Rises and Falls of the Socioeconomic-Ecological Systems along the Silk Road

*Jiquan Chen[1], Zutao Ouyang[1], Changliang Shao[2], Ranjeet John[1], Geoffrey M Henebry[1], Pavel Groisman[3]

1. Center for Global Changes and Earth Observation, Department of Geography, Environment, and Spatial Sciences, Michigan State University, 2. Institute of Agricultural Resources and Regional Planning, Chinese Academy of Agricultural Sciences, 3. NC State University Research Scholar, NOAA National Centers for Environment Information

Our focus is recent fluctuations in the Socioeconomic-Ecological Systems (SES) within the Asian Dryland Belt (ADB) –a region that contains the ancient Silk Road that was, for centuries, the primary route for migration and cultural exchange across Eurasia, as well as trade between east Asia and Europe. Our study advances sustainability science by including institutions as the essential foundation of the three-pillared SES to understand changes in 22 political entities in 17 countries during 1992-2016 (hereafter MacroSES). The ADB includes three broadly-defined subregions: Middle East, Central Asia, and East Asia. Land degradation and land use conversion have occurred at an alarming rate across the region, with shrublands and savannas showing a high degree of turnover across the ADB. Meanwhile, the long term changes in annual precipitation and temperature showed uneven spatial distributions with the numerous hotspots of drying or wetting trends that do not always correspond with the land use. We calculated the relative values of LEI (life expectancy index) , GDPp (gross domestic production per capita), and GPPp (gross primary production per capita) to represent "EconSys" , "EcoSys" , and "SocSys" , respectively. A new sustainable index (SI) was calculated for the 17 MacroSES within the ADB. The balance of the three systems (EconSys, EcoSys SocSys) exhibits distinct temporal trends over the study period. Changes in relationships among LEI, GDPp, and GPPp show that MacroSESs in East Asia were very directional and dynamic, but more stable for the Central Asian MacroSESs, and more variable for the Middle East. One of the major findings is changes in the SI over the study period were attributable to armed conflicts (Iraq, Afghanistan, and Syria) or to reorientation toward a market-driven economy (Mongolia and China). Nevertheless, the three systems in 1992 are in disequilibrium and tilted in favor of ecosystem function, but during 2001-2016, the MacroSESs appear to move in a direction of equilibrium.

Keywords: Sustainability, Asian Drylands Belt, Socioeconomic-ecological systems