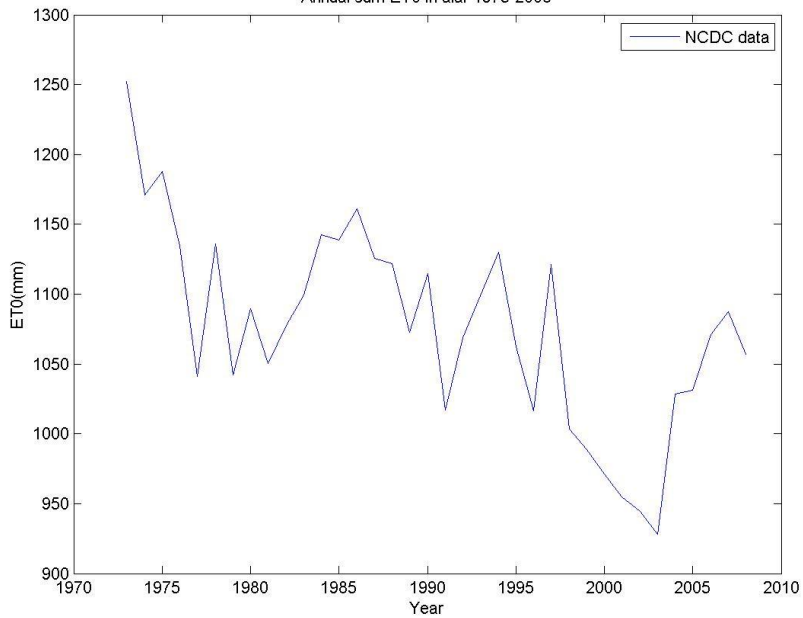


2005

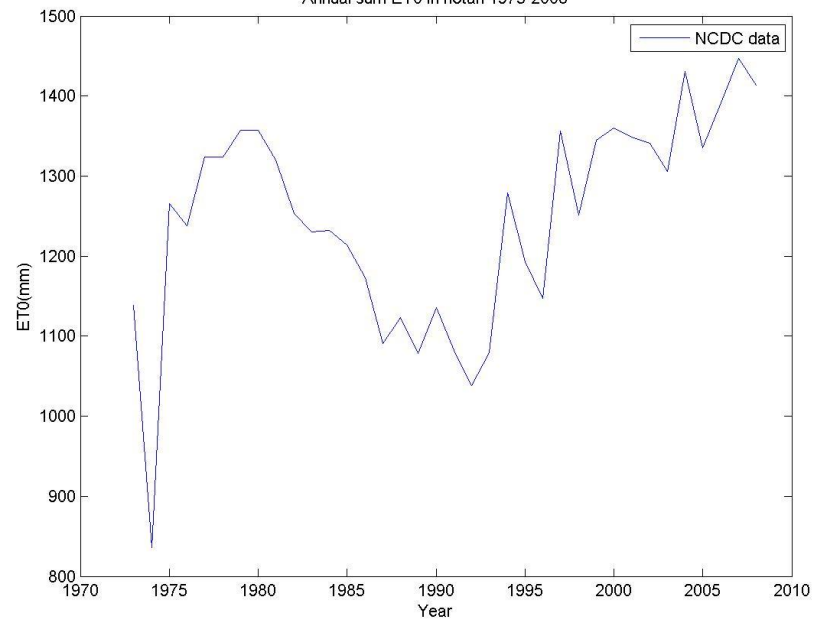




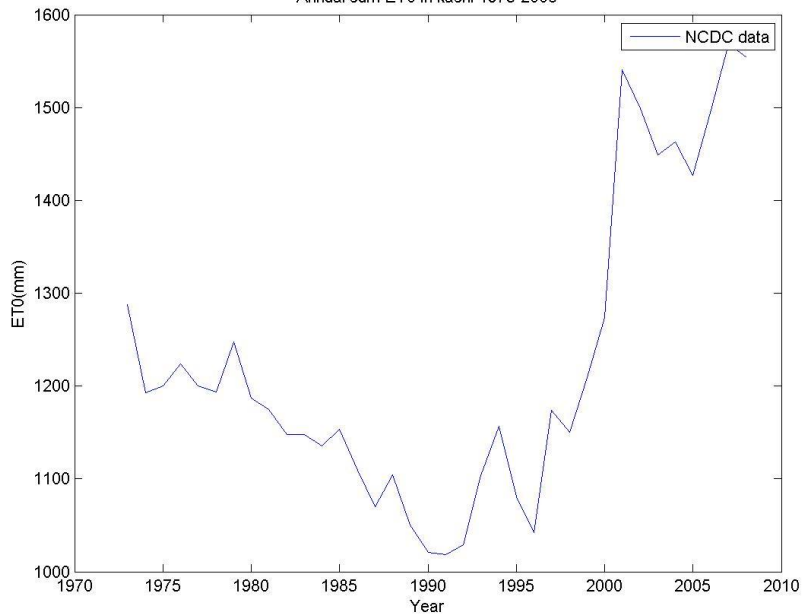
Annual sum ET0 in alar 1973-2008



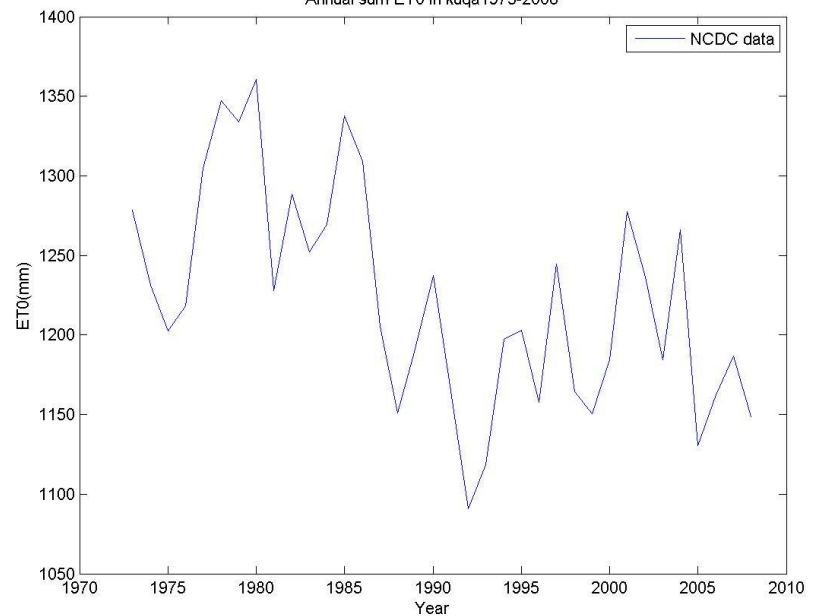
Annual sum ET0 in hotan 1973-2008



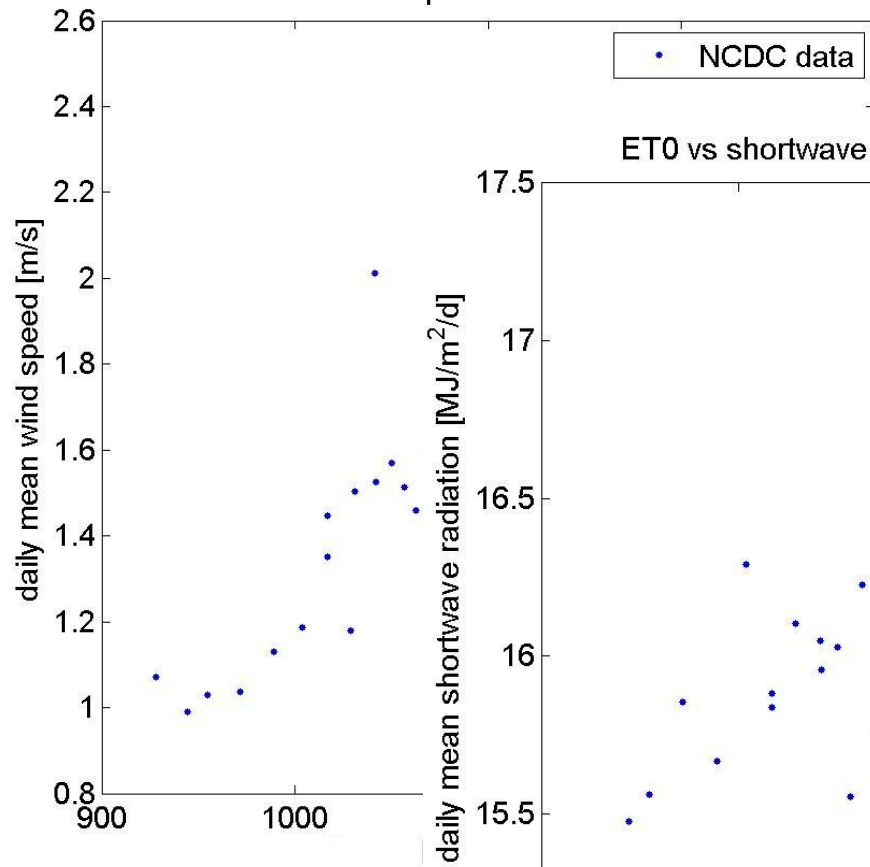
Annual sum ET0 in kashi 1973-2008



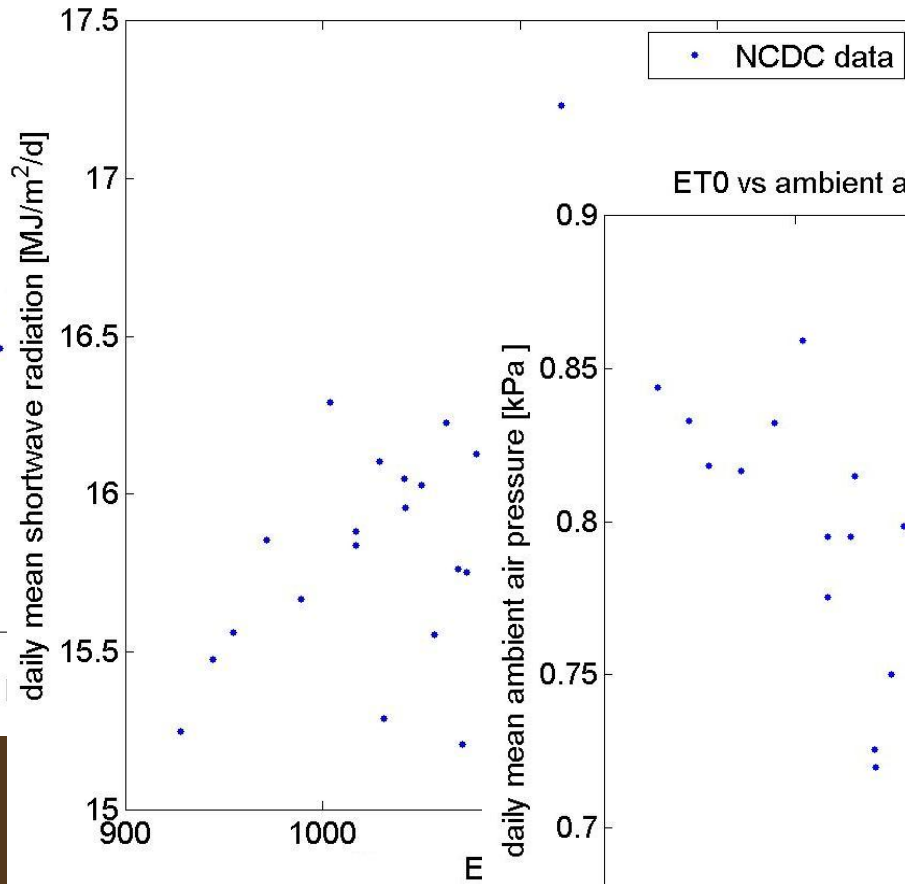
Annual sum ET0 in kuqa 1973-2008



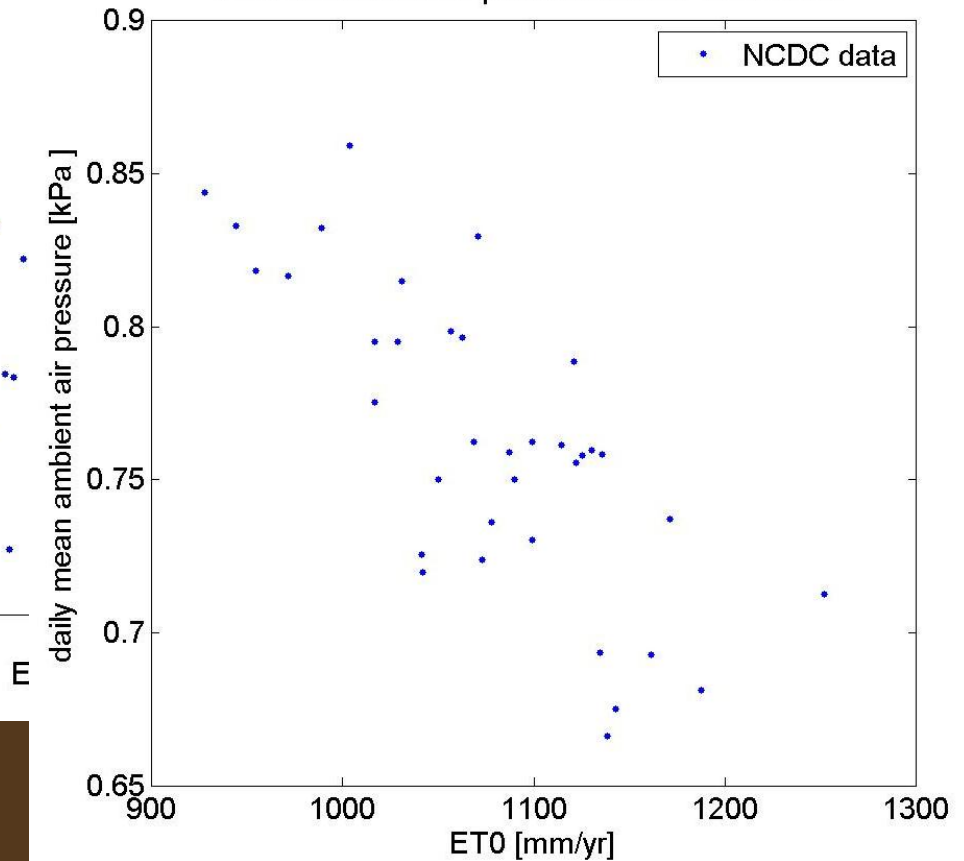
ET0 vs wind speed in alar 1973-2008



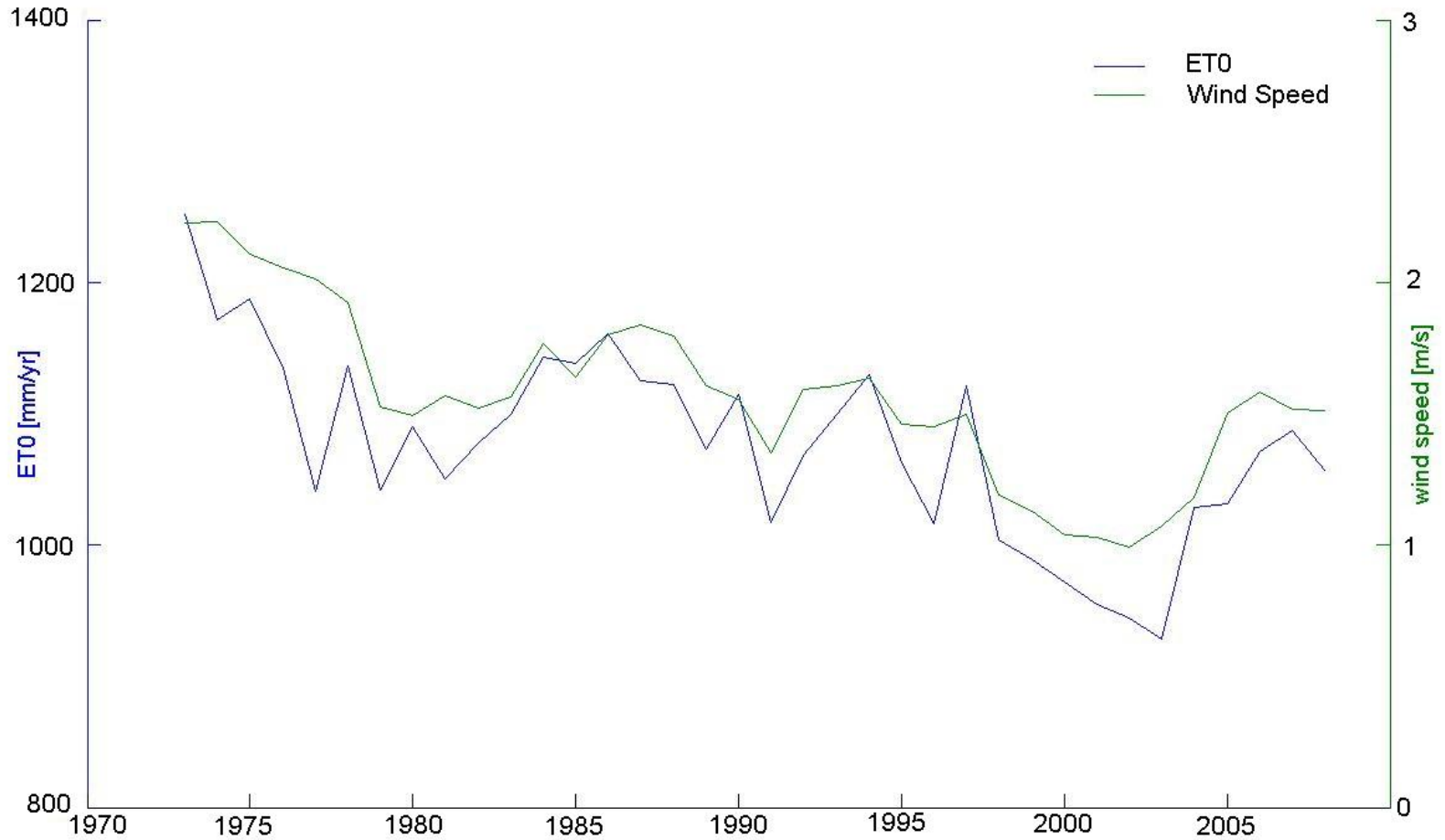
ET0 vs shortwave radiation in alar 1973-2008



ET0 vs ambient air pressure in alar 1973-2008



Potential ET and wind speed



Summary

CA as a large water limited region undergoing tremendous change with its climate, land-use, and institutions

In Mongolian landscapes grasslands are changing rapidly due mostly to institutional changes such as migration and markets with implications for hydrology and biology

In the Tarim basin, land-use change combined with climatic change is affecting the amount of water transfer to the atmosphere from the land surface



Thank you...