Interacting effects of socio-political and environmental factors on rangeland dynamics in the Altai Mountains in Central Asia

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A remarkable opportunity to better understand the social and economic drivers on rangeland change because it presents a homogeneity of culture and ecology (high elevation grasslands sharing the distinctive Altai biota) intersected by a striking geopolitical differences.
Changes after the 1991 USSR Collapse:

China’s Altai Mountain area grazing systems remain similar to those in Mongolia, Kazakhstan and Russia during the Soviet era: carefully planned, heavily subsidized and intensive.

This is in stark contrast to Russia’s and Kazakhstan’s livestock industries, which have dwindled, and Mongolia’s, which have both greatly expanded in response to global markets for cashmere and changed in herd composition.
Examine land-cover change consequences of the collapse of top-down government approaches to managing grazing resources of mountain regions.
Q1: How accurately do satellite data capture vegetation cover in grasslands?
Ground Validation of NDVI-Vegetation Relationship
Both Aqua and Terra VIs for May were highly predictive of July vegetation cover ($R^2 = 0.80 - 0.84$)

We can now:

- Estimate current vegetation on ground using satellite data
- Map rangeland conditions efficiently across entire region
- Predict conditions 1-2 months ahead
Q1: How accurately do satellite data capture vegetation cover in grasslands?

Q2: Do promising new RS classification methods (Deep Learners) offer substantial advantages?
Deep Learners have demonstrated significant advances in multiple fields. What is their added value for RS tasks?

Meta-analysis of 92 studies that offer direct comparisons of Deep NNets vs SVMs
Meta-analysis of 92 studies – Deep NNets vs SVMs

Convolutional Neural Network (CNN), Deep Belief Network (DBN), Stacked AutoEncoder (SAE)
Meta-analysis of 92 studies – Deep NNets vs SVMs

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Convolutional Neural Network (CNN), Deep Belief Network (DBN), Stacked AutoEncoder (SAE)
Effect of Spatial Resolution: Benefits slightly higher for smaller pixel sizes
Effect of Network Complexity: No need to overcomplicate things!

Meta-analysis of 92 studies – Deep NNet vs SVMs
Meta-analysis of 92 studies – Deep NNets vs SVMs

Effect of Spectral Resolution: Limited
Meta-analysis of 92 studies – Deep NNets vs SVMs

Reaching Accuracy Saturation for Hyperspectral Data

Effect of Spectral Resolution: Limited
Meta-analysis of 92 studies – Deep NNets vs SVMs

Deep learners are promising for VHR data

In House >3M reference samples

Collaborations
Αλλαζουμε ταχυτητα
Q3: Can we link Traditional Ecological Knowledge to satellite-derived vegetation indices?
TEK in relation to NDVI
Q4: Can a socioecological model explain vegetation trends?
Interacting effects of socio-political and environmental factors on rangeland dynamics in the Altai Mountains in Central Asia

Data collection complete: 50+ herders interviewed in all four countries

Synthesis now in process
## Herders Survey

Координаты места проведения опроса по GPS:
- Широта: 
- Долгота: 
- Место опроса (долина/урочище): 
- Дата: 
- Кто опрашивал:

### Состояние пастбищ

1. Как Вы оцениваете состояние Ваших летних пастбищ в этом году?
2. Как Вы оцениваете состояние Ваших зимних пастбищ в этом году?

<table>
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<th>Год</th>
<th>Хорошее</th>
<th>Среднее</th>
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3. Какова Ваша оценка состояния Ваших пастбищ в период с 2006 по 2015 гг.?
Analysis Ongoing – Early Results
Perceived impact of management on livelihood

Russia
Mongolia
Kazakhstan
China

Response | don’t know | negative | neutral | positive
----------|-----------|----------|---------|----------
          |           |          |         |          
          |           |          |         |          
          |           |          |         |          
          |           |          |         |          

Proportion

0.00 0.25 0.50 0.75 1.00
Q5: Can we generate a timely, policy-relevant rangeland dynamics monitoring tool?
Altai Vital Signs

Select an indicator
- Productivity
- Land surface temperature
- Precipitation
- Snow

Created by Bradley Cosentino and James Gibbs
“Vital Signs”

- 28 regions
- 4 indicators
- “real-time”
Productivity

Altai Vital Signs: Productivity (NDVI, EVI)

Choose a productivity metric
- NDVI
- EVI

Choose a monitoring unit
4. Katon-Karagnayskiy / Катон-Карагайский

NDVI & EVI are measured on a scale from 0 to 1. Values closer to 1 indicate dense vegetation.

Data source: MODIS/Terra Vegetation Indices, MOD13A1 v6

2019 NDVI time series: u4

Historical mean NDVI
95% of historical observations
Altai Vital Signs: Land surface temperature (LST)

Biweekly land surface temperature relative to historical observations.

Choose a monitoring unit
1. Habahe / 哈巴河

Other information about snow data entered here.

Data source: MODIS/Terra Land Surface Temperature, MOD11A1 v6

2019 LST time series: u1

Last observation began 03/27/19
Precipitation

Altai Vital Signs: Precipitation

Cumulative daily precipitation relative to historical observations.

Choose a monitoring unit

1. Habahé / 哈巴河

Data source: CPC Global Unified Precipitation data provided by NOAA/OAR/ESRL PSD, Boulder, Colorado, USA
Snow Cover

Altai Vital Signs: Snow cover (SNOW)

Maximum snow cover during day periods relative to historical observations.

Choose a monitoring unit
1. Habahe / 哈巴河

Other information about snow data entered here.

2019 SNOW time series:

Proportion snow cover

2019 SNOW
Historical mean SNOW

Month

Data source: MODIS/Terra Snow Cover 8-Day L3 Global 500m Grid, Version 6
Next steps

• Modeling
  – Forecasting NDVI & EVI
  – Finalize Deep Learning classifiers
  – Complete SocioEconomic Model

• Outreach
  – “Lite” version of our web portal for weaker internet connections in region
  – Workshop among stakeholders on tool use in late 2019
Productivity


Web Portal (under construction):
Altai Mountains “Vital Signs” Rangeland Monitoring and Forecasting Tool
https://altai.shinyapps.io/splash/
Questions

Photo credit James Gibbs