

# Integrating ecosystem services and human well-being into management practices: Insights from a mountain-basin area, China



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## ABSTRACT

The integration of ecosystem services and human well-being into local management and planning remains a challenge in mountain-basin areas. We described the spatial distribution of 8 ecosystem services and analyzed tradeoffs and synergies among them in 2005–2015 based on spatial data and statistical data. Using data from a questionnaire survey, we identified the perception of ecosystem services and assessed subjective well-being. We integrated ecosystem services and subjective well-being using a cluster analysis across townships in the Huailai mountain-basin area, located in a farming-pastoral area of China. Within the mountain-basin area, regulating services (carbon sequestration and soil retention), habitat quality and forest recreation were most represented in mountain areas, which had low levels of well-being. High provisioning services generally coincided with high well-being. From the perspectives of stakeholders, two provisioning services (crop and fruit) were perceived as important to well-being but not vulnerable, and four services (soil fertility, nature appreciation, carbon sequestration and fresh water) were critical. Five indicators in well-being (housing conditions, the public health system, natural hazard control, educational freedom and job freedom) were identified as important but not satisfied. Based on our findings, we developed a framework for integrating ecosystem services and human well-being into management practices.

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## 1. Introduction

Ecosystem services and human well-being have emerged as a powerful bridge between human society and the natural environment and have attracted much attention (Bennett et al., 2015; Swallow et al., 2009). Integrating ecosystem services and human well-being into sustainable spatial management is a new approach to researchers, managers and decision makers (Butler et al., 2013; Felipe-Lucia and Comín, 2015; Rabe et al., 2016). The Millennium Ecosystem Assessment (MA) gave the world its first insight into the relationships between ecosystem services and human well-being. However, it only proposed a conceptual framework and is focused on the global scale (MA, 2005). As the linkage between

ecosystem services and human well-being should occur at smaller spatial scales, more empirical studies, particularly of local areas, need to be conducted to verify and enrich the relational framework (Delgado and Marín, 2016; Duraipappah, 2011).

During the past decade, there have been efforts to study ecosystem services assessment and the synergies and tradeoffs of multiple ecosystem services to integrate them into land management and policies (Ma et al., 2016; Nelson et al., 2009; Raudsepp-Hearne et al., 2010; Yao et al., 2016; Zheng et al., 2016). Meanwhile, human well-being is increasingly linking to ecosystem services (Balmford and Bond, 2005; Butler and Oluoch-Kosura, 2006; Delgado and Marín, 2016; Fagerholm et al., 2016). However, most of previous studies have generally focused on the economic well-being or objective well-being (Hamann et al., 2016; Hossain et al., 2017; Hou et al., 2014). We still lack the linkages between subjective well-being and ecosystem services (Bryce et al., 2016; Yang et al., 2013). In addition, some efforts have been made to unravel the linkages between ecosystem services and human well-being and elucidate their implications for decision-making processes (Ciftcioglu, 2017; Terrado et al., 2016). Yet, an integrated approach to connecting ecosystem services and multiple domains

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of subjective well-being to come to practical application is not common in practice (Abunge et al., 2013; Bennett et al., 2015). Ecosystem services is the product generated by natural ecosystem, processes and human activities (Fischer and Eastwood, 2016); people's freedom and choice in living their lives is considered to be of ultimate importance and is the heart of the MA Framework (Abunge et al., 2013; Sen, 1999). Thus, combined biophysical and socio-cultural approaches to identifying and managing ecosystem services are critical in order to avoid mistakes caused by lacking social demands and to successfully link ecosystem services with human well-being (Garrido et al., 2017; Martín-López et al., 2012; Mensah et al., 2017). While perceptions and preferences of stakeholders is a prerequisite for effective assessments of ecosystem services and human well-being at the operational level, we have too little empirical understanding about the perception of ecosystem services and well-being (Bennett et al., 2015; Casado-Arzuaga et al., 2013; Daw et al., 2011).

In recent years, the assessment and mapping of ecosystem services and human well-being have been widely applied to watersheds (Delgado and Marín, 2016; Iniesta-Arandia et al., 2014; Qiu and Turner, 2013; Simonit and Perrings, 2013; Yao et al., 2016), while other geographical areas, especially mountain-basin systems, have received limited attention (Fu et al., 2015; Xu et al., 2016). The mountain-basin system (MBS), defined by Zhang (2001), features alternating mountains and basins in a multi-functional landscape. The Huailai mountain-basin system is close to China's capital city of Beijing and is located upwind of Beijing. In the context of planning for the collaborative Development of Beijing, Tianjin and Hebei released by the Chinese government, Huailai County is assuming responsibility for the critical ecological support of Beijing (Chen et al., 2016). Here, there are three chal-

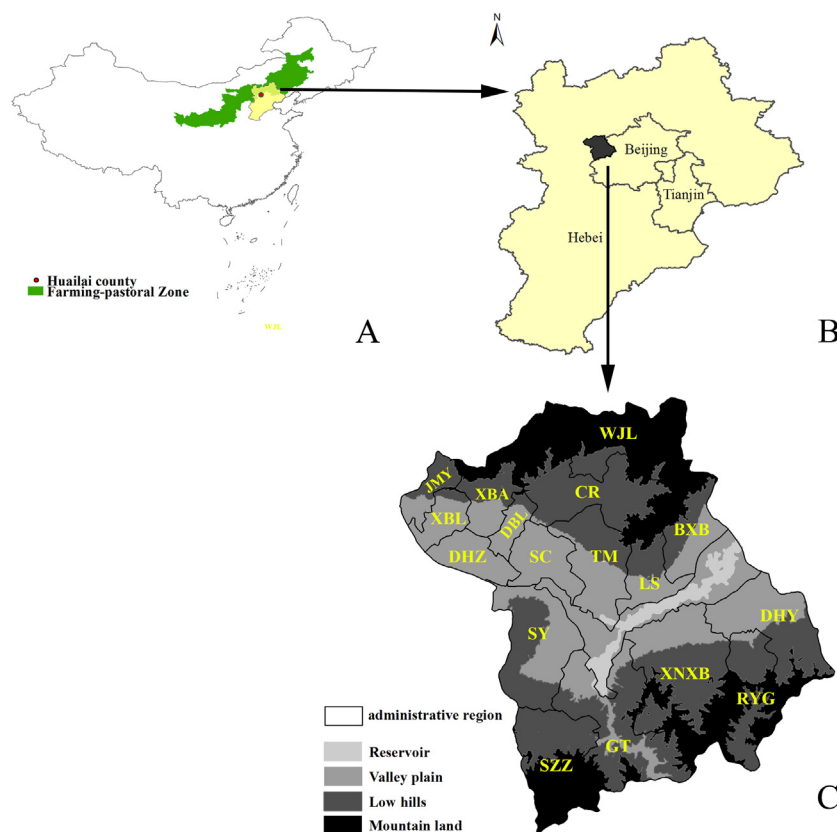
lenges to address in management: (1) ecological conservation, (2) agricultural development, and (3) improvement of well-being.

To address these challenges, we analyzed the spatial distribution of ecosystem services and tradeoffs and synergies between pairs of ecosystem services. We identified the vulnerability and importance of ecosystem services and assessed subjective well-being through questionnaires. Lastly, we link ecosystem services and human well-being in the Huailai mountain-basin spatial management. We summarized a framework based on our findings to describe the approaches that integrate ecosystem services and subjective well-being into management practices.

## 2. Methods

### 2.1. Study area

We selected the Huailai mountain-basin in a farming-pastoral area, located approximately 100 km northwest of the capital Beijing (Fig. 1). The mean annual temperature is 9.2 °C and the average annual precipitation is 383 mm, and 70% of the rainfall occurs during June to August. The region has a complex topography and is located between 394 and 1978 m above sea level, with the Guanting Reservoir in the middle. Of the total size of the study area (approximately 178701 ha), 37% of the land is under agricultural use (including 20% orchard and 17% farmland); 24% is covered by forest; and 4% is water. A paradigm has been proposed by Tang and Zhang (2003) in the context of the landscape's characteristics, which includes three layers and five functional regions: mountain land (a mountain region for ecological conservation), low hills (a hilly region for pastures and raising livestock), and the intermountain basin (a reservoir and economically efficient region in



**Fig. 1.** Location of (A) Farming pastoral zone and the Beijing-Tianjin-Hebei region in China; (B) Huailai county in the Beijing-Tianjin-Hebei region; (C) Huailai mountain-basin area, capital letters in Huailai county are designed to represent abbreviation of towns.

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