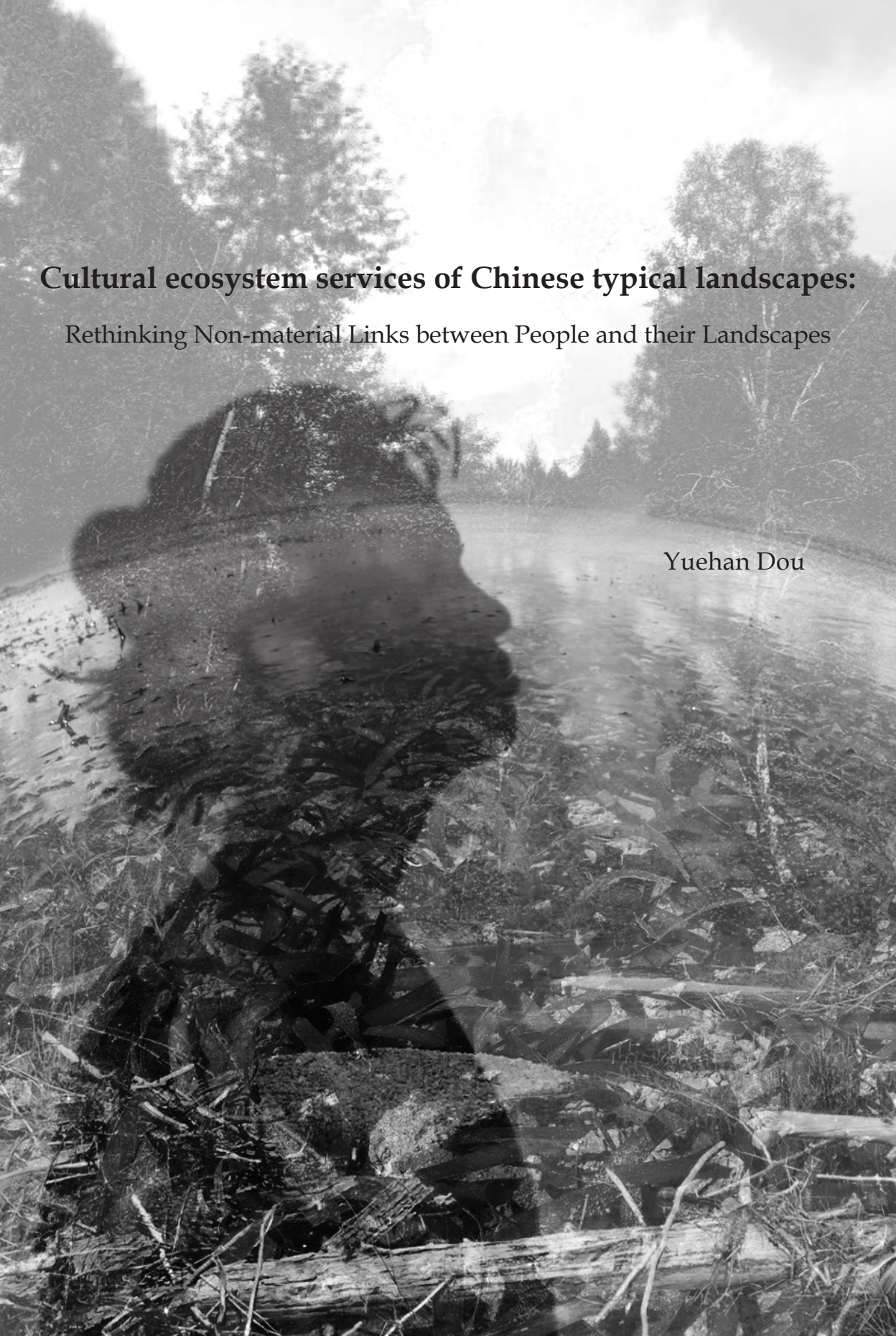

Cultural ecosystem services of Chinese typical landscapes:

Rethinking Non-material Links between People and their Landscapes

Yuehan Dou

Propositions

1. The habitat quality of human species are overlooked in ecological restoration projects.

(this thesis)

2. The influence of demographic factors on the perception of cultural ecosystem services is investigable but not predictable.

(this thesis)

3. Participatory planning with a non-representative set of stakeholders is worse than no participation at all.

4. Rural revitalization strategies need to be customized for the cultural identity of rural communities.

5. Scientific researchers can never be neutral as long as they have research intentions.

6. Speaking Mandarin is to no avail when conducting surveys in China's rural communities.

7. Easy-to-measure indicators for cultural ecosystem services such as "presence of tourists" do not reflect what is important to local inhabitants.

Propositions belonging to the thesis, entitled

Cultural ecosystem services of Chinese typical landscapes: Rethinking Non-material Links between People and their Landscapes

Yuehan Dou

Wageningen, 8 September 2020

Cultural ecosystem services of Chinese typical landscapes:

Rethinking Non-material Links between People and their Landscapes

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Cultural ecosystem services of Chinese typical landscapes:

Rethinking Non-material Links between People and their Landscapes

Yuehan Dou

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Contents

Millet
(Dry land product in Yanán China)

Chapter 1

General Introduction

1.1 Background

Maintaining and enhancing landscapes' beneficial contributions to a good quality of life is a major challenge of our time (Díaz et al., 2018). For centuries, researchers − from philosophers to engineers − have tried to characterize the complex, dynamic relationships between humans and landscapes (Gould et al., 2015; Haines-Young and Potschin, 2009; Kaplan and Kaplan, 1989; Schama, 1995). Landscapes have been and are being changed by processes such as urbanization and economic development. In response to ecosystem degradation from rapid economic development, China began investing heavily in protecting and restoring ecosystems since 1990s (Ouyang et al., 2016). In addition to the economic development, ecological restoration and conservation may also sharply change the landscapes, and these changes may − just like the changes brought about by urbanization and industrialization − affect the ways in which people interact with their landscapes (Dou et al., 2019).

Aided by ecologists and economists, the concept of Ecosystem Services (ES) has been widely adopted by scientists and policymakers as a framework to assess the consequences of landscape interventions, not only on provisioning services (food, fibre and fuel production), but also on regulating, supporting, and cultural ecosystem services (Collins et al., 2011; Costanza et al., 2014). Cultural ecosystem services (CES) are probably the least tangible of all ecosystem services, and have therefore remained relatively unexplored by scientists for a long time (Fish et al., 2016b). CES refer to the benefits people receive from ecosystems in the form of spiritual, religious, recreational, inspirational and educational experiences (Russell et al., 2013; Seppelt et al., 2011), and can be considered as the non-material links between people and ecosystems (De Groot et al., 2002). More recently, CES started to receive more attention and over the past decade it developed into a vibrant research field, influenced policy discourse, and advanced the sustainability agenda (Díaz et al., 2018; MA, 2005; Sagie et al., 2013).

The integration of CES into landscape planning and management remains a challenge (Bryce et al., 2016). While CES are greatly valued by diverse stakeholders, CES provided by a landscape are notoriously difficult to evaluate due to the difficulties associated with defining, articulating and measuring (Chan et al., 2011b; Kumar and Kumar, 2008; Plieninger et al., 2013b). Since they are so difficult to evaluate, policy makers tend to sacrifice them in favour of economic and ecological targets (Braat and De Groot, 2012; Chan et al., 2011a; De Groot et al., 2006). As a result, ecological restoration and conservation projects have been dominated by ecology and economy driven approaches, and are in need of more holistic approaches incorporating the impact of ecological restoration on human perceptions of CES (Cao, 2010; Du et al., 2018; Higgs, 1997; König et al., 2014a; Zhen et al., 2010b). More attention is needed for CES as an indicator of the potential non-material consequences of ecological restoration measures (Berkel et al., 2018; Ridding et al., 2018).

1.2 Problem statement

To inform decision-making for sustainable landscape management, an elicitation of people's concerns associated with their landscapes from socio-cultural perspectives is required (Gould et al., 2015). CES are strongly associated with the ways in which people interact with and gain non-material benefits from their landscape and been intensively studied in recent years (Chan et al., 2011a; Daniel et al., 2012; Groot et al., 2018; De Groot et al., 2002; Kibria et al., 2018). However, approaches of investigating CES tend towards using quantitative variables, such as revenues or visitor numbers (Dou et al., 2017b; Satz et al., 2013; Smukler et al., 2012), or establishing CES appraisal techniques, such as contingent valuation and hedonic pricing (Chen et al., 2017; Van Berkel and Verburg, 2014; Zhen et al., 2014), which have been criticized for voluntary self-exclusion of disciplines, over-valuing tourist-attractive landscapes and neglecting critical social impacts or dynamics (Fish et al., 2016b; Gould et al., 2015; Martín-López et al., 2012; Pleasant et al., 2014).

Moreover, due to the limitation of accessible data and applicable methods, rarely does such research capture the cultural diversity of CES perceived by *local communities* (Berkel et al., 2018; Ridding et al., 2018; Sherrouse et al., 2011). However, ignoring the cultural relations local communities have with the landscapes they inhabit may undermine these communities, in particular when ethnic minorities are concerned (Díaz et al., 2018; Swinton et al., 2007). Such communities often develop unique relationships with landscapes through rich histories of people–landscape interaction and the continuity of culture, and they place a high value on their endowment to future generations (Cuerrier et al., 2007). Understanding the importance local communities (and potential ethnic minorities within the community) place on CES can help ensure that resource governance institutions are appropriately designed and targeted, thereby improving both livelihoods and environmental sustainability (Iniesta-Arandia et al., 2014; Sagie et al., 2013).

In addition, CES have usually been studied in stable ecosystems, and little is known about how CES change under ecological restoration or conservation, especially for large-scale, intensive programs such as Grain for Green (Liu et al., 2016; Lü et al., 2012). In addition to the ecological targets, the changes of CES may be more directly perceived and experienced by residents of the program area, and the changes may be perceived in different ways rather than ecological achievement, particularly for aesthetic services (e.g., appreciation of the beauty of the original or changed landscape), cultural heritage and identity services, spiritual or religious inspiration, and education and scientific opportunities (La Rosa et al., 2016; Langemeyer et al., 2015). Neglecting the local people's relationship with the land in ecological restoration may even evoke sabotage of the restoration project (Cheung and Hui, 2018; Karanth and Nepal, 2012; Sakurai et al., 2016). Consequently, considering the influences of ecological restoration or conservation projects on CES in policy development and decision-making may help local communities adapt to changes or mitigate the possible negative impacts from socio-cultural perspective.

1.3 Research objectives and research questions

In accordance with the above discussed challenges, the objective of my research was to investigate the non-material links between people and landscapes by analysing CES from an interdisciplinary perspective, in four typical Chinese landscapes. This research especially addresses the subjective nature of CES perception and the socio-cultural consequences of ecological restoration and conservation projects through their influence on CES perception. To achieve the objective, the following research questions (RQs) were addressed:

RQ1 What CES are perceived by local inhabitants in selected landscapes of China?

RQ2 How are the perceived CES correlated with the characteristics of the local population (such as gender, age, and ethnicity) in different landscapes?

RQ3 How are the perceived CES influenced by the landscape characteristics in different landscapes?

RQ4 How do ecological restoration and conservation projects influence the perceived CES in different landscapes?

These questions were investigated using a mixture of qualitative and quantitative approaches, applied to a selection of study areas. The results of this research aim to support landscape planning by providing evidence on the interaction between CES of landscapes and local communities (and ethnic minorities), and to support multi-functional and sustainable landscape management by assessing the socio-cultural impacts of ecological restoration and conservation.

1.4 Ecological restoration and conservation projects in China

To conserve natural capital and recover degraded landscapes, the Chinese central government has implemented a series of national programmes and conservation schemes, which sharply changed landscapes (Ouyang et al., 2016). In this research, I investigated the effects of three representative projects/schemes which are described below.

1.4.1 Grain for Green Project

To deal with severe problems related to widespread soil erosion and land degradation and to restore or protect the ecological quality of agricultural landscapes, China's central government initiated a nationwide land retirement

program called “Grain for Green”, also known as the Sloping Land Conversion Program, in 1999. The program's goal is to convert agricultural land on steep slopes and other heavily degraded land to forest or grassland, which is desirable because the steep slopes make access difficult for agricultural equipment, which can increase the risk of damaging the surface vegetation (e.g., due to slipping of wheels caused by a loss of traction), and because this damage and cultivation of the soil (e.g., tilling) expose the fine-grained soil to erosion by wind and water. The ultimate goal is to prevent soil erosion by increasing vegetation cover and reducing the area of exposed soil (Feng et al., 2005; Rozelle, 2005).

The implementation of the Grain for Green project converted over 3000 ha of fragile or degraded cropland to forests or grasslands by 2012, thereby significantly changing land cover and land use in many regions. This is especially true in western China, the region that has the largest area of cultivated sloping land, where the loss of grain resulting from this program was expected to reach 50% (Feng et al., 2005; SFA, 2013). Displaced farmers are given an annual allowance of grain to compensate for their lost farm fields, and are paid a small amount for participating in restoration activities such as tree planting and grassland restoration (Guyuan Bureau of Statistics, 2016b).

1.4.2 Comprehensive grassland restoration

In the course of the previous century, the combination of a harsh climate with a growing grazing pressure led to grassland degradation, which intensified the human-nature conflicts in Inner Mongolia (Xiao et al., 2013). To halt this, a series of policies have been enforced, starting in the nineties, to alleviate the anthropogenic stress at both national and local levels. This was mostly done by top-down

arrangements to enforce sustainable use of the grasslands since 1995 and broadly extended after several years' experience (Du et al., 2018).

The implemented policy and countermeasures to reverse grassland degradation can be summarized as 'Fencing grassland, forbidding grazing and moving users' (Du et al., 2016). Their implementation varied with grassland conditions, and with consideration for the influences on local livelihoods to a great extent through "seasonal grazing", "rotational grazing", "grazing prohibition", "control of livestock rearing" and "herder emigration" (Dong et al., 2007).

1.4.3 National parks system

Beginning in 1956, China has officially recognized 2538 nature reserves of all categories covering over 15% of the land mass of China (over 50% of these areas date since 1995). Effective management of these nature reserves has been difficult and the inappropriate development within protected areas could not be prevented (Zhou and Edward Grumbine, 2011). National parks are included in the Chinese Protected Areas System that aims to improve nature reserves by adjusting the balance between protection and utilization (Ma et al., 2009). The assumption is that national parks adapted to the conditions in China can better serve to protect biodiversity and human livelihoods while allowing for tourism development that would fund conservation management (Wang et al., 2012). Since the first National Forest Park was established in China in 1982 (Zhangjiajie National Forest Park), various types of parks have been established, including National Forest Parks, National Key Scenic Resorts, National Natural Reserves, National Geoparks, National Wetland Parks, National Mining Parks, and National Water Reserve Parks.

1.5 Study area

The research focuses on four typical landscapes in China (grassland, forest, dry agricultural land and wetland), covering three fifth of the Chinese terrestrial area. Five areas were selected as study area, based on their wide geographical distribution, their involvement in restoration or conservation programmes and the diverse ethnic and social-cultural background of their population: Inner Mongolia (North China; forest & wetland landscape and grassland landscape), Ningxia and Shanxi Province (Northwest China; agricultural landscape) and Hainan province (South China; coastal wetland landscape). The areas are all affected by ecological restoration and/or conservation programmes (Figure 1-1).

1.5.1 Guyuan

Guyuan is located in the Ningxia Hui Autonomous Region of northern China. It is a typical semi-arid area of northern China, in the Loess Plateau, which is an area of fine-grained soils that are heavily incised by gullies created by water erosion. The fertile soils have created a farming culture that dates back more than 2000 years to the "ancient Silk Road" period (Xue, 1997). Guyuan has a mixture of land use types (including cultivated land, grassland, and forests) and a mixture of ethnic groups (Han people and Hui people). The climate imposes strong constraints on farming due to both the variable precipitation and so does the undulating topography (Zhen et al., 2010a). Since 1990s, Guyuan has been under the implementation of Grain for Green project.

1.5.2 Genhe

Genhe is located in the north of China, within the provincial boundary of Inner Mongolia, and has a typically cold temperate climate. The study area is around 60 km^2 and mainly consists of forested wetlands, meadow wetlands, bodies of water (lake and seasonal rivers), and bare rock. The study area is also famous for its rich ethic cultures. Five ethnic groups, including three ethnic minorities (Oroqen, Ewenki, Daur, Mongolian, and Han) have lived around the area of Genheyuan National Wetland Park for centuries. The three ethnic minorities have created and maintained rich and precious cultures in the long process of historical development. For instance, the Ewenki people, called the "Chinese last hunting tribe", gradually formed a reindeer culture, a "shaman" culture, and a birch bark culture, all of which are very valuable from ethnological perspective. The Genheyuan National Wetland Park was established in 2011 and attracts over 60 thousand tourists per year (Genhe Tourism Development Association 2018).

1.5.3 Xilin Gol League

Xilin Gol League is located in the central part of Inner Mongolia Autonomous Region of China. It has an annual precipitation of 288mm and annual average temperature of 3.6°C. Inhabitants of this region are challenged by frequent dry spells as well as severe winter weather (Du et al., 2014). The main land cover types are natural grasslands (89.9%) and forests (7.1%). Arable land is sparse, there are several towns and villages, and the remaining area is covered by water bodies and wetlands. It has with a total population of 1,047 million by 2016, of which 35.5% are rural residents. The population mainly consists of Han people (64.2%), followed by Mongolian people (31.3%) and other ethnic minorities (4.5%). From north to south, Xilin Gol is naturally divided into three natural transects characterized by distinguishing topographical characteristics, which differs in both socio-economic

conditions and landscape compositions. All zones are predominantly used for grazing by cattle and sheep and under the implementation of comprehensive grassland restoration projects (Kang et al., 2007).

1.5.4 Wenchang

Wenchang is located in southern China, Hainan province. It has an annual precipitation of 1728 mm and annual average temperature of 23.9°C. The topography of Wenchang is relatively subtle, and landscapes are characterized by villages, open sea, sand beach, mangroves and mudflats. By the end of 2016, Wenchang had 17 towns, with a total population of 558,800, mainly belongs to the ethnic group of Han. Huiwen wetland is in the southeast of Wenchang city. It has no administrative boundary but covers the coastal wetlands from Qinglan Harbor to Fengjia Bay. Huiwen wetland is rich in biodiversity and is considered as an important habitat for mitigatory shorebirds.

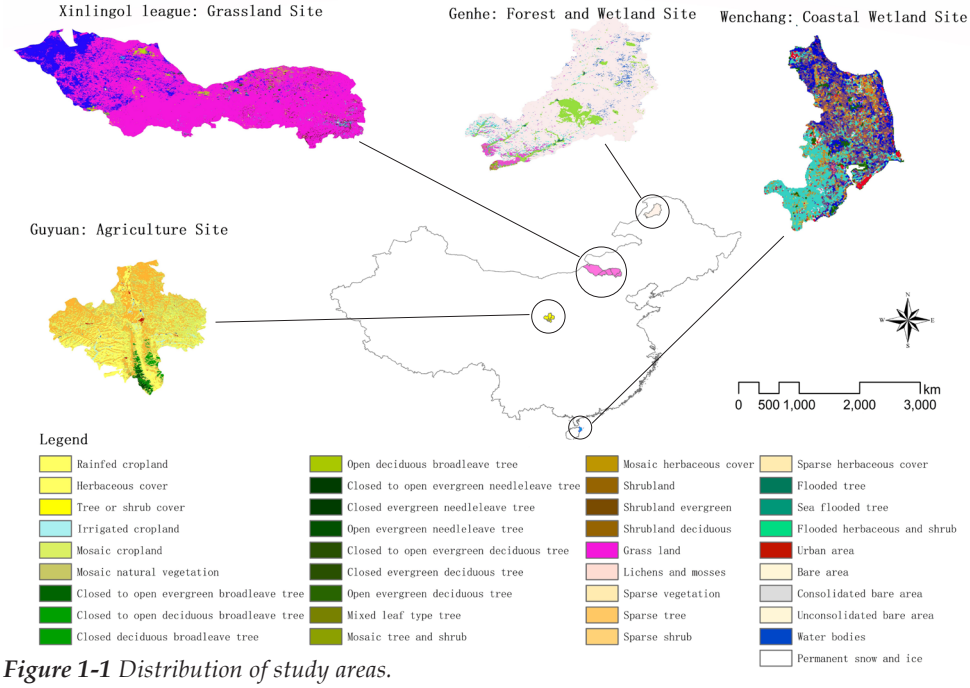


Figure 1-1 *Distribution of study areas.*

1.6 Research concepts and framework

1.6.1 Research concepts

There are many interpretations of CES, such as "a product of natural processes underpinning natural capital as with other ecosystem services" (De Groot et al., 2002), or "services expressed as products of human labour and the outcome of human thought and perception" (Fish et al., 2016b). In this study, I used the definition of Chan et al. (2011) who describe CES as "a co-produced / co-created outcome of peoples' interaction with landscapes". In their definition, CES constitute and reflect the values and histories people share, the cultural practices they engage in, and the landscapes they inhabit (Chan et al., 2012a), rather than the a priori products of nature that people utilize for a particular benefit to well-being (Fish et al., 2016b). In accordance with the definition, I generally followed the terminology and classification of CES suggested by Millennium Ecosystem Assessment (2005), but also incorporated indicator descriptions used in other studies references to present the various CES categories in a way that could be easily understood. The classification and indicator statements are shown in Table 1-1.

Table 1-1 *Selected CES and their indicator statements / descriptions used in this study.*

CES	Potential indicator statements / descriptions
Physical and mental health	Visiting these places gives me a sense of freedom. (Tratalos et al., 2016) Visiting these places leaves me feeling healthier. (Bryce et al., 2016)
Recreational services	I like spending leisure time in these places. (Dou et al., 2017a; Hernández-Morcillo et al., 2013) I do walking, hiking, walking dogs … etc. in these places. (Dou et al., 2017a)
Aesthetic services	I have felt touched by the beauty of these places. (Church et al., 2014)
Inspirations	These places inspire me (such as art, folklore, national symbols, architecture, and advertising). (Chan et al., 2011a; Chan et al., 2012b) I gain perspectives on life during my visits to these places. (Dallimer et al., 2012)

Education and science	Visiting these places has made me learn more about nature. (Bryce et al., 2016) I feel these places provide the basis for education and science. (Hernández-Morcillo et al., 2013)
Religious and spiritual services	At these places, I feel part of something that is greater than me. (Chan et al., 2012a; Chan et al., 2012b) At these places, I feel more connected to my religion or beliefs.
Cultural heritage	These places have additional value because of its historical meanings. (Tengberg et al., 2012) I feel like I can contribute to protect special species, features, skills or knowledge of these places. (Bryce et al., 2016; Tengberg et al., 2012)
Sense of place	I feel a sense of belonging in these places.(Tengberg et al., 2012) I have had a lot of memorable experiences at these places.(Buchel and Frantzeskaki, 2015; Tengberg et al., 2012)
Social relations	I have made strong bonds with others through visiting these places. (Bryce et al., 2016) I miss these places when I have been away from them for a long time. (Chan et al., 2012a)

1.6.2 Conceptual framework and research design

The above interpretation of CES is consistent with the conceptual framework of the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES), which stresses the need to incorporate an analysis of relational terms on which values in and through landscapes are constructed, besides a consideration of benefits that people gain from landscapes to enhance their quality of life (Díaz et al., 2015). From this definition arises that emphasis in this research is on humanities in CES (such as relations between people's characteristics and perceived CES) to strengthen the integration of human-cultural perspective for landscape development, and also on a geographical understanding of CES, which is suggested as a powerful framework for researchers and decision makers to understand the cultural value and significance of landscapes in material terms (Chan et al., 2012b; Fish et al., 2016a).

Therefore, I adopted the CES conceptual framework by Fish et al. (2016) (Figure 1-2). Furthermore, I focused on interactions between landscapes and *local inhabitants* (Chan et al., 2011a; Tratalos et al., 2016), in line with the objective of this research. Since I followed Chan et al.'s definition of CES, who consider CES as a co-product of peoples' interaction with landscapes rather than a particular benefit, I directly used the perception of CES (including their perceived appreciation) rather than the two components (cultural benefits and cultural goods) proposed by Fish et al. (2016). Based on previous studies of the nonmaterial aspects of people-landscape relationships in the scientific domains of environmental psychology, landscape architecture, anthropology, and sociology, although not under the CES label (Daniel et al., 2012; Kaplan and Kaplan, 1989; Russell et al., 2013; Sagie et al., 2013; Schama, 1995; Westerink et al., 2017), I also added the inter-correlations among the selected people's characteristics.

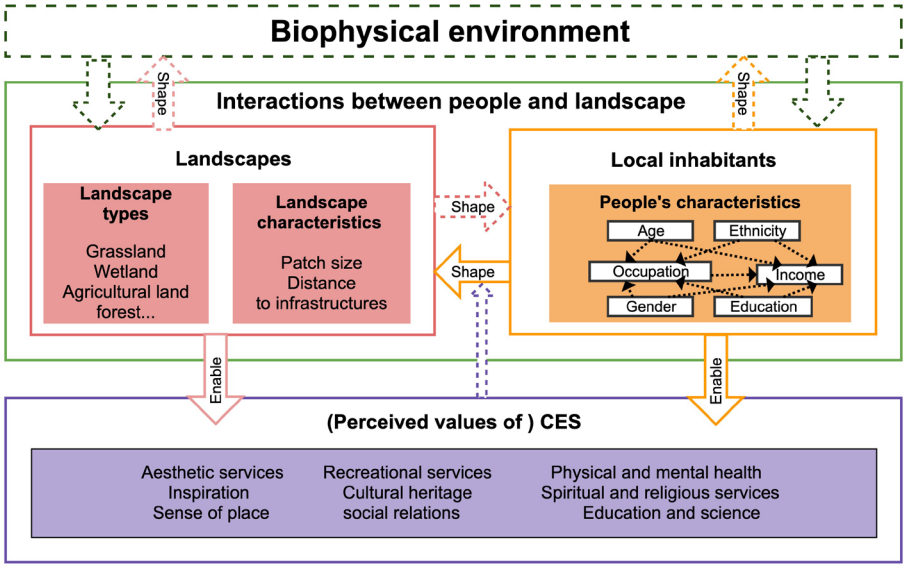


Figure 1-2 *Conceptual framework adapted from UK BEA Follow-on CES framework (Fish et al., 2016b).*

1.7 Methods

The approach conducted in this study includes a suite of semi-quantitative methods which incorporate perception survey data into quantitative assessment methods to bridge the gap between CES and other ES assessment.

1.7.1 Data collection and field work

Since this study focuses on people's perceptions, the data were gathered by questionnaires survey or semi-structured interviews depending on the local context, as well as participatory mapping and field observations to further diagnose CES appraisal and their spatial distribution.

Five field investigations were done during a 20-month period, along with four different project activities, from March 2017 to January 2019. All the surveys were carried out in the selected study areas, supported by literature review and local experts' opinions. Most of the surveys were done in households for the interviewee's convenience, at different times in the morning, at lunch time, in the afternoon, and in the evening.

The field work took place in Guyuan (2017), Genhe (2017), Xilin Gol League (2017), Yan'an (2017) and Wenchang (2018 and 2019) respectively. In total, I straight randomly sampled 1890 respondents from 69 villages (or equal). The field work was conducted with the help of 27 local researchers, scientists and university students. They helped in the different study areas and all of them were skilled in social survey and were trained for background knowledge about this research.

1.7.2 CES identification and correlational analysis (RQ1 &RQ2)

The perceived CES were identified through combined assessments of the beliefs and perceptions of the interviewee's and their reported activities. The responses to the interview questions were used to determine whether the interviewee perceived each CES and to collect the value they assigned to their perceptions. Six basic characteristics (age, gender, ethnicity, ethnicity, income, occupation and education level) were used in analysing the correlation between people's characteristics and CES perception. To test for significant relationships between respondents' characteristics and the presence/absence (yes / no) and perceived values of each CES, chi-square tables and Cramer's *V* coefficient were used to test for the strength of the relationships. Depending on the quality of survey-collected data, I used Structural Equation Modelling (SEM) to further explore the relationships between multiple factors in the present system based on prior knowledge of their causal relationships, but also to differentiate in relationship intensity between each factor (path coefficient) (Rosseel, 2012). This allows to both evaluate the model structure (the pattern of relationships among variables) and to test these relationships using field data (Sutton-Grier et al., 2010).

1.7.3 Analysis of the influence of landscapes on CES perception (RQ3&4)

Depending on the data availability and the different conditions of the selected landscapes, two different methods were used to assess the relationship between landscapes and the perception of CES. Equation 1 was used to calculate the importance of landscapes for the perceived provision of CES in Guyuan, where land cover data was available. For the other study areas the land cover was layered

and the landscape features were mixed, and here a CES Diversity Index was used to overcome the data limitation.

1.7.4 Intervention analysis (RQ3&4)

Intervention analysis was used as a systematic method to further investigate how people interact with external interventions through their stated perceptions. For the conservation-oriented interventions such as ecological restoration and national park scheme, the analysis was combined with the previous methods. For local economic interventions, we applied Random Forest method to identify the influence of local related infrastructures on the perception of CES. Random Forest (RF) is an ensemble machine learning method for classification and regression, developed by Leo Breiman in 2001 (Breiman, 2001), which consists of a number of decision trees with decision nodes. The CES perception was predicted with predictor variables using Random Forest package in R 3.6.1 (Wright and Ziegler, 2015).

1.8 Outline of the thesis

To address the research objective and research questions, all the analyses were implemented following the same framework (Figure 1-2) but intentionally differentiated among the study areas to reflect and compare the influences of different landscapes and external interventions on CES perception. After the "General introduction" (**Chapter 1**), the Chapters 2 to 5 each answer the research questions for a specific landscape / area context. Chapter 6 compares the findings of all study areas. The structure of this thesis and research is summarized in Figure 1-3.

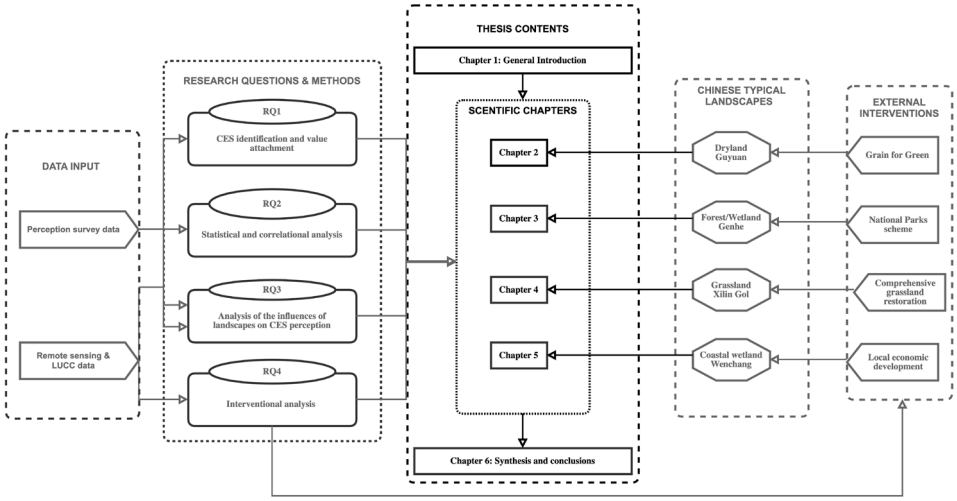


Figure 1-3 *Structure of the research and thesis.*

Chapter 2 addresses the influences of ecological restoration on the perceptions of cultural ecosystem services by residents of agricultural landscapes. Based on the household survey data collected in Guyuan, western China (dry land / agricultural landscape), my co-authors and I discuss the local perception of CES and landscapes. In addition, we assess the influence of changes of landscapes on CES perception by comparing the changes of CES perceptions before and after an ecological restoration project, initiated by the "Grain for Green Project".

Chapter 3 analyses the relationship between cross-cultural perceptions of landscapes and CES. The data was collected in Genheyuan region (forest / wetland), northeast China. In this chapter, the emphasis is on the differences in perception among ethnic groups of the same landscapes. An assessment tool (CES Diversity Index) is proposed to mitigate the limitation of unavailable spatial data. The internal correlations among people's characteristics were analysed through Structural Equation Modelling. My co-authors and I also discuss the impacts of establishing a National Wetland Park, a conservation-oriented project, on CES perception.

Chapter 4 investigates the potential impact of ecological restoration strategies on people-landscape interactions through CES perception. The data was collected in Xilin Gol, northern China (grassland). In line with analysing the influences of landscapes and people's characteristics on CES perception, my co-authors and I took the advantages of its natural transects to analyse how people (from similar population composition) perceive CES from different natural transects (different landscape compositions). The external intervention discussed in this chapter is a comprehensive grassland restoration strategy, which aims at both restoring and conserving grassland according to different degraded levels.

Chapter 5 analyses how coastal landscape characteristics influence the perception of CES. Based on data collected in Huiwen wetland, Wenchang, southern China, my co-authors and I analyse the socio-cultural consequences of local economic development, using factors which may be correlated to CES perception. We used Random Forest Method, to identify the influence of economic-targeted landscape and infrastructure interventions on CES perception.

Chapter 6 provides a general synthesis of the main findings across the different study areas and the key conclusions. The synthesis of the research findings answers the research questions proposed at the beginning of this chapter. The discussion includes a comparison of research findings in different study areas and their limitations. These reflections were also placed in a broader context to elaborate the implications of the research to science and potential contributions to sustainable landscape planning and management.

Abandoned traditional living cave.
(Guyuan China)

Chapter 2

The content of this chapter is based on a published paper: Dou, Yuehan, Lin Zhen, Xiubo Yu, Martha Bakker, Gerrit-Jan Carsjens, and Zhichao Xue. "Assessing the influences of ecological restoration on perceptions of cultural ecosystem services by residents of agricultural landscapes of western China." *Science of the Total Environment* 646 (2019): 685-695.

Assessing the influences of ecological restoration on perceptions of cultural ecosystem services by residents of agricultural landscapes of western China

2.1 Introduction

Agricultural landscapes are key ecosystems that support human livelihoods and well-being. In addition to their main function of producing food, livestock feed, and fibre, they can − if they are well-managed − also play a role in soil and water conservation (Forouzangohar et al., 2014), climate regulation (Anderson-Teixeira et al., 2012), and habitat provision for many species (Burel and Baudry, 2005; Opdam et al., 2015). Moreover, agricultural landscapes have important socioeconomic significance for their roles in food provision and job creation (Chen et al., 2017; Smukler et al., 2012). These functions are especially indispensable in dry-land ecosystems, where more than 2 billion people currently live (UN, 2011). The majority of dry agricultural landscapes are located in developing countries, and 10 to 20% of this land is suffering from one or more forms of land degradation (MEA 2005). Given the significant role of agricultural landscapes in delivering ecosystem services and their ongoing degradation of these landscapes (MEA, 2005), provision of these services is an important area of research and implementation, particularly in the context of ecological restoration programs such as reforestation of abandoned farmland (Barral et al., 2015).

To deal with severe problems related to widespread soil erosion and land degradation and to restore or protect the ecological quality of agricultural landscapes, China's central government initiated a nationwide land retirement program called "Grain for Green", also known as the Sloping Land Conversion Program, in 1999 (Du and Sun, 2011; Jiao et al., 2005; Xu et al., 2010). The program's goal is to convert agricultural land on steep slopes and other heavily degraded land into forest or grassland, and to restore degraded forest and grassland. This conversion is desirable because the steep slopes make access difficult for agricultural equipment, which can increase the risk of damaging the surface vegetation (e.g., due to slipping of wheels caused by a loss of traction), and because this damage and cultivation of the soil (e.g., tilling) expose the fine-grained soil to erosion by wind and water. The ultimate goal is to prevent soil erosion by increasing vegetation cover and reducing the area of exposed soil (Feng et al., 2005; Rozelle, 2005). The implementation of Grain for Green converted 28.67 million ha of fragile or degraded cropland to forests or grasslands by 2012, thereby significantly changing land cover and land use in many regions. This is especially true in western China, the region that has the largest area of cultivated sloping land, where the loss of grain resulting from this program was expected to reach 50% (Feng et al., 2005; SFA, 2013). Displaced farmers are given an annual allowance of grain to compensate for their lost farm fields, and are paid a small amount for participating in restoration activities such as tree planting and grassland restoration (Guyuan Bureau of Statistics, 2016b). However, these benefits were scheduled to decrease and gradually disappear when the program ended in 2015, and were only extended in some parts of the program areas (Xue and Zhen, 2018).

This description shows that the program's intensive conversion of agricultural landscapes will affect more than just ecological restoration; it can also undermine the cultural identity of human inhabitants by dramatically affecting the lifestyle

of residents and their employment opportunities (Cerretelli et al., 2018; Chen et al., 2017; Speldewinde et al., 2015). Because the residents of areas affected by such programs must believe in the value of the programs before they will be willing to participate, it is necessary for program planners and implementers to understand how these residents perceive these changes. This understanding will help the government to evaluate the influence of the changes and mitigate any unsuspected but serious consequences by exploring the experiences of local communities. This knowledge can improve the planning and implementation of an ecological restoration project that is conducted in regions where established agricultural landscapes will change to new land cover types, thereby affecting the culture and livelihoods of the residents (Chen et al., 2017). Researchers in environmental psychology research have found that people observe and value their surroundings for more than just the spatial quality; they also evaluate the changes over time, forms of maintenance, use for sensory experiences, and use options, among other things (Buchel and Frantzeskaki, 2015; Dou et al., 2017b).

Cultural ecosystem services (CES) are strongly associated with the ways in which people interact with and gain benefits from their landscape (Chan et al., 2011a; Daniel et al., 2012; De Groot et al., 2002). CES include aesthetic services (Zanten et al., 2016), recreational services (Martín-López et al., 2012), inspirations for art and design (Chen et al., 2017), cultural heritage (Tengberg et al., 2012), spiritual or religious inspiration (Smukler et al., 2012), and education and scientific opportunities (Arnaiz-Schmitz et al., 2017). In developed countries, CES are highly valued for their therapeutic and recreational benefits (Tielbörger et al., 2010). In contrast, societies in developing countries value CES more for their roles in cultural identity and survival (MEA 2005). However, in contrast to more tangible and commonly used ecosystem services, such as the provisioning of food and drinking water, the intangible and subjective nature of CES makes it challenging to identify

and value them (Chan et al., 2012b; Fish et al., 2016b; Russell et al., 2013; Satz et al., 2013) The integration of CES into the ecosystem services framework therefore remains a challenge due to the difficulties associated with defining, articulating, and measuring CES (Bryce et al., 2016).

Although a number of studies have proposed CES assessment methods (Berkel et al., 2014; Chan et al., 2012a; Dou et al., 2017b; Tengberg et al., 2012), the focus has been on factors that can be easily measured, such as tourism revenues or visitor numbers (Satz et al., 2013). The bias towards such easy-to-measure variables may lead to over-valuation of landscapes that attract tourists, and under-valuation of landscapes that form the daily environment of rural communities, such as agricultural landscapes. Some scientists have used more sophisticated techniques to assess CES appraisal, such as contingent valuation and hedonic pricing (Chen et al., 2017; Zhen et al., 2014), but these methods have been criticized both because they can under- or overestimate "willingness to pay" and because assigning monetary values to vulnerable public goods such as (cultural) ecosystem services is inherently risky (Chan et al., 2012b; Fish et al., 2016b; Pleasant et al., 2014). This risk arises both because the values are highly subjective and because different socioeconomic groups may have greatly different willingness to pay, or equal willingness but different ability to pay.

In addition, CES have usually been studied in stable ecosystems, and little is known about how CES changes under ecological restoration, especially for large-scale, intensive programs such as Grain for Green (Liu et al., 2016; Lü et al., 2012). Under such programs, the changes of CES may be more directly perceived and experienced by residents of the program area, and their benefits may be appreciated in different ways, particularly for aesthetic services (e.g., appreciation of the beauty of the original or changed landscape), cultural heritage and

identity services, spiritual or religious inspiration, and education and scientific opportunities (La Rosa et al., 2016; Langemeyer et al., 2015). Consequently, it is necessary to increase our awareness of and knowledge about the impacts of ecological restoration on the CES of the communities affected by the program to provide support for policy development and decision-making that will mitigate the impacts on these communities.

To help fill the knowledge gap, we designed a study to analyse the influences of Chinese ecological restoration policy on the CES of rural communities. To account for the subjective nature of perceptions of the value of CES, we developed an approach to assess the changes of CES under ecological restoration by identifying how local residents perceive CES and the relationships between these perceptions and the physical changes in their landscape.

2.2 Data and methods

2.2.1 Case study area

The details of study area Guyuan has been introduced in Section 1.5.1 (Figure 2-1). Like most areas of the Loess Plateau, Guyuan has a complex mixture of land use types (including cultivated land, grassland, and forests). The climate imposes strong constraints on farming due to both the variable precipitation and the undulating and often steep topography (Zhen et al., 2010a). Since implementation of the Grain for Green program in 1999, Guyuan City has increased its area of forest and grassland by 3.11×105 ha, of which 1.69×105 ha was provided by conversion of cultivated land to forest or grassland; this accounted for 44.9% of the total crop area (3.76×105 ha) in 2015 (Xue and Zhen, 2018).

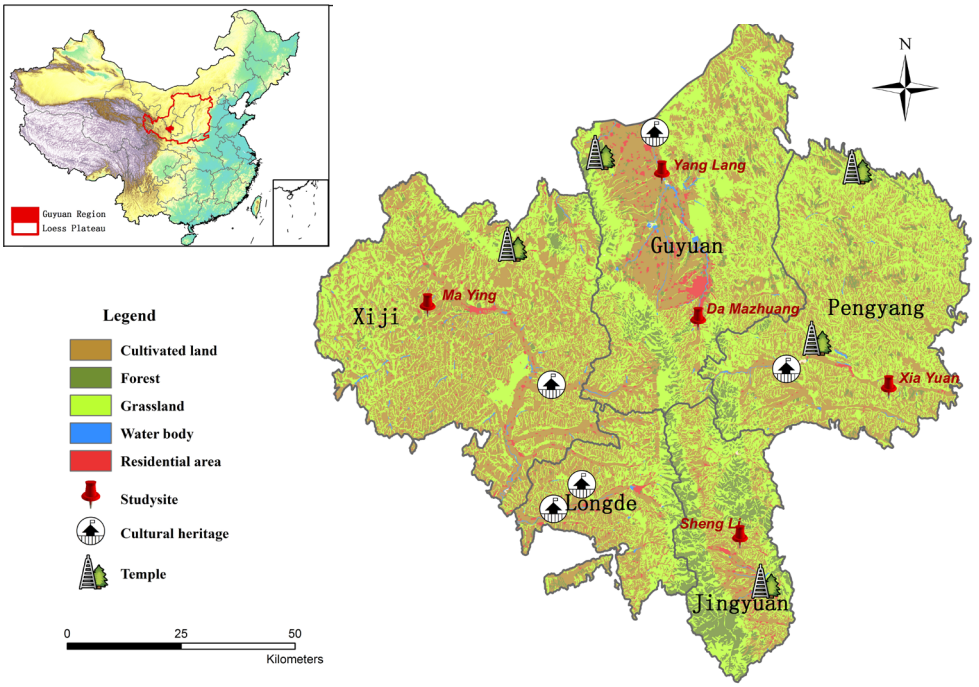


Figure 2-1 *Spatial distribution of the landscape types and locations of the survey sites in Guyuan City.*

Table 2-1 summarizes the proportions of each land use type in 2015. The Grain for Green program has strongly influenced the landscape of Guyuan and the livelihoods and economic conditions of residents (König et al., 2014b). To comprehensively assess the influences of the program, we selected five representative villages to sample in consultation with local experts and conducted interviews with the villagers. The villages are representative of different aspects of the region's landscape conditions: valley plains, loess table land, plateau hills, stony mountains, and peri-urban rural villages. The details of the villages are provided in Appendix 2-1.

Table 2-1 *General Information About the Landscape Composition in Guyuan (2015).*

Landscape type	Proportion of total land area (%)	Area (103 km²)
Cultivated land	44.7	5213.5
Forest	7.4	858.5
Grassland	44.9	5239.7
Water body	0.8	95.2
Residential area	2.2	254.6
Temples, cultural heritage sites, etc.	--	--

2.2.2 Survey design

The data used for this analysis were gathered from semi-structured interviews (i.e., we used our questionnaire to provide structure and consistency between interviews, but also allowed the collection of freely contributed answers that were not a formal part of the questionnaire). The questionnaire was developed and then tested during an expert workshop carried out in the study area in May 2017. The main objective was to collect data on the experiences and perceptions of local residents related to the changes of the landscape after implementation of the Grain for Green program.

To mitigate the potential bias of current memory of recalling the changes during time, we tested the questionnaire ex ante, before using it to collect data, and used follow-up questions, ex post, to clarify any unclear responses during the interviews. It has been demonstrated that this can successfully mitigate and even eliminate bias by using follow-up questions to get people more involved (Whitehead and Cherry, 2007). An ex-ante verification of the semi-structured interview was conducted with local experts and stakeholders in a Framework for Participatory Impact Assessment (FoPIA) workshop (König et al., 2014b; Morris et al., 2011). FoPIA is one popular sustainability assessment method that uses both qualitative knowledge provided by stakeholders and quantitative information obtained by researchers or governments (König et al., 2014b). It is structured around the

driver-pressure-state-impact–response framework (OECD, 1993). In this research, we combined both frameworks in one workshop. We used FoPIA mainly to assess the impact of the new land-use policy on land use functions, including the maintenance of ecosystem processes. The more important approach to support the present CES assessment research was that we organized the participants in the FoPIA to do focus group discussions or test interviews related to our questionnaire. The workshop participants identified a total of eight CES that they believed were relevant to residents of our study area, and reviewed the questionnaire to ensure that it obtained information on their perceptions of these CES. In summary, we asked the experts to fill in the questionnaire from the perspective of a local farmer and to point out places where we should improve and adjust the questions. Based on their feedback, we redesigned and clarified the final interview questions. As a result of this process, we identified eight CES: recreational, aesthetic, cultural heritage, Physical and mental health, education and science, inspiration, sense of place, and religious and spiritual services.

2.2.3 Survey sampling and implementation

We selected potential interviewee's by means of random sampling in the five villages (Figure 2-1). We decided the final sample size (number of households) based on the permanent resident population (i.e., so that the sample size was proportional to the population) and the suggestions of the village managers to obtain a reliable and representative sample. We surveyed households around 50% of the permanent population of each village following the suggestion of Tabachnick and Fidell (Tabachnick and Fidell, 2007) that a sample should be around 50% when the total households of the survey unit group are lower than 100. Only residents who had lived in Guyuan for more than 15 years were included in the interviews because we also followed the suggestion of Mjelde et al. (2012) that increasing familiarity

with a subject will reduce the potential bias. The semi-structured interviews were implemented with the help from three other researchers who were experienced in social surveys. The interviews were conducted in "hotspots" selected based on the results of the FoPIA workshop. The interview included questions related to the interviewee's perception about the local landscape, the changes in the landscape, and their experiences and feelings about the Grain for Green project. In addition, it included questions on their demographic characteristics. The questions used in semi-structured interviews are shown in Appendix 2-2. Table 2-2 summarizes the demographic characteristics of the survey population in the selected areas.

2.2.4 Perception analysis and CES identification

We analysed the interview results using version 22 of the SPSS software (www.ibm.com/analytics/us/en/technology/spss/) and Excel 2010 (www.microsoft.com) to identify significant influences of the demographic characteristics (gender, age, education, and ethnicity) on the perception of CES. Interviews were eliminated from our sample if the interviewee did not answer at least 50% of the questions. We obtained a total of 202 usable responses, ranging from 33 to 49 responses per village, for an overall response rate of 93.1%.

We used the responses to the interview questions to determine whether the interviewee perceived each CES and to quantify the value they assigned to their perceptions. For each CES, the perceived presence of that CES (yes/no) was identified according to the response to our questions. In addition to the presence or absence of a CES, we quantified its strength by assigning numeric values to each statement (e.g., strongly agree = 2). We then calculated the mean perceived value for each CES from these values. Table 2-3 summarizes the rules we used to assign the values. To test for significant relationships between respondent characteristics

(age, gender, ethnicity, and education level) and the presence / absence (yes/no) and perceived values of each CES, 2×2 chi-square tables and Cramer's *V* coefficient was used to test for the strength of the relationships. These methods were chosen because they fit the nominal scale levels that we used.

Table 2-2 *Basic Demographic Information About the Interviewee's in the Five Villages.*

Demographic information		***Proportion of total (%)***
Gender	Male	69
	Female	31
Ethnicity	Han	78.2
	Hui	21.8
Education level	No education	12.9
	Primary school	43.0
	Middle school	25.2
	High school or above	18.9
Age	20-30	16.3
	30-40	12.4
	40-50	31.2
	50-60	14.8
	>60	25.3

Table 2-3 *Assignment Rules for the Presence / Absence and Perceived Values of each Cultural Ecosystem Service (CES).*

Description	**CES presence**	**Assigned value**	**Average value (0 to 2) and the corresponding assigned rank**
(Strongly) Disagree with/have no idea about the statement/have never participated in related activities.	No	0	No value
Agree with the statement/have occasionally participated in related activities.	Yes	1	(0–1) Low value
(Strongly) Agree with the statement/have often participated in related activities.	Yes	2	(1–2) High value

2.2.5 *Importance of landscapes to the perceived provision of CES*

We assessed the importance of landscape for the provision of CES by considering three aspects: (1) the capacity to provide the CES, (2) the potential risk of that capacity decreasing, and (3) the landscape's importance to providing the CES. We used equation 1 to calculate that importance:

$$La = (S_a T_i / A) + \Sigma(T_i n_a / N) + \log(M_a / S_a) \quad \text{Equation 1}$$

Where *La* is the importance of land use *a* (*a* = 1 to 5) to provide a given CES; S_a is the area of land use *a* (from Table 2-1); T_i is the number of CES (*i* = 0 to 8) provided by land use *a*; *A* is the total study area (21.2 × 106 km^2); n_a is the number of interviewee's who believed that CES *i* was provided by land use *a* (defined in Appendix 2-3); *N* is the total number of usable interviews (*N* = 202); and M_a is the mean annual decrease of the area (km^2) of land use a in the past 5 years from 2010 to 2015 (= 0 for an increase in the area).

To better account for the role that landscape plays in perceptions of CES, we incorporated land use data (the proportion of the total area occupied by a certain landscape (Table 2-1) to jointly represent the capacity of providing a CES and the number of different CES perceived by each interviewee. The capacity of providing a CES was determined by the existing land uses in the landscape. The potential risk of the capacity decreasing was represented by the trend of changes in the area of a land use during the past 5 years. We used the mean annual decrease in area during this period as the indicator. The more the area decreased, the higher the potential risk. If the area actually increased, we defined the risk of the capacity decreasing as 0. The capacity of the land use to provide a given CES equalled the mean value (defined in Table 2-3) for all responses, divided into three ranks: no, low, and high values.

We interpreted Landsat TM / ETM data (land use and land cover data 2015, 1 km × 1 km) to distinguish between cultivated land, forest, grassland, bodies of water, grassland, residential areas, and scattered cultural heritage sites such as old temples and traditional residences. We obtained this data from the Environment and Resource Data Centre of the Chinese Academy of Sciences (http://www.resdc.cn/). The spatial distribution of the importance values for the different land uses was visualized using version 10.2 of the ArcGIS software (www.esri.com).

2.3 Results

2.3.1 Survey responses and respondent characteristics

The final sample consisted of 202 semi-structured interviews, for an effective completion rate of 93.1% (Table 2-2). The largest group of interviewee's (31.2%) was 40 to 50 years old, followed by the group who were older than 60 years (25.3%). More men than women participated in the interviews (69% versus 31%, respectively). Responses from Hui participants were much lower than from Han participants (about 25% of the number of Han response). In terms of education, 56% had education equivalent to primary school or below, and only 1% were university graduates.

2.3.2 Perception of cultural ecosystem services

The interviews demonstrated that respondents perceived all eight CES that we proposed. Table 2-4 presents the proportions of the interviewee's who perceived each CES for all demographic groups combined, with values ranging between 56.0% and 98.9% of the total number of interviewee's, and their mean perceived values. Recreational services received the highest score, being recognized by

almost all respondents, closely followed by aesthetic services and cultural heritage. Regardless of the demographic influences, cultural heritage had the highest mean perceived value (1.89), followed by recreational services (1.82) and physical and mental health (1.78). The religious and spiritual value had the lowest perceived value (0.85).

Most of the interviewee's (96.7%) perceived at least six types of CES. No respondent perceived fewer than three types of CES. In general, people in the two middle age groups (30 to 50 years) perceived a wider range of CES than the oldest (> 60 years) and the youngest (20 to 30 years). All of the Hui respondents perceived six to eight types of CES, compared with three to six for Han respondents, and men perceived more diverse CES than women. These findings were consistent in all five villages.

Table 2-4 *Cultural ecosystem services (CES) perceived by local residents for all demographic groups combined, and examples of the interpretations of the meanings of each CES in their life.*

CES	Meaning or relevance (examples)	Proportion of total interviewee's who perceived the CES (%)	Mean perceived value
Recreational services	I like spending leisure time, walking, playing football / basketball, walking my dog, playing with kids, dancing, etc.	98.9	1.82
Aesthetic services	I find the land beautiful, scenic, colourful, etc.	97.8	1.71
Cultural heritage	The land has existed for more than 100 years. I heard it was used by (description) when I was young. The land use is related to the Long March of the Red Army.	97.8	1.89

Physical and mental health	Walking here and breathing the air is good for my health. Being here makes me feel happier. I like to stay here for a while when I have difficult things to think about or when I am upset.	95.6	1.78
Education and science	I learned a lot from the land when I grew up (knowledge of farming, animals, trees, etc.). I think these places should be visited by children and students.	94.5	1.7
Inspiration	I gained inspiration for paintings, photos, architecture, advertising design, etc. I gained a new perspective on life (in touch with others).	85.7	1.52
Sense of place	I feel safest when I stay here. I don't want to leave for other places. This is the most comfortable place for me. I miss this place when I work elsewhere for a long time. I've had many memorable experiences.	85.7	1.55
Religious and spiritual services	I visited these places when I or my family had problems. I feel that I will be lucky when I do something there. I believe I will be blessed when I am here.	56	0.85

2.3.3 The relationships between respondent characteristics and perceptions of CES

Table 2-5 summarizes which sources of variation significantly affected the perception of CES. The respondent's gender significantly affected the perception of Sense of place, Religious and spiritual services, and Physical and mental health. Age significantly affected the Sense of place, Cultural heritage, and Religious and spiritual services. Ethnicity only significantly affected Religious and spiritual

services. Education significantly affected Aesthetic, Cultural heritage, and Religious and spiritual services.

Table 2-5 *Factors That Significantly Affected Perception of Each Cultural Ecosystem Service (CES).*

	Factor that affected CES perception			
	Gender	**Age**	**Ethnicity**	**Education**
Aesthetic services	NS	NS	NS	P = 0.031
Recreational services	NS	NS	NS	NS
Education and science	NS	NS	NS	NS
Inspiration	NS	NS	NS	NS
Sense of place	P = 0.004	P = 0.031	NS	NS
Cultural heritage	NS	P = 0.024	NS	P = 0.004
Religious and spiritual services	P < 0.001	P = 0.002	P = 0.038	P = 0.002
Physical and mental health	P = 0.036	NS	NS	NS

We examined the perceived value of each CES more closely for the significant results shown in Table 2-6. In terms of education, Table 2-6 shows that interviewee's with at least some education perceived *Cultural heritage* as more valuable (a mean grade ≥ 1.82) than interviewee's with no education (a mean grade of 1.67). The Hui people (1.60) perceived more *Religious and spiritual services* value than the Han people (1.33). Male interviewee's attached more value to *Sense of place* (1.73) than female interviewee's (1.10), as well as to *Religious and spiritual services* (male 1.74, female 1.07). In addition, Table 6 shows that the highest weighted mean value of *Sense of place* (1.82) was found in the oldest age group (> 60 years), followed by the 40 to 50 years and 20 to 30 years age groups (1.79 and 1.63, respectively). *Religious and spiritual services* were also valued differently by different age groups. Interestingly, the youngest people (20 to 30 years) and those with the highest education (high school) valued this CES most highly (1.18 and 1.88, respectively). The youngest and oldest groups (20-30 and > 60) valued *Cultural heritage* most (2.0).

Table 2-6 *The Mean Values of Cultural Ecosystem Services (CES) in Different Demographic Groups. Values are based on the Rules Defined in Table 2-3. Only Statistically Significant Values (Table 2-5) are provided.*

Demographic factors		CES value				
		Aesthetic services	**Sense of place**	**Cultural heritage**	**Religious and spiritual services**	**Physical and mental health**
Age	20-30		1.63	2.00	1.18	
	30-40		1.23	1.94	0.62	
	40-50		1.79	1.81	1.14	
	50-60		1.18	1.83	0.41	
	Above 60		1.82	2.00	0.88	
Gender	Male		1.73		1.74	1.80
	Female		1.10		1.07	1.73
Ethnicity	Han				1.33	
	Hui				1.60	
Education	No education experience	1.43		1.67	1.33	
	Primary school	1.74		1.97	1.54	
	Middle school	1.78		1.91	1.43	
	High school or above	1.47		1.82	1.88	

2.3.4 *Perception of CES after implementing the Grain for Green program*

Figure 2-2 shows the perceived changes of CES after reforestation under Grain for Green. In general, the perceived values of *Physical and mental health*, *Religious and spiritual*, and *Cultural heritage services* were perceived as having decreased. Most of the interviewee's believed that *Religious and spiritual service* (70.8%) and *Physical and mental health* (18.5%) values decreased, and more than half (56.5%)

also believed that the *Cultural heritage* value had decreased. The proportion of people who perceived *Sense of place* as having decreased was slightly higher (by 2.3%) than the proportion who perceived it as having increased, but 8% believed that the Grain for Green program did not affect *Sense of place*.

In contrast, *Aesthetic*, *Recreational*, *Inspiration*, and *Education and science services* were perceived as having increased in value after the implementation of Grain for Green. Most of the interviewee's (86.9%) believed that the *Aesthetic service* value increased, which was slightly higher than the proportions for *Recreation* (71.5%), *Education and science* (86.1%), and *Inspiration* (61.6%%). *Education and science* was perceived by largest group of interviewee's (25%, and almost two times the next highest value of 13.8% for *Inspiration*) as showing no significant change.

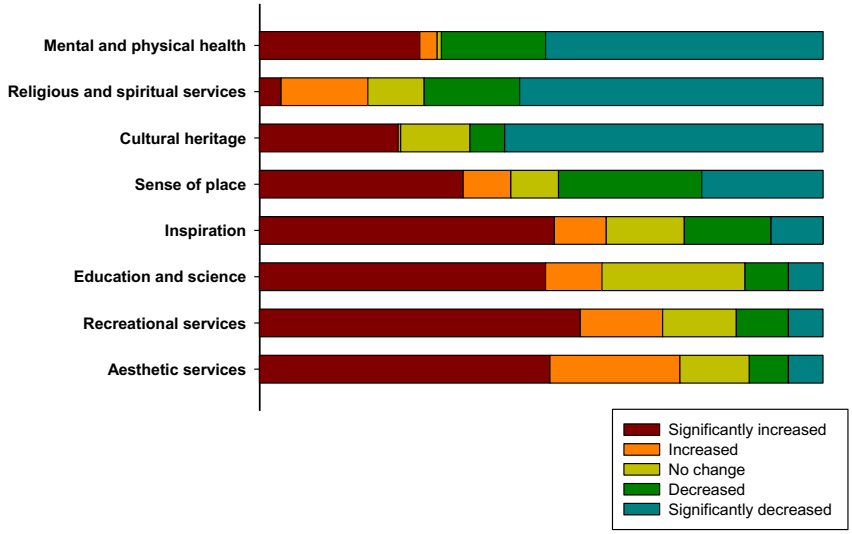


Figure 2-2 *Perceived changes in cultural ecosystem service values after implementation of Grain for Green.*

2.3.5 *Importance of the major land use types to CES provision*

In Guyuan, cultivated land was perceived as the most important land use for providing CES, with the importance (8.0) calculated using equation 1. This was followed by grassland (5.9), forest (4.5), residential areas (3.5), bodies of water (3.0), and cultural heritage sites (whose locations are shown in Figures 2-1; 1-5). Figure 2-3 displays the spatial variation of the overall calculated CES provision importance.

Figure 2-3 *Spatial variation in the importance of cultural ecosystem services in Guyuan.*

2.4 Discussion

2.4.1 Perceptions of CES in Guyuan

Our results clearly show that residents in Guyuan who have been affected by the Grain for Green program perceived at least three types of CES provided by their land. Most perceived several more CES, and some perceived all eight types. On the one hand, this can be explained by the diverse cultures and long history of the study region, which have created different perspectives that contribute to the perception of diverse CES. On the other hand, there are likely to be combinations of certain CES that overlap with specific uses of the landscape's CES (such as *Physical and mental health*, *Aesthetic and Recreational services*). This process of combining ecosystem services has been recognized because of the close relationship between certain services (Milcu et al., 2013); for example, people who engage in outdoor exercise (i.e., take advantage of the recreation services) tend to be healthier (i.e., take advantage of the physical and mental health). Previous discussion of CES has therefore acknowledged the multi-functionality of these services, particularly in the context of agricultural landscapes (Barral et al., 2015; Gordon et al., 2010; Swinton et al., 2007). Rural people in southwest China, East Africa and several South-east Asian countries also perceived many CES from nearby landscapes, including aesthetic, recreational, spiritual services, physical and mental health and social relations (Allendorf and Yang, 2013; Cuni-Sanchez et al., 2016; Sodhi et al., 2010).

In addition, like Cuni-Sanchez et al.(2016) and Sagie et al. (2013) demonstrated in their cross-cultural studies, ethnicity influences CES perception and values. In this study, Hui People perceives more CES than Han People. For example, the Hui People, the second largest group of residents, have totally different living styles from the Han People, such as their religion, their dietary habits, and their

agricultural practices. Because of the distinctive local characteristics of Guyuan, the residents have traditionally participated in diverse cultural activities and have a strong sense of attachment to their land (Su, 2008; Xue, 2012). Consistent with previous findings (e.g., Van Berkel et al., 2014, Zoderer et al., 2016), we also found that respondents especially value the aesthetic services and recreation services of the landscape, whereas the religious and spiritual service plays a minor role. This relatively low value of religious and spiritual services in our case area can be explained by the local ethnic structure (most interviewee's belong to the Han people) and the changes in the lifestyle of the Hui people (from living alone in remote mountainous areas to living with the Han in flat areas) caused by Grain for Green. The lower perception of value for religious and spiritual services among the Han is the result of this people lacking a strong religious tradition (Xue, 2012). However, the Han still recognized the value of spiritual services, using descriptions such as "I visited this land when I or my family was in trouble". The implementation of Grain for Green was accompanied by an influx of more "modern" ideas, including atheistic communist opinions, which reduced the Han belief in prayer. The perception of value for religious and spiritual services was mainly contributed by the ethnic minority Hui people, who follow Islam. The Hui culture therefore includes religious activities such as prayer in specific places (i.e., mosques) (Hu, 2016). However, Grain for Green has changed the residential areas of the Hui People from relatively isolated communities in mountainous areas to coexisting with the Han in flatter land. Most of the Hui People are currently living together with the Han people. As a result, some of the Hui people are becoming less religiously strict so they can blend into the life of the larger community.

In contrast to previously conducted landscape perception studies (e.g., Zoderer et al., 2016a and Scolozzi et al., 2015), cultural heritage are highly (third highest) perceived in Guyuan, especially by the oldest group of people. The rich cultural

heritages were developed from Guyuan's position on the ancient Silk Road arose from mixtures of eastern and western cultures and beliefs and its importance role played in Chinese Revolution War (Xue, 1997; Xue, 2012). The high perceptions from the oldest group on cultural heritage and sense of place meet Stephenson's expectation that local residents draw their knowledge about certain landscapes from their long-time relationship and experience with the landscape (Stephenson, 2008).

Surprisingly, our results demonstrated that men appreciated the agricultural landscape more for the immaterial values than did women in contrast to previous studies (Howley et al., 2012; Plieninger et al., 2013a; Zoderer et al., 2016a). Despite the commonly explanations through the women's characteristics such as ethic of care towards the environment (Zoderer et al., 2016a), men are much more involved in the change of local landscapes, for instance, from doing farming activities to leaving their land to work in other places.

We assessed the changes in CES perception after the implementation of Grain for Green. The most significant changes induced by Grain for Green are land cover change from cultivated land to forest and grassland (König et al., 2014b). Because of this change, the use of those lands changed from generating material benefits (e.g., sales of crops and wood) to immaterial benefits, such as the CES described in the present study (Nowak et al., 2014). In addition, most of the new forests are defined as ecological forest, with the primary goal of soil conservation, and the forests are rarely used for other purposes, even recreational services. In contrast to intensive farming systems, where the homogeneity of ecological forest structure was held as being less attractive, traditional cultivated systems are found more attractive due to their aesthetic diversity and cultural identity (Arriaza et al., 2004). Also, because villagers are forbidden to harvest trees from the new forests or to plant other tree species that might produce economic benefits, villagers have little interest in the

new forests. However, they have found alternatives that do not damage the forests, such as beekeeping and "grazing" of chickens under the trees.

Grain for Green also changed local livelihoods from farming to various forms of self-employment. Grain for Green was implemented by providing subsidies, but did not provide additional employment opportunities, leading to much migration of young workers in search of jobs and the need for some remaining farmers to seek part-time work (König et al., 2010). This problem has been exacerbated by the rapid economic development taking place in other parts of China (such as the eastern and southeastern coastal zones), where there are more and better employment opportunities. Our results support this conclusion, as the majority of interviewee's (71.3%) were older than 40 years. The loss of young people from communities in the study area might result in a decreasing perception of the cultural heritage service. This may be because the old were alive during a time when the cultural heritage provided by the landscape was still accessible to all residents, whereas the youngest residents might have only been taught about the information in an abstract form, without experiencing it sufficiently directly to develop a strong sense of their cultural heritage.

Overall, regional income has improved since Grain for Green was implemented, despite the elimination of traditional occupations such as farming and livestock grazing for many residents (Guyuan Bureau of Statistics, 2016a). Many of them have changed from land-based farmers to migrant labourers. The income from this transferred employment accounted for 44.3% of the regional average per capita disposable income of farmers (Guyuan Bureau of Statistics, 2016b). The program reduced the dependence of the local people on their land (Hu, 2016), and changed their traditional life styles. The current sense of place for local residents in Guyuan emanates from memories of personal and community engagement with the local

farming activities. More non-agricultural means of earning a living might result in decreased spiritual and religious resonance compared with their traditional activities, resulting in a decreased sense of place.

2.4.2 *Importance of the landscape types to CES provision*

We found that residents perceived cultivated land as more important than forest and other land uses for the provision of CES. A general preference is found for cultivated landscape in terms of aesthetic, recreational, religious and spiritual services and sense of place. This finding supports a number of previous studies conducted in different contexts (e.g., Howley et al., 2012, (Zoderer et al., 2016 and Tempesta 2010). The results for cultivated land are interesting because they suggest that residents of the study area believe that reforestation reduces the overall provision of CES. One reason might be that the local communities have a thorough understanding of the landscape they relied on for many generations and of the local farming culture (Xue, 1997). The residents grew up here with their friends and family (*Recreational services* and *Sense of place*), appreciated the growth of their crops (*Aesthetic services*), prayed for a good harvest (*Religious and spiritual services*), and were taught how to live in harmony with nature (*Education and science*).

In addition, the importance of forest to CES provision might be influenced by the fact that the contributions of forest are likely to be perceived less favourably because the uses of the new forest are limited. With a slope of more than 15°C at most forested sites, the forests have low accessibility and provide fewer opportunities for CES related to outdoor activity, such as recreational services. Also, local traditions have not taught residents to appreciate outdoor activities such as hiking or biking (Ma, 2014). Most of the time they spend outside is in their cultivated land, which is more familiar to them and more accessible. In addition, after working a long day as

a farmer, most residents (and particularly older ones) have little energy remaining for outdoor recreation.

We also found that residential areas had high perceived importance. This probably results from the local tradition of paying visits to other people. People who live in agricultural landscapes are very social and have strong bonds within their neighbourhood (Ma, 2014). They spend much time with other families, helping each other with farming activities and obtaining valuable social contacts. In this way, the residential areas were perceived as especially important in terms of their provision of a sense of place, as well as in terms of their physical and mental health and recreational services.

2.4.3 Limitations of our study

The main goal of our research was to identify the influences of ecological restoration on CES from the perspective of human perceptions in an agricultural landscape. However, we focused only on the Grain for Green in northern China. To obtain a fuller picture of the influences of ecological restoration on CES in agricultural landscapes, restoration projects in other areas and with different emphasis (e.g., wetland restoration) should be included in future assessments. Reliable data on the relationships between CES and ethnic diversity (here, the Han and Hui peoples) in other agricultural landscapes in China have not been published to the best of our knowledge, particularly in the context of Grain for Green, making it difficult to compare our results with other related research, particularly given the lack of data on CES derived from human perceptions. However, we addressed some cross-culture perception studies from other countries to provide some comparisons.

We assessed the influence of Grain for Green on CES based on human perceptions of agricultural landscapes. However, there are several potential factors that we did not include in our analysis. These include the influence of the duration of the restoration project, which started in 1999; thus, our data on land use change only go back 18 years, which is not long enough to reveal clear differences between generations and how those differences have evolved over time. Instead, we assumed that the influence of passing of time and of differences among generations could be reflected by the current age groups and the changes in land use during the short Grain for Green implementation period. However, future research should account for changes over time both within and between generations. In addition, we did not obtain economic data for our study area, particularly in the context of the effects of broader economic considerations (e.g., for China as a whole) on local economic factors. Such considerations would be complex, and are beyond the framework of the present study.

Our survey locations and survey sampling also influenced the results. The budgetary and geographic constraints (the large distances between villages and difficulty reaching them by car) prevented us from performing random sampling with a large sample size in each demographic category and in a larger number of villages. Therefore we have been careful not to rely too heavily on results for specific categories in each demographic factor. The sampling locations mainly emphasized sites populated by the Han and Hui peoples, and did not account for other ethnicities, such as the Mongolian people, thereby creating a bias that should be addressed by including these other peoples in future research. Because our results are based on human perceptions of CES, they are inevitably highly subjective and likely to be influenced by cultural differences among different peoples. However, bias in responses is often considered as an common issue in preference and non-priced valuation studies, but does not negate the value of such surveys (Berkel et al., 2014; Mjelde et al., 2012).

2.5 Conclusions

In this study, we assessed the influence of China's national Grain for Green program on the well-being of residents of a program area in northern China, using the value of the cultural ecosystem services provided by their landscape as a proxy for well-being. Interviewee's generally perceived most of the eight CES that we identified as potentially important before we conducted the survey, which are aesthetic services, recreational services, inspiration, sense of place, religious and spiritual services, and educational and scientific services.

Interviewee's generally believed that the values for physical and mental health, religious and spiritual services, and cultural heritage had decreased under Grain for Green, whereas the values of aesthetic services, recreation, education and science, and inspiration services increased. In part, these changes resulted directly from the land cover changes, but the economic changes and migration of young workers had important indirect effects.

Residents perceived cultivated land as being more important to CES provision than forest, which can be explained by the fact that the local residents thoroughly understand the agricultural landscape they have relied on for generations, and consequently perceived agriculture as most important. This effect was strengthened by the limited use of and accessibility of reforested areas, where harvesting of wood products and related activities are forbidden; this lowered the perceived importance of the forests. In addition, residential areas were perceived as highly significant providers of CES because of close bonds between neighbours and the local traditions of hospitality and mutual aid.

Although we identified factors that significantly affected CES values, more work must be done to clarify the relationship between perceptions of CES and these factors and on elucidating the underlying factors responsible for the observed spatial heterogeneity of the CES values. In particular, it will be necessary to obtain data from areas affected by ecological projects with different goals (e.g., wetland restoration) to allow a comparison with the present results. Such comparisons often reveal important differences in the underlying factors.

Another important finding was that reforestation may contribute to ecological restoration, but not to CES in general. Some CES such as cultural heritage services and spiritual and religious services might fade away because of the migration of young people in search of employment, leading to a loss of transmission of the value of these services between generations. In contrast, the provision of a sense of place appears to be closely related to residential areas, and may therefore be preserved by the local traditions of hospitality and mutual aid. The importance of residential areas and the trade-off between cultivated land and forest should not be undervalued in such restoration projects, particularly in terms of what happens after the project is complete.

Reindeers
(Symbol animals in Genhe China)

Chapter 3

The content of this chapter is based on a published paper: Yuehan Dou, Xiubo Yu, Martha Bakker, Rudolf De Groot, Gerrit-Jan Carsjens, Houlang Duan, Chao Huang. "Analysis of the relationship between cross-cultural perceptions of landscapes and cultural ecosystem services in Genheyuan region, Northeast China" *Ecosystem Services* 43 (2020): 101112.

Analysis of the relationship between cross-cultural perceptions of landscapes and cultural ecosystem services in Genheyuan region, Northeast China.

3.1 Introduction

Maintaining and enhancing ecosystems' beneficial contributions to a good quality of life is a major challenge of our time (Díaz et al., 2018). To inform decision-making for sustainable ecosystem management, an elicitation of people's benefits and concerns associated with their landscapes is required (Gould et al., 2015). For centuries, researchers − from philosophers to engineers − have tried to characterize the complex, dynamic relationships between humans and landscapes (Gould et al., 2015; Haines-Young and Potschin, 2009; Kaplan and Kaplan, 1989; Schama, 1995). Aided by ecologists and economists, the ecosystem services (ES) approach emerged as a prominent conceptual link between environment and society (Collins et al., 2011). Over the past decades, it developed into a vibrant research field, influenced policy discourse, and advanced the sustainability agenda (Díaz et al., 2018; MA, 2005; Sagie et al., 2013).

Most of the ES research has been conducted by ecologists and economists (Ohl et al., 2007), building on the Millennium Ecosystem Assessment (MEA) and valuing ES in ecological and economic terms (Sagie et al., 2013), such as the provisioning of food and drinking water (Groot et al., 2018; Malmstrom et al., 2009; Mietzner and Leymann, 2008; Ouyang et al., 2004). Yet the overwhelming amount of research on such ES has been conducted by ecologists and economists (Ohl et al., 2007), and some claim this has resulted in a mutual alienation process in which MEA-inspired studies and policies became increasingly narrow, which led to voluntary self-exclusion of disciplines, stakeholders, and worldviews (Díaz et al., 2018; Satz et al., 2013). As a consequence, the ecosystem services research program developed largely without benefit from insights and tools in social sciences and humanities (Díaz et al., 2018). For example, the unpacking and valuation of non-material benefits (such as spiritual importance, cultural heritage, and sense of place etc.) themselves arising from more complex and less tangible people-landscape relationships, but which are not readily amenable to biophysical or monetary metrics, have lagged behind (Chan et al., 2011a; Daniel et al., 2012; Fish et al., 2016b), and so has their mainstreaming into policy (Díaz et al., 2018; Oleson et al., 2015; Satz et al., 2013). Such benefits, also described as the nonmaterial benefits people derive from ecosystems, are identified in ES frameworks as cultural ecosystem services (CES) (MA, 2005).

Although cultural ecosystem services (CES) are, just like 'regular' ecosystem services, associated with how people interact with and gain benefits from their landscape (Chan et al., 2011a; Daniel et al., 2012; De Groot et al., 2002), they are relatively intangible and subjective (MA, 2005). Many scholars see defining and measuring CES as problematic for numerous reasons (Oleson et al., 2015; Satterfield et al., 2013; Satz et al., 2013), including difficulties in articulation, representation of varied perspectives, and potential incommensurability of values (Gould et al.,

2015). Several studies have proposed CES assessment methods, but they have merely focused on the spatial representation of aesthetics, tourism, and recreation with easy-to-measure, quantitative variables, such as revenues or visitor numbers (Chen et al., 2017; Satz et al., 2013; Smukler et al., 2012), or they use established monetary valuation techniques (Chen et al., 2017; Van Berkel and Verburg, 2014) which have been criticized for over-valuing tourist-attractive landscapes, neglecting critical social impacts or dynamics, or excluding key stakeholders (Dou et al., 2019; Fish et al., 2016b; Gould et al., 2015; Martín-López et al., 2012; Pleasant et al., 2014).

It is important to note that the nonmaterial aspects of human-ecosystem relationships have been widely studied in the scientific literature of environmental psychology, landscape architecture, anthropology, and sociology, although not under the CES label (Daniel et al., 2012; Kaplan and Kaplan, 1989; Russell et al., 2013; Sagie et al., 2013; Schama, 1995; Westerink et al., 2017). However, the theory, methods, and approaches in these studies (e.g., sociological and anthropological theory and methods) provide frameworks for studying CES of local populations, assessing the spiritual and cultural identity reflected in CES, and gaining the perspectives of different cultural groups, such as ethnic minorities (Díaz et al., 2018; Sagie et al., 2013).

Prioritizing management decisions toward the needs of the public requires engagement with the local communities that inhabit the landscapes, in particular when these communities include ethnic minorities (Díaz et al., 2018; Swinton et al., 2007). Such communities often develop unique relationships with ecosystems through rich histories of human-environment interaction and the continuity of culture, and they place a high value on their endowment to future generations (Cuerrier et al., 2007). Understanding the importance local communities (and

potential ethnic minorities within the community) place on cultural ecosystem services can help ensure that resource governance institutions are appropriately designed and targeted, thereby improving both livelihoods and environmental sustainability (Iniesta-Arandia et al., 2014; Sagie et al., 2013).

This paper presents an approach to analysing the characteristics of cultural ecosystem services of local communities and ethnic minority groups. The approach has been tested in the Genheyuan Wetland area in China. Interviews, questionnaires, and structural equation modelling were applied to identify how local residents perceive CES and to study the relationships between the perceived CES and the characteristics of the physical landscape. The presented approach aims to improve decision-making in environmental management and landscape planning by providing evidence about the importance of CES of landscapes for local communities and ethnic minorities.

3.2 Data and methods

3.2.1 Study area

The detailed introduction of study area is shown in section 1.5.2 (Figure 3-1). The Genheyuan National Wetland Park was established in 2011 and attracts over 60 thousand tourists per year because of its special scenery of a forest-wetland ecosystem in a cold temperate zone, rich biodiversity, recreation vehicle camping, and its status as the coldest point of China (Genhe Tourism Development Association 2018). The geographic data used to distinguish land cover is interpreted from Landsat TM / ETM data 2015, 1 km×1 km; the data was provided by Environment and Resource Data Centre of the Chinese Academy of Sciences http://www.resdc.cn/.

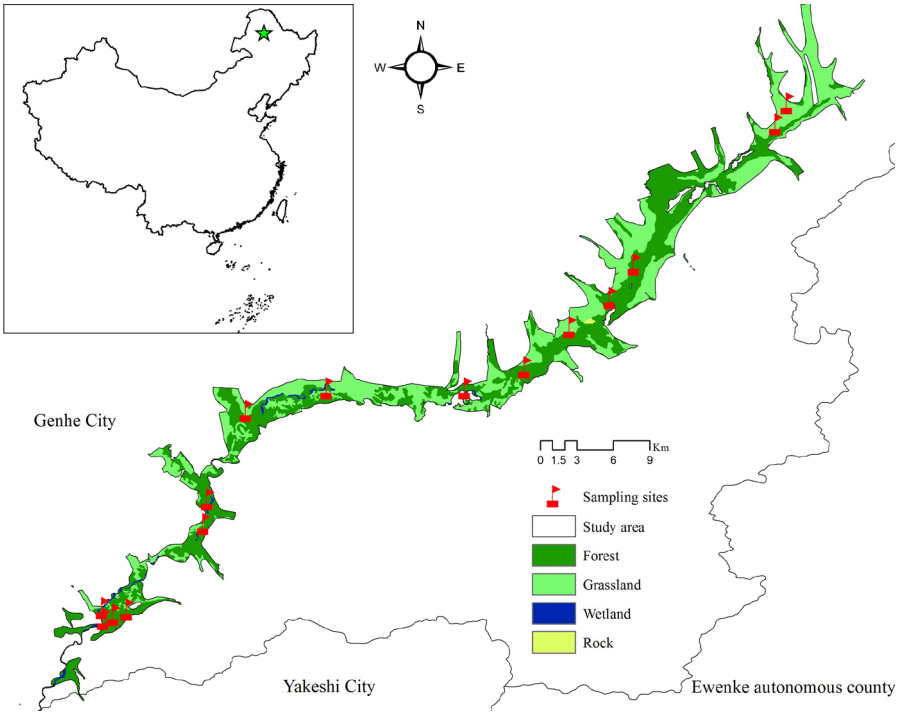


Figure 3-1 *Study area and sampling sites.*

3.2.2 *Classification and indicator questions of CES*

Our assessment of CES is based on the categories established in the Millennium Ecosystem Assessment (MA, 2005). As the Millennium Assessment does not provide explicit definitions of CES (Plieninger et al., 2013b), and not all the CES are applicable and understandable in a given local context. Therefore, we incorporated the terminology of CES and the indicator descriptions used in other studies references for the semi-structured interview (Table 3-1). We aimed to present the various CES categories in a way that could be easily understood by the local respondents who are not familiar with the concept of CES and the ecosystem services framework.

Table 3-1 *Selected CES and their indicator statements / descriptions used in this study.*

CES	Potential indicator statements / descriptions
Physical and mental health	Visiting these places gives me a sense of freedom. (Tratalos et al., 2016) Visiting these places leaves me feeling healthier. (Bryce et al., 2016)
Recreational services	I like spending leisure time in these places. (Dou et al., 2017a; Hernández-Morcillo et al., 2013) I do walking, hiking, walking dogs … etc. in these places. (Dou et al., 2017a)
Aesthetic services	I have felt touched by the beauty of these places. (Church et al., 2014)
Inspirations	These places inspire me (such as art, folklore, national symbols, architecture, and advertising). (Chan et al., 2011a; Chan et al., 2012) I gain perspectives on life during my visits to these places. (Dallimer et al., 2012)
Education and science	Visiting these places has made me learn more about nature. (Bryce et al., 2016) I feel these places provide the basis for education and science. (Hernández-Morcillo et al., 2013)
Religious and spiritual services	At these places, I feel part of something that is greater than me. (Chan et al., 2012a; Chan et al., 2012) At these places, I feel more connected to my religion or beliefs.

Cultural heritage	These places have additional value because of its historical meanings. (Tengberg et al., 2012) I feel like I can contribute to protect special species, features, skills or knowledge of these places. (Bryce et al., 2016; Tengberg et al., 2012)
Sense of place	I feel a sense of belonging in these places.(Tengberg et al., 2012) I have had a lot of memorable experiences at these places.(Buchel and Frantzeskaki, 2015; Tengberg et al., 2012)
Social relations	I have made strong bonds with others through visiting these places. (Bryce et al., 2016) I miss these places when I have been away from them for a long time. (Chan et al., 2012a)

3.2.3 Survey design

The data used for this analysis were gathered from semi-structured interviews combined with questionnaires (Appendix 3-1). Hereby we used the questionnaire to provide structure and consistency between interviews, but also to allow for the collection of freely contributed answers that were not a formal part of the questionnaire. A pre-test of the semi-structure interview was conducted with local experts and stakeholders in a Focus Group Discussion (FGD). They were invited to provide feedback about confusing questions by answering as if they were real interviewee's. Based on their feedback, the final interview questions were redesigned and clarified. In addition to the pre-test, we used follow-up questions during the interviews to clarify any unclear responses during the interviews in order. to mitigate the potential bias. The use of pre-test and follow-up questions has demonstrated that they can mitigate and even eliminate bias by using follow-up questions to get people more involved (Whitehead and Cherry, 2007). The final interview included questions related to the interviewee's perception about local landscapes, the activities they applied with their surrounding landscapes, and their experiences and feelings about any interventions happened. It also included questions on the socioeconomic and demographic characteristics of the interviewee's. The detailed interview questions can be found in Appendix 3-1.

In addition to the semi-structured interviews, we also applied participatory mapping which engages various stakeholders to identify and map CES that originate from local-based knowledge (Burkhard and Maes, 2017). The participatory mapping was implemented in a workshop with a Focus Group Discussion (FGD), which allowed communication among the participants and interactive exploration of the CES (Plieninger et al., 2013a). In total, 26 local stakeholders participated in the FGD, including local experts, a government officer, a local tourism company representative, a forest farmer, a handicraftsman, a reindeer herder, the wetland park manager, small business owners, and people from the ethnic minority groups. They were asked to describe the activities they normally do in or the feelings they might perceive from the surrounding landscape and point out the corresponding areas of these activities / feelings in a simplified map. After the FDG workshop, we further identified the feelings and activities they reported to CES according to the indicator questions /statements (Table 3-1). The combination of these data allowed to identify and map Services Provision Hotspots (SPHs).

3.2.4 Survey sampling and implementation

As the wetland parks have spatially mixed land cover, this study used nine landscape characteristics collected from empirical observation in semi-structured interviews, which are forest, wetland, grassland, seasonal rivers and lakes, cultural heritage, Obo (temples), iconic animals, traditional residential areas (Ger, Culuo), and tourism facilities. The boundary of the study area was drawn around the national wetland park and did not correspond with any administrative boundary. The population living in the study area was relatively small and hard to identify. For instance, some ethnic minority families officially register their citizenships in nearby towns, but they are living around the wetland park with their reindeers in the forests. Therefore, the population we drew our sample from was defined by

the knowledge of local officials and Genheyuan National Wetland Park managers. According to their estimation, there are around 350 households living and working within this region, some of which (nomadism) change their location irregularly. We determined the final sample size based on the estimated resident population (i.e., so that the sample size was proportional to the population) and the suggestions of the village managers to obtain a reliable and representative sample.

We straight-randomly interviewed around 70% (250 interviewee's), following the suggestion of Tabachnick and Fidell (2007) that a sample should be over 50% when the total households of the survey unit group are small, but also considering local circumstances (accessibility). The semi-structured interviews were carried out with the help of three researchers experienced in social surveys. The interviews were conducted in 17 sites where the interviewee's are living or working (Figure 3-1). Most of the semi-structured interviews were held in their homesteads and working places for interviewee's convenience, at different times in the morning, at lunch time, in the afternoon, and in the evening. We only included interviewee's who had been living or working in the study area for over 15 years for analysis because increasing familiarity with the area will reduce potential bias (Mjelde et al., 2012). Interviews were eliminated from the sample if the interviewee did not answer at least 70% of the questions.

3.2.5 Analytical methods

Perception analysis and CES identification

We identified the perceived CES through combined assessments of the beliefs and perceptions of the interviewee's and their reported activities. We used the responses to the interview questions to determine whether the interviewee perceived each

CES and to collect the value they assigned to their perceptions. We used Likert-scales with five degrees of "importance" assigned for each of the perceived CES and reported activities. In addition to the different degrees of agreement for each perceived CES, we quantified its strength by assigning numeric values to each statement (e.g., strongly agree = 2). We then calculated the mean perceived value for each CES from these values. Table 3-2 summarizes the rules we used to assign the values.

To further test for significant relationships between people's characteristics and the perception of CES, a Structural Equation Model (SEM) was used. Compared with the traditional regression method, SEM allows to explore the relationships between a complex of factors which are − based on prior system knowledge − interrelated, but also to differentiate in relationship intensity between each factor (path coefficient) (Rosseel, 2012). This allows the opportunity to both evaluate the model structure (the pattern of relationships among variables) and to quantify these relationships using field data (Sutton-Grier et al., 2010).

Chan's definition of CES considers CES as co-product of peoples' interaction with landscapes (Chan et al., 2012b). Hence, we hypothesized that people's characteristics will influence their perception of CES, as well as the ways they interact with landscapes. Six characteristics were selected as distinct variables used in SEM, reflecting the local context and using previous studies as a reference (Buijs et al., 2006; Dou et al., 2019; Martín-López et al., 2012; Schama, 1995; Tengberg et al., 2012). In order to reflect the differences in perception of CES, the different degrees (1-5) of the 5-point Likert-scale were used as the indicators of observed variables rather than using the assigned perceived values or dichotomous presence of CES (see Table 3-2; more detailed information about the semi-structured interviews is provided in Appendix 3-1).

Table 3-2 *Assignment rules for the perceived values of each CES (Adopted from Dou et al. 2019).*

Description	Degree of agreement with each statement related to the proposed CES	Assigned perceived value	Mean perceived value (0 to 3) and the corresponding assigned rank
(Strongly) Disagree with / have no idea about the statement / have never participated in related activities.	1/2	0	No value
Not sure about the statement / May have participated in related activities.	3	1	(0–1) Low value
Agree with the statement / have occasionally participated in related activities.	4	2	(1–2) Medium value
(Strongly) Agree with the statement / have often participated in related activities.	5	3	(2–3) High value

Relationships between perceived CES and demographic characteristics

The initial conceptual model only included the direct relationships between people's characteristics and CES (as in multiple linear regression), and we evaluated it with the observational dataset. This initial model was rejected because of its poor fit to the sample data (the modification indices were examined to detect discrepancies between model and data) and a second version of the model contained a more complex set of causal relationships. Again, poor model fit suggested that changes needed to be made to this model and new pathways were identified based on the modification indices. The model that was finally selected is depicted in Figure 3-2. In this model gender, age, education, income, occupation, and ethnicity directly influence the perception of CES, while age and occupation indirectly influence CES perception via income; gender also indirectly influence CES perception through

occupation; and education and ethnicity indirectly influence CES perception through both income and occupation (Figure 3-2).

All SEM analysis were conducted in *R* lavaan package 0.6-1 (http://lavaan.ugent.be). A chi-square test was used to primarily test the model fit. A non-significant p-value means there is a plausible fit between the data and the model (Byrne, 2013; McDonald and Ho, 2002; Sutton-Grier et al., 2010). We employed the Maximum Likelihood method (non-robust estimator) for parameter estimation, because it is more stable and less biased for small samples compared to robust estimators, despite its loss of asymptotic efficiency (Savalei, 2014). In addition to the widely used indexes of model fit Root Mean Square Error of Approximation (RMSEA), we also employed other measures of model fit recommended for small sample sizes: Comparative Fit Index (CFI) and Standardized Root Mean Square Residual (SRMR) (Capmourteres and Anand, 2016; Fan et al., 1999; Kline, 2015; MacCallum et al., 1996; Weston and Gore Jr, 2006). We assessed the final model with a CFI $\geq$ 0.95 and RMSEA $\leq$ 0.05 (Byrne, 2013; Hooper et al., 2008). When the model fit was satisfactory, we retrieved the parameter estimates and calculated the path coefficients. The total effects of variables were represented by the sum of direct and indirect effects through different pathways.

Relationships between perceived CES and landscapes

Landscapes contribute to CES provision physically through landform, landscape cover and location, mentally through the interactions with people (Dou et al., 2019). The spatial distribution of CES is considered to be associated with physical land features. In the analysis of mapped CES, the study areas have a predefined precise boundary, but the Services Provision Hotspots (SPHs) are considered as presenting the centroid of the spatial occurrence of a specific CES extending outwards to an unknown distance (Brown and Fagerholm, 2015). The spatial distribution of the SPHs was visualized using version 10.2 of the ArcGIS software (www.esri.com).

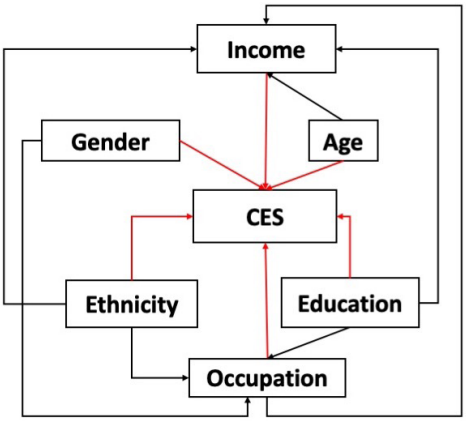


Figure 3-2 *Pathways of people's characteristics influencing CES perception, the red arrows indicate that the influences are direct on CES perception, the black arrows indicate the influences are on other people's characteristics.*

Considering the situations of mixed land cover, trans-located landscape features, and the reported CES-important characteristics that are hardly calculated or collected in a quantitative way (such as iconic animals), we further analysed the CES diversity of landscape characteristics by proposing an approach for qualitative data in addition to the spatial variability of CES. Therefore, we assessed the variety of CES of landscape characteristics by adopting a cultural diversity index developed from Shannon-Wiener index (Shen et al., 2018).

The cultural diversity index developed from Shannon-Wiener index uses pre-identified types of cultures and bases on the main assumption that the proportion of the population with a specific cultural background represents the existing condition of a culture and when all proportions are equal, the cultural diversity is highest (Shen et al., 2018). To analyse the diversity of CES provided by each landscape, we adopted the framework of a cultural diversity index and developed a CES Diversity Index by using perception data collected from the semi-structured interviews.

Considering the subjective nature of CES, the CES Diversity Index approach was designed to suit the survey data, with the assumption that the proportion of people who perceive a CES from a certain landscape feature is positively correlated with its capacity of providing diverse CES (Dou et al., 2019; Palomo et al., 2018). The following equation was used to represent the CES Diversity Index (CDI).

$$CDI = -\sum_{i=1}^{N}\left(\left({}^{Pi}/_{\sum_{i=1}^{N} Pi}\right) \times \ln\left({}^{Pi}/_{\sum_{i=1}^{N} Pi}\right)\right) \quad \text{Equation 2}$$

Where *Pi* is the number of people who perceived CES *i* from a landscape feature; *N* is the total number of perceived CES.

3.3 Results

3.3.1 Survey responses and respondent characteristics

The final sample consisted of 199 semi-structured interviews, with an effective completion rate of 79.6%. The largest group of interviewee's (57.8%) was 30 to 40 years old, followed by the group that was 40-50 years old (26%). Men and women were equally represented in the interviews (49% versus 51%, respectively). Mongolian and Han people were the largest groups of interviewee's (34.2% and 32.2%), followed by Manchu People (12%), while Ewenki people were the smallest group (5%). In terms of education, 87.9% had an education level equal to or higher than middle school, while 10.1% had no education at all (Table 3-3).

Table 3-3 *Basic demographic information of the interviewee's.*

Demographic factors	Classification	Proportions
Gender	Male	49%
	Female	51%
Age	Below 20	0.1%
	20-30	15.6%
	30-40	57.8%
	40-50	26%
	50-60	0. 4%
	Above 60	0.1%
Ethnicity	Han	32.2%
	Evenki	5%
	Oroqin	7%
	Daur	11.6%
	Mongolian	34.2%
	Manchu	12%
Education	No education	10.1%
	Primary school	2%
	Middle school	44.7%
	High school	24.6%
	University or above	18.6%
Occupation	Tourism-related employee	13.6%
	Forest-related worker	52.3%
	Small-business owner	6.0%
	Public official	5.5%
	Husbandry	2.5%
	Unemployed/retired	20.1%
Annual income (Yuan / RMB)	Below 10,000	12.1%
	10,000 to 30,000	72.9%
	30,000 to 50,000	11.6%
	Above 50,000	3.5%

3.3.2 *Perception of cultural ecosystem services*

The results showed that 70.8% of the total respondents perceived all nine pre-defined CES. The respondents who perceived less than six CES, 6.5% of the total respondents, all have an education level below middle school. For all CES, the proportion of people who perceived the CES ranges between 91% and 99.5%. Table 3-4 presents the proportions of respondents who perceived CES for all demographic groups combined. *Inspiration* received the highest perception, being recognized by 99.5% of the respondents, closely followed by *Physical and mental health* (96%). *Social relations* and *Aesthetic services* were perceived by the fewest respondents (91% and 91.5%).

Table 3-4 *Cultural Ecosystem Services (CES) perceived by local residents for all demographic groups combined and examples of the interpretations of the meanings of each CES in their life.*

CES	Meaning or relevance (examples)	Proportion of total interviewee's who perceived the CES (%)
Recreational services	I like spending leisure time, walking, playing football/basketball, walking my dog, playing with kids, dancing, etc.	94.5%
Aesthetic services	I find the land beautiful, scenic, colourful, etc.	91.5%
Cultural heritage	The land has existed for over 100 years. I heard it was used by (description) when I was young. The land use is (was) related to the forestry enterprises culture or other historical events.	95.5%
Physical and mental health	Walking here and breathing the air is good for my health. Being here makes me feel happier. I like to stay here for a while when I have difficult things to think about or when I am upset.	96%
Education and science	I learned a lot from the land when I grew up (knowledge of farming, animals, trees, etc.). These places should be visited by children and students.	92%

Inspiration	I gained inspiration for paintings, photos, architecture, design, etc. I gained a new perspective on life.	99.5%
Sense of place	I feel safest when I stay here. I do not want to leave for other places. This is the most comfortable place for me. I miss this place when I work elsewhere for a long time. I have had many memorable experiences.	94.7%
Religious and spiritual services	I visited these places when I or my family had problems. I feel I will be lucky when I do something there. I believe I will be blessed when I am here.	92.5%
Social relations	I have made strong bonds with others through staying here.	91%

3.3.3 The determined characteristics for CES perception

By running Structured Equational Model for each CES, we found that ethnicity and age are the two most influential characteristics for CES perception in Genheyuan Region. The calculated standardized path coefficients are shown in Table 3-5 and the model results are shown in Figure 3-3. The results for the different CES show similarities but also differences. No characteristic is significantly related to the perception of *Physical and mental health*. *Inspirations* and *Recreational services* were significantly related to ethnicity only. Ethnicity plays a role of significant influence factor for most of the CES except for *Physical and mental health* and *Cultural heritage*. For the case of age, negative relationships were observed: the higher the age, the smaller the perception of *Aesthetic services*, *Education and science*, *Spiritual and religious services*, *Cultural heritage*, *Sense of place* and *Social relations*. The relationship between perception of CES and income, gender, occupation and education was not significant. In addition to the calculated path coefficients between the influence factors and CES, also significant relationships between ethnicity, education and occupation were observed (Figure 3-3).

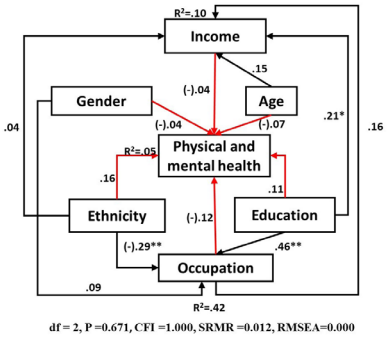
Table 3-5 Calculated standardized correlation effects for each CES model.

CES Model	Calculated path coefficients					
	Ethnicity	Income	Age	Gender	Occupation	Education
Physical and mental health	0.19	-0.04	-0.08	-0.05	-0.13	0.04
Inspirations	**0.18***	0.01	-0.04	0.14	0.05	0.02
Aesthetic services	**0.20***	-0.02	**-0.27****	-0.10	0.02	0.19
Education and science	**0.27****	-0.04	**-0.18***	-0.02	0.06	0.20
Spiritual and religious services	**0.27***	0.09	**-0.18***	0.11	-0.14	-0.17
Cultural heritage	0.17	-0.02	**-0.46****	-0.14	-0.07	-0.06
Sense of place	**0.27****	-0.02	**-0.19***	0.10	-0.08	0.14
Recreational services	**0.35****	0.14	-0.08	-0.11	-0.03	0.05
Social relations	**0.32***	0.21	**-0.18***	-0.02	-0.17	0.08

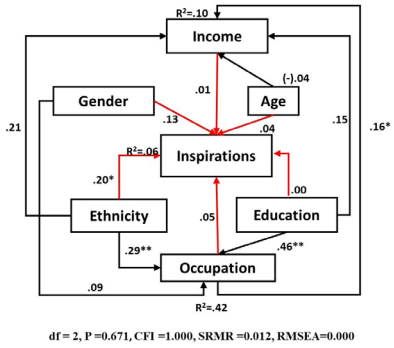
Coefficient values significant at p-value < 0.05 are shown in **bold**.

* p-value < 0.05; **p-value < 0.01.

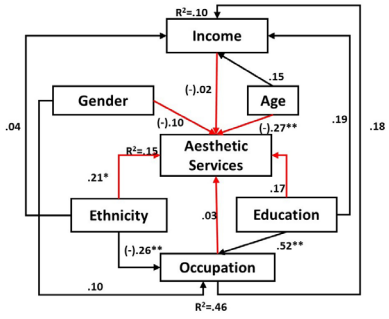
More information on model coefficients among variables can be found in Appendix 3-2.



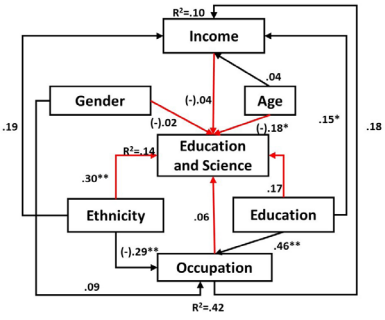
df = 2, P =0.671, CFI =1.000, SRMR =0.012, RMSEA=0.000



df = 2, P =0.671, CFI =1.000, SRMR =0.012, RMSEA=0.000



df = 2, P =0.693, CFI =1.000, SRMR =0.012, RMSEA=0.000



df = 2, P =0.671, CFI =1.000, SRMR =0.012, RMSEA=0.000

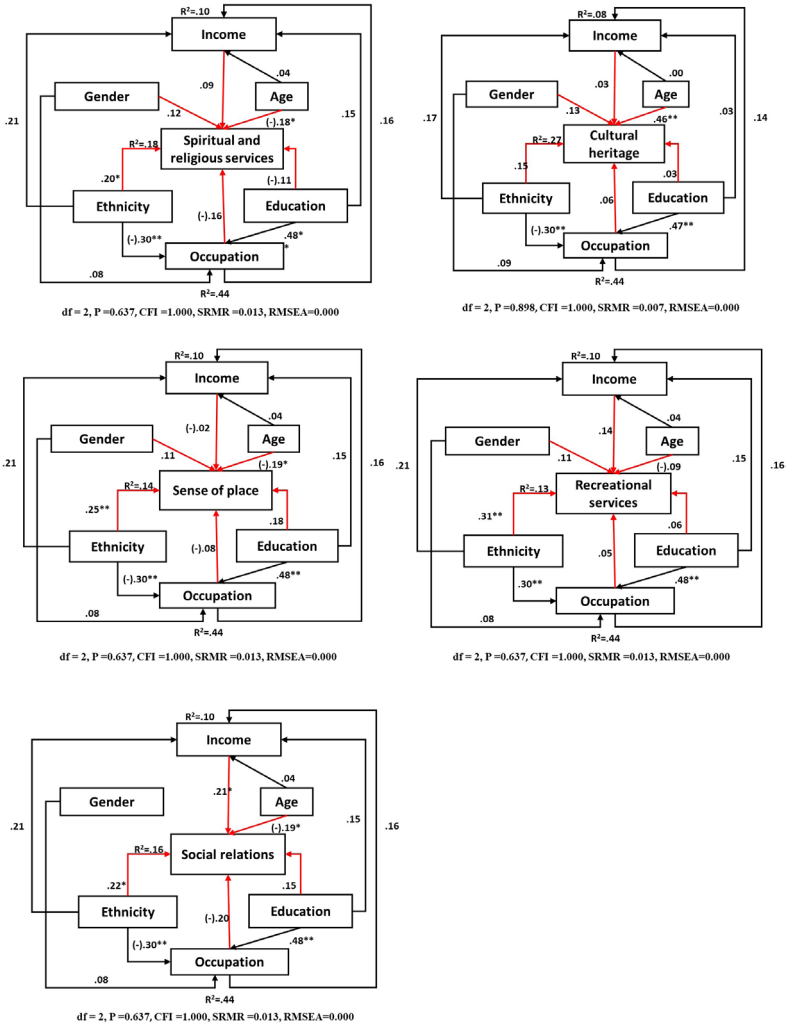


Figure 3-3 *Model results for all CES models; Coefficient values significant at p-value < 0.05; * p-value < 0.05; ** p < 0.01.*

3.3.4 *Perceived values of CES among different ethnicities*

Among all respondents, *Inspiration* has the highest mean perceived value, followed by *Aesthetic services*, *Cultural heritage*, and *Physical and mental health* (Figure 3-4). The *Science and education* had the lowest perceived value among all identified CES.

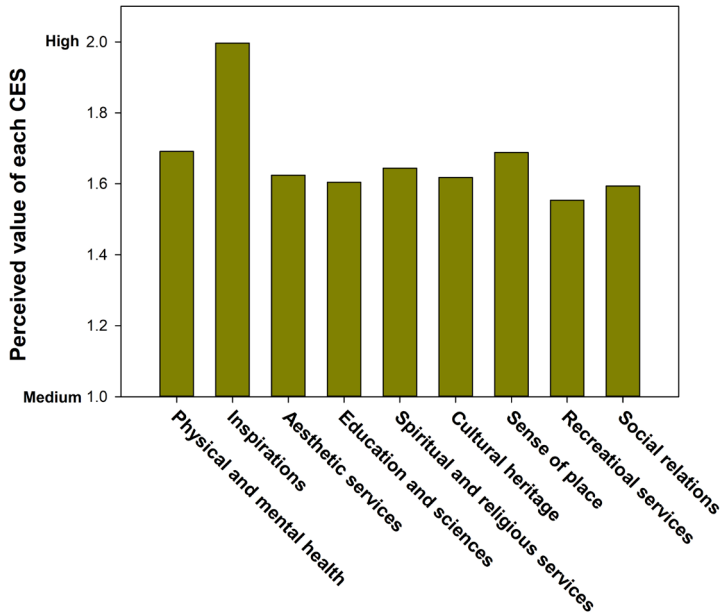


Figure 3-4 *The perceived values of each CES for all demographic groups combined.*

To further explore the influence of ethnicity on the perceived values of CES, we compared the perceived values of each CES in the five ethnic groups (Han, Ewenki, Oroqin, Daur, and Mongolian people). Among all interviewed respondents, the Mongolian people perceived relatively high values for all identified CES. Ewenki people especially perceived *Inspiration*, *Spiritual and religious services* and *Science and education*, while Oroqin people mostly perceived *Inspiration*, *Aesthetic services*

and *Cultural heritage*. The Daur people predominantly perceived *Inspiration*, *Cultural heritage* and *Sense of place*. Among all nine CES, *Inspiration* and *Physical and mental health* were perceived most differently among the ethnic groups. Mongolian people perceived higher values of *Physical and mental health* compared to the other four ethnic groups, while Han people perceived much lower values of *Inspiration* than the other groups (Figure 3-5).

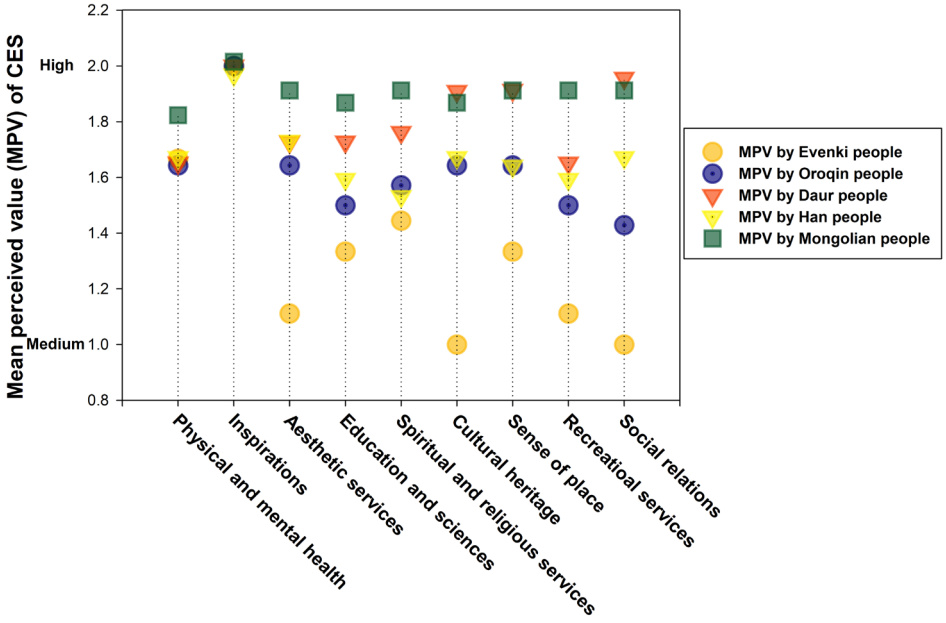


Figure 3-5 *Values of each CES perceived by different ethnic groups.*

3.3.5 *Relationships between perceived CES and landscapes properties*

In Genheyuan region, wetland was perceived as the most important landscape characteristic for providing diverse CES, with a CDI of 2.73 (calculated using equation 1). This was closely followed by seasonal rivers and lakes (2.67), forest (2.17), traditional residential areas (2.03), iconic animals (2.03), cultural heritages

(2.03), and Obo / temples (1.97). Among all identified landscape features, tourism facilities were perceived as having the least CES diversity (1.39). Figure 3-6 shows the CDI of different landscapes.

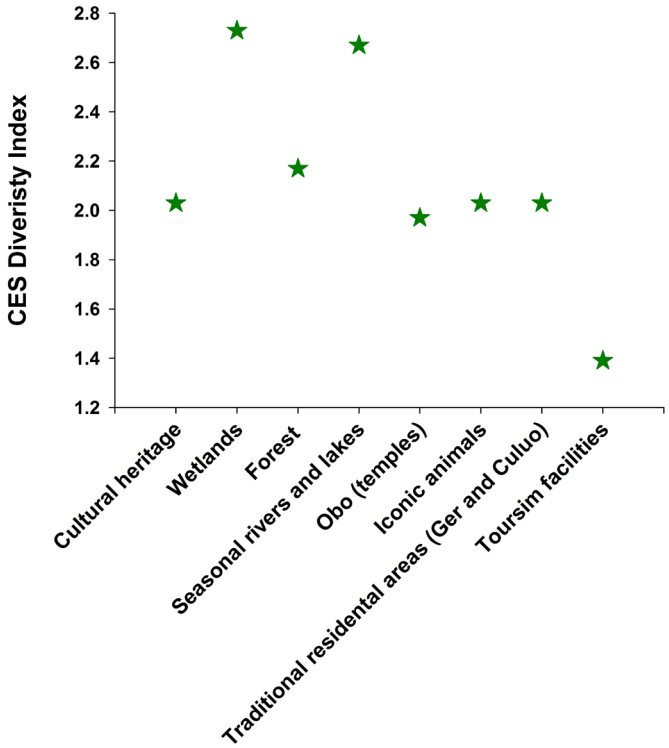


Figure 3-6 *CES Diversity Index (CDI) (based on equation 2) of different landscapes in Genheyuan region, northeast China.*

In addition, by comparing the participatory mapping results and the panoramic tourist map of Genhe River Source National Wetland Park[1], we found that the hotspots highlighted in participatory mapping was overlapping with the designed scenic spots in the national wetland park. For example, the identified science and education zone (Figure 3-7a) was close to the 517 Lumberjack Experiencing Spot (Figure 3-7b), the aesthetic services zone (Figure 3-7a) is included in the Walkway for sightseeing in Lengji Gulf (3-7b).

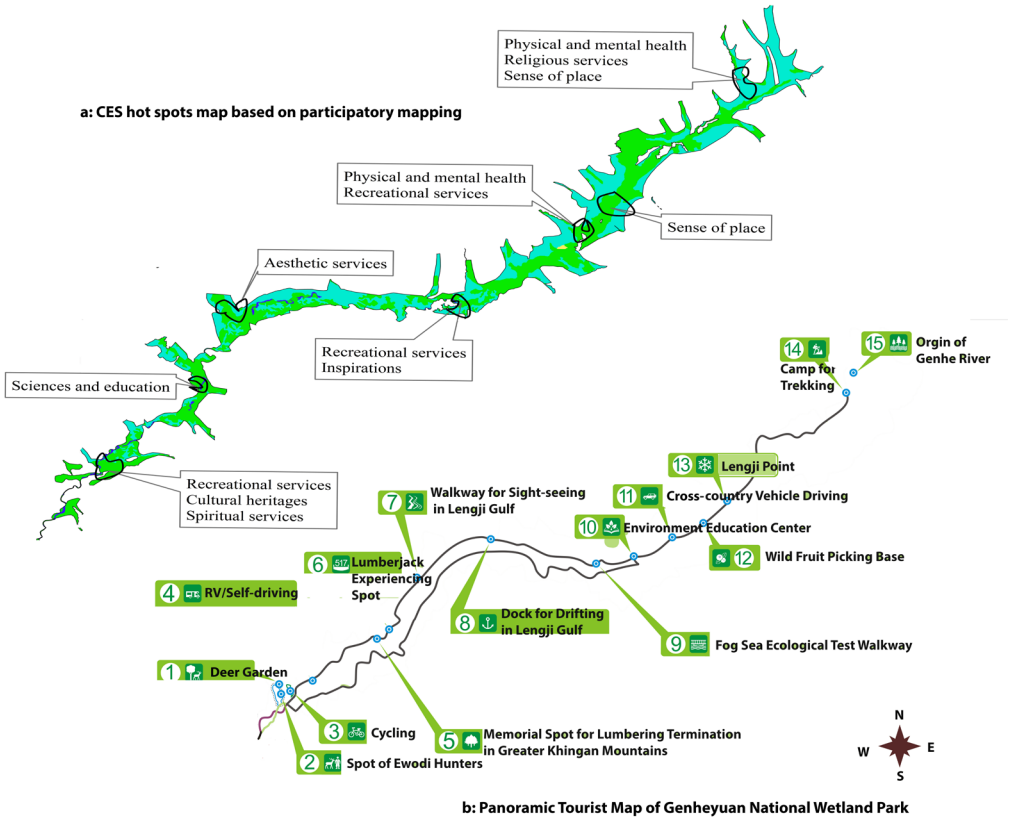


***Figure 3-7 a**: Comparison of the CES hotspots as results of participatory mapping and **b**: the panoramic tourist map of Genhe River Source National Wetland Park (conceptual map).*

[1] The Genhe River Source National Wetland Park is included in the study area of this research. The study area, Genheyuan region, also includes some forest zones out of the park boundary, where some nomadic Ewenki families are still living.

3.4 Discussion

3.4.1 Perceptions and perceived values of cultural ecosystem services in Genheyuan region

Our results showed that 93.5% of the residents in Genheyuan region perceive at least six types of CES provided by their landscape, and 70.8% perceived all nine types. On the one hand, these high percentages can be explained by the diversity of landscapes features (including traditional residential forms and iconic animals) and multiple ethnic communities, which may have created different perspectives that contribute to the perception of diverse CES. But the establishment of the national park and the adjustment of forest lumbering policy have most likely raised the awareness among the residents about the aesthetic, recreational and educational significance of their landscape. In addition, people may alter their attitude toward their living environment when confronted with changes, to make their landscapes more manageable and understandable (Leviston et al., 2018). The establishment of the national park and the consequent change in livelihoods probably made people perceive more non-material services in several ways. For instance, by forbidding traditional lumbering, using those lands changed from generating material benefits (e.g., wood) to immaterial benefits, such as the CES described in the present study (Nowak et al. 2014). The transition of livelihoods also made people attach more importance to the tourism related CES than the raw material provision they paid attention to before. Local residents perceive several working / lumbering sites as 'new' cultural heritages or educational sites (e.g., the 517 Lumberjack Experiencing Spot in Figure 3-7b) to highlight their identity of lumbering culture in the past decades.

In contrast to conducted landscape perception studies − e.g., Zoderer et al. (2016a), Scolozzi et al. (2015) and Dou et al. (2019) − inspirational services are highly

(highest) perceived and valued (highest) in this study, yet Han people perceived lower values of *Inspiration* than the others. The highest perception of *Inspiration* may be because Genheyuan region is an ethnically mixed area, and most of the nomadic ethnic groups have good handicraft skills and rich musical and cultural expression forms. Appendix 3-3 shows the cultural-specific activities of Ewenki, Daur and Oroqin people. Besides the mentioned nomadic culture, the different perceived values between Han people and other four ethnic groups can be explained by the cultural differences. For example, Han people are traditionally engaged little with handicraft making and nature worshiping (Yisong et al., 2007), which means they have fewer needs and opportunities to gain inspiration from landscapes. Besides, the correlations between age, *Cultural heritage* and *Sense of place* demonstrated in the studies of Stephenson (2008) and Dou et al. (2019) show that people gain knowledge and understandings about landscapes from long-time interactions with these landscapes.

3.4.2 Relationships between people's characteristics and CES perception

Consistent with previous cross-cultural analyses (Cuni-Sanchez et al., 2016; Sagie et al., 2013), our results from SEM and CES assessment both indicated the significant influence of ethnicity on CES perception and their perceived values. It revealed that the nomadic people (Ewenki, Oroqin, Daur, and Mongolian) perceived higher values of spiritual and religious services than the Han people do. This can be explained by the different cultural background of the nomadic people. Most nomads have a long history of nature and fetish worship practices, while Han people normally are lacking strong religious traditions (Dou et al., 2019; Ureltu, 2007). However, the research also revealed that the differences in perceptions of *Spiritual and religious* CES among the five ethnic groups has been

reduced, because the groups are living close together in the Genheyuan region in compact communities. In addition, Daur and Mongolian people attach significant importance to *Sense of place* and *Social relations*, which can be explained by their family-bonded community structure and the recurrent migration in the past (Yisong et al., 2007).

Surprisingly, the SEM standardized coefficient effects showed that occupation, income and education were not significant related to any of the CES, while these three characteristics have been reported as influential in other studies (Dou et al., 2019; Oleson et al., 2015; Van Berkel and Verburg, 2014). This result can be explained by the small variance in the levels of income, occupation and education. The occupation of most respondents in Genheyuan National Wetland Park is related to the park, and consequently their income level does not differ much. Compared with the richer coastal regions, people in the study area have less sources of income and mostly rely on a single salary (Fleisher and Chen, 1997). In addition, there has been a trend in educated labour migration from the study region since the 1990s (Wang et al., 2000). This phenomenon has resulted in a less educated local labour community and minor differences in education levels.

3.4.3 Relationships between perceived CES and landscapes

We found that local residents generally perceived that wetland, seasonal rivers, and lakes provide more diverse CES than other landscape features. This was also found by several previous studies (Costanza et al., 2014; Fisher et al., 2011; Jenkins et al., 2010) showing that bodies of water and wetlands are typically more appreciated or valued than other landscapes. This conclusion is not surprising because bodies of water are considered to be one of the distinct landscape features in Genheyuan region and selected as the theme of a national park. The establishment of the

national wetland park can also have encouraged people to perceive the diverse CES of wetland as discussed above. In another way, we could conclude from this study that people being in a water based park perceived water related landscape features more important than other landscape features for the provision of diverse CES. Similar findings could be found in the studies conducted in agricultural landscapes where people perceived cultivated lands more important rather than others (Dou et al., 2019). Therefore, we could primarily assume that people may perceive the local dominant landscape type more important because of more interaction with it, more familiarity with it, or more (non) material benefits gained from it.

It is interesting that forests were considered to provide fewer types of CES. Although lumbering sites are perceived as new-born cultural heritage sites, this is most likely caused by prohibiting lumbering activities. The high diversity of CES in traditional residential areas and iconic animals give credit to the strong and different ethnic cultural identities, the nature worship of nomadic groups, and the rich sources of wild animals in Genheyuan region. We also found the participatory highlighted CES hotspots had certain overlaps with the designed scenic spots along with the tourism facilities, although the people perceive the latter less than other CES. The overlap can be explained by tourism being based on non-material resource capital, which can be considered CES (Smith and Ram, 2017; Willis, 2015). Furthermore, the perception of CES by individuals is also shaped by opportunities for local people to participate and their access to resources (Leviston et al., 2018). We believe that the creation of tourism facilities will improve the accessibility to and participation of people in landscape features and will enhance their perception of CES. In addition, the shifting role of tourism in Genheyuan region can also be explained by the needs-based theory, which originates from the psychological sciences (Buijs et al., 2006). The increasing dominance of tourism and the jobs created by it will make that people will perceive tourism related landscape features

as increasingly important for their contribution to fundamental human needs of subsistence, affection, understanding, participation, leisure, creation, and identity (Roberts et al., 2015).

3.4.4 Implications for ecosystem services assessment and landscape management

The ecosystem services approach has received much attention in landscape planning and policy realms in China and all over the world, especially in changing or human-shaped landscapes (Chen et al., 2017; Plieninger et al., 2013b). Our study supports the belief that assessing ecosystem services for management decisions requires engaging with local communities, in particular ethnic minorities (Díaz et al., 2018; Swinton et al., 2007) and a collaborative assessment of CES should be integrated in landscape planning and management (Plieninger et al., 2013b). Our approach incorporates the perceived values that local communities attach to landscapes and overcomes the limited application of non-spatiality explicit CES in broader ecosystem assessment by assessing the perceptions of local communities. While CES has been increasingly applied in ecosystem services assessment, we highlighted the need to identify different CES perception from different ethnic groups and consider multiple and diverse CES perceived from landscapes to guide multi-functional and sustainable landscape management.

Our results also indicated that different traditional ethnic knowledge and activities contribute significantly to local CES conceptualization and therefore may also be powerful for creating benefits and supporting biodiversity conservation. It has been highlighted by many studies that the customs and special cultures of ethnic / indigenous people contribute to eco-tourism as an alternative livelihood after the establishment of protected areas (Amoamo et al., 2018; Ramírez and

Santana, 2019). However, traditional knowledge of people from minor ethnicities is hardly recognized. Such knowledge is often related to medicine, species breeding and spiritual icons, and it may also play a collaborative role in biodiversity conservation and sustainable uses of natural resources (Oka, 2018; Potvin et al., 2017). In our study, traditional knowledge was expressed through CES such as spiritual services, sense of place, and inspirations (examples in Appendix 3-3). The use of such in-depth CES identification opens up opportunities for more sustainable use of multiple resources and innovative cultural landscape conservation. Similar conclusions were drawn by Biró et al. (2019) and Yang et al. (2018).

The assessment of CES was conducted in a national park with rich ethnic cultures and biodiversity (Zhang and Ma, 2016). National parks play increasingly important roles in ecological conservation and sustainable uses of natural resources in both political and practical perspectives (Ma et al., 2019; Wei et al., 2017). However, eco-tourism targeted planning has been debated for ignoring local benefits and cultural sensitivities (Wang et al., 2012; Wang, 2019). Therefore, it is essential to identify multiple social functions of national parks that better contribute to benefits for the local people and support different cultures. Capitalizing on CES of the national parks may be an approach to achieve this (Plieninger et al., 2013b). By identifying the values and hotspots of different locally perceived CES and connecting the access and benefit sharing relations among planner / authorities, potential users, and local communities, it would be easier to build local trust, improve conservation effectiveness, and pioneer new co-management arrangements (Ament et al., 2017; Cuerrier et al., 2007; Stephenson, 2008).

3.4.5 *Limitations*

The analysis of cross-cultural perceptions of CES and their interaction with the landscape in Genheyuan region is based on a small local data set. The size of the study area and the relatively small survey sample may have influenced the results. However, data required for CES assessment is typically not available for larger areas, considering the specific nature of CES. Consequently, in-depth study of different cultural backgrounds in specific areas provides more meaningful results than large-scale studies. The sampling strategy was influenced by time constraints (the difficulty of visiting more nomadic families living in the forest) and geographic constraints (the large distance to and low accessibility of the study area). Although we managed to straight-randomly interview 70% of the people permanently living or working in the area, we have been careful to not to rely too heavily on results for specific categories of demographic factors. The potential bias in responses caused by people's subjectivity was recognized but considered acceptable, because it is an inevitable issue in perception and non-priced valuation studies, and it does not decrease the value of such surveys (Mjelde et al., 2012; Van Berkel and Verburg, 2014).

Given the special contexts of study areas, land uses have spatial overlaps, and we were not able to interpret accurate land use and cover data from remote sensing images. We mitigated this problem by developing an approach (CES Diversity Index) to analyse the relationships between the perception of CES and landscapes characteristics, using methods from the domain of sociology to collect data and obtain a preliminary assessment of the spatial distribution of the CES by participatory mapping. Although SEM is widely understood as a method that cannot be used to prove causality or predict/reproduce processes, it can support conceptual models that represent causal relationships (Angelini et al., 2016; Grace, 2006; PEARL, 1995). Main reason is that SEM originates from the

social sciences, where the main interest is often inferential, such as answering the question of influential variables or strength of relationships (Grace et al., 2010)2010. Understanding these limitations of SEM in predicting or proving causality, we used SEM only as a tool to identify which defined characteristics influence each other, in order to improve our understanding of the relationship between the perceptions of CES and landscapes.

Finally, the research included no changes in perception and landscape characteristics over time. Typically, landscapes are dynamic and change over time, while human perceptions will change as well. However, without reliable long-term social tracking data, we could not analyse long-term changes in human perceptions and landscape characteristics. In this study, we assumed that the influence of time and landscape change was reflected in the different age groups of the respondents in the survey. However, future research should account for changes over time both within and between generations when such data become available.

3.5 Conclusion

In this study, we analysed the cultural ecosystem services (CES) provision and valuation in Genheyuan region by collecting the perceptions of local inhabitants on CES provided by their landscapes, as a proxy for well-being. The results showed that the selected demographic characteristics (age, occupation, education, income, ethnicity and gender) influenced the perception of CES both directly and indirectly through influencing other demographic characteristics. Age is especially correlated with sense of place and cultural heritage, while ethnicity influences all other CES in Genheyuan region.

Among all the identified landscape features, bodies of water such as wetland and seasonal rivers and lakes are perceived as having the highest CES diversity. Due to the strong and mixed ethnic cultural identities in area and the nature worship of nomadic groups, people also perceived multiple CES from iconic animals and traditional residential areas. Although tourism facilities are one of the dominant landscape features in Genheyuan region, they are still perceived less than other CES.

Another remarkable finding was that the participatory highlighted CES hotspots have certain overlaps with the designed scenic spots. Moreover, the perception of CES from landscapes features is likely to grow, due to growing number of tourism facilities and related jobs in the tourism industry. Furthermore, the importance of landscapes features people attach to CES is shaped by the different roles that landscape features play in meeting fundamental human needs.

The developed approach is a promising tool to assess the importance of landscapes for local communities and ethnic minorities, without the need of detailed land use data. The approach allows incorporating cultural aspects and human needs in landscape management and planning. The needs of local communities often critically influence the success or failure of management and planning actions, and the approach may not observe the fact that these are neglected and may hinder the sustainable use of landscapes and achieving sustainable environment management goals. However, more research is needed to better account for the role that landscape plays in the perception of CES and elucidate the underlying factors responsible for the observed spatial heterogeneity in CES perception.

Surveyor with local people
(Xlin Gol China)

Chapter 4

The content of this chapter is based on a submitted paper "Investigating the potential impact of ecological restoration strategies on people-landscape interaction through cultural ecosystem services". Yuehan Dou, Xiubo Yu, Lin Zhen, Martha Bakker, Gerrit-Jan Carsjens, Rudolf de Groot. (Submitted to *Sustainability*)

Investigating the potential impact of ecological restoration strategies on people-landscape interaction through cultural ecosystem services

4.1 Introduction

Ecological restoration is one of the most world-wide commonly used human interventions to assist the recovery of an degraded, damaged or destroyed ecosystem (Clewell and Aronson, 2011). China has been implementing unprecedented large-scale efforts to restore degraded ecosystems since the last century (Cao et al., 2009). The rapid rise of ecological restoration raised questions about what good restoration entails (Higgs, 1997). Research shows that ecology / economics-dominated approaches prevail, while more holistic perspectives have been largely neglected (Cao, 2010; Higgs, 1997). Consequently, the consequences of ecological restoration on the interactions between people and landscapes remain unclear (Du et al., 2018; König et al., 2014a; Zhen et al., 2010b).

In line with the definition of Chan et al. (2011), cultural ecosystem services (CES) have been described as a co-produced / co-created outcome of peoples' interaction with landscapes. CES constitute and reflect the values and histories people share, the cultural practices they engage in, and how they perceive the meaning of the landscapes they inhabit, such as spiritual, religious, recreational, inspirational and educational (Buijs et al., 2006; MA, 2005; Ren-Jie et al., 2015; Sandifer et al., 2015). These perceptions lead to the formation of values (desirability of outcomes) and preferences (actual desires), shaping how people respond to and manage or use the landscape (Dorning et al., 2017; Meyfroidt, 2013; Zube et al., 1982).

In addition to the ecological targets, the changes of CES may be more directly perceived and experienced by residents of the program area, and the changes may be perceived in different ways rather than ecological achievement, particularly for aesthetic services (e.g., appreciation of the beauty of the original or changed landscape), cultural heritage and identity services, spiritual or religious inspiration, and education and scientific opportunities (La Rosa et al., 2016; Langemeyer et al., 2015). Neglecting the local people's relationship with the land in ecological restoration may even evoke sabotage of the restoration project (Cheung and Hui, 2018; Karanth and Nepal, 2012; Sakurai et al., 2016). Therefore, sufficient attention needs to be paid to CES as indicator of the potential non-material consequences caused by different ecological restoration measures and their adoption in response to the interaction with landscapes, especially in the landscapes being sharply changed (e.g., Inner Mongolia) (Berkel et al., 2018; Ridding et al., 2018).

While CES are greatly valued by diverse stakeholders, the full range of CES perceived from landscapes is notoriously difficult to evaluate due to the difficulties associated with defining, articulating and measuring and the absence of data about potentially CES-determining landscape features which is subject to strong

variability (Chan et al., 2011b; Kumar and Kumar, 2008; Plieninger et al., 2013b). Probably due to this intangibility, policy makers tend to sacrifice CES in favour of more tangible economic and ecological targets, especially in the ecological restoration projects (Braat and De Groot, 2012; De Groot et al., 2006). Rarely do these projects capture CES from landscapes, as they are typically confined to specific locations and small communities (Berkel et al., 2018; Sherrouse et al., 2011).

Therefore, to provide holistic perspectives of the influences of ecological restorations on local communities, we conducted the research in Xilin Gol, Inner Mongolia, China. By analysing the data collected from perception survey, we aim to answer the following two research questions:

1. How do the perception of CES correlated with demographic characteristics and landscape characteristics?
2. How do the perceptions of CES vary among different natural zones that influenced by different ecological restoration strategies?

4.2 Data and methods

4.2.1 Study area

The basic information of Xilin Gol League is introduced in section 1.5.3, and the spatial distribution of study area and sampling sites are shown in Figure 4-1. From north to south, Xilin Gol is naturally divided into three natural zones characterized by distinguishing topographical characteristics, Typical grassland pastoral (TGP) zone, Hunshandake sandy pastoral (HSP) zone and Agro-pastoral transitional (APT) zone. All zones are predominantly rely on grazing cattle and sheep (Kang et al., 2007), but differs in socio-economic conditions, landscape compositions and implementations of restoration strategies (Table 4-1).

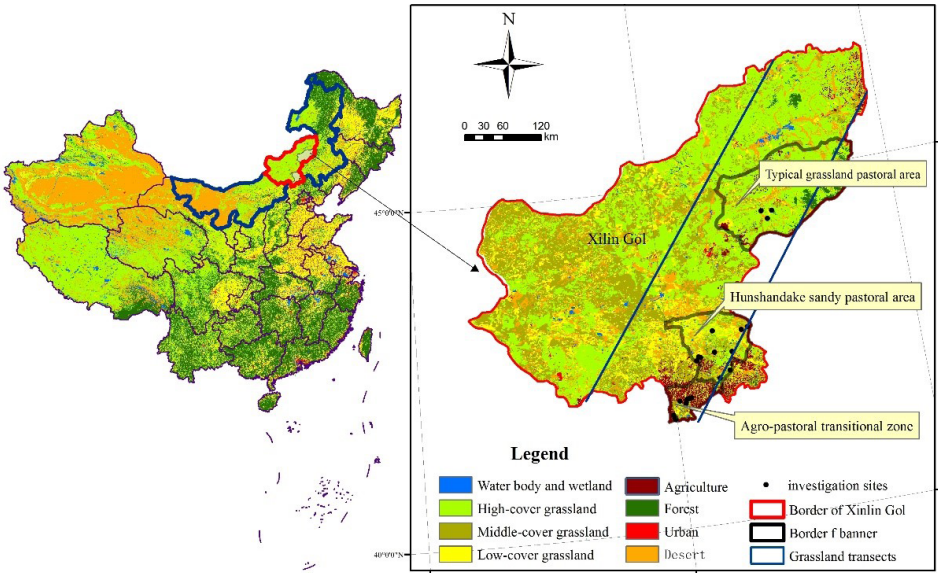


Figure 4-1 *Map of study area and investigation sites.*

Table 4-1 *Basic information of the natural zones in Xilin Gol League.*

Natural zones		**TGP zone**	**HSP zone**	**APT zone**
Area (km^2)		2.24×10^4	1.02×10^4	3415
Average precipitation(mm)		350	365	400
Population		8.70×10^4	8.30×10^4	2.10×10^5
GDP 2016 (10^9 yuan)		11.85	6.75	5.40
Dominant landscape composition (Area large to small)	Grassland, water body and wetland	Desert, grassland and residential areas	Cultivated land, grassland and forest	
Implementation of restoration startegies in different natural zones (proportion of total grassland) (Du et al., 2016)	Seasonal grazing	74.19%	64.07%	100%
	Rotational grazing	0.41%	7.78%	0%
	Grazing prohibition	19.25%	28.15%	17.33%
	Control of livestock rearing	83.75%	73.1%	18%
	Herder emigration	All inhabitants related to grassland-based employment		

4.2.2 *Data collection*

We applied stratified random sampling, whereby the stratification zones were the three natural zones: grassland pastoral zone, Hunshandake sand pastoral zone, and agro-pastoral transitional zone as sampling sites. In each zone, we randomly selected a route in the study area to conduct survey with the farmers (household) or herdsmen we met along the route. Limited by the local context of low population density (0.2 person/km^2) and far distances between household, we finally visited one town in the typical grassland pastoral area, five towns in the HSP zone, and three towns in the APT zone. In each sampling site, we interviewed around 60 households of farmers and herdsmen. In total, we got 175 households in nine towns, and 24 villages. Because the survey was carried out using face-to-face interviewing of the respondents or having the respondents complete the questions under the research group members' guidance, we obtained a response rate of 96.2%. The survey was carried out in August 2017. More information can be found in Appendix 4-1.

People were asked about the level of their agreement (5-scale Likert) on the statements that describing different CES. Based on Millennium Ecosystem Assessment, 9 types of CES were used in this survey, which are *Aesthetic services*, *Recreational services*, *Inspiration*, *Cultural heritage*, *Religious and spiritual services*, *Education and science*, *Physical and mental health*, *Sense of place* and *Social relations*. *Social relations* were excluded after pre-test because it did not fit in local context. Therefore, 8 types of CES were used in the interview. Detailed interview questions can be found in Appendix 4-2.

The spatial data we used in this research is provided by 2015 China Land Use Data (1 km × 1 km) of Resource and Environment Data Platform of Chinese Academy of Sciences (CAS). The land use data is generated and interpreted from Landsat

8 remote sensing images. The survey point tracking data is recorded by the GPS instrument when we did the household survey. The socio-economic data refers to population, ethnic distribution or GDP (at League / County level) and ecological restoration strategies used in the analysis are collected from the Economic and Social Statistical Yearbook and government's annual work reports published on the official website of the Xilin Gol League government (http://www.xlgl.gov.cn).

4.2.3 Analytical methods

We first conducted a correlation analysis between the perception of CES and the demographic characteristics (age, gender, ethnicity, education and occupation), as well as the different zones where the respondents lived. Kendall's tau correlation coefficient was chosen because it the original data we collected and analysed were categorical (Agresti, 2010). All statistical analysis was conducted in SPSS Statistic 25.

CES Diversity Index (CDI) was used to investigate the relationships between landscapes and CES perception. It is developed from Shannon-Wiener index (Shen et al., 2018) and designed to suit the survey data (Dou et al., 2020), with the assumption that the proportion of people who perceive a CES from a certain landscape feature is positively correlated with its capacity of providing diverse CES (Dou et al., 2019; Palomo et al., 2018).

The following equation was used to represent the CES Diversity Index (CDI) (Dou et al., 2020).

$$CDI = -\sum_{i=1}^{N}\left(\left({}^{Pi}/_{\sum_{i=1}^{N} Pi}\right) \times \ln\left({}^{Pi}/_{\sum_{i=1}^{N} Pi}\right)\right) \qquad \text{Equation 2}$$

Where *Pi* is the number of people who perceived CES *i* from a landscape feature, *i* can be one of *Spiritual and religious services*, *Recreational services*, *Inspirations*, *Aesthetic services*, *Sense of place*, *Educational and sciences* and *Physical and mental health*; *N* is the total number of perceived CES.

By combining the field observations and spatial data of land use distribution (Figure 4-1), we defined eight landscape features related to the normal life of local residents, regarding both the non-material connection to landscapes and the functional terms. These were grassland, cultivated land, forest, river and lakes (seasonal), Ger and Obo (traditional Mongolian dwellings), cultural heritage, desert, and wetlands. Their abundance was determined based on the actual area and distribution of the land use type and the field observations with the help of local experts. For example, the frequency of grassland was obviously high because of its large area and wide distribution. For more scarce landscape features at small sites, such as Ger and cultural heritage, we determined their frequency qualitatively by observations and experts' suggestions. The levels of people's appreciation of those landscape features were represented by the no. of respondents who perceived CES from them.

4.3 Results

4.3.1 Survey responses and respondent characteristics

The final sample consisted of 175 semi-structured interviews. The largest group of interviewee's (35%) was those who were over 60 years old, followed by the 50-60 years old (27.7%). More men than women participated in the interviews (67.2% versus 32.8%, respectively). Han and Mongolian People are the major ethnic groups among the respondents (97.7% in total). In terms of education, 46.3% had

education equivalent to primary school or below, and only 3.3% were university graduates. About 66.3% of respondents have jobs related to animal husbandry. More detailed information is shown in Appendix 4-1.

4.3.2 *Perception of CES and their relationships with respondents' characteristics*

In general, 98.9% of the respondents perceived more than three types of CES, and 81.9% showed appreciation for 6-8 types of CES. The most commonly perceived CES is *Physical and mental health* (97.2%), while the lowest one is *Cultural heritage* (54.8%). According to the results of correlational analysis (Table 4-2), the perception of *Education and sciences* is only significantly correlated with gender, while the perception of *Inspirations* and *Cultural heritage* are significantly correlated to all defined characteristics but gender. There are also significant correlations between the perception of *Physical and mental health* and age, and the perception of *Recreational services* with occupation. The perception of *Sense of place* is only significantly with the variation of zones. However, no significant correlation was found between the perception of *Aesthetic services* and defined characteristics. The variation of zones seems play an important role in perceiving *Physical and mental health*, *Inspirations*, *Cultural heritage*, *Sense of place* and *Recreational services*.

Table 4-2 *Correlation coefficients between perception of CES and respondents' characteristics.*

CES	**Kendall's tau correlation coefficients**					
	Gender	**Age**	**Ethnicity**	**Education**	**Occupation**	**Transects**
Physical and mental health	-0.096	**0.129***	0.065	-0.075	0.106	**0.166***
Inspirations	0.123	**-0.160****	**-0.182***	**0.149***	**-0.236****	**-0.213****
Aesthetic services	-0.081	-0.034	-0.047	0.109	0.010	0.038
Education and science	**-0.186***	0.092	0.094	0.044	0.005	0.116

Spiritual and religious services	-0.021	0.060	-0.021	-0.008	-0.049	0.006
Cultural heritage	-0.055	**-0.195****	**-0.205****	**0.226****	**-0.243****	**-0.211****
Sense of place	-0.106	0.064	0.070	0.035	0.060	0.141*
Recreational services	-0.125	0.087	0.085	0.004	**0.169***	**0.196****

Notes: ** Correlation is significant at the 0.01 level (2-tailed); * Correlation is significant at the 0.05 level (2-tailed); Negative / positive correlation does not have important meaning in gender, ethnicity and occupation because the data are nominal.

4.3.3 The perceptions of selected CES in different transects regarding ethnicity and occupation

In line with the results of section 3.2, we further compared the perception of those five CES in different transects regarding occupation (Figure 4-2) and ethnicity (Figure 4-3). In general, the most perceived CES is *Sense of place* in the Hunshandake sandy pastoral zone (100% perceived by interviewed inhabitants), followed by *Physical and mental health* (95%) and *Recreational services* (92%) in the agro-pastoral transitional zone.

The results of comparison of CES perception regarding occupation (Figure 4-2) showed that in typical the grassland pastoral zone and Hunshandake sandy pastoral zone, the people perceiving all identified 5 CES mainly work in animal husbandry and related jobs. Whereas in the agro-pastoral transitional zone, the majority of people perceiving CES are occupied in farming and related jobs.

The results of comparison of CES perception regarding ethnicity (Figure 4-3) showed that in the grassland pastoral zone, the people perceiving all identified five CES are mainly Mongolian. In the Hunshandake sandy pastoral zone, the number of Mongolian people are only slightly higher than Han people, followed by Hui people. In agro-pastoral transitional zone, the people perceiving CES are all Han.

Figure 4-2 *The perception of CES which identified as significantly correlated with the variation of transects regarding different occupations;* **A***: Physical and mental health;* **B***: Inspirations;* **C***: Cultural heritage;* **D***: Sense of Place;* **E***: Recreational services.*

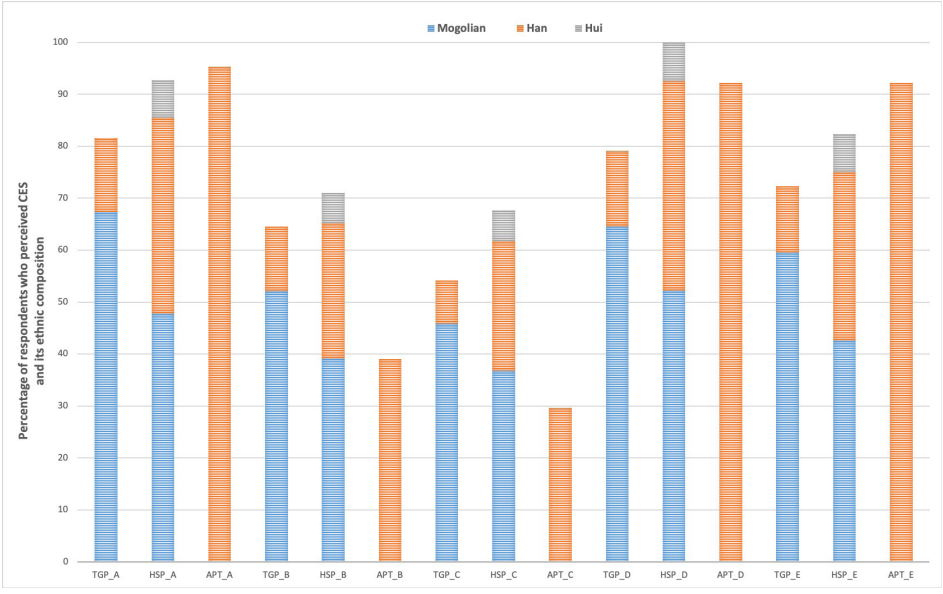


Figure 4-3 *The perception of CES which identified as significantly correlated with the variation of zones regarding different ethnic groups;* **A***: Physical and mental health;* **B***: Inspirations;* **C***: Cultural heritage;* **D***: Sense of Place;* **E***: Recreational services.*

4.3.4 *The relationships between perception of CES and landscapes features*

The results in Figure 4-4 show that CES diversity (CDI) in general is perceived the highest in grassland in all three natural transects, closely followed by wetlands and (seasonal) rivers and lakes. Cultivated land also has a high CDI, but only in the agro-pastoral transitional zone. In the Hunshandake sandy pastoral zone people especially perceive a high CDI in grassland, wetland and (seasonal) rivers and lakes, and desert. In the typical grassland pastoral zone, a high CDI was especially perceived in *Cultural heritage*, temples and Ger and Obo. No CES were perceived from desert, temples, Obo and Ger (CDI = 0) in the agro-pastoral transitional zone; and the CDI of desert and cultivated land in the typical grassland pastoral zone were zero too. Similar results appeared in the Hunshandake sandy pastoral zone where cultivated land was perceived as providing no CES at all.

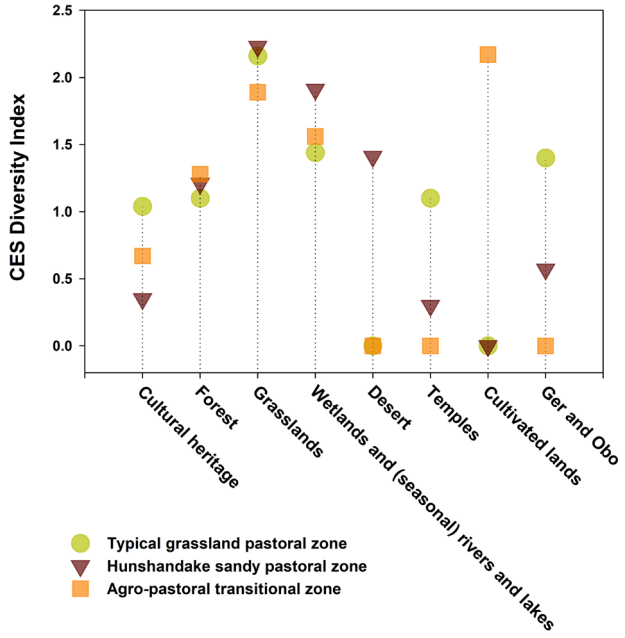


Figure 4-4 *The comparison of CDI among three zones.*

4.4 Discussion

4.4.1 Perceptions of CES in Xilin Gol League

Our results clearly show that a wide range of CES are perceived among the local residents in Xilin Gol League, other than the *Aesthetic services* or *Recreational services* demonstrated in previously CES studies (Dou et al., 2017c; Zoderer et al., 2016b). Especially physical and mental health are highly perceived in Xilin Gol League. The high perception of *Physical and mental health* can be explained by the local outdoor living and working styles. With the increase of outdoor activities resulting in more interactions with landscapes, people perceive more physical and mental benefits from it (Dai et al., 2019).

Consistently with other cross-cultural research (Cuni-Sanchez et al., 2016; Sagie et al., 2013), this study also shows that ethnicity influences CES perception. Although the results show that ethnicity is significantly correlated with inspirations and cultural heritage, the influence of ethnicity on overall CES perceptions is smaller than in previous studies (Dou et al., 2019). The difference can be explained by the fact that shared life-style and livelihoods between the two majority ethnic groups (Mongolian and Han people), which apparently occur more here than in the other cases mitigate their original cultural difference, which used to be believed as main influence factor of the landscape perception (Brancalion et al., 2014; Sagie et al., 2013).

Cultural heritage is perceived the least, because of the rarity of cultural heritage sites and the local nomadic life. However, the perception of cultural heritage is significantly correlated with most of the demographic characteristics (such as age, ethnicity, education and occupation). The differences caused by ethnicity can be explained by the different ethnically cultural backgrounds in the study area. Due

to the traditional nomadic living style the Mongolian people became adapted to regular moving and shifting cultural dependence on particular heritage sites, as well as the sense of specific places in the study areas. We believe the significant correlation between the perceptions of cultural heritage and education, occupation and age are not surprising as both living experiences and education can contribute to the identification and recognition of cultural heritage (Dou et al., 2019; Zhen et al., 2010a).

Although aging is a global problem and especially noticeable in China's rural areas because of the migration of young people to the cities, we believe that the implementation of restoration strategies, such as herder emigration accelerated the trend of aging in the study area. The results of the survey showed that 62.7% of the respondents are over 50 years old. In addition to the corresponded change of occupation (type of employment), the restoration policies also influence local livelihood by shaping population compositions, and possibly further influence the perception of physical and mental health, inspirations and cultural heritage, which showed significantly correlation with age.

By comparing the implemented restoration measures in different zones and the demographic characteristics significantly correlated with the perception of CES, we discovered that the influences of restoration activities are likely to take place in the utility patterns of grassland. On the one hand, it reflected the key purpose of ecological conservation, on the other hand, it may because that the changes of income was largely mitigated by multiple government subsidies given based on different conditions (Du et al., 2016). For instance, by forbidding traditional use of grassland, local residents have to take risks and seek for alternatives to adapt to the changes. Although the restoration strategies provide assistance in job training or employment opportunities, people may take long time to alter their attitude and

willingness when confronted with changes (Du et al., 2014; Zhen et al., 2010b). In addition, the perception of CES significantly correlated with occupation, such as inspirations, cultural heritage and recreational services, could be shifted according to those changes.

4.4.2 Relationships between landscape features and CES

The restoration strategies especially influence the perceived CES in grassland areas, because restoration reduces/limits the use of grassland. The people living in the typical pastoral zone and the Hunshandke sandy pastoral zone are likely to be influenced more than the people in the agro-pastoral transitional zone, because of the higher dependence on grassland for their pastoral activities. As discussed above, the transition of livelihoods and decreasing dominance of on-farm work and grazing may make that people attach less importance to the landscape features (e.g., grassland and cultivated land) they traditionally used for fundamental needs (Roberts et al., 2015). Since the perception of CES by individuals is also shaped by opportunities for local people to participate and get access to resources (Leviston et al., 2018), a reduced access of these landscape features will also result in a reduction of the related perceived CES.

When we compare CDI of each landscape features among the three different transects (Figure 4-4), the results of cultivated land and desert are interesting. Cultivated lands is only perceived to providing diverse CES in agro-pastoral transitional zone, while its CDI is zero in the other two transects. We assume the actual use of landscape features influences the CES perception of these landscape features. For example, cultivated land is not widely distributed nor covers big areas, but local residents have more interaction with it due to demanding working activities. Other studies in different contexts (Dou et al., 2019; Howley et al., 2012;

Tempesta, 2010) demonstrated that when people highly rely on the landscape for basic survival, they normally also perceive it as highly significant for other non-material purposes, such as related worship and religious activities.

In addition, the assumption of utility of landscape is likely linked to another result, that the dominant landscapes play more important roles in CES provision rather than the landscapes less common. As described in the data and methods section, the three dominant landscapes can be understood as three different compositions of grassland, desert and cultivated land. Therefore, we can explain this result from two perspectives. One explanation is that the composition of landscapes affects the perception of landscapes, which has been widely reported in visual preference studies (Häfner et al., 2018; Nikolov et al., 2014; Ode and Miller, 2011). The other explanation is that the different dominant landscapes, as natural / physical capital, determine the lifestyle of the residents who live in these landscapes and shape their perceptions (Sheil et al., 2003).

Similar to the results of cultivated lands, the CDI of desert is high in Hunshandake sandy pastoral zone, while the desert is perceived to provide no CES at all in the other two zones. These results are likely related to the frequency of landscape features. Desert is mostly distributed in Hunshandake sandy pastoral zone so the residents in the other two transects rarely experience or interact with desert for any purpose. Not surprisingly, grasslands are highly perceived as providing diverse CES in all three transects, since it is a dominant landscape feature in all transects and its utility for pastoral livelihood.

We also found that local residents in all three transects generally perceived that wetlands, seasonal rivers and lakes provide diverse CES and have higher CDI scores than other landscape features, although wetlands and water bodies have

a low frequency among all landscape features. Similar findings are described in many previous studies (Costanza et al., 2014; Dou et al., 2017c; Fisher et al., 2011; Jenkins et al., 2010). An explanation for this phenomenon is that water bodies and wetlands provide an additional value as a scarce resource (Dou et al., 2017c; Hardin, 1968).

4.4.3 Limitations

The influential factors of interaction between people and human perception were investigated based on a relatively small data set. The data collection was largely limited by time constraints (the difficulty of visiting more nomadic families) and geographic constraints (low population density and far distances between households). The relatively small sample also limited drawing conclusions for the different demographic groups. Consequently, we had to be careful not to rely too heavily on results for specific categories, especially for the different demographic factors. The potential bias in responses caused by people's subjectivity was prospective but considered acceptable, because it is an inevitable issue in perception and non-priced valuation studies, not decreasing the value of such surveys (Mjelde et al., 2012; Van Berkel and Verburg, 2014).

Another bias might be caused by using the respondent-determined landscape frequency instead of a more detailed landscape pattern index to figure out the effects of landscape features. However, the spatial context limited the application of such index, because of the unique characteristics of the local identified landscape features. For example, most of the Obo and Ger are regularly moving, having no fixed positions. And for cultural heritage sites, there is little spatial information of their location. Therefore, we used land cover maps and field observations to primarily determine the frequency of each landscape feature and

also used local experts who are familiar with the geographic and social context to mitigate the potential bias.

In addition, a more complete picture of the influences of restoration strategies on human perception could be obtained if we can compare our results with those in other restoration areas. However, reliable data about other restoration areas have not been published to the best of our knowledge. To solve this problem, we compared our results with cases which are partly similar to our study. For example, we compared our results with a case in Guyuan, China, where human perceptions in agricultural landscapes were studied (Dou et al., 2019). Future research should account for more related cases and more spatial explicit information.

4.5 Conclusion

Our research found that the variation of zones seems play an important role in perceiving physical and mental health, inspirations, cultural heritage, sense of place and recreational services, while no significant correlation was found between the perception of aesthetic services and defined characteristics. The influence of ethnicity on the perception of CES is likely to be mitigated by shared lifestyle and livelihoods between the two majority ethnic groups (Mongolian and Han people).

The restoration strategies especially influence the perceived CES in grassland areas because of the reduction or limitation of use of grassland. The transition of livelihoods and decreasing dominance of on-farm work and grazing may make that people attach less importance to the landscape features. In addition to the corresponded change of occupation (type of employment), the restoration policies also influence local livelihood by shaping population compositions, and possibly

further influence the perception of physical and mental health, inspirations and cultural heritage, which showed significantly correlation with age. Another consistent finding is that people highly rely on the landscape for basic survival, they normally also perceive it as highly significant for other non-material purposes, such as related worship and religious activities.

Although there remains a need to integrate spatial explicit social science data with detailed landscape features for elaborating landscape patterns, livelihoods shifting and CES as local benefits, our research has highlighted that in addition to the ecology / economics-dominated targets, a more holistic perspective should be considered in ecological restoration regarding both sustainable management and local well-being.

Scientists field observation
(Huiwen wetland, Hainan China)

Chapter 5

The content of this chapter is based on a submitted paper "How do human interventions influence local perceptions of Cultural Ecosystem Services, a case study of Huiwen wetland, a coastal landscape in China". Yuehan Dou, Mengxiao Liu, Martha Bakker, Xiubo Yu, Gerrit-Jan Carsjens, Rudolf de Groot. (Submitted to *Ecosystem Services)*.

How do human interventions influence local perceptions of Cultural Ecosystem Services, a case study of Huiwen wetland, a coastal landscape in China

5.1 Introduction

Maintaining and enhancing the beneficial contribution of landscapes to quality of life is a major challenge of our time (Díaz et al., 2018). For centuries, researchers − from philosophers to engineers − have tried to characterize the complex, dynamic relationships between humans and landscapes (Gould et al., 2015; Haines-Young and Potschin, 2009; Kaplan and Kaplan, 1989; Schama, 1995). Coastal landscapes in China are changing rapidly due to economic development and urbanization, as well as measures to mitigate ecosystem degradation (Li et al., 2020; Ouyang et al., 2016). These changes may undermine the ways in which people interact with the landscapes in which they live (Dou et al., 2019).

Aided by ecologists and economists, the concept of Ecosystem Services (ES) has been widely adopted by scientists and policymakers as a framework to assess the consequences of landscape interventions, not only on provisioning services (food, fibre and fuel production), but also on regulating, supporting, and cultural ecosystem services (Collins et al., 2011; Costanza et al., 2014). Cultural ecosystem services (CES) refer to the benefits people receive from ecosystems in the form of spiritual, religious, recreational, inspirational and educational experiences (Dou et al., 2017b; Roux et al., 2020; Russell et al., 2013; Seppelt et al., 2011). With or without the label of CES, the non-material benefits people gain from landscapes have been intensively studied in recent years (Chan et al., 2011a; Daniel et al., 2012; Groot et al., 2018; De Groot et al., 2002; Kibria et al., 2018; Roux et al., 2020; Xu and Liu, 2019).

However, current studies have been criticized for voluntary self-exclusion of disciplines, over-valuing tourist-attractive landscapes and neglecting critical social impacts or dynamics (Fish et al., 2016b; Gould et al., 2015; Martín-López et al., 2012; Pleasant et al., 2014). Furthermore, studies on the relationships between local residents, CES and landscapes and the resilience of local perception of CES facing human intervention are rare. The attention for the importance of CES for sustainable landscape management is expected to grow in decision-making processes, as these services reflect the concerns of local communities associated with landscapes (Gould et al., 2015; Kibria et al., 2018).

In order to better inform planners and policymakers about how their actions affect local people's relationship with landscapes, more research is required about how local communities experience the CES provided local landscapes, especially the landscapes that sensitive to interventions. For instance, the coastal wetland in the south of China is an area that is subject to lots of human interventions, in the form of potential ecological restorations, local infrastructure constrictions, and

commercial aquaculture, which are likely to affect the local landscape features and possibly further affect the provision of CES.

Hence, we conducted questionnaires among local residents in the coastal area of southern China to better understand the relationships between coastal landscapes and the local perception of CES. We studied 23 coastal villages and assessed 1 - the local residents' perception of CES from coastal landscapes, 2 - the influence of demographic characteristics on the local perception of CES, 3 - the influence of human interventions on the local perception of CES.

5.2 Data and methods

5.2.1 Study area

The detailed information of Huiwen Wetland is traduced in section 1.5.4 Pond-based fish / shrimp breeding and farming are the main local livelihoods. The distribution of study area and sampling sites are shown in Figure 5-1.

5.2.2 Data collection

The data collection methods included questionnaires, field observation and interviews. The data were collected between December 2018 and February 2019. The questionnaire involved questions about 9 types of CES, including *Aesthetic services*, *Recreational services*, *Cultural heritage*, *Physical and mental health*, *Spiritual and religious services*, *Education and science*, *Inspirations*, *Sense of place* and *Social relations*. The selected CES are based on the categories in the Millennium Ecosystem Assessment (2005). Since not all CES were applicable and understandable in a given local context, we incorporated simplified descriptions of CES, similar to

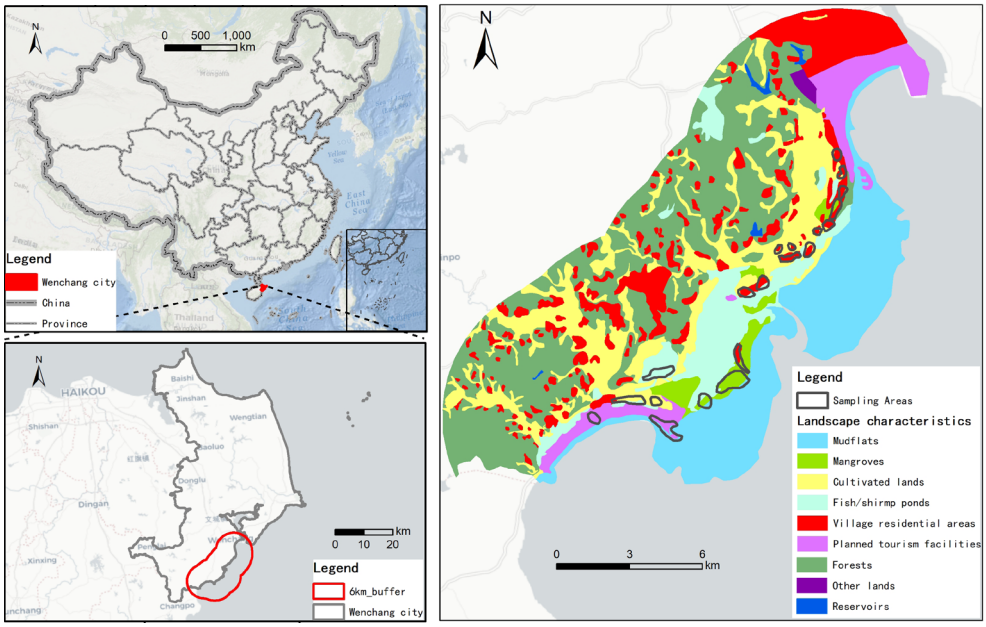


Figure 5-1 *Study area and sampling sites.*

other studies (Bryce et al., 2016; Chan et al., 2011a; Tengberg et al., 2012; Tratalos et al., 2016). For example, *Physical and mental health* was assessed using the indicator statement "Visiting these places gives me a sense of freedom" (Tratalos et al., 2016) and "Visiting these places leaves me feeling healthier". (Bryce et al., 2016). A 5-point Likert scale was used for the answer options. We applied stratified random sampling of residents, whereby the stratification zones were the small villages and counties along the coastal wetlands in the study area. The full questionnaire can be found in the Appendix 5-1.

With the help of 11 skilled surveyors from Hainan University, the questionnaire covered 23 sampling sites in the study area (Figure 5-1), and 685 responses. The questionnaire was conducted face-to-face or having the respondents complete the questions under the researchers' guidance. When conducting the questionnaire, we

also recorded the location of the respondents using a GPS instrument. Other spatial data used in this study were taken from remote sensing images with a spatial resolution of 1 m, acquired from Google Earth on March 2019.

Field observations were conducted to identify the dominant local landscape features. Seven most common landscape features in the local context were identified: villages, mudflats and water bird areas, cultivated lands, temples, mangroves, beach and coral reefs and open sea. In total, 11 key stakeholders were interviewed separately, including fish farmers (2), farmers (1), NGOs (3), government officer (2), and academic researchers (3) to identify potential changes in the perceived CES due to policy or other human interventions. The summarized potential human interventions from interviews were used to define model variables.

5.5.3 The role of demographic characteristics on perception of CES

To analyse the relationships between the demographic characteristics of the respondents and their perception of CES we applied Structural Equation Modelling (SEM). SEM can be used to explore the relationships between a complex of factors and to differentiate in the relationship intensity between each factor (Rosseel, 2012). This allows the opportunity to both evaluate the model structure (the pattern of relationships among variables) and to quantify these relationships using field data (Sutton-Grier et al., 2010). The demographic variables comprised: age, gender, education, occupation, income, village and the number of years the respondent has lived in the village (Table 5-1). We used the answers of questionnaire (5-point Likert-scale) as indicators (1-5) for the levels of perception among the respondents.

An initial model was developed based on two main hypotheses, using previous studies as references. We first hypothesized that the perceived CES are related to the defined demographic characteristics (Chen et al., 2017; Cuni-Sanchez et al., 2016; Oleson et al., 2015; Tengberg et al., 2012), and then hypothesized that there are also inter-relationships among the demographic factors (Dou et al., 2020). Therefore, we included both direct and indirect pathways between CES and demographic characteristics in the initial conceptual model (Figure 5-2) and tested it with the observational dataset. When the initial model was rejected because of a poor fit to the observational dataset, we examined the modification indices (MI) to detect discrepancies between the model and the data. The Maximum Likelihood method was chosen for parameter estimation.

Table 5-1 *Variables used in SEM.*

Demographic variable	Description	Measuring scale
Village	Code of village the respondent lives in	Nominal (23 categories)
Income	Scale of respondent's annual income	Ordinal (6 categories)
Age	Scale of respondent's age	Ordinal (6 categories)
Education	Scale of respondent's education level	Ordinal (5 categories)
Occupation	Code of respondent's occupation type	Nominal (12 categories)
Living length	Scale of the length the respondent lives in the study area	Ordinal (9 categories)
Gender	Code of respondent's gender	Nominal (2 categories)

In the process of model improvement, we used a series of indexes of model fit. Chi-square was used to primarily test the model fit. When the chi-square value is low and insignificant ($p > 0.05$), there is no significant difference between observed and predicted data, and thus the tested model is plausible (Byrne, 2013; McDonald and Ho, 2002; Sutton-Grier et al., 2010). We also used the Comparative Fit Index (≥ 0.95), Standardized Root Mean Square Residual (≤ 0.05) and Mean Square Error

of Approximation (≤ 0.05) as model fit measures (Byrne, 2013; Hooper et al., 2008). We retrieved the parameter estimates and calculated the path coefficient as the effects of variables when all the model fits were satisfactory. All SEM analysis were conducted in R lavaan package 0.6-1 (http://lavaan.ugent.be).

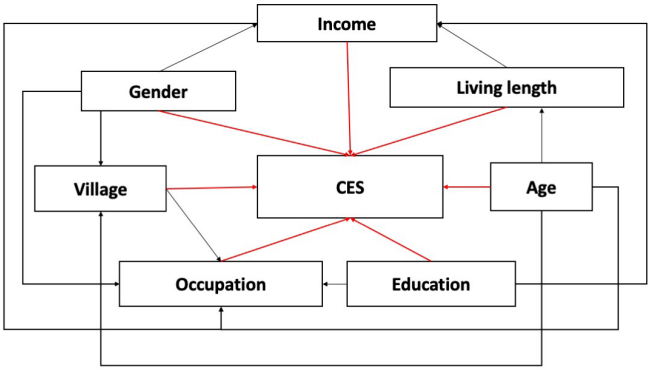


Figure 5-2 *Initial conceptual model (adopted from Dou et al., 2020), the red arrows indicate direct relationships between CES perception and demographic factors, while the black arrows indicate indirect relationships between CES perception and demographic factors.*

5.2.4 The role of landscape factors on perception of CES

Because CES are not only dependent on the observer, but also on the 'real' quality of the landscape, we can also hypothesize that some landscape features are likely to provide more CES than others (Palomo et al., 2018; Shen et al., 2018). To test this, we analysed the perception of CES from different landscape features using the CES Diversity Index (CDI). This diversity index measures how many CES are perceived and by how many people. The index was developed to assess the spatial variability of CES by connecting the collected perception data with landscape features (Dou et al., 2020). CDI is defined as:

$$CDI = -\sum_{i=1}^{N}\left(\left({}^{Pi}/_{\sum_{i=1}^{N} Pi}\right) \times \ln\left({}^{Pi}/_{\sum_{i=1}^{N} Pi}\right)\right) \qquad \text{Equation 2}$$

Where *Pi* is the number of people who perceive CES *i* from a landscape feature (see section 5.2.2); *N* is the total number of perceived CES. CES *i* can be: *Spiritual and religious services*, *Cultural heritage*, *Recreational services*, *Inspirations*, *Aesthetic services*, *Sense of place*, *Educational and sciences*, *Physical and mental health* and *Social relations*.

5.2.5 *The effect of human interventions on CES perception*

To examine whether human interventions in the coastal landscapes influenced the local perception of CES, we converted the information of the perceived changes collected in the interviews to predictor variables and applied the Random Forest (RF) method to predict the importance of each variable. RF is an ensemble learning method for classification and regression (Breiman, 1996; 2001; Ho, 1995). In RF, the importance of a variable is based on how much the prediction error increases when the out of bag (OOB) data for that variable is permuted while all other data remain unchanged (Liaw and Wiener, 2002). Compared with other machine learning methods, RF has the advantage that it has fewer tuning parameters (Probst et al., 2019). The two most important hyperparameters in RF are tuned: mtry, which represents the number of variables used at each split; and ntree, which represents the number of decision trees to grow.

We used the default (500 trees) of the ntree parameter for all nine CES, because 500 trees were sufficient to ensure the stability of both the OOB and test error (Genuer et al., 2008). The parameter mtry was tuned using tuneRF with the minimization of out-of-bag-prediction error as an objective function to select an appropriate value for mtry. Finally, the variable importance was extracted based on node impurity, which was calculated based on the mean decrease in Gini index of prediction after splitting nodes (Wright and Ziegler, 2015). To validate the model, we randomly

split the data into a training / calibration set (80% of the total data) and a testing / validation set (20% of the total data) (Genuer et al., 2008). Each of the five levels of each CES perception were sampled independently to ensure that the training and testing dataset contained the same percentage of samples for each grade. The calculated variable importance (abbreviated VI) (Mean Decrease Gini) indicated the importance of predicator variables.

The data used in RF were the perception of each CES (with 5 levels), collected from the questionnaire, and the positioning data of each respondent. According to the field observation and interview, potential human interventions were summarized and used to define model predictor variables. The predictor variables used to predict the CES perception are shown in Table 5-2. The spatial data used in this analysis was interpreted from remote sensing images within a 300-meter buffer zone of the samples position. Because all sampling sites were distributed along the coast, the location of most respondents was within 300 meters from the sea. All the RF analyses were conducted in R 3.6.1 (http://www.R-project.org/) and Random Forest 4.6-1 package (Wright and Ziegler, 2015).

Table 5-2 *Predictor variables used in random forest.*

Potential human derived interventions	**Variable abbreviations**	**Description**
Construction of infrastructure	dist_road	Distance to the nearest road from respondent's position
Economically derived expansion or environment conservation derived decrease	dist_pond	Distance to the nearest pond from respondent's position
Economically/naturally derived loss	dist_mud	Distance to the nearest mudflats from respondent's position
Economically derived expansion or environment conservation derived decrease	dist_mine	Distance to the nearest mining point from respondent's position

Economically/domestically derived loss/ environment conservation derived increase	dist_mangrove	Distance to the nearest mangrove forest from respondent's position
Economically/domestically derived loss	area_mudflats (%)	Proportion of the area of mudflats within a 300-metre buffer zone
Economically/domestically derived loss/ environment conservation derived increase	area_mangroves (%)	Proportion of the area of mangroves within a 300-metre buffer zone
Economically/domestically derived increase	area_cultivated lands (%)	Proportion of the area of cultivated lands within a 300-metre buffer zone
Economically derived expansion or environment conservation derived decrease	area_ponds (%)	Proportion of the area of (fish/shrimp) ponds within a 300-metre buffer zone
Economically derived expansion	area_residential areas (%)	Proportion of the area of residential areas within a 300-metre buffer zone

5.3 Results

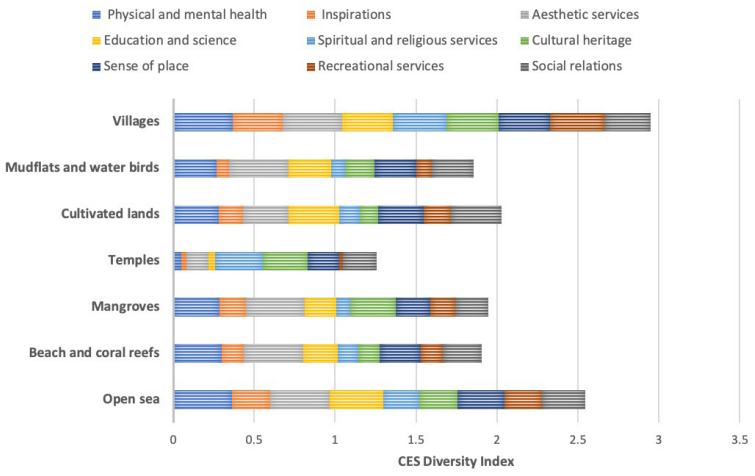
5.3.1 Local perception of CES from different landscape features

The final sample consisted of 632 questionnaires (92.3% of the total). The summary of respondents' demographic information is shown in Appendix 5-2. In general, over 90% of the respondents perceived *Social relations*, *Sense of place* and *Recreational services* from the local landscape, of which *Social relations* are perceived the most (97.1%). *Inspiration and Cultural heritage* are perceived least with percentages of 33.1% and 45.5% respectively.

When comparing the results of the CES Diversity Index (CDI) for each identified local landscape feature, we found that villages have the highest CDI score and contribute to all types of CES (Figure 5-3a). These contributions are equally

distributed among the different types of CES (Figure 5-3b). Contrarily, the CDI of temples is the lowest, which means temples are perceived as the least important in providing different kinds of CES (CDI = 1.26). The results show that the contribution of temples to CES provision is concentrated around just a few CES, and mostly to *Spiritual and religious services*. (Figure 5-3b). The composition of CDI of temples also shows that temples are mainly related to *Spiritual and religious services* and *Cultural heritage*, rather than *Physical and mental health* or *Inspiration* (Figure 5-3a).

(a)



(b)

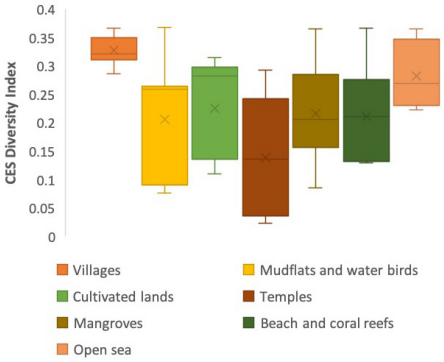


Figure 5-3 (a) *CDI of different landscape features and its composition;* ***(b)*** *the box plot of CDI of each CES in different landscape features.*

Surprisingly, cultivated lands were perceived slightly more important to provide CES than mangroves, mudflats and water bird areas and beach and coral reefs, especially the provision of *Education and science* and *Social relations*. *Aesthetic services* and *Sense of place* were perceived more or less the same from all landscape features, while *Inspiration* was perceived as highly associated with villages and open sea (Figure 5-3a).

5.3.2 *Relations between demographic characteristics and the perception of CES*

The final structural model was improved by adjusting the hypothesized relationships in the conceptual model (Figure 5-2). The results of final structural model are shown in Table 5-3. The regression results show that the relationships with demographic characteristics are different for each CES. For example, *Physical and mental health* tend to be perceived more by men, people with higher income and people with shorter living length. While the perception of *Inspiration* differs significantly from village to villages. The model results also show that the demographic characteristics are significantly related with each other (Table 5-3).

Physical and mental health
Inspirations
Aesthetic services
Education and science
Spiritual and religious services
Cultural heritage
Sense of place
Recreational services
Social relations
Occupation
Income
Village
Living length
Education

In general, the gender has significant relationships with the perception of *Physical and mental health* and *Education and science* only, but indirectly influences the perception of other CES by being significantly related to all other demographic characteristics but age. Income has significant relationships with

the perception of *Physical and mental health* and *Aesthetic services*, meanwhile influencing other CES by being associated with Occupation. More than age, people having longer living length perceived more *Social relations* and *Sense of Place*, but less *Physical and mental health* and *Spiritual and religious services*. In addition, the higher the education, the lower the perception of the service *Social relations*.

The results showed that *Recreational services* and *Cultural heritage* were influenced by villages only. *Spiritual and religious services* are also significantly related with villages, as well as occupation and living length. *Education and science* are mostly influenced by demographic characteristics compared with other CES. The perception of *Education of sciences* is significantly related with gender, age, education and occupation (Table 5-3).

Table 5-3 *Coefficient values of demographic characteristics and CES perception.*

Gender	Village	Living length	Income	Occupation	Age	Education	R^2
-0.078*	-0.045	**-0.103***	**0.122****	X	X	X	0.406
-0.024	**-0.180****	-0.050	0.049	X	X	X	0.064
0.018	**-0.093***	-0.080	**0.151***	-0.031	X	X	0.338
-0.294**	0.011	-0.007		**0.174****	**-0.123***	**0.088***	0.247
-0.026	**0.108****	**-0.116****	-0.033	**0.161****	X	X	0.345
-0.064	**-0.174***	0.000	-0.061	X	X	-0.043	0.119
0.062	-0.068	***0.115****	0.004	**0.089***	X	X	0.228
X	**-0.147****	0.032	-0.019	0.01	X	X	0.356
X	0.012	**0.164****	-0.055	0.054	X	**-0.131****	0.231
0.103**	**0.073***	X	**0.124****	X	**0.547****	**-0.139****	0.297
-0.175**	X	**-0.164****	X	X	0.060	**0.101***	0.045
0.158**	X	**0.111***	X	X	X	X	0.041
-0.144**	X	X	X	X	**0.593****	**0.127****	0.430
0.188**	-0.075	X	X	X	0.272**	X	0.098

Chi-square: 0.966; CFI: 1.000; RMSEA: 0.000; SRMR: 0.013

Note: Coefficient values significant at p-value < 0.05 are shown in **bold**. * p < 0.05; ** p < 0.01; X indicates no relationship.

5.3.3 *Influence of defined human derived changes on the perception of CES*

In general, the results of Random Forest (RF) showed that the distance variables (dist_) have a higher influence on the perception of all nine CES than the areas variables (area_). The training and test accuracy can be found in Appendix 5-3. The perception of *Education and science*, *Cultural heritage* and *Inspiration* seem relatively more sensitive to these changes, since half of the variables have higher influential coefficients on these CES (Figure 5-4). *Social relations* and *Sense of place* were relatively less influenced by these variables, compared with other CES in general. The perceived CES are influenced less by area variables compared with distance variables, and there are no significant differences in the influence of the area variables, especially the area of mudflats, among the different CES.

The distance to mining points has the highest influence on the perception of *Spiritual and religious services* (61.48), of which the VI was very close to the ones of *Cultural heritage* (59.60) and *Education and sciences* (59.40). The distance to mangroves influences the perception of *Education and science* more than other CES (52.48). The distance to mining points, ponds and mudflats also have a high influence on the perception of *Inspiration*. In addition, the distance to mangrove forests has a high influence on the perception of *Aesthetic services* and *Physical and mental health* (Figure 5-4).

Changes in area of mudflats seem to have little influence on the perception of CES according to the results. The VI of the nine types of CES are all less than 1 (between 0.61 to 0.97). The highest VI of the area variables is the residential areas, influencing the perception of *Sense of place* (Figure 5-4). The areas of mangrove forest, ponds and cultivated lands influence the perceived *Inspiration*, *Cultural heritage* and *Education and science* the most respectively.

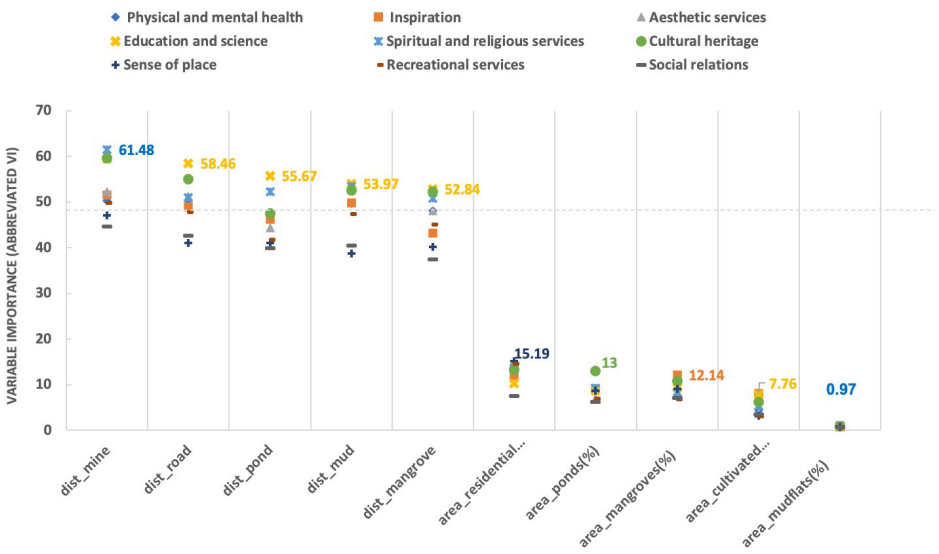


Figure 5-4 *Variable importance plot of RF with defined predicator variables on the perception of CES, variables presented in descending order of variable importance based on mean decrease in Gini index.*

5.4 Discussion

5.4.1 Relationships between people, perception of CES and local landscape features

The results revealed a distinct relationship between villages and the perceived CES. The role of villages is twofold: First, it can be considered as a landscape feature, the role of the village in CES provision is attached with the experiences and shared activities of inhabitants, which is also shown by other studies (Dou et al., 2019; Plieninger et al., 2013b; Zoderer et al., 2016a). Secondly, it also serves as a demographic variable, in the sense that the perception of CES by an individual is

strongly determined by the villages someone is from. In the study area, most of the villages are traditional family villages, which means that most of the residents in the village share a family history, as well as worshiping and living styles (Tian and Guo, 2019; Xie and Wall, 2002). This could explain why the perception of *Aesthetic services*, *Cultural heritage*, *Recreational services* and *Spiritual and religious services* differs strongly from village to village. In addition, the significant relationship between village and occupation verified that collective management of resources and collective economic development is still very common in Chinese coastal villages (Yi, 2019).

In line with previous studies, temples are mainly related to *Spiritual and religious services* and *Cultural heritage* (Dou et al., 2020; Dou et al., 2019; Gao et al., 2018; Huu et al., 2018). Surprisingly, cultivated lands were perceived as slightly more important in providing CES than landscape features such as mangroves, mudflats and water bird areas or beaches, especially in providing *Social relations* and *Education and sciences*. The higher perceived importance can be explained by the higher interaction between people and cultivated lands, their day-to-day experiences and related memories (Chen et al., 2017; Roux et al., 2020; Tscharntke et al., 2005). People have to spend more time in the cultivated land for harvesting than other landscape features and farming is often a group activity in villages. People gained traditional and practical farming knowledge from farming and gained social relations when they help each other and work together in busy seasons (Dou et al., 2019).

This may also be connected to another result, which is that the education level has a significant negative relationship with the perception of *Social relations*. Higher educated people spend less time on farming and associated social relations. Moreover, people who follow higher education mostly leave the village and

therefore have less shared experiences, activities and living styles which are essential elements for the perception of *Social relations* (Martín-López et al., 2019). Furthermore, our results showed that the time people lived in the village (living length) is more important in perceiving *Social relations*, *Sense of place*, *Physical and mental health* and *Spiritual and religious services* than age. This result supports the claim that CES are perceived through interacting with landscape features (Kibria et al., 2018; Roux et al., 2020), and the influence of demographic factors (such as age) on perception is shaped by the experiences of interacting with landscapes (Dou et al., 2020) . In addition, the SEM results showed that there were also inter-relationships among demographic characteristics, which point to indirect relationships between demographic factors and the perception of CES.

5.4.2 *Potential influences of human derived interventions on the perception of CES*

Human interventions are likely to change or shape the current villages and lead to the change of perception of CES. the VI are neutral, we could still conclude that *Education and science*, *Cultural heritage* and *Inspiration* are under the highest risk of disappearing due to human interventions.

The results of the Random Forest (RF) method indicated that the predictor variables regarding distance to particular activities have more influence on the perception of CES than the variables regarding the extent of a particular landscape (i.e. the area variables). Although area of landscape is one of the most important factors in the spatial analysis of CES (Guyuan Bureau of Statistics, 2016a; Ramachandra and Kumar, 2004; Sherrouse et al., 2017), the (visual and/or physical) accessibility of landscape features in long and narrow coastal areas seems more important to local perception. This result offers the opportunity to mitigate the negative influences

of landscape interventions (such as mining points) by increasing the distance to local communities. However, the opposite cannot be concluded, i.e. that a decrease in the area of natural coastal landscape features (such as mangrove and mudflats) will not influence the local perception of CES. Because as in most the coastal areas, villages are aligned along the coastline. When the areas of mangroves / mudflats along the coast are larger, their distance to the inhabitants will also be affected.

Although the results indicate that the area of mudflats and mangroves have little influence on the perception of CES (Figure 5-4), the area of mudflats and mangroves indirectly influences the local perception by providing habitats for water birds, which showed strong relations with the perception of *Aesthetic services* and *Education and sciences* in both our results (Figure 5-3a) and in other studies (Green and Elmberg, 2014; Guyuan Bureau of Statistics, 2016a; van Roomen et al., 2012). The RF results also showed that the perception of *Cultural heritage* and *Inspiration* seems to be more sensitive to human interventions. This may be explained by their significant relationships with villages (Table 5-2).

5.4.3 Limitations

The analysis of the perception of CES is based on questionnaire data. Although we straight-randomly sampled the respondents and surveyed with trained helpers, a potential bias in the responses caused by people's subjectivity has to acknowledged. We avoided to heavily rely on the results for specific categories of demographic factors and accepted the potential bias as something inevitable in perception and non-priced valuation studies (Mjelde et al., 2012; Van Berkel and Verburg, 2014). Another type of potential bias might be caused by using field observation to determine the landscape features. Because of the characteristics of coastal wetlands, some landscape features cannot be properly indicated from maps,

such as water bird areas and mudflats. By using local experts who were familiar with the geographic and social context of the study area, we tried to mitigate this potential bias. Although SEM can test models representing causal relationships, it cannot be used to prove causality or predict / reproduce processes, nor can the RF method (Angelini et al., 2016; Grace, 2006; PEARL, 1995). Therefore, we used SEM and RF only as tools to identify which defined characteristics influenced the perception of CES, in order to improve our understanding of the relationship between the perception of CES and landscapes and discuss the potential influences with the locally collected information and other references.

5.5 Conclusion

This research aimed to explore the potential influence of human interventions on the perception of CES of coastal landscapes in China. Villages influence the perception of CES as a demographic characteristic (the community that respondents live in) and providing CES as a landscape feature. Moreover, in the local perception, cultivated lands play a more important role in providing CES than the dominant landscape features of coastal areas, especially for the provision of *Social relations* and *Education and sciences*. Human interventions that result in changes in distance to landscape features showed to be the most influential for changes in perception of CES of local residents. Changes in distance showed to be more influential than changes in the area of landscape features. In addition, the perception of the two lowest perceived CES, *Inspiration* and *Cultural heritage* showed to be most sensitive for changes in both the distance to and the area of landscape features.

Concluding, landscape management and human interventions can negatively influence the perception of CES when ignoring the contribution of non-dominant

landscape features (such as cultivated land and villages). As most of the perception of CES differs significantly from village to villages, the implementation of any ecological restoration or other interventional projects may give more attention at village scale. While CES have been increasingly applied in ecosystem services assessment, this paper highlights the need to identify different perceived CES and consider the diverse roles of local landscape features for CES provision from local perspective to guide multi-functional and sustainable landscape management.

Seagrass
(Huiwen wetland, Hainan China)
(© mr.Gang Lu)

Chapter 6

Synthesis and conclusion

The objective of this thesis was to investigate the non-material links between people and landscapes by analysing CES from an interdisciplinary perspective. To do so, four typical Chinese landscapes were taken as case studies. Four research questions were formulated:

1. What CES are perceived by local inhabitants in selected landscapes of China?
2. How are the perceived CES correlated with the characteristics of the local population (such as gender, age, and ethnicity) in different landscapes?
3. How are the perceived CES influenced by the landscape characteristics in different landscapes?
4. How do ecological restoration and conservation projects influence the perceived CES in different landscapes?

I will first summarize the answers to the research questions for each type of landscape separately, followed by a synthesis and discussion of the commonalities and differences. Then I critically reflect on the limitations of the research, and I conclude with a set of recommendations.

6.1 Synthesis

The first landscape in Chapter 2 was a cultivated dryland landscape in Guyuan. The results showed that residents in Guyuan who have been affected by the Grain for Green program perceived at least three types of CES provided by the landscape, and some perceived all eight types (*Aesthetic services*, *Recreational services*, *Education and science*, *Inspirations*, *Sense of place*, *Cultural heritage*, *Religious and spiritual services* and *Physical and mental health*). The high number of perceived CES was explained by the diverse cultures and long history of the study region and the possibility that these CES are correlated in special bundles. I also found that respondents especially valued the *Aesthetic services* and *Recreation services* of the landscape, whereas the *Religious and spiritual service* played a minor role. The respondent's gender significantly affected the perception of *Sense of place*, *Religious and spiritual services* and *Physical and mental health*. Age significantly affected the *Sense of place*, *Cultural heritage* and *Religious and spiritual services*. Ethnicity only significantly affected religious and spiritual services, as the Hui people were more receptive to these services than Han people. Education significantly affected *Aesthetic services*, *Cultural heritage* and *Religious and spiritual services*, with the higher educated inhabitants being less receptive to these services than those with only low or no education. I found that residents perceived cultivated land as more important than forest and other land uses for the provision of CES, which can be explained by the fact that the local residents thoroughly understand the agricultural landscape they have relied on for generations and consequently perceived agriculture as more important than nature. Residential areas were also perceived as contributing to CES provision, probably resulting from the local tradition of paying visits to other people and strong bonds within their neighbourhood. In addition, respondents generally believed that the values for *Physical and mental health*, *Religious and spiritual services* and *Cultural heritage* had decreased under

the Grain for Green program, whereas the values of *Aesthetic services*, *Recreational services*, *Education and science* and *Inspiration* increased.

The second landscape in Chapter 3 was a wetland landscape in the Genheyuan Region. The results showed that 93.5% of the residents in this region perceived at least six types of CES provided by their landscape, and 70.8% perceived all nine types (*Aesthetic services*, *Recreational services*, *Education and science*, *Inspiration*, *Sense of place*, *Cultural heritage*, *Social relations*, *Religious and spiritual services* and *Physical and mental health*). The high number of perceived CES was explained by the diversity of landscape features (including traditional residential forms and iconic animals), the multiple ethnic communities, as well as the presence of a national wetland park. The establishment of the national park and the adjustment of forest lumbering policy most likely raised the awareness among the residents about the aesthetic, recreational and educational significance of their landscape. It evoked a change in livelihoods which probably made people perceive more non-material services and attach more importance to the tourism related CES than the raw material provisioning they paid attention to before. The results showed that the selected demographic characteristics (age, occupation, education, income, ethnicity and gender) influenced the perception of CES directly, but also indirectly through influencing other demographic characteristics. Age was especially correlated with *Sense of place* and *Cultural heritage*, with older people being less receptive to these services than younger people. While ethnicity influenced all CES but *Physical and mental health* and *Cultural heritage* in Genheyuan region, while Han people perceived these services less than others. Among all the identified landscape features, bodies of water such as wetland and seasonal rivers and lakes were perceived as providing most CES, both in number and in magnitude. Due to the strong and mixed ethnic cultural identities in the area and the worshipping of nature by nomadic groups, people also perceived multiple CES from iconic

animals and traditional residential areas. Although tourism facilities were one of the dominant landscape features in Genheyuan region, they were perceived less than other CES.

The third landscape in Chapter 4 was a grassland landscape in Xilin Gol League. The results showed that CES were highly perceived among the local residents, 98.9% of the respondents perceived more than three types of CES, and 81.9% showed appreciation for 6-8 types of CES (*Aesthetic services*, *Recreational services*, *Education and science*, *Inspiration*, *Sense of place*, *Cultural heritage*, *Religious and spiritual services* and Physical and mental health). The perception of *Education and sciences* was significantly correlated with gender only, men showing a higher perception than women. In addition, the perception of *Inspiration* and *Cultural heritage* was significantly correlated to all defined characteristics but gender. There were also significant correlations between the perception of *Physical and mental health* and age, which older people appreciate more, and the perception of *Recreational services* with occupation, as people working for the national wetland park perceived more *Recreational services* than people with other occupation. The perception of *Sense of place* was only significantly related with the three transects within the area, which showed that people living in different transects perceived sense of place differently. *Aesthetic services* were perceived regardless of any of the demographic characteristics. The transects seemed to affect the perception of *Physical and mental health*, *Inspiration*, *Cultural heritage*, *Sense of place* and *Recreational services*. The respondents in different transects perceived the importance of the same landscape feature differently, which was assumed to be influenced by the utility of landscape features and the frequency of landscape features (i.e. the more common a landscape feature was, the higher the value was attached to it). I also found that the implementation of comprehensive grassland restoration mainly affected the economic dependence of grassland by limiting the accessibility, but the

resulting potential decrease of local income was mitigated by multiple government subsidies. In addition, the resulting changes of income, occupation and age (young labour migration) changed the composition of age and occupation groups, and possibly further influenced the perception of *Physical and mental health*, *Inspiration* and *Cultural heritage* through significantly correlation with age and occupation.

The fourth landscape in Chapter 5 was a coastal wetland in Wenchang.

Among all identified nine types of CES (*Aesthetic services*, *Recreational services*, *Education and science*, *Inspiration*, *Sense of place*, *Cultural heritage*, *Social relations*, *Religious and spiritual services* and *Physical and mental health*), over 90% of the respondents perceived social relations, sense of place and recreational services from the local landscape, of which *Social relations* were perceived the most (97.1%). *Inspiration* and *Cultural heritage* were perceived the least with percentages of 33.1% and 45.5% respectively. *Physical and mental health* tended to be perceived more by men, people with higher income and people who have lived in the area for less time. The perception of *Inspiration* differed significantly from village to village. More than age, people who have lived longer in their village perceived more *Social relations* and *Sense of place*, but less *Physical and mental health* and *Spiritual and religious services*. In addition, the higher the education, the lower the perception of the service *Social relations*. In addition, the results showed there were also inter-relationships among the demographic characteristics, which may lead to indirect relationships between the demographic factors and the perception of CES. The results also revealed that the perceived CES differed strongly from village to village. Furthermore, open sea, cultivated lands, mangroves, beach and coral reefs, mudflats and water birds and temples were landscape features that were associated with CES. As a landscape feature, the village was an important provider of CES. *Aesthetic services* and *Sense of place* were perceived more or less the same from all landscape features, while *Inspiration* was perceived as highly associated

with villages and open sea. Regarding the human induced changes, *Social relations* and *Sense of place* were relatively less influenced by these variables, compared with other CES in general. Any deterioration of CES by human activities, such as mining or road construction, was determined by the distance from the 'disturbed' location rather than the spatial extent of the disturbance.

Commonalities. By comparing the results of the four landscapes types, some commonalities can be identified. First, many CES were perceived by local communities in all four landscapes. From dryland to coastal wetlands, at least 70.8% of the local communities perceived all identified CES. Second, ethnicity influenced CES perception and values in all study areas exhibiting ethnic variability. For example, in dryland landscapes (Chapter 2), Hui people (the second largest group of residents) perceived more CES than Han People, in wetland landscapes (Chapter 3) nomadic people (Ewenki, Oroqin, Daur, and Mongolian) perceived higher values of *Spiritual and religious services* than the Han people do and in grassland (Chapter 4), Mongolian people perceived more *Inspiration* and *Cultural heritage* than Han people. The differences are caused by their different religions, dietary habits, agricultural practices and cultural background. In addition, most nomads have a long history of nature and fetish worship practices, while Han people generally do not have strong religious traditions (Dou et al., 2019; Ureltu, 2007).

Third, dominant landscape features were perceived more important by local communities than other landscape features in providing diverse CES. For example, the highest perceived landscape features were cultivated lands in the agricultural landscape and agro-pastoral zone (Chapters 2 and 4); the wetlands and water bodies in the wetland landscape (Chapter 3); and the deserts in the Hunshandake sandy pastoral zone (Chapter 4). Most likely, these features really define the landscape,

and therefore also the societies within it. For example, in dryland landscapes, a general preference is found for cultivated landscapes in terms of *Aesthetic, Recreational*, *Religious and spiritual services* and *Sense of place*, because the local communities have a thorough understanding of these landscapes and relied on them for many generations and of the local farming culture. Most of the time they spend outside is in their cultivated land, which is more familiar to them and more accessible. Forests, on the other hand, were perceived less important regarding CES provision, because the uses of new forests are limited under the reforestation programme. Similar results were also found in other landscapes. In Genheyuan (wetlands), local residents generally perceived that wetlands, seasonal rivers, and lakes provide more diverse CES than other landscape features; although in coastal wetlands (Wenchang), cultivated lands were locally perceived slightly more important in providing CES than the dominant landscape features in coastal areas, such as mangroves, mudflats and water bird areas or beaches, especially providing *Social relations* and *Education and sciences*. The higher perceived importance can be explained by the higher interaction between people and cultivated lands, their day-to-day experiences and related memories (Chen et al., 2017; Roux et al., 2020; Tscharntke et al., 2005). Overall, this finding suggests that it is not the special or rare features of the landscape that are responsible for the dominant CES provision, but the common and widespread ones.

Fourth, human interventions, such as ecological restoration, conservation and local economic development influenced CES perception by influencing the opportunities for local people to engage with their landscapes. For example, the most significant changes induced by the Grain for Green program were land cover changes from cultivated land to forest (König et al., 2014). Because most of the new forests are defined as ecological forest, villagers are forbidden to harvest trees or to plant other tree species that might produce economic benefits. Because of this, villagers have

little interest in the new forests. Grain for Green also changed local livelihoods from farming to various forms of self-employment, which probably also affected the relationships between villages and their landscapes. Similarly, the biggest changes of the comprehensive grassland restoration program were land cover changes from grazing land to grassland and the migration of herders, which changed the way local residents use the grassland and reduced the local grassland dependence by encouraging people to work elsewhere. The establishment of the national wetland parks changed the perception of the people living in the park, making water related landscape features more important than other landscape features. The people were somehow indirectly educated about the importance of wetland protection and their attractiveness for tourists. The results of the influence of human intervention on CES perception in coastal wetlands (Chapter 5) also indicated that the distance to landscape features play a more important role in influencing the perception of CES than the area of landscape features.

Differences. There are also some differences among the landscapes regarding the interaction between people and landscapes. Firstly, although CES are highly perceived in all landscapes, the highest perceived CES differ. *Cultural heritage* is most perceived in Guyuan because of the rich cultural heritage sites developed due to Guyuan's position on the ancient Silk Road (Xue, 1997; Xue, 2012). *Inspiration* is most perceived in the Genheyuan region, which is an ethnically mixed area, and most of the nomadic ethnic groups have good handicraft skills and rich musical and cultural expression forms. *Physical and mental health* is perceived the most in Xinlin Gol League. This may be explained by the local outdoor living and working habits. With an increase of outdoor activities, people tend to perceive more physical and mental benefits (Dai et al. 2019). In Wenchang, *Social relations* are highest perceived as most of the villages are traditional family villages, and play quite an important role in worshiping, daily life and economic activities.

The second difference is that demographic characteristics have a different influence due to the local context. For example, in the Genheyuan region, occupation, income and education were not significantly related to any of the CES, while these three characteristics have been reported as influential in other studies (Dou et al., 2019; Oleson et al., 2015; Van Berkel and Verburg, 2014). This result can be explained by the small variance in the levels of income, occupation and education. The occupation of most respondents in Genheyuan National Wetland Park was related to the park, and consequently their income level did not differ much. Compared with the richer coastal regions, people in the study area have less sources of income and mostly rely on a single salary (Fleisher and Chen, 1997). In Huiwen wetland, education level has, other than in the other landscapes, a negative relationship with the perception of *Social relations*. Higher educated people spend less time on farming and associated *Social relations* as most of them have to move out of their hometown to receive education beyond high school. Moreover, people in this area have to leave the home village to follow higher education and therefore have less shared experiences, activities and living styles which are essential elements to the perception of *Social relations* (Martín-López et al., 2019). Furthermore, the results showed that the time people lived in the village is more important in perceiving *Social relations*, *Sense of place*, *Physical and mental health* and *Religious and spiritual services* than age.

The third difference is that landscape features play a different role in different landscapes. For example, residential areas in Guyuan (dryland agricultural landscapes) were perceived as especially important in terms of their provision of *Sense of place* as well as in terms of their *Physical and mental health* and recreational services, because of the local tradition of paying visits to other people, helping each other with farming activities and obtaining valuable social contacts. The residential

areas were perceived highly important in view of *Cultural heritage* and *Religious and spiritual services* (the nature worship of nomadic groups) in Genheyuan region.

Synthesizing the findings of Chapters 2-5, the concluding answers to the four research questions are:

1. In general, Aesthetic services, Recreational services, Education and science, Inspirations, Sense of place, Cultural heritage, Religious and spiritual services and Physical and mental health are all highly perceived in China's typical landscapes including wetlands, grassland, cultivated lands and coastal wetlands. While social relations were only identified in wetlands and coastal wetlands.
2. Demographic characteristics affect the perception of CES, especially ethnicity, age and education. In spite of fact that demographic characteristics determine how people perceive CES, no generic rules such as "women tend to perceive more CES than men or old people tend to perceive more CES than young people" could be found.
3. Landscape features play a different role in the different landscapes, but dominant landscape features are perceived as more important by local communities. The appreciation appeared to be closely linked to the intensity of the interaction and common landscape features are more appreciated than special landscape features.
4. Human interventions, including ecological restoration, conservation and local economic development influence CES perception, by influencing the opportunities for local people to engage with their landscapes, as well as potentially influencing the demographic characteristics of local communities (such as occupation, income and even age composition). Ecological restoration tends to have a positive effect on recreational services but a negative effect on sense of place.

Limitations. The research reported in this thesis may be subject to several simplifications and limitations, which may have an effect on the reliability of the obtained results. For instance, there may be a sample selection bias, due to the way respondents were sampled. Although we used straight- random sampling, the budgetary and geographic constraints (the large distances between villages and difficulty reaching them by car) prevented us from performing a true random sampling with a large sample size in each demographic category and in a larger number of villages. The sample size is also not the same among all study areas, which somewhat hinders a cross-area comparison. For example, the analysis of cross-cultural perceptions of CES and their interaction with the landscape in Genheyuan region is based on a small local data set. The size of the study area and the relatively small survey sample may also have influenced the results. For example, in Chapter 3, occupation, income and education were reported not significant related to any of the CES due to the small variance in the levels of income, occupation and education within a small sample set. Although we have been careful not to rely too heavily on results for specific categories in each demographic factor, this may have led to bias when comparing the results with other study areas.

Besides, the research included no changes in perception and landscape characteristics over time. Typically, landscapes are dynamic and change over time, and human perceptions will change as well. For example, in Chapter 2, the Grain for Green program was started in 1999, which is not long enough to reveal clear differences between generations and how such differences have evolved over time. Instead, we assumed that the influence of the passing of time and of differences among generations were reflected by the current age groups of the respondents in the survey and the changes in land use during the short Grain for Green implementation period. However, without reliable long-term social tracking

data, we could not analyse long-term changes in human perceptions and landscape characteristics. Future research should account for changes over time both within and between generations when such data become available.

We assessed the influence of ecological restoration and conservation programs or local economic developments on the human perception of CES, mainly based on the activities which could be expressed as variables or spatially explicated. However, there are several other potential factors that we did not include in our analysis, such as the economic data for our study area, particularly in the context of the effects of broader economic considerations (e.g., for China as a whole) on local economic factors. Such considerations would be complex and are beyond the framework of the present study. Finally, our results are based on human perceptions of CES, which inevitably are highly subjective and likely to be influenced by cultural differences among different people. However, bias in responses is often considered as a common issue in preference and non-priced valuation studies but does not negate the value of such surveys (Mjelde et al., 2012; Van Berkel et al., 2014).

6.2 Conclusions and recommendations

Aiming at investigating the non-material links between people and landscapes by analysing CES from an interdisciplinary perspective, this research showed that local perception of CES is affected by demographic factors, including those related to cultural and individual characteristics (e.g., ethnicity, age, education, etc.), but also the use of landscape features reflecting people's lifestyles and landscape dependence. These influences differ from case to case. The dependence of local residents on landscape features will be reduced by human interventions changing the land cover or the traditional livelihoods in an area. Although we proposed an

approach that incorporates the perceived values that local communities attach to landscapes and overcomes the limited application of non-spatiality explicit CES in broader ecosystem assessment by assessing the perceptions of local communities, there remains a need to better account for the role that landscape plays in the perception of CES and elucidate the underlying factors responsible for the observed spatial heterogeneity in CES perception, to develop and integrate spatially-explicit social science data with detailed landscape features.

While CES have been increasingly applied in ecosystem services assessment, the needs of local communities are often neglected and may hinder the sustainable use of landscapes and achieving sustainable environment management goals. This thesis highlights the need to identify different perceived CES and consider the diverse roles of local landscape features for CES provision from local perspective to guide multi-functional and sustainable landscape management. When analysing CES as perceived by local people, field surveys may not be the only choice, and alternatives are becoming available. With the development of volunteered geographic information from social media, using crowdsourced data becomes a new possibility to identify CES and quantify and connect CES with spatial information. By incorporating field survey data with crowdsource data, further research may take advantage of big data and mitigate the scale limitations and contribute to the integration of CES into ES assessment frameworks.

Despite the limitations of this research, we showed that considering cultural ecosystem services, local communities, and the way they interact with different landscape features in ecological conservation and landscape management can help to improve conservation effectiveness, and pioneer new co-management arrangements.

Traditional handcrafted Mongolian cloth
(Genhe China)

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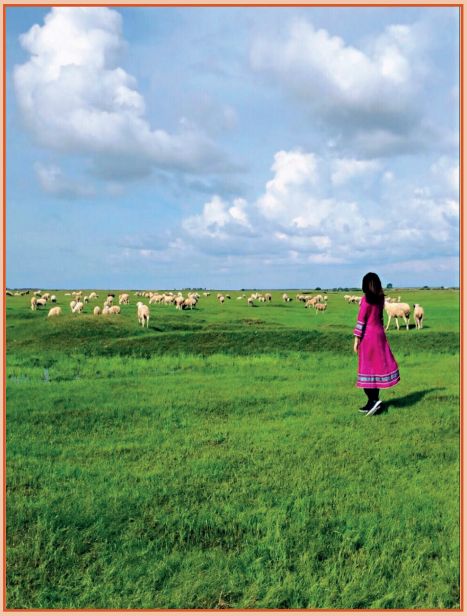

Daur grazing woman in traditional cloth
(Inner Mongolia China)

Appendices

Appendices Chapter 2

Appendix 2-1 Distribution of survey sites and samples in Guyuan.

Village	Dominant feature	Slope of cultivated land	Livelihoods	No. of interviewee's (usable responses)	Proportion (%) of the total permanent households in the country
Yang Lang	Valley plains	99.6% with slopes <5°	Mainly work in town	49	51.2%
Da Mazhuang	Suburban village	62.4% with slopes <5°	Mainly work in town	43	47.8%
Ma Ying	Plateau hills	72.6% with slopes >25°	Mainly farming, with part-time jobs (e.g., in nearby cities)	33	38.8%
Xia Yuan	Loess tableland	64.6% with slopes <15°	Mainly farming and raising livestock, with part-time jobs (e.g., in nearby cities)	37	34.9%
Sheng Li	Stony mountains	65.8% with slopes >15°	Mainly work in town	40	57.1%

Note: Data of permanent households are estimated by local experts and local officers during FoPIA basing on the National Population Sample Survey in 2015.

Appendix 2-2 Questions used in semi-structured interviews in Guyuan.

(The original version was in Chinese. We have translated it for convenience.)

Your age is:	You are:	Your ethnicity is:	Your educational background is:
< 20	Male	Hui	< Primary school
20 to 30	Female	Han	Primary school
30 to 40			Middle school
40 to 50			High School
50 to 60			≥ Bachelor's degree
> 60			

Main interview questions for discussion

1. How long have you been living in … (name of village/ or country)?
2. If you ask you to introduce your surroundings to me, what would you tell me?
   Please briefly report anything that comes to your mind.
   Probe: Forest? Cultivated land? Grassland? Water bodies? Temples? Etc.
3. What do you normally do in your daily life? And where?
   Probes: what do you work for? Play with your friends? Family activities?
   Optional questions
4. Do you know the "Grain for Green Project"? What do you think it has changed your life?
   Probes: land you own? Money you earn? Your surroundings? Changes in your villages?

Then I will give you some statement about your living landscapes, could you please tell how much you agree with me (1: Strongly disagree; 2: Disagree; 3: Not sure; 4: Agree; 5: strongly agree)

5. There are places you believe very beautiful.
    a) Can you describe these places a bit?
    b) Is this perception changed after GFG? If yes, how?
    c) What do you think caused these changes?
6. There are places make you feel happier, healthier or more relaxed when you watch or visit.
    a) Can you describe these places a bit?
    b) Is this perception changed after GFG? If yes, how?
    c) What do you think caused these changes?
7. There are places you like spending leisure time, such as walking, playing with kids etc.
    a) What do you normally do?
    b) Can you describe these places a bit?
    c) Is this perception changed after GFG? If yes, how?
    d) What do you think caused these changes?
8. There are places that you can get/has got inspiration from, such as art, folklore, national symbols, architecture, and advertising or even get new ideas of your life.
    a) What did you get? When?
    b) Can you describe these places a bit?
    c) Is this perception changed after GFG? If yes, how?
    d) What do you think caused these changes?
9. There are places you feel could provide the basis for education and science/ you once learned something from.
    a) What did you learn?
    b) Can you describe these places a bit?
    c) Is this perception changed after GFG? If yes, how?
    d) What do you think caused these changes?

10. There are places make you feel part of something that is greater than you, or connected to my religion or beliefs. Places you don't want (you/your children) to pass by.
    a) Do you have any religion?
    b) Can you describe these places a bit?
    c) Is this perception changed after GFG? If yes, how?
    d) What do you think caused these changes?
11. There are places you believe has historical meanings.
    a) What are these meanings about?
    b) Where are they? Can you describe these places a bit?
    c) Is this perception changed after GFG? If yes, how?
    d) What do you think caused these changes?
12. There are places make you feel a sense of belonging.
    a) What kind of belonging?
    b) Where are they? Can you describe these places a bit?
    c) Is this perception changed after GFG? If yes, how?
    d) What do you think caused these changes?
13. There are places you can make strong bonds with others through visiting there.
    a) With whom?
    b) Where are they? Can you describe these places a bit?
    c) Is this perception changed after GFG? If yes, how?
    d) What do you think caused these changes?
14. Are there places in the Guyuan that are especially important to you? If yes, why do you believe they are important?
15. What about your community / family? Are there places in the Guyuan that are especially important to your community / family?
16. Are there places that remind you of important past events that are important are important to you and your countries / villages?

17. Now, what about ceremony? Do you consider any ceremony to be associated with this place?
    If yes, could you come up with an example? What do you normally do for the ceremony?
18. Are there places in the Guyuan that are important for special activities? If yes, how long have they been places for these activities?
19. Are there any special folk customs here?
20. Is there any special mythology here? Any kind of stories
    If yes, could you tell me the stories?
21. Are there particular experiences associated with any landscapes that you hope your kids or kids in your country / village will experiences in the future?
22. Tell me something about your children? (optional) Would you like your children keep living here?
    Probes: Why? Income? Livelihood? Environment? …
23. Is there anything you believe still missing if I would like to know this area?
24. Who do you think should I visit with to learn more about my questions?

Appendix 2-3 Number of interviewee's who perceived the CES provided by the local landscapes in Guyuan.

Types of perceived CES	Cultivated land	Forest	Grassland	Water body	Residential areas	Cultural heritage
Aesthetic services	0	5	1	6	9	117
Recreational services	19	24	13	87	24	73
Education and science	25	38	92	69	76	12
Inspiration	0	89	69	12	78	0
Sense of place	56	21	0	18	0	0
Cultural heritage	48	15	27	3	12	0
Religious and spiritual services	33	8	0	7	3	0
Physical and mental health	21	2	0	0	0	0
Total (N)	202	202	202	202	202	202

Appendices Chapter 3

Appendix 3-1 Semi-structured interview questions used in Genheyuan.

(The original version was in Chinese. We have translated it for convenience)

1. What is your age, generally?
2. When did you finish your education?
3. What is your ethnicity, job?
4. How long have you been living in … (name of village/ or country)?
5. If you are asked to introduce your surroundings what would you tell me? Please briefly report anything that comes to your mind.
6. What do you normally do in your daily life?
7. Do you know the "Genheyuan National Wetland Park"? How do you think it has changed your life?
    a) Probes: Profession? Money you earn? Your surroundings? Changes in your villages?

Then I will give you some statement about your living landscapes, could you please tell how much you agree with me (1: Strongly disagree; 2: Disagree; 3: Not sure; 4: Agree; 5: strongly agree)

8. There are places you believe very beautiful.
    a) Can you describe these places?
    b) Is this perception changed after the establishment of national wetland park? If yes, how?
    c) What do you think caused these changes?

9. There are places make you feel happier, healthier, or more relaxed when you watch or visit.
    a) Can you describe these places?
    b) Is this perception changed after the establishment of national wetland park? If yes, how?
    c) What do you think caused these changes?
10. There are places you like spending leisure time, such as walking, playing with kids etc.
    a) What do you normally do?
    b) Can you describe these places?
    c) Is this perception changed after the establishment of national wetland park? If yes, how?
    d) What do you think caused these changes?
11. There are places you can get/has inspiration from, such as art, folklore, national symbols, architecture, and advertising or even get new ideas of your life.
    a) What did you get? When?
    b) Can you describe these places?
    c) Is this perception changed after the establishment of national wetland park? If yes, how?
    d) What do you think caused these changes?
12. There are places you feel could provide the basis for education and science/ you once learned something from.
    a) What did you learn?
    b) Can you describe these places?
    c) Is this perception changed after the establishment of national wetland park? If yes, how?
    d) What do you think caused these changes?

13. There are places make you feel part of something that is greater than you, or connected to my religion or beliefs, places you do not want (you/your children) to pass by.
    a) Do you have any religion?
    b) Can you describe these places?
    c) Is this perception changed after the establishment of national wetland park? If yes, how?
    d) What do you think caused these changes?
14. There are places you believe has historical meanings.
    a) What are these meanings about?
    b) Where are they? Can you describe these places?
    c) Is this perception changed after the establishment of national wetland park? If yes, how?
    d) What do you think caused these changes?
15. There are places make you feel a sense of belonging.
    a) What kind of belonging?
    b) Where are they? Can you describe these places?
    c) Is this perception changed after the establishment of national wetland park? If yes, how?
    d) What do you think caused these changes?
16. There are places you can make strong bonds with others through staying there.
    a) With whom?
    b) Where are they? Can you describe these places?
    c) Is this perception changed after the establishment of national wetland park? If yes, how?
    d) What do you think caused these changes?
17. Are there places in the Guyuan especially important to you? If yes, why do you believe they are important?

18. What about your community / family? Are there places in the Guyuan especially important to your community / family?
19. Are there places that remind you of important past events that are important are important to you and your countries / villages?
20. Now, what about ceremony? Do you consider any ceremony to be associated with this place?
    If yes, could you come up with an example? What do you normally do for the ceremony?
21. Are there places in the Guyuan important for special activities?
    If yes, how long have they been places for these activities?
22. Are there any special folk customs here?
23. Is there any special mythology here? Any kind of stories?
    If yes, could you tell me the stories?
24. Are there particular experiences associated with any landscapes you hope your kids or kids in your country / village will experience in the future?
25. Can you tell me something about your children? (optional) Would you like your children to keep living here?
    Probes: Why? Income? Livelihood? Environment? …
26. Is there anything you believe still missing that I might like to know about this area?
27. Who do you think should I visit with to learn more about my questions?

Appendix 3-2 Parameter estimates, errors, and associate p-values of SEM.

CES Models		Estimate	Std. Error	p-value
Physical and mental health	**Regressions for physical and mental health**			
	Ethnicity	0.047	0.030	0.121
	Income	-0.041	0.091	0.653
	Age	-0.051	0.064	0.425
	Gender	-0.039	0.090	0.667
	Occupation	-0.033	0.030	0.266
	Education	0.069	0.068	0.308
	Regressions for income			
	Occupation	0.041	0.028	0.141
	Ethnicity	0.012	0.029	0.670
	Education	0.125	0.063	0.050
	Age	0.100	0.060	0.096
	Regressions for occupation			
	Ethnicity	-0.325	0.082	0.000
	Education	1.039	0.165	0.000
	Gender	0.362	0.259	0.162
	Variances			
	Physical and mental health	0.258	0.032	0.000
	Income	0.232	0.028	0.000
	Occupation	2.191	0.269	0.000
Inspirations	**Regressions for inspirations**			
	Ethnicity	0.017	0.009	0.049
	Income	0.002	0.026	0.927
	Age	-0.008	0.018	0.682
	Gender	0.040	0.026	0.122
	Occupation	0.003	0.009	0.684
	Education	0.000	0.019	0.999
	Regressions for income			
	Occupation	0.041	0.028	0.141
	Ethnicity	0.125	0.063	0.050

	Education	0.100	0.060	0.096
	Age	0.012	0.029	0.670
	Regressions for occupation			
	Ethnicity	-0.325	0.082	0.000
	Education	1.039	0.165	0.000
	Gender	0.362	0.259	0.162
	Variances			
	Physical and mental health	0.021	0.003	0.000
	Income	0.232	0.028	0.000
	Occupation	2.191	0.269	0.000
Aesthetic services	**Regressions for aesthetic services**			
	Ethnicity	0.078	0.036	0.031
	Income	-0.021	0.108	0.842
	Age	-0.237	0.076	0.002
	Gender	-0.127	0.106	0.232
	Occupation	0.008	0.038	0.824
	Education	0.133	0.084	0.113
	Regressions for income			
	Occupation	0.047	0.030	0.115
	Ethnicity	0.113	0.067	0.091
	Education	0.102	0.061	0.091
	Age	0.011	0.029	0.706
	Regressions for occupation			
	Ethnicity	-0.289	0.079	0.000
	Education	10157	0.159	0.000
	Gender	0.364	0.246	0.140
	Variances			
	Physical and mental health	0.357	0.044	0.000
	Income	0.235	0.029	0.000
	Occupation	1.964	0.234	0.000

Education and science	**Regressions for education and science**			
	Ethnicity	0.120	0.038	0.002
	Income	-0.049	0.116	0.673
	Age	-0.169	0.081	0.037
	Gender	-0.030	0.113	0.789
	Occupation	0.023	0.038	0.546
	Education	0.140	0.086	0.102
	Regressions for income			
	Occupation	0.041	0.028	0.141
	Ethnicity	0.125	0.063	0.050
	Education	0.100	0.060	0.096
	Age	0.012	0.029	0.670
	Regressions for occupation			
	Ethnicity	-0.325	0.082	0.000
	Education	1.039	0.165	0.000
	Gender	0.362	0.259	0.162
	Variances			
	Physical and mental health	0.414	0.051	0.000
	Income	0.232	0.028	0.000
	Occupation	2.191	0.269	0.000
Spiritual and religious services	**Regressions for spiritual and religious services**			
	Ethnicity	0.091	0.042	0.031
	Income	0.136	0.126	0.279
	Age	-0.191	0.088	0.031
	Gender	0.181	0.124	0.142
	Occupation	-0.062	0.042	0.142
	Education	-0.095	0.095	0.320
	Regressions for income			
	Occupation	0.041	0.029	0.511
	Ethnicity	0.125	0.065	0.055
	Education	0.100	0.060	0.097
	Age	0.012	0.029	0.674
	Regressions for occupation			
	Ethnicity	-0.334	0.081	0.000

	Education	1.088	0.164	0.000
	Gender	0.308	0.256	0.229
	Variances			
	Physical and mental health	0.489	0.060	0.000
	Income	0.234	0.029	0.000
	Occupation	2.131	0.262	0.000
Cultural heritage	**Regressions for cultural heritage**			
	Ethnicity	0.054	0.032	0.091
	Income	-0.031	0.098	0.755
	Age	-0.407	0.071	0.000
	Gender	-0.160	0.093	0.085
	Occupation	-0.020	0.032	0.536
	Education	-0.020	0.072	0.785
	Regressions for income			
	Occupation	0.034	0.028	0.218
	Ethnicity	0.099	0.063	0.118
	Education	0.018	0.063	0.779
	Age	-0.003	0.028	0.928
	Regressions for occupation			
	Ethnicity	-0.339	0.081	0.000
	Education	1.077	0.164	0.000
	Gender	0.336	0.257	0.191
	Variances			
	Physical and mental health	0.274	0.034	0.000
	Income	0.217	0.027	0.000
	Occupation	2.125	0.263	0.000
Sense of place	**Regressions for sense of place**			
	Ethnicity	0.093	0.036	0.010
	Income	-0.022	0.108	0.837
	Age	-0.166	0.076	0.029
	Gender	0.138	0.107	0.194
	Occupation	-0.027	0.036	0.461
	Education	0.135	0.082	0.101
	Regressions for income			

	Occupation	0.041	0.029	0.151
	Ethnicity	0.125	0.065	0.055
	Education	0.100	0.060	0.097
	Age	0.012	0.029	0.674
	Regressions for occupation			
	Ethnicity	-0.334	0.081	0.000
	Education	1.088	0.164	0.000
	Gender	0.308	0.256	0.229
	Variances			
	Physical and mental health	0.363	0.045	0.000
	Income	0.234	0.029	0.000
	Occupation	2.131	0.262	0.000
Recreational services	**Regressions for recreational services**			
	Ethnicity	0.112	0.035	0.112
	Income	0.173	0.105	0.173
	Age	-0.073	0.074	-0.073
	Gender	-0.134	0.130	-0.134
	Occupation	-0.017	0.035	-0.017
	Education	0.041	0.080	0.041
	Regressions for income			
	Occupation	0.041	0.029	0.041
	Ethnicity	0.125	0.065	0.125
	Education	0.100	0.060	0.100
	Age	0.012	0.029	0.012
	Regressions for occupation			
	Ethnicity	-0.334	0.081	-0.344
	Education	1.088	0.164	1.088
	Gender	0.308	0.256	0.308
	Variances			
	Physical and mental health	0.342	0.042	0.342
	Income	0.234	0.029	0.234
	Occupation	2.131	0.262	2.131

Social relations	**Regressions for social relations**			
	Ethnicity	0.086	0.038	0.022
	Income	0.280	0.112	0.012
	Age	-0.177	0.079	0.025
	Gender	-0.002	0.110	0.989
	Occupation	-0.072	0.037	0.056
	Education	0.120	0.085	0.157
	Regressions for income			
	Occupation	0.041	0.029	0.151
	Ethnicity	0.125	0.065	0.055
	Education	0.100	0.060	0.097
	Age	0.012	0.029	0.674
	Regressions for occupation			
	Ethnicity	-0.344	0.081	0.000
	Education	1.088	0.164	0.000
	Gender	0.308	0.256	0.229
	Variances			
	Physical and mental health	0.389	0.048	0.000
	Income	0.234	0.029	0.000
	Occupation	2.131	0.262	0.000

Ewenki People

"Ewenki" means "the people living in the mountains and forests" in Ewenki language.

Descriptions of beliefs, stories and activities	Related CES
Most of the Ewenki people believe in shamanism, and the residents living in the pastoral area also believe in Lamaism. Some of the Ewenki people still maintain religious beliefs such as fire worship, animal worship, totem worship, and ancestor worship. Some of the clan's worship totems are birds and bears.	Religious services Spiritual services
The folk literature of the Ewenki people contains myths, legends, stories, narrative poems, proverbs, riddles, and other forms; themes are related to ancient events, animals, and weather.	Inspirations Cultural heritage
Reindeer are the object of love and protection of the Ewenki people. As for the Ewenki people, reindeer are a symbol of auspiciousness, happiness, and enterprise, and also a symbol of pursuing beauty and lofty ideals.	Spiritual services
The Ewenki people have accumulated a variety of life techniques and experience, such as hunting, traps, spear-using, arrows, and birch bark products.	Science and education
The Ewenki worship the swan and regard the swan as a totem. The swan dance, which is called "Woriqie" in their language, is a folk dance of the Ewenki people. In leisure time, women often imitate the different postures of the swan as a form of entertainment. As years go by, these dance movements gradually evolve into a fixed dance − the swan dance.	Spiritual services Inspirations Recreational services
Traditional Dwellings "Cuoluozi", which means "Pointed tent with wooden poles", inspired by the construction of dead standing trees.	Inspirations Science and education
Ewenki women are good at embroidery, carving, paper cutting, and other processes. Most patterns are based on production and life, such as deer, birds, clouds, flowers, etc.	Inspirations Aesthetic services Social relations
Ewenki people often process birch bark, such as carving, hollowing out or painting various geometric patterns, flowers and grass patterns. The art of carving can be divided into bone carving, wood carving, and so on. Embroidery techniques include flat embroidery, lock embroidery, and fabric supplement embroidery with bold and exaggerating colors and patterns of clouds, geometric shape, plants, animals, people, etc.	Inspirations Aesthetic services Social relation

At the "Obo Festival", the Ewenki people will slaughter cattle or sheep as sacrifices, in order to pray for the safety of humans and animals.	Spiritual services Recreational services
In the Ewenki society, they have developed a unique set of methods for time, distance, weights and measures, direction, forecasting age, and climate.	Science and education
Daur people	
The Daur people believe in shamanism, enshrine and worship “Gajiri Barken” or "Banajiyin" (both are the Land God) associated with the agriculture, “Jiyaqi Barken” (Livestock God) associated with the stock farming, “Birigei Barken” (Water God) associated with the fishing industry, “Bainacha” (Mountain God), and “Batehe Barken” (Hunting God).	Religious services Spiritual services
The Daur folk literature includes myths, legends, folktales, slang, riddles, tribute words, folk songs, and folk dance lyrics with diverse subjects and abundant content, which comprehensively reflects the contents of the material production, social life, history, and culture of the Daur people.	Cultural heritage Inspirations Recreational services
WuQin music is a folk form of singing of Dawuer nationalities. It is a solo, repeated form of a basic tune. It is a kind of light singing mainly singing while talking subsidiary, associated with the rhythm.	Cultural heritage
Folk songs for expressing worship to the gods.	Spiritual services
The lyrics for Daur dance accompaniment express different content, such as “Fish”, “Deer”, “Zeni flowers”, “Sika deer”. Dance and accompaniment related to the nature and environment, such as “Hamo” (bear roar),“Geku” (the call of cuckoos) and “Zhuwei” (the voice of calling an eagle).	Inspirations Recreational services
Orechun	
The Oroqen people believe in shamanism with “Nature Worship“ and concept of animism.	Religious services

The nature god worshipped by the Oroqen people include the Sun God, the Moon God, the Big Dipper God, the Fire God, the God of Heaven, the Earth God, the Wind God, the Rain God, the Thunder God, the Water God, the Grass God, the Mountain God, and so on. Besides the nature worship, the Oroqen ancestors also worshiped the totem of "Niu Niu Ku" (Bear) and "Lao Ma Si" (Tiger).	Spiritual services
Traditional robes are decorated with patterns such as "bow and scissors shape", "antler shape", and "cloud roll shape".	Inspirations
Legends, stories, myths, proverbs, riddles, songs, jokes, after-speech, and other forms of singing literature like "Mosukun".	Recreational services Cultural heritage
The theme of fur-cutting art includes mythological stories, character images, animal images, decorative patterns, and so on. Engravings with patterns of clouds,the Chinese character “Hui”, geometric figures, waves, crosses, flower groups, and so on. Embroidery with patterns of flowers, birds, fish, insects, and small animals.	Inspirations
Unique medical knowledge and experience of Orechun community.	Science and education

Appendices Chapter 4

Appendix 4-1 Summary of respondents' demographic information in Xilin Gol.

Study area	Average age	% of female	% of ethnicity	% of occupation	Household income (10^3 yuan)	Number of interviewee's
TGP zone	43.0	35.3	Han (19.6) Mongolian (80.4)	Animal husbandry (95.9) Farming (0.0) Migrant labor (0.0) Others (4.1)	119.16	49
HSP zone	49.6	35.8	Han (56.7) Mongolian (37.3) Hui (6.0)	Animal husbandry (97.0) Farming (0.0) Migrant labor (0.0) Others (3.0)	67.76	67
APT zone	59.6	27.1	Han (94.9) Mongolian (5.1)	Animal husbandry (6.8) Farming (74.6) Migrant labor (18.6) Others(0.0)	11.91	59
Total	51.0	32.0	Han (52.0) Mongolian (45.7) Hui (2.3)	Animal husbandry (66.3) Farming (25.1) Migrant labor (6.9) Others (1.7)	63.32	175

Appendix 4-2 Semi-structured interview questions used in Xilin Gol.

(The original version was in Chinese. We have translated it for convenience)

Your age is:	**You are:**	**Your ethnicity is:**	**Your educational background is:**
< 20	Male	Mongolian	< Primary school
20 to 30	Female	Han	Primary school
30 to 40		Other	Middle school
40 to 50			High School
50 to 60			≥ Bachelor's degree
> 60			

Then I will give you some statement about your living landscapes, could you please tell how much you agree with me (1: Strongly disagree; 2: Disagree; 3: Not sure; 4: Agree; 5: strongly agree)

1. There are places you believe very beautiful.
    a) How much do you agree with this statement?
    b) Which one (or more) object below you think connect to the above statement (1) cultural heritage (2) forest (3) grasslands (4) lakes/seasonal rivers (5) wetlands (6) desert (7) temples (8) cultivated lands (9) Obo and Ger
2. There are places make you feel happier, healthier, or more relaxed when you watch or visit.
    a) How much do you agree with this statement?
    b) Which one (or more) object below you think connect to the above statement (1) cultural heritage (2) forest (3) grasslands (4) lakes/seasonal rivers (5) wetlands (6) desert (7) temples (8) cultivated lands (9) Obo and Ger

3. There are places you like spending leisure time, such as walking, playing with kids etc.
    a) How much do you agree with this statement?
    b) Which one (or more) object below you think connect to the above statement (1) cultural heritage (2) forest (3) grasslands (4) lakes/seasonal rivers (5) wetlands (6) desert (7) temples (8) cultivated lands (9) Obo and Ger
4. There are places you can get/has inspiration from, such as art, folklore, national symbols, architecture, and advertising or even get new ideas of your life.
    a) How much do you agree with this statement?
    b) Which one (or more) object below you think connect to the above statement (1) cultural heritage (2) forest (3) grasslands (4) lakes/seasonal rivers (5) wetlands (6) desert (7) temples (8) cultivated lands (9) Obo and Ger
5. There are places you feel could provide the basis for education and science/ you once learned something from.
    a) How much do you agree with this statement?
    b) Which one (or more) object below you think connect to the above statement (1) cultural heritage (2) forest (3) grasslands (4) lakes/seasonal rivers (5) wetlands (6) desert (7) temples (8) cultivated lands (9) Obo and Ger
6. There are places make you feel part of something that is greater than you, or connected to my religion or beliefs, places you do not want (you/your children) to pass by.
    a) How much do you agree with this statement?
    b) Which one (or more) object below you think connect to the above statement (1) cultural heritage (2) forest (3) grasslands (4) lakes/seasonal rivers (5) wetlands (6) desert (7) temples (8) cultivated lands (9) Obo and Ger

7. There are places you believe has historical meanings.
    a) How much do you agree with this statement?
    b) Which one (or more) object below you think connect to the above statement (1) cultural heritage (2) forest (3) grasslands (4) lakes/seasonal rivers (5) wetlands (6) desert (7) temples (8) cultivated lands (9) Obo and Ger
8. There are places make you feel a sense of belonging.
    a) How much do you agree with this statement?
    b) Which one (or more) object below you think connect to the above statement (1) cultural heritage (2) forest (3) grasslands (4) lakes/seasonal rivers (5) wetlands (6) desert (7) temples (8) cultivated lands (9) Obo and Ger
9. Is there anything you believe still missing that I might like to know about this area?
10. Who do you think should I visit with to learn more about my questions?

Appendices Chapter 5

Appendix 5-1 Questionnaire and key stakeholder interview questions used in Huiwen Wetland.

(The original version was in Chinese. We have translated it for convenience)

1. What is your age, generally?
2. When did you finish your education?
3. What is your job?
4. How long have you been living in … (name of village)?
5. If you are asked to introduce your surroundings what would you tell me? Please briefly report anything that comes to your mind.
6. What do you normally do in your daily life?

Then I will give you some statement about your living landscapes, could you please tell how much you agree with me (1: Strongly disagree; 2: Disagree; 3: Not sure; 4: Agree; 5: strongly agree)

7. There are places you believe very beautiful.
    a) How much do you agree with this statement?
    b) Which one (or more) object below you think connect to the above statement (1) open sea (2) mudflats and water birds (3) villages (4) mangroves (5) cultivated lands (6) temples (7) beach and coral reef
8. There are places make you feel happier, healthier, or more relaxed when you watch or visit.
    a) How much do you agree with this statement?

b) Which one (or more) object below you think connect to the above statement (1) open sea (2) mudflats and water birds (3) villages (4) mangroves (5) cultivated lands (6) temples (7) beach and coral reef

9. There are places you like spending leisure time, such as walking, playing with kids etc.
   a) How much do you agree with this statement?
   b) Which one (or more) object below you think connect to the above statement (1) open sea (2) mudflats and water birds (3) villages (4) mangroves (5) cultivated lands (6) temples (7) beach and coral reef
10. There are places you can get/has inspiration from, such as art, folklore, national symbols, architecture, and advertising or even get new ideas of your life.
   a) How much do you agree with this statement?
   b) Which one (or more) object below you think connect to the above statement (1) open sea (2) mudflats and water birds (3) villages (4) mangroves (5) cultivated lands (6) temples (7) beach and coral reef
11. There are places you feel could provide the basis for education and science/ you once learned something from.
   a) How much do you agree with this statement?
   b) Which one (or more) object below you think connect to the above statement (1) open sea (2) mudflats and water birds (3) villages (4) mangroves (5) cultivated lands (6) temples (7) beach and coral reef
12. There are places make you feel part of something that is greater than you, or connected to my religion or beliefs, places you do not want (you/your children) to pass by.
   a) How much do you agree with this statement?
   b) Which one (or more) object below you think connect to the above statement (1) open sea (2) mudflats and water birds (3) villages (4) mangroves (5) cultivated lands (6) temples (7) beach and coral reef

13. There are places you believe has historical meanings.
    a) How much do you agree with this statement?
    b) Which one (or more) object below you think connect to the above statement (1) open sea (2) mudflats and water birds (3) villages (4) mangroves (5) cultivated lands (6) temples (7) beach and coral reef
14. There are places make you feel a sense of belonging.
    a) How much do you agree with this statement?
    b) Which one (or more) object below you think connect to the above statement (1) open sea (2) mudflats and water birds (3) villages (4) mangroves (5) cultivated lands (6) temples (7) beach and coral reef
15. There are places you can make strong bonds with others through staying there.
    a) How much do you agree with this statement?
    b) Which one (or more) object below you think connect to the above statement (1) open sea (2) mudflats and water birds (3) villages (4) mangroves (5) cultivated lands (6) temples (7) beach and coral reef
16. Is there anything you believe still missing that I might like to know about this area?
17. Who do you think should I visit with to learn more about my questions?

Interview questions (for key stakeholders)

1. How long have you been living in/working/doing research about Huiwen wetland?
2. Could you please briefly describe the landscapes here?
3. What do the local people do for living? (main livelihood)
4. Are there places especially important to local people? If yes, where and why?
5. Did you recognize any changes happening or happened in past years?
6. What do you think led to the mentioned changes?

7. Have you heard any information about any project will be implemented in Huiwen wetland?
8. Do you think there will be any projects that influences the landscapes in recent future? What kind of project and why?
9. Is there anything you believe still missing that I might like to know about this area?
10. Who do you think should I visit with to learn more about my questions?

Appendix 5-2 Summary of demographic information of respondents in Huiwen wetland.

Demographic factors	Classification	Proportions (%)
Gender	Male	55.6
	Female	44.4
Age	Below 20	5.0
	20-30	6.4
	30-40	16.4
	40-50	18.0
	50-60	20.9
	Above 60	33.4
Education	No education	12.1
	Primary school	33.4
	Middle school	37.8
	High school	13.7
	University or above	2.9
Annual income (Yuan/RMB)	Below 10,000	33.1
	10,000 to 30,000	14.7
	20,000 to 30,000	6.7
	30,000 to 50,000	5.8
	Above 50,000	5.4
	Refused to answer	34.2

Appendix 5-3 Training and test accuracy of random forest.

Perception of CES	Training accuracy	Test accuracy	Level 1	Level 2	Level 3	Level 4	Level 5
Physical and mental health	0.42	0.37	0.00	0.06	0.28	0.50	0.55
Inspiration	0.43	0.35	0.59	0.41	0.38	0.08	0.11
Aesthetic services	0.39	0.42	0.00	0.16	0.22	0.44	0.50
Education and science	0.37	0.27	0.56	0.30	0.29	0.32	0.26
Spiritual and religious services	0.37	0.36	0.25	0.22	0.26	0.40	0.56
Cultural heritage	0.34	0.38	0.42	0.33	0.26	0.22	0.34
Sense of place	0.43	0.41	0.08	0.00	0.00	0.51	0.67
Recreational services	0.39	0.51	0.06	0.00	0.17	0.53	0.50
Social relations	0.54	0.54	0.00	0.00	0.00	0.42	0.69

Coral reefs
(Huiwen wetland, Hainan China)

Summary

Summary

Maintaining and enhancing landscapes' beneficial contributions to a good quality of life is a major challenge of our time. Landscapes have been and are being changed by processes such as urbanization, economic development and ecological restorations which may sharply change the landscapes, and these changes may affect the ways in which people interact with their landscapes. The concept of Ecosystem Services (ES) has been widely adopted by scientists and policymakers as a framework to assess the consequences of landscape interventions, on provisioning, regulating, supporting, and Cultural Ecosystem Services (CES). CES refer to the benefits people receive from ecosystems in the form of spiritual, religious, recreational, inspirational and educational experiences.

To inform decision-making for sustainable landscape management, an elicitation of people's concerns associated with their landscapes from socio-cultural perspectives is. However, current approaches of investigating CES have been criticized for voluntary self-exclusion of disciplines, over-valuing tourist-attractive landscapes and neglecting critical social impacts or dynamics. Moreover, due to the limitation of accessible data and applicable methods, rarely does research capture the cultural diversity of CES perceived by *local communities* and little is known about how CES change under human interventions.

The objective of this research was to investigate the non-material links between people and landscapes by analysing CES from an interdisciplinary perspective, in four typical Chinese landscapes (Dryland agricultural landscape, wetlands, grasslands and coastal wetlands). The research especially addresses the subjective

nature of CES perception and the socio-cultural consequences of ecological restoration and conservation projects through their influence on CES perception. The approach incorporates the perceived values that local communities attach to landscapes and overcomes the limited application of non-spatiality explicit CES in broader ecosystem assessment by assessing the perceptions of local communities. Data were gathered by questionnaires survey or semi-structured interviews depending on the local context, as well as participatory mapping and field observations to further diagnose CES appraisal and their spatial distribution.

Synthesizing the findings of this research, there are several conclusions we can draw:

1. In general, Aesthetic services, Recreational services, Education and science, Inspirations, Sense of place, Cultural heritage, Religious and spiritual services and Physical and mental health are all highly perceived in China's typical landscapes including wetlands, grassland, cultivated lands and coastal wetlands. Social relations were only identified in wetlands and coastal wetlands.
2. Demographic characteristics affect the perception of CES, especially ethnicity, age and education. Although demographic characteristics determine how people perceive CES, no generic rules such as "women tend to perceive more CES than men" or "old people tend to perceive more CES than young people" could be found.
3. Landscape features play a different role in different landscapes, but dominant landscape features are perceived as more important by local communities. The appreciation appeared to be closely linked to the intensity of the interaction and common landscape features are more appreciated than special landscape features.
4. Human interventions, including ecological restoration, conservation and local economic development influence CES perception, by influencing the

opportunities for local people to engage with their landscapes, as well as potentially influencing the demographic characteristics of local communities (such as occupation, income and even age composition). Ecological restoration tends to have a positive effect on recreational services but a negative effect on sense of place.

Despite the limitations of data and methods, we showed that considering cultural ecosystem services, local communities, and the way they interact with different landscape features in ecological conservation and landscape management can help to improve conservation effectiveness, and pioneer new co-management arrangements.

Yuehan Dou
Wageningen School of Social Sciences (WASS)
Completed Training and Supervision Plan

Wageningen School of Social Sciences

Name of the learning activity	Department/Institute	Year	ECTS*
A) Project related competences			
Research Methodology: From Topic to Proposal	WASS	2016	4
PhD Proposal	WASS	2019	6
The Essentials of Scientific Writing and Presenting	Wageningen in'to Languages	2016	1.2
Introduction to R for Statistical Analysis	SENSE	2016	0.6
ESPA Summer School	Ecosystem Services for Poverty Alleviation	2016	2
'Assessing the influence of ecological restoration on cultural ecosystem services in agricultural landscapes'	ESP 9 World Conference, Shenzhen, China	2017	1
'The importance of coastal landscape characteristics for the perception of cultural ecosystem services: A case of Wenchang, China'	ESP 10 World Conference, Hannover, Germany	2019	1
B) General research related competences			
Introduction course	WASS	2016	1
Meta-Analysis and Data Integration	Chinese Ecosystem Research Network	2017	1.5
Ecology	Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences	2017	2
Theory and Application of Modern Human Geography	Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences	2018	2
Artificial Intelligence for Ecosystem Services	Ecosystem Service Partnership	2019	0.3
Attending chair group meetings and seminars	Landscape Architecture and Spatial Planning Group	2016, 2019	1.4
C) Career related competences/personal development			
Internship	Simon Fraser University	2018	6
Total			**30**

*One credit according to ECTS is on average equivalent to 28 hours of study load

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Biography

Yuehan Dou grew up in Suihua city, Heilongjiang province, exploring the Black Glebe and the typical agricultural landscape of China. She went on to study Environmental System Analysis and Land Use Planning at Wageningen University, the Netherlands. Her studies revealed that people's quality of life was not only dependent on urban planning or physical environment but also largely influenced by public attitudes and awareness, promoting her to explore human perception of landscapes and outreach following graduation. She was served for diverse NGOs and research institutes as a project researcher and environmental specialist, working on the database of diverse values of global ecosystem services, interviewing the local people on the importance of green and blue areas in Beijing, and protecting water birds habitants along EAAF flyway. These experiences illuminated the immense non-material values of landscapes and profound experiences local people have interacted with them.

These experiences encouraged her to pursue a graduate studentship with Prof. Bakker and Dr. Carsjens in Landscape Architecture and Spatial planning Group, Department of Environment Sciences. Together with Prof. Yu from the Institute

of Geographic Sciences and Natural Resources Research (Chinese Academy of Sciences), they explore the non-material links between people and landscapes by analysing CES from an interdisciplinary perspective, in four typical Chinese landscapes (Dryland agricultural landscape, wetlands, grasslands, and coastal wetlands). This work seeks to support decision-making for sustainable landscape management with evidence of people's concerns associated with their landscapes and the possible socio-cultural consequences of ecological restoration and conservation projects. During her time as a graduate student, Yuehan also served as project researcher and coordinator in the interdisciplinary projects such as GEF-funded "Strengthening the Management Effectiveness of the Protected Area Network in the Daxing'anling Landscape" and NGO-funded 'Green Book: China's Coastal Wetlands', promoting the unveiling of traditional knowledge of ethnic minorities and evaluating the health condition of coastal wetlands and incorporation of social values in comprehensive ecosystem assessment. Yuehan is interested in using her understanding of local perception to generate and enhance people's non-material relationship with landscapes through ecological restoration and landscape management.

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