Catena 150 (2017) 100–107

Contents lists available at ScienceDirect

Catena

journal homepage: www.elsevier.com/locate/catena

What is the main cause of grassland degradation? A case study of grassland ecosystem service in the middle-south Inner Mongolia

Zhan Wang [a,b,c], Xiangzheng Deng [a,c,d,*], Wei Song [a], Zhihui Li [a,c,d], Jiancheng Chen [b]

[a] Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, Beijing 100101, China
[b] School of Economics & Management, Beijing Forestry University, Beijing 100083, China
[c] Center for Chinese Agricultural Policy, Chinese Academy of Sciences, Beijing 100101, China
[d] University of Chinese Academy of Sciences, Beijing 10049, China

ARTICLE INFO

Article history:
Received 25 December 2015
Received in revised form 22 September 2016
Accepted 11 November 2016
Available online 15 November 2016

Keywords:
Ecosystem assessment
Ecosystem service
Inner Mongolia
Grassland
Human wellbeing

ABSTRACT

In this study, we analyze the changes of indicators of ecosystem services and functions, in order to understand the main cause of grassland degradation due to climatic variation or land use changes in the middle-south Inner Mongolia. The soil nutrient and the water supply of supporting service got recovery during 1988–2008. The loss of net primary production declined, and the quality of the retained unconverted grassland (RUG) even increasingly degraded from 2000 to 2008. Analytical results show that environmental degradation on the land-use-changed-area is lower than that on the RUG from 2000 to 2008. It illustrates that climatic variation has more negative impacts on grassland ecosystem service, and which is significantly higher than the so-called “overgrazing” induced grassland degradation. Moreover, it cannot be excluded that those species died out on the RUG due to natural selection or competitive evolution in an evolutionary process under the deteriorative weather condition rather than overgrazing. The positive impacts of human activities such as conservation programs and wildlife protection laws also benefit to regional grassland ecosystem obviously in the study area, so that can delay the environmental degradation even if each planet has its life cycle. It indicates that an integrated regional planning involving the considerations of climatic conditions, geographical characteristics, socioeconomic factors, and ecological functions and biodiversity can benefit to regional grassland conservation based on monitoring and management *via* scientific methods.

© 2016 Elsevier B.V. All rights reserved.

1. Introduction

Many researchers believe that reclamation, deforestation, and overgrazing in recent decades have induced global desertification and grassland degradation that endanger to regional ecosystem services and functions severely (Gang et al., 2014). Inner Mongolia grassland is the largest pasture in China. It has been a long history to accommodate Mongolian herdsmen over hundreds of years. It includes the large areas of Khorchin, Ulan Qab, Erdos, Hulun Buir, and Xilin Gol. However, Khorchin, Ulan Qab, and Erdos had lost many high quality pastures (Bai et al., 2010). According to Ministry of Environmental Protection of the PR. of China in 1999 survey report, the percentage of total area of the grassland degradation was about to 31.8% of the total grassland area. From 60's to 80's in the 20th century, the total grassland area sharply declined from 88 million ha to 78 million ha, and continually decreasing to 69 million ha until the end of 90's. Khorchin is one of the typical areas suffering from severe degradation. Their people lost their pasture with the rate at 3.7% in every year. Until 2005, Khorchin had lost 50% of high quality grassland. The similar issue occurred in Hulun Buir. Its degradation area expanded from 15 to 49%. In Xilin Gol of Inner Mongolia, degradation occurred over 74% of pasture land. Moreover, grassland degradation has occurred in all the regions of Ongniud Banner, Uxin Banner, Evenk Autonomous Banner, Sonid Left and Right Banners, East Ujimqin Banner, and Wulate Middle Banner of Inner Mongolia.

Grassland changes are directly influenced by both climatic variation and human activities (Qi et al., 2012). Many researchers also believe that natural hazards due to climate changes have occurred more frequently than before. Inner Mongolia has suffered from droughts for recent several decades (Tachiiri et al., 2008; John et al., 2013). Because the annual precipitation is around 100–400 mm, and 70% of them occurred in June throughout August during the summer time; these droughts with strong winds usually happen in spring, so that surface soil is blown away easily. For example, there are severe windy days at 8– 9 grade over 10 days per year at northwest of Xilin Gol, and over 50 days per year at the north of the Yinshan Mountains, over 40 days

* Corresponding author at: Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, Beijing 100101, China.
E-mail addresses: wangz@igsnrr.ac.cn (Z. Wang), dengxz.ccap@igsnrr.ac.cn (X. Deng), songw@igsnrr.ac.cn (W. Song), lizh.12b@igsnrr.ac.cn (Z. Li), chenjc1963@163.com (J. Chen).

http://dx.doi.org/10.1016/j.catena.2016.11.014
0341-8162/© 2016 Elsevier B.V. All rights reserved.

at Erdos, over 30 days at Hulun Buir, which aggravate desertification spreading out to neighborhoods (Li et al., 2004; Zhao et al., 2006). Moreover, those insect pest attacks are also easily spread out with the wind. Thus, insect pest attacks get pasture worse with the climate changes, and harmed regional biodiversity by breaks of food chain (Ji et al., 2010).

Many researchers also believe that human activities such like overgrazing and urban construction have influenced regional ecosystem services negatively and severely (Seto et al., 2011). As population increases and food structure changes, the increasing demand of meet increasingly drives the number of livestock to be feed by natural grassland (Liu et al., 2008). Consequently, a vicious cycle is gradually formed. Soil nutrient is decreasing; sward soil becomes tight; high quality grassland is degraded; and the net primary productivity is decreasing (Su et al., 2005; Steffens et al., 2008). Especially, for those areas across the border with unclear grassland property rights, farmers prefer to use the "public" area for conserving own grassland resource to minimize the feeding cost (Li et al., 2007). It intensifies overgrazing occurred disorderly, and leads to illegal reclamation. Natural plants are cut for reclaiming grassland but induce soil fertility declines and desertification coming soon (Wilson and MacLeod, 1991). In Hulun Buir, due to overcutting without remaining the belt for rotation, the plant height of Chinese wildrye have decreased from 40 cm to 30 cm, vegetation coverage decreased on average from 284 count cover 60% to 82 count cover 20% per square meter (Wang et al., 2009).

All the above information are pessimistic research results, and we almost believe that grassland degradation due to human activities more significantly than climate changes. However, whether there are some positive impacts of climate changes and positive effects of human activates on grassland in some specific regions, and whether the so-called "overgrazing" have decreasingly impacts on grassland degradation that we have not known yet or have become much severer than that we have known already (Wilson and MacLeod, 1991). In the rest of this paper, we will examine the changes of grassland ecosystem services and functions in the middle-south Inner Mongolia. Based on the reliable remote sensing data and geographical information analysis, we find some interesting positive trends of the changes in grassland ecosystem of the study area.

2. Study area and data

Data sources are from the remote sensing dataset produced by the Chinese Academy of Science (Liu et al., 2002, 2005; Liu and Deng, 2010). During 1988–2008, grassland in Inner Mongolia decreased. However, the growth rate of quality degradation was decreasing. The difference between the conversion of the grassland-to-other-types (GOT) and the other-types-to-grassland (TOG) were decreasing. The net decreases (ND) declined from 7860 km^2 during 1988–2000 to 3002 km^2 during 2000–2008, accounts for the proportion decreasing from 1.46 to 0.57% of the total grassland area in baseline year (BY) respectively. According to physical land use changes at marco-level, we will further reveal the relevant ecosystem service changes in the middle-south Inner Mongolia. See land use changes in Table 1.

Table 1
Comparison analysis of land use changes in the middle-south Inner Mongolia, 1980s–2000s.

Indicators (km^2)	88_00	00_08
Total_88	537,396	–
Total_00	529,536	529,536
Total_08	–	526,534
ND	7860	3002
ND % of BY	1.46	0.57
GOT	17,376	8016
GOT % of BY	3.23	1.51
TOG	9516	5014
TOG % of BY	1.77	0.95

3. Ecosystem service and function changes in the middle-south Inner Mongolia

Ecosystem service research as a hotspot has been discussed for many years. Mainstream researchers incline to use the method of Costanza et al. (1998) and Millennium Ecosystem Assessment Report (MA) (2005) as the benchmarks. They stress the capacity of environment and the statue of degradation in almost everywhere (Zhen and Zhang, 2011). However, their results may overestimate the negative impacts and underestimate the capability of ecosystem itself restoration and human behaviors of conservations in some regions (Zhan et al., 2009; Wang et al., 2011). Thus, in this research, we use a very straightforward method to calculate the performance of the selected ecological indicators (Song et al., 2015). Based on an application of Song et al. (2015) assessment method in the study area, we have selected eight ecological indicators to examine ecosystem services changes in the middle-south Inner Mongolia. We assume close linkages among land use, ecosystem service, and human activities interactively influence to human wellbeing in this region (Liu et al., 2007; Alberti et al., 2011). Hence, the changes of ecological indicators can indicate physical outputs of grassland ecosystem.

3.1. Supporting function of ecosystem service

The net primary production (henceforth NPP) is a representative indicator of supporting function of ecosystem service (Cramer et al., 1999). It is a synthesis of transformation from inorganic substances, water and carbon dioxide into organic substances, which is depending upon sunlight through the process of photosynthesis on most of vegetation, such as forest, grass, and other green plants (Qi et al., 1994). Because regional climatic variables including temperature and precipitation determinate potential evapotranspiration, climatic variables interact to illumination of solar energy during the cohesive process of evapotranspiration and photosynthesis (Zhang et al., 2001). Thus, the performance of ecosystem function in study area can be reflected by values of NPP efficiently. The calculation of NPP contents the techniques of remote sensing data collection and topographic interpretation. In the calculation framework, NPP can be extracted by ground meteorological data and remote sensing data (Zhu et al., 2005). According to our analysis, the changes of spatial distribution of NPP were decreased from northeast toward southwest in the middle-south Inner Mongolia. Their seasonal variations were about 72.7% of the total annual NPP occurred in the three months of June, July and August.

3.1.1. Net primary production

According to our research analysis in the middle-south of Inner Mongolia, the NPP of the RUG dropped 308.8 MT C/a (million ton C/annual) from 1988 to 2000, while NPP increased 296.1 MT C/a from 2000 to 2008, so that in total, a net loss of NPP at 12.69 MT C/a accounts for 4.1% decreased during 1988–2008. There was a loss of NPP about 116.3 thousand ton C/a because of some grassland converted into other types of land, and a small part of other type of land converted into grassland which contributed to a slight increase of the NPP. By comparing the NPP changes of the TOG with the NPP changes of the GOT, we find a net loss of NPP was about 113.1 thousand ton C/a during 1988–2008. However, its number is much lower than the net loss of NPP on the RUG. It demonstrates that the degradation of grassland quality is highly possible driven by uncertain climatic variation rather than undue human activities.

Carbon dioxide (CO_2) is transformed to oxygen (O_2) during the process of photosynthesis, and it is usually supposed that human activities induced grassland conversion can harm this process (Zheng et al., 2008; Shao et al., 2013). During 1988–2008, CO_2 lost 180.4 thousand ton/a due to grassland use changes, while the RUG had a largest portion of deceases of CO_2 accounts for 205.7 thousand ton/a. Furthermore, the conversion of grassland resulted in O_2 loss about 135.6 thousand ton/a,

Download English Version:

https://daneshyari.com/en/article/6407641

Download Persian Version:

https://daneshyari.com/article/6407641

Daneshyari.com