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Project title:
Landscape Dynamics and Landscape Potential for CO2-sequestration in Central Asia- Case study from Kazakhstan.

Abstract:
The current epoch has been characterized by the irreversible massive changes of the biosphere and the awareness of the human society about its responsibility for these changes. Most of these changes are associated with the term "global change" which has rapidly got into the focus of politics and mass-media in the last two decades. The contemporary global change, its possible consequences and prevention steps have been objected by politician, scientists and decision makers at numerous international forums at all levels from the global to local (for instance, the UN Climate Change Conference, 2007). One of the most important components of global change is carbon cycle. Understanding the imperative role of carbon cycle in global change has led to increasing demand on detailed knowledge of carbon sinks and sources as well as their spatial distribution. Drylands cover more than 30% of the earth area and comprise a variety of ecosystems, such as shrublands and grasslands, which are large reservoirs of carbon as well as potential carbon sinks and sources to the atmosphere (Heimann, 2001). The Kyoto protocol clearly affirmed the importance of drylands with regard to their contribution to regional and global carbon cycle (UNFCCC). In Central Asia, where drylands cover about 85% of the total territory, shrubland and grassland carbon sinks represent the major pool for carbon absorption and are believed to offset significant proportion of carbon emissions associated with fossil fuel combustion (Lal, 2004). Thus, monitoring carbon sequestration in drylands of Central Asia is of great interest in relation to understanding the current status of the global carbon cycle and to meeting requirements of the Kyoto Protocol.
Recent studies have shown that carbon sequestration in the terrestrial biosphere has evidence of spatial and temporal changeability (Heimann, 2001; Ichi et al., 2005; Goulden et al., 1996). Variations in the carbon budget of the terrestrial biosphere have a significant impact on the global environment in terms of CO2 concentration and potentially, climate change at the scales from sub-regional to global. Climate is the most important factor affecting both interannual and intraannual dynamics of terrestrial carbon balance (Bousquet et al., 2000; McPherson, 2007; Shaefer et al., 2002). According to the Intergovernmental Panel on Climate Change (IPCC, 2007), the Earth's climate has warmed by 0.7°C over the past 100 years. Thus, increases in spring temperatures following by an earlier start of vegetation growing season are reported to be the main driving force for increase in vegetation photosynthesis in the northern high latitudes of Eurasia and North America (Tucker et al, 2001; Xiao & Moody, 2005; Young & Harris, 2005). In other cases, increase in vegetation growth over the last two decades is controlled by rainfall increase (Chen et al., 2004; Zhou et al., 2001; Tateishi & Ebata, 2004). Schaefer et al. (2002) reported that globally about 44% of interannual variability in net ecosystem production resulted from precipitation, about 16% from temperature and about 12% from soil carbon. Considerable changes in carbon sequestration also result from El Nino-Southern Oscillation (ENSO) events (Anyamba et al, 2001; Gutmann et al, 2000; Bousquet et al., 2000). Human activities represent the major non-climatic factor affecting carbon cycle and changing carbon sequestration in terrestrial ecosystems, which becomes more and more important in the 20th century due to technical progress (Houghton, 1998). Human society has been impacting the carbon cycle in two different ways: (1) through emissions of CO2 into the atmosphere by fossil fuel combustion and (2) through change of land use and land cover (LULCC). Human-caused emissions contributed nearly 7.0 Pg CO2 per year to the atmosphere since the 1980s (Prentice et al., 2001). LULCC commonly results in significant change in carbon sequestration causing losses of carbon, when the land was converted from perennial vegetation to agricultural land. On contrary, when agricultural land is no

longer used for cultivation and natural vegetation is reverting, carbon can accumulate (Post & Kwon, 2000).

The collapse of the Soviet Union in 1991 triggered the most widespread and abrupt episode of LULCC in the 20th century. This political change produced a massive land-use change expressing in a rapid and gigantic decrease of human pressure on the ecosystems occurred throughout the former Soviet Union and its satellite countries. Thus, alone in the former Soviet Union, a large croplands area, up to 20 millions hectares, was abandoned (FAO, 2004). On the abandonment lands, a recovering of grass-dominated vegetation occurred relatively rapidly. This process affected very seriously carbon sequestration in ecosystems and had a significant impact on the global carbon cycle. A carbon sink in the abandoned croplands of the Russian Federation (the largest country in the former Soviet Union, 17.3 millions km²) is estimated of 8 Tg C/year (Vuichard et al., 2009).

However, abandonment of agricultural land was far more massive in the Republic of Kazakhstan, the second area largest country in the former Soviet Union (2.7 millions km²). Thus, the area of cropland in Kazakhstan dropped dramatically from about 15 millions hectares to less than 8 millions hectares, the crop production decreased from about 18 millions tones to 5 millions tones (Figure 1). The stock heads of Kazakhstan reduced from about 50 millions to 11 millions during the period 1991-1998. Obviously, these drastic land use changes caused a rapid environmental change, which has been proofed in recent studies from the region. DeBeurs and Henebry (2004) reported that the institutional change affected the intraannual phenology of grasslands throughout Kazakhstan. Robinson et al. (2002) observed significant rehabilitation of grass-dominated vegetation in wide areas of pasture lands in Central Kazakhstan. Studies by Propastin et al. (2008 a, b) and Propastin (2007) showed evidence of human-induced rehabilitation of vegetation cover in Kazakhstan and other Republics of Central Asia.

A comprehensive analysis of carbon balance in relation to land cover and land use dynamics is a very important issue if we expect to provide credible guidance about effective strategies for adapting to climate change. The story of agricultural land use change occurred in Kazakhstan in the wake of the collapse of the Soviet Union. It is only one of its kind in the whole 20th century. This event is an excellent opportunity to improve our understanding the inter-relationships between carbon balance, climate and land use change in drylands ecosystems. This has been recognized by some authors (Lioubimtseva et al., 2005; Henebry, 2009). However, the changes in carbon balance of Kazakhstan's drylands relating to the institutional change have not been investigated yet.

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Since 2007 ongoing

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