Consequences of Institutional Change: Land-Cover Dynamics in Kazakhstan

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Were the institutional changes in Kazakhstan in 1991 of sufficient magnitude to alter the land surface phenology?

Research question:

Given a long image time series with (1) sufficient temporal density to characterize seasonality and (2) the temporal depth to characterize interannual variability, **how do we distinguish among the effects of sensor artifacts, climatic variation, and changes in land cover on land surface phenology? In particular, how could we assess whether the institutional changes in Kazakhstan in the early 1990s may have affected the local and regional water and carbon cycles?**

Goals:

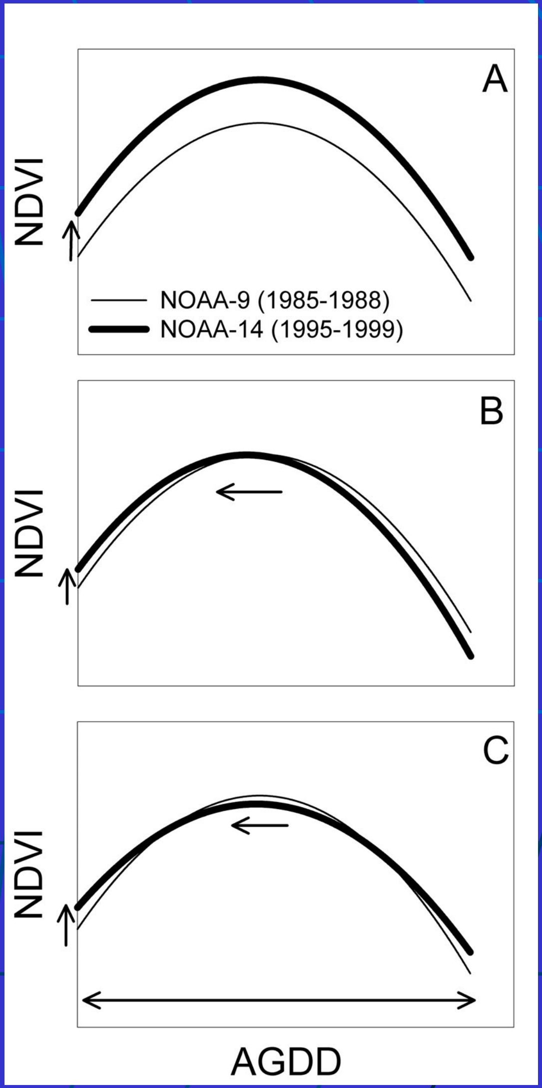
(1) Develop a statistical framework capable of partitioning observed variation captured in long image time series. (2) Determine the magnitude and significance of change in NDVI spatio-temporal pattern before and after 1991.

Approach:

- Identify methods to compare time series between multiple periods.
- Identify methods for trend analysis within periods.
- Estimate and compare phenological models based on growing degree days.

Results

- We established that PAL NDVI from NOAA-9 and NOAA-14 can be compared without confounding sensor noise/artifacts (and that NOAA-11 is significantly different from both 9 & 14).
- We applied the statistical change analysis framework to PAL NDVI time series (NOAA-9 & 14) to two different spatial partitionings:
  - 7 agricultural regions (3768-65942 km^2) within KZ
  - 19 subsets (each 1600 km^2) one in every KZ ecoregion
- Inferred changes in land surface phenology were consistent between partitionings.
- In locations where the land surface phenology changed, we found that it followed one of the three patterns to the right (out of 15 distinct change possibilities).



- Future steps
  - Extend the statistical change analysis framework using Principal Component Analysis eigenvectors and time series of spatial pattern metrics.
  - Improve phenomenological models with other explanatory variables (e.g., precipitation or soil moisture).

Conclusions

- The PAL NDVI global dataset has sufficient spatio-temporal resolution to distinguish between variability and changes in the land surface phenology of Kazakhstan.
- The changes are not primarily attributable to changing climate and there is the potential to link significant changes to socioeconomic factors.
- The institutional change was of sufficient magnitude to alter the land surface phenology and thereby the local and regional water and carbon cycles.
- The statistical change analysis framework provides a powerful quantitative tool to improve the science of LCLUC.
- Wide Dynamic Range Vegetation Index (WDRVI) provides a new tool to enhance sensitivity to vegetation dynamics in moderate-to-high aboveground biomass and which can be applied readily to archived imagery (AVHRR, TM, MSS, ETM+, etc.).

<u>Publications:</u>

- **Gitelson, A. A.** 2004. Wide Dynamic Range Vegetation Index for remote quantification of biophysical characteristics of vegetation. ***Journal of Plant Physiology***, 161:165-173.
- **de Beurs, K.M. and G.M. Henebry**. 2004. Land surface phenology, climatic variation, and institutional change: Analyzing agricultural land cover change in Kazakhstan. ***Remote Sensing of Environment***, in press.
- **Viña, A., G.M. Henebry, and A.A. Gitelson**. 2004. Satellite monitoring of vegetation dynamics: Sensitivity enhancement by the Wide Dynamic Range Vegetation Index. ***Geophysical Research Letters***, in press.
- **de Beurs, K.M. and G.M. Henebry**. 2004. A statistical framework for the analysis of long image time series. ***International Journal of Remote Sensing***, in review.
- **Ratcliffe, I.C., and G.M. Henebry**. 2004. Using DISP data for urban land cover dynamics. ***Photogrammetric Engineering and Remote Sensing***, in prep.