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1. Activities addressing objectives, findings, and main challenges:

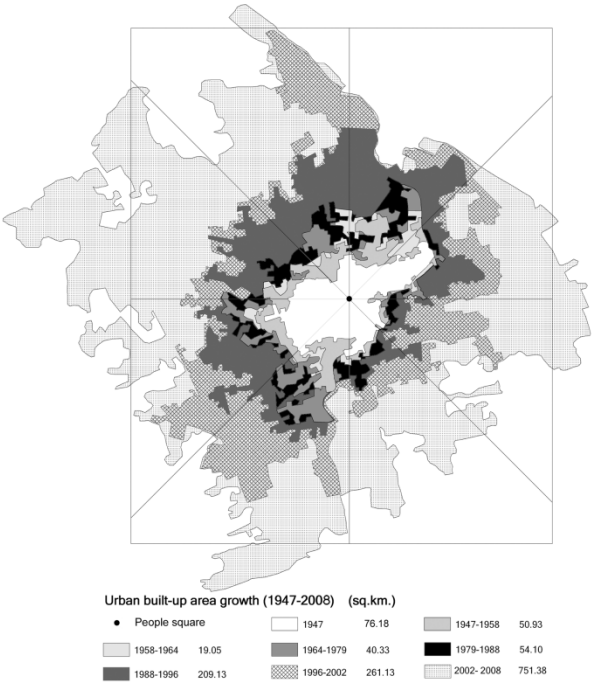
Objective 1. Linkage between urbanization, LULC, and climate change (SH and Urumqi)

- *Urban sustainability of Shanghai and Urumqi*

Relying on a sustainability index, we evaluated the position of Shanghai and Urumqi versus other major cities in China in terms of urban sustainability in recent years, measured in three dimensions: economic development, urban environment, and social equity.
Findings: Shanghai fared well in sustainable urban development, listed with the second highest urban sustainability index of 30 major Chinese cities in 2006, with continuing improvement in recent years. However, a closer examination reveals that although Shanghai scores high in economic and equity measures, its urban environment has declined below the national average. Ranked as the fourth lowest city in urban sustainability, Urumqi is the only major city in China that had a decreased urban sustainability index value from 2003 to 2006. It has the lowest score of urban environment in 2006, offsetting the economic and equity progress of the city.

- *Socioeconomic forces for spatial restructuring –DPSEF model*

We have collected most data needed for the DPSEF model for both Shanghai and Urumqi to investigate the causal linkage between urbanization, LULC, and climate change from 1979 to 2009. **Main challenge and future plan:** Some of the data needed for the DPSEF model is incomplete, for instance, number of registered vehicles are available only from 1996 to 2008; SO_2, industrial soot, and industrial dust emission data are only available from 1991 to 2008; concentration of SO_2, NO_2, PM_{10} are only available from 1991 to 2008. Our local collaborators will help us to find the missing data. To carry on the analysis, we will either adjust the period for the model or do back transformation of the missing data. We plan to plot the data and see if they fit environment Kuznet Curve or urban environmental transition theory. We also plan to use correlation analysis and regression models on the collected data.

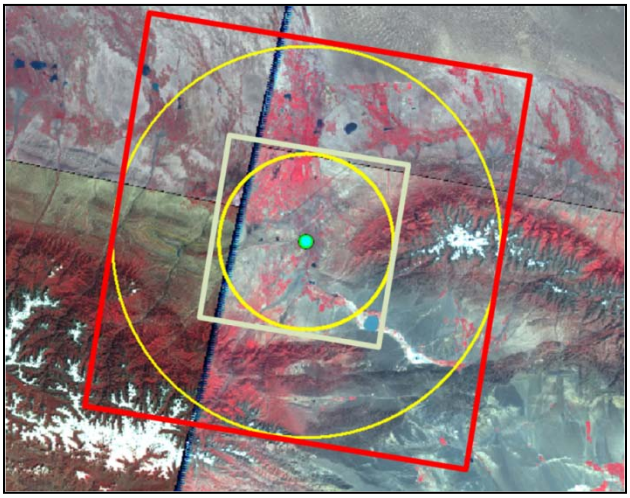


<=Fig.1 Urban built-up area growth in Shanghai

- *Socioeconomic forces for spatial restructuring –Shanghai's urbanization*

We investigated Shanghai's urbanization, LULC, and urban environment change at the city level (Fig.1) and the district (sub-city) level and presented the result at the Global Land Project Workshop in June 2009 in Beijing. **Findings:** Urban districts of Shanghai evolved differently due to their different locations, historical experiences and development policies from 1949, especially during the reform era started from 1978. While some districts exhibited positive urbanization trends, indicated by rapid

economic growth, better environment conditions, and more appropriate land use, others showed negative urbanization trends, illustrated by slow economic growth, worse environment conditions, and less appropriate land use. We found that economic restructuring and globalization, migration policy, and institutional involvement, such as development of Pudong New Area, urban planning policies, and district government's role, are crucial for the urban transformation and spatial differentiation.



- *1a Historic and current LULC*

Historical- and current LULC are generated for the three time periods of circa 1965, 1985, and 2010 ('current'). Historical (1965 and 1985) LULC for Urumqi and Shanghai are generated from aerial photos and Landsat MSS/TM imagery. To gap fill regions without products or data we are using historical Landsat archives and GLS products (1975, 1990, 2000). We expect to have at least four decadal products for both Urumqi and Shanghai study areas.

<= Fig 2. Landsat 5TM mosaics for generating Urumqi regional urban maps.

For current (2010) LULC, Landsat 5 TM was downloaded from USGS GLOVIS for Urumqi and Shanghai regions for the past five years to create a set of Landsat mosaics (Fig. 2). Imagery was preprocessed and converted from Digital Number to radiance to TOA reflectance to surface reflectance using the COST (Chavez 1997) method and a cross image calibration routine. Mosaics were constructed for the two case study cities and to combine with PALSAR data for generating a set of urban map products (Fig. 3). The primary challenge for this task has been obtaining overpass dates and constructing mosaics for the precise temporal windows we desire. For a few path/rows covering the modeling domains (study areas) the available imagery has some phenological inconsistencies. We are overcoming this obstacle by utilizing a larger temporal window for creating decadal change maps of urban land use/covers in Urumqi and Shanghai.

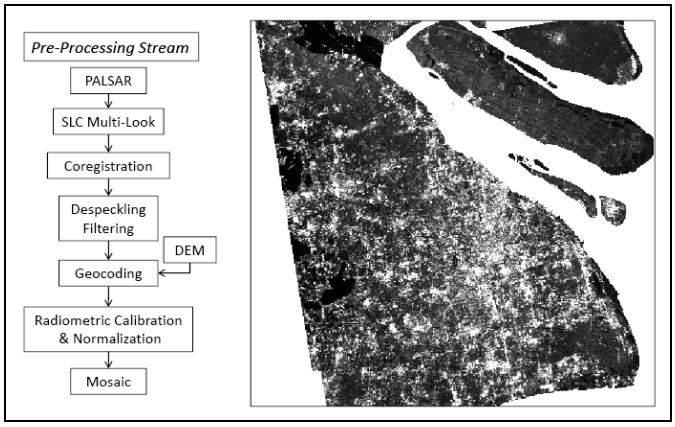


Fig 3. PALSAR SLC preprocessing regime and threshold urban map for Shanghai region urban maps

- *1b Historic and current climate*

Initial simulations of Urumqi and Shanghai areas were configured and initially run for 1-month periods for validation tests. Some aspects of microphysics parameterization were adjusted to improve the model performance, along with replacing NDVI parameters with MODIS data. Initial simulations were conducted with fractional cover reduced by 25%, 50%, 75%, and 100% to estimate the effects of increased grazing on atmospheric conditions. Simulation results were reported in part at the AGU Fall Meeting. **Findings:** We found that grazing pressures, if increased, would not significantly affect wind speeds in Urumqi; this is due to the already very low amount of grazing area available. We also found

relatively small impacts due to reduced vegetation even in the relatively small irrigated areas on the northern slopes of the TianShan range. Some shortcomings of the simulations are that the rainfall and heat fluxes are not accurate enough for model validation, and that the land cover classes (based on MDGLC 2005) may need improved biophysical parameters in the lookup table. The simulations are being re-run with some changes and better results are expected in March or April 2010. **Future Plan**: Specifically, we will also include the MODIS albedo product for the study area, as this is potentially a source of error in the surface energy budget. In addition, given the effects of heavy pollution on incident radiation in Urumqi, we may nudge the model internally with Urumqi radiosonde data.

Objective 2. Simulation of future LULC and regional climate changes, impact of climate change, and adaption and mitigation strategies

- *2a Simulation of current and future LULC*

Current data models for representing geospatial data are decades old and well-developed. Despite their widespread adoption and clear utility for many applications, these traditional models suffer two major flaws. First, they employ a one-size-fits-all approach, in which no connection is made between the characteristics of data and the specific applications that employ the data. Second, they fail to convey adequate information about the gap between the data and the phenomena they represent. We seek to address this by developing a systematic approach to embed spatial data error handling within the modeling process. In contrast to current systems, this framework employs explicit linkages between applications and appropriate uncertainty models by improving stochastic uncertainty models for digital elevation and LULC data. One of the interesting themes from this project is exploring the accumulative role error and uncertainty throughout the spatial LULC modeling process. We plan a series of papers covering this issue.

Activity has centered on the development of a software package to enable rapid and extensive geostatistical simulation and this much has centered on the translation of the simulation process from a suite of disparate software and languages to a single common IDL software package being developed as part of this project. To that end, we translated a series of GSLIB programs from Fortran to IDL. More activities addressing this objective will be conducted in Year 2 as scheduled.

- *2b Regional climate simulation under IPCC scenarios*

Activities addressing this objective will start from Year 2 as scheduled

- *2c Impact of climate change on cities & 2d Adaptation and mitigation strategies*

We will complete most of our data collection on past and current adaptation strategies by March 2010. We are also developing questionnaires for the field trip. Fan meets our local collaborator and interviews some government officials in Shanghai. A special focus has been given to collect data on public health (respiratory disease) and mortality rate related to extreme weathers, energy consumption related to weather change, and urban poor locations. More activities addressing this objective will be conducted in Year 2 as scheduled. For instance, a database of adaptation tools will be built in Year 2.

2. Publications and Presentations/Posters at Conferences

Fan, Peilei and Qi, Jiaguo. 2010. Assessing the sustainability of major cities in China. *Sustainability Science Journal* 5(1): 51-68.

Moore, Nathan. 2009. Simulated Climate Effects of Land Degradation near Urumqi, China. American Geophysical Union Annual Conference. San Francisco. December, 2009.

Yue, Wenze, Fan, Peilei and Qi, Jiaguo. 2009. Spatio-temporal evolution of urban structure in Shanghai. Workshop on Vulnerability and Resilience of Land Systems in Asia. Global Land Project: Beijing, June 15-17, 2009.