



Research article

Patterns and dynamics of the human appropriation of net primary production and its components in Tibet

Yanjie Zhang ^{a, b, 1}, Ying Pan ^{c, 1}, Xianzhou Zhang ^{a, b, *}, Junxi Wu ^{a, **, 1}, Chengqun Yu ^a,
Meng Li ^{a, b}, Jianshuang Wu ^{a, d}

^a Lhasa Plateau Ecosystem Research Station, Key Laboratory of Ecosystem Network Observation and Modelling, Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, Beijing 100101, China

^b University of Chinese Academy of Sciences, Beijing 100049, China

^c Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, Beijing 100101, China

^d Biodiversity-Ecological Modelling, Institute of Biology, Free University of Berlin, Berlin 14195, Germany



ARTICLE INFO

Article history:

Received 28 September 2017

Received in revised form

9 January 2018

Accepted 12 January 2018

Keywords:

HANPP

Anthropogenic activities

Grassland degradation

Ecosystem management

Tibetan Plateau

ABSTRACT

Anthropogenic activities have induced profound changes across the globe. Human appropriation of net primary production (HANPP) is a useful indicator for quantifying anthropogenic influences on natural ecosystems. We applied a detailed HANPP framework to the Tibet Autonomous Region of China for the period 1989–2015 and performed clustering analysis to explore county-level dynamics of HANPP components. The results indicated a continuous increase in HANPP per unit area from 10.3 g C/m²/yr in 1989 to 18.5 g C/m²/yr in 2008, with some fluctuation and a decline to 16.8 C/m²/yr in 2015. As a percentage of potential net primary production (NPP_{pot}), HANPP increased from 6.9% to 13.5%. This rise was mainly driven by the commercialization of animal husbandry and by ecological conservation policies. Animal stocks dominated HANPP in Tibet in 1989, and by 2015 beef or crop production had become predominant in 30 of 73 counties. However, HANPP did not change uniformly across all locations. Changes were mainly concentrated in the south-central river valley area because of the growth in beef and crop production there. While in almost half of the 73 counties located in the northwestern regions, HANPP was dominated by sheep stocks and changed only slightly over the study period. These findings indicate that a comprehensive spatiotemporal analysis of HANPP components in Tibet provides deeper insights into changes in production and livelihood strategies of local residents, aligned with ecological conservation policies and economic development. Moreover, it unravels the complex impacts of human activities on alpine ecosystems, and indicates the need to optimize local ecosystem management and conservation policies.

© 2018 Elsevier Ltd. All rights reserved.

1. Introduction

In recent decades, humans have significantly altered and continue to transform the planet Earth. Almost 88% of Earth's ice-free land is occupied by settlements, roads, agriculture, and other land-use types (Ellis and Ramankutty, 2008). Given unprecedented

systemic changes, scientists have defined Earth's current human-altered era as a new geological epoch - the Anthropocene (Crutzen, 2002; Ellis, 2011; Steffen et al., 2007).

Net primary production (NPP) is a critical limiting resource for all heterotrophs, including humans. There are concerns that human consumption of NPP may well reach the planetary boundary over the next few decades (Running, 2012). Human appropriation of net primary production (HANPP) has been increasingly applied as a socioecological indicator to better understand the extent of human domination and modification of ecosystems (Haberl, 1997; Haberl et al., 2007, 2014). HANPP can be defined either through area-specific (HANPP) or consumption-based (eHANPP) approaches (Haberl et al., 2014). The major difference is that eHANPP is embodied in consumed biomass products, regardless of where it

* Corresponding author. Lhasa Plateau Ecosystem Research Station, Key Laboratory of Ecosystem Network Observation and Modelling, Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, Beijing 100101, China.

** Corresponding author.

E-mail addresses: zhangxz@igsnr.ac.cn (X. Zhang), wujx@igsnr.ac.cn (J. Wu).

¹ Equal contribution.

occurs, whereas the HANPP measures human appropriation only within the observed system.

A HANPP framework has been operationalized within empirical studies at various spatial and temporal scales, including the global scale (Haberl et al., 2007; Imhoff et al., 2004; Krausmann et al., 2013), the continental scale (Fetzel et al., 2016; Plutzer et al., 2016); and the national scale such as Austria (Haberl, 1997; Krausmann, 2001), the United Kingdom (Musel, 2009), Hungary (Kohlheb and Krausmann, 2009), Spain (Schwarzlmüller, 2009), the Czech Republic (Vackar and Orlitova, 2011), South Africa (Niedertscheider et al., 2012), Germany (Niedertscheider et al., 2014), Italy (Niedertscheider and Erb, 2014), New Zealand (Fetzel et al., 2014), and China (Chen et al., 2015). These studies have revealed the extent of human modification of ecosystems at many scales. However, fewer studies have been performed at subnational levels (Andersen et al., 2015; Haberl et al., 2004; O'Neill et al., 2007; Pan et al., 2016; Zhang et al., 2015). The same extent of human activities may lead to different degrees of appropriation of NPP within heterogeneous ecosystems. Consequently, more refined studies are needed at subnational levels. Furthermore, most of the above studies focused on total HANPP, or explored HANPP for different land-use/cover types (e.g., forests, cropland, grazing land, and settlement areas). An analysis of more detailed components is crucial for comprehensively examining how NPP is appropriated by humans, underlying minimal changes in land-use types of those areas entailing one dominant land-use type (e.g., grassland).

The Tibet Autonomous Region of China (hereinafter Tibet) is an underdeveloped region exhibiting little land-use change (Liu et al., 2003, 2010), in which grassland is the predominant land-use type (Fig. 1). Tibet covers approximately half of the world's highest plateau—the Tibetan Plateau—which exhibits marked variation in its climate and land-cover characteristics along elevation and latitude gradients. The region is highly sensitive to climate change and anthropogenic activities. There are concerns over increasingly severe environmental issues such as shrinking wetlands and grassland degradation in Tibet (Cao et al., 2013; Fan et al., 2010; Harris, 2010; Qiu, 2007, 2008; Yu et al., 2012). Against this background, we integrated social and ecological data on Tibet into a HANPP

framework and performed a detailed analysis of HANPP components to assess the magnitude and dynamics of human alterations of ecosystems. We aimed first to acquire deeper insights into relations between socioeconomic development and human interference in ecosystems in this high alpine region and, second, to explore their implications for optimizing local ecosystem management and conservation policies.

2. Material and methods

2.1. Study area

Tibet covers an area of 1.23 million km², accounting for nearly 13% of the total land area of China, and its average elevation is above 4000 m. Tibet comprises three distinct regions: a river valley area in south-central Tibet covered with grassland and shrubs; a mountainous area in southeastern part of the plateau with forests, distinguished by high mountain ranges; and the plateau area, encompassing the vast northwestern plateau at high elevations, comprises alpine grassland, meadows and deserts (mostly above 4500 m). The climate is extremely variable from southeast to northwest, with annual precipitation decreasing from around 2500 mm in forests to 50 mm in alpine deserts. Mean annual temperature ranges from 8 °C in the southeast to below 0 °C in northern Tibet. Atmospheric oxygen levels mostly range between 60% and 70% of sea level content, posing considerable challenges for human habitation.

According to the national population census, the total population in Tibet was 3 million in 2010. Lhasa is the most densely populated area with over 400 persons/km², whereas the population density for the rest of Tibet is less than 5 persons/km² (Fig. S1). The traditional Tibetan economy is dominated by subsistence agriculture, with animal husbandry based on cattle, yaks, sheep, and goats being the primary occupation. Crop production, mainly of highland barley, wheat, and rapeseeds, is concentrated in the river valley area. According to data obtained from the Tibet Statistical Yearbook, the growth rate of the economy in Tibet has remained above 10% in recent years. In 2015, the gross domestic product

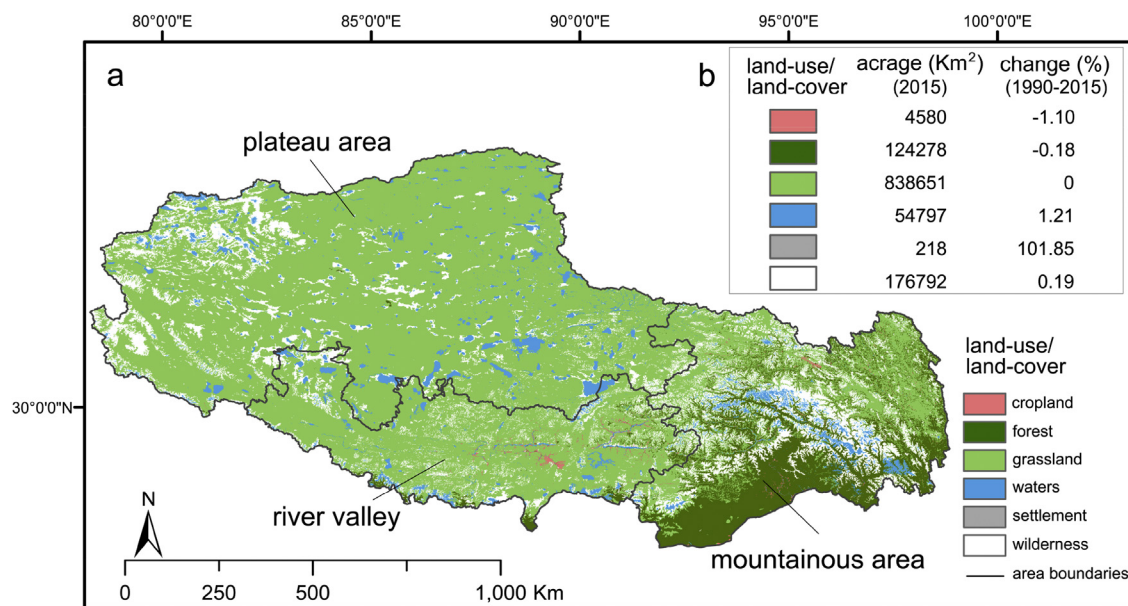


Fig. 1. (a) Land-use/cover in 2015; (b) Land-use/cover change from 1990 to 2015 in Tibet. (Source: Data Center for Resources and Environmental Sciences, Chinese Academy of Sciences, <http://www.resdc.cn/>).

Download English Version:

<https://daneshyari.com/en/article/7478305>

Download Persian Version:

<https://daneshyari.com/article/7478305>

[Daneshyari.com](https://daneshyari.com)