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Linking Demographic Factors, Land Use, Ecosystem Services, and Human Well-Being: Insights from an Sandy Landscape, Uxin in Inner Mongolia, China

Jing Zhang [1,2], Xueming Li [1,*], Tongliga Bao [3], Zhenghai Li [2], Chong Liu [2,4] and Yuan Xu [2,5]

1 School of Geography, Liaoning Normal University, Dalian 116029, China; zhangjing@dlnu.edu.cn
2 College of Environment and Resources, Dalian Minzu University, Dalian 116600, China; lzhh@dlnu.edu.cn (Z.L.); ltt9980@163.com (C.L.); xuyuan021066@163.com (Y.X.)
3 College of Architecture, Dalian Minzu University, Dalian 116600, China; tongliga@dlnu.edu.cn
4 Nanjing Daopu Environmental Engineering Design Co., Ltd., Nanjing 210000, China
5 Guangdong Jinghe Testing Co., Ltd., Guangzhou 510700, China
* Correspondence: lixueming999@163.com

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Abstract: Ecosystem services are fundamental in supporting human well-being which is a core component of sustainability. Understanding the relationship between ecosystem services (ESs) and human well-being (HWB) in a changing landscape is important to implement appropriate ecosystem management and policy development. Combining with demographic, economic, and cultural factors, their land use are the elements linking ESs and HWB at fine scale. Within this context, the purpose of this study is to evaluate household HWB changes in the past decade, and understand the relationship between demographic factors, land use, ESs, and HWB in the social-ecological landscapes of Uxin, in Inner Mongolia. Our results indicate that: the levels of HWB of local herder families were slightly improved from 2007 to 2016; changes in family demographic factors enhanced their land use intensity, resulting in an increased supply capacity of ecosystems and improved HWB; in addition, regulating services contributed more to HWB than provisioning services. The results of this study can help improve the understanding of the relationship between ESs and HWB, and provide valuable information to policy-makers to maintain particular ESs or to improve HWB.

Keywords: ecosystem services; human well-being; structural equation model; sand land; Uxin

1. Introduction

Ecosystem services (ESs) and human well-being (HWB) are co-produced by environment and society [1]. Derived from ecosystem processes, ESs are the benefits that people obtain from ecosystems directly or indirectly [2], which support human existence, health, well-being, and the provision of livelihoods fundamentally [3,4]. HWB is a multidimensional concept that includes both an objective dimension and a subjective dimension, and incorporates economic, social, and environmental well-being [5]. Therefore, a better understanding of the relationship between these two elements in a constantly changing landscape is essential to adopt appropriate ecosystem management policies [6,7].

Human beings perceive ESs by changing the strategy and intensity of land use, leading to changes in their HWB [8]. After the synthesis report by the Millennium Ecosystem Assessment (MA) [2], the number of studies integrating ESs and HWB has gradually increased [6,9,10]. Although the view that ESs are vital to HWB is widely accepted, the way in which ESs affect the different components of HWB remains poorly understood [1,11]. Many people expect ecosystem degradation to have a negative impact (or positive correlation) on HWB [12]. However, MA showed the contradictory trend of increase in HWB despite the decline in most ESs at the global scale [2]. Raudsepp-Hearne et al. hypothesize that this may be due to an inadequate consideration of the critical dimensions of HWB, the prepotency of provisioning services, technology and social innovation, and the time lag between ESs degradation and its effects on HWB [12]. Duraiappah et al. suggests that the link between ESs and HWB should be investigated at fine scales [13]. In line with this recommendation, Delgado and Marín [14] analyzed empirical ES/HWB data at watershed scale, and agree with the positive relationship between the provisioning and regulating services and the material conditions of HWB. They also suggest that the link between ESs and HWB should be studied further, analyzing their components and sub-components within or across different countries. Afterwards, other researchers found that provisioning services have an influence on HWB [6,9]; in particular, they have a stronger relationship with material conditions, and a weaker relationship with the indices pertaining to safety and health [15].

In recent years, researchers have paid increasing attention to the relationship between ESs and the HWB of household landowners [10,16], as they are a fundamental unit linking ESs and HWB [17]. In fact, combined with demographic [18], economic [19], cultural [7,20], and psychological factors [21,22], their land use decisions and strategies determine major long-term land use patterns, which maintain local ecological conditions and landscape sustainability, can lead to changes in ESs and HWB [23–25]. Xu et al. suggested that the increasing land use intensity has a positive correlation with crop production and living standard well-being in Huailai County, China [26]. In Manas River Basin, Xinjiang, the land use changes resulted in a large increase in human economic income well-being, in contrast with the obvious decrease in the regulation services by natural ecosystem degradation [8]. In addition, the implementation of ecological restoration policies and measures and the recognition of the expected results are always inseparable from landowners' participation. For example, Mudaca et al. investigated that household age, the educational level of the head, land area are important variables in explaining the level of rural households' decision to participate in the payments for ecosystem services programme [27]. Yang et al. conducts an empirical analysis to discern the perceptive differences on ecosystem services importance and HWB satisfaction degree between rural and urban residents [10]. In Xiji County, Ningxia, China, as the restored vegetation failed to generate short-term economic benefits, deforestation was conducted by local residents [28]. As another example, during the ecological restoration of the Sacramento River Basin in the USA, the concern over its possible negative effects on their lives led the surrounding residents to vote and decide to reduce the size of the recovery area [29].

However, an understanding of the full relationship between ES and HWB at household-level demands a dynamical perspective based on long-term data [30], for example, the potential time lag effects between ESs and HWB, that can give insight into the complex and uncertain social-ecological system. Therefore, we took Uxin Banner (an area that may be considered as equal to a county) in Inner Mongolia as the research area, and developed a questionnaire as the main data source to assess the relationship between ESs and HWB. The major objectives of the study include: (i) To evaluate the changes in the HWB of herders' families in the past decade; (ii) to analyze the relationship between demographic factors, land use, ESs, and HWB; and (iii) to examine the major drivers of change. The results of this study can help policy-makers and ecosystem managers to improve their understanding of the link between ESs and HWB, and to integrate these insights into decision-making processes at the landscape scale.

2. Materials and Methods

2.1. Framework

The relationship between demographic, land use, ecosystem services, and human well-being is explained in Figure 1. Following the research framework, we first applied a questionnaire survey to evaluate family HWB changes in the past decade (2007–2016), and then fit a structural equation model (SEM) to analyze the relationship between family demographic factors, land use, ESs, and HWB in the social-ecological landscapes of Uxin.

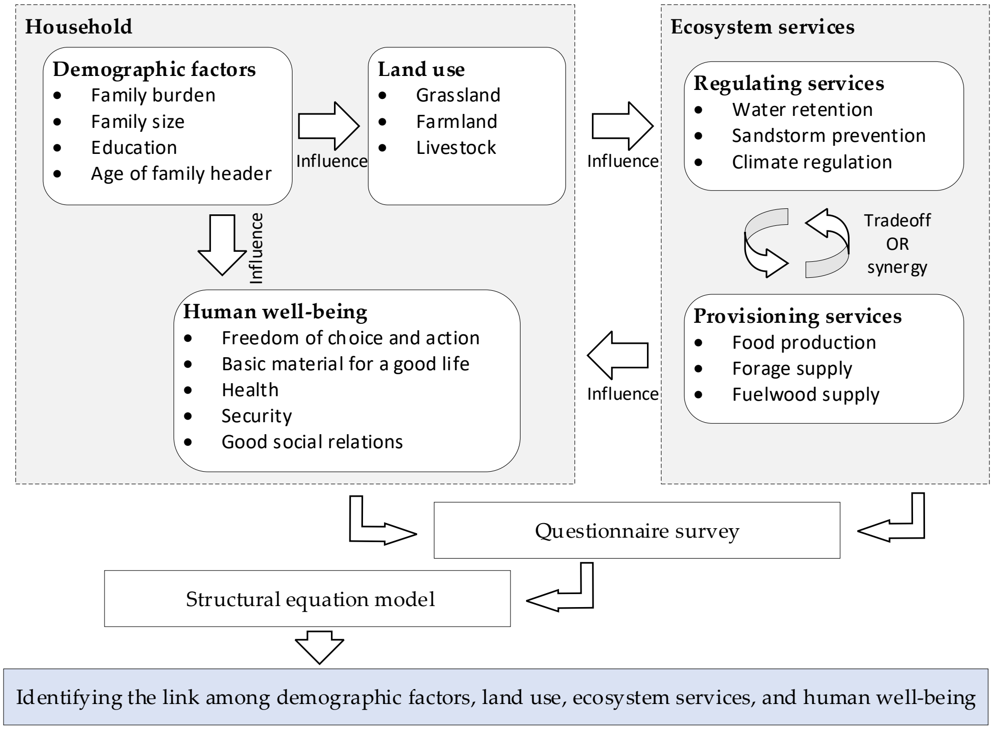

Figure 1. The framework to link demographic, land use, ecosystem services, and human well-being in Uxin.

2.2. Study Area

Uxin is located in the southeast part of the Ordos Plateau in Inner Mongolia, in north China (see Figure 2). By 2017, the population of Uxin was 133,400, including 30,000 Mongols. Uxin has a typical temperate continental climate, with a mean annual temperature of 6.8 °C, a mean annual precipitation of about 350 mm, and a mean annual evaporation of 2200 mm. As it belongs to the Mu Us sandy land, sand dunes cover most of its landscape. Shrubs and subshrubs are the dominant vegetation type. As a typical agro-pastoral transitional zone of northern China, over the past two decades this region experienced vegetation recovery [31]. The main land use types include grassland (including fixed and semi-fixed sand land, 53.0%), desert (moving sand land, 27.7%), marshland (9.30%), and cropland (6.30%), followed by water body (1.11%), saline alkali land (1.10%), town or village (0.75%) and forest (0.70%) in 2017. The normalized difference vegetation index (NDVI) trend is shown in Figure 1.

2.3. Questionnaire Survey

The data collection for this study was completed in July 2017. We conducted face-to-face interviews in 12 randomly sampled villages and obtained 344 valid questionnaires. Structured questionnaires were provided to local herdsmen. The respondents were mostly middle-aged, which can guarantee the authenticity of their opinion on the changes in ecosystems and living standards in the past decade. The questionnaire was divided into four parts: (i) Basic socio-economic and land-use characteristics of the respondents and their families, including gender, age, family size, income, grassland area, and cultivated land area; (ii) basic living conditions of the family, including the procurement of food, water resources, and fuelwood; (iii) perception of changes in ESs over the past ten years, including provisioning services (i.e., food production, and forage and fuelwood supply) and regulating services (i.e., sand storm prevention, water retention, and climate regulation); (iv) life satisfaction (income satisfaction, cultivation and husbandry satisfaction, health satisfaction, etc.,). Respondents were asked to evaluate the perception and satisfaction of the changes in ESs in a point-5 Likert Scale. The family main characteristics in the questionnaire are shown in Table 1; these include aspects such as gender, age, annual family income, and family size.

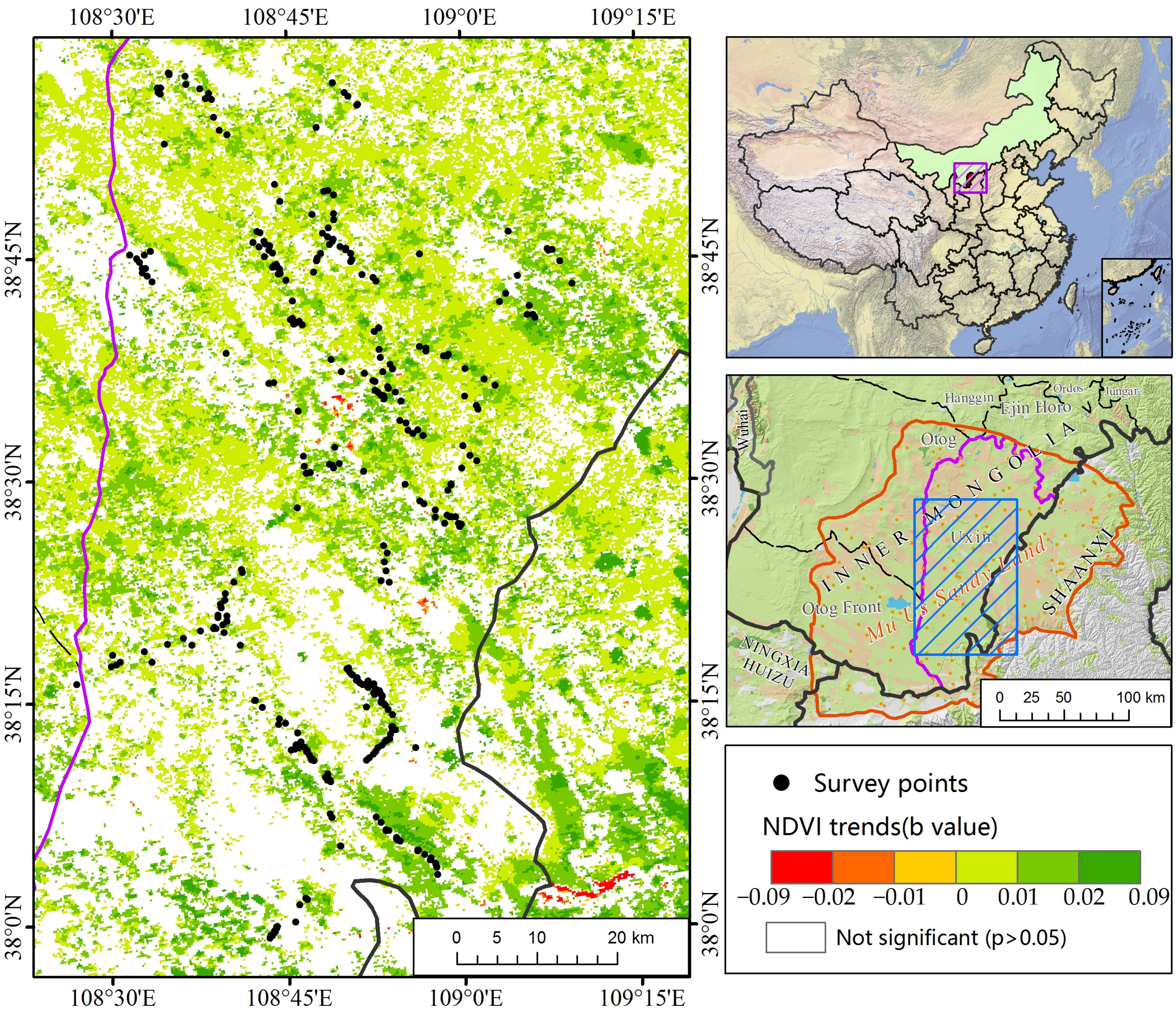

Figure 2. The location of Uxin and NDVI trends and survey points. The NDVI trends color change from red to green represents a variation in the vegetation coverage from degradation to recovery in the period investigated (2007–2016).

Table 1. Main characteristics of the respondents

Characteristics	Category: Number
Gender of the household head	Male: 308, Female: 36
Age	<16 years: 129; 16–45 years: 417; 45–60 years: 381; >60 years: 352
Annual family income	0–10,000 CNY [1]: 37; 10,001–30,000 CNY: 112; 30,001–50,000 CNY: 78 50,001–70,000 CNY: 24; >70001 CNY: 93
Family components	<4 people: 165; 4–5 people: 136; >5 people: 43
Cultivated land area	<2 hm^2: 162; 2–5 hm^2: 108; 5–8 hm^2: 47; >8 hm^2: 16
Grassland area	<10 hm^2: 20; 10–100 hm^2: 129; 100–200 hm^2: 49; >200 hm^2: 19

[1] 1 USD ≈ 6.5 CNY.

2.4. Human Well-Being Assessment

According to the classification of HWB components included in the MA [2] and Yang et al. [32], we selected the HWB indicators that were closely related to ecosystem services, and established an evaluation index system for the well-being of local herdsmen. Integrated opinion of three experts with experience in the Mu Us Sands, a subjective weighting method was used to evaluate the indicators of human well-being; the average values for the weight were considered and appropriately adjusted (the sum of values for each weight is 100). The weights are shown in Appendix A Table A1. We normalized the values of each well-being indicator to the range 0–1 to allow their comparison.

2.5. Drivers Analysis of the Relationship between ESs and HWB

2.5.1. Hypotheses

We developed a structural equation model (SEM), considering family demographic factors as exogenous latent variables (equivalent to independent variables), land use, and ESs as intermediate latent variables, and HWB as endogenous latent variables (equivalent to dependent variables). According to the theoretical model shown in Figure 3 (data of Figure 3, see Supplementary Materials), a change in demographic factors would impel families to alter their land use strategies, adjust land use intensity, improve ESs output, and thus increase or decrease HWB.

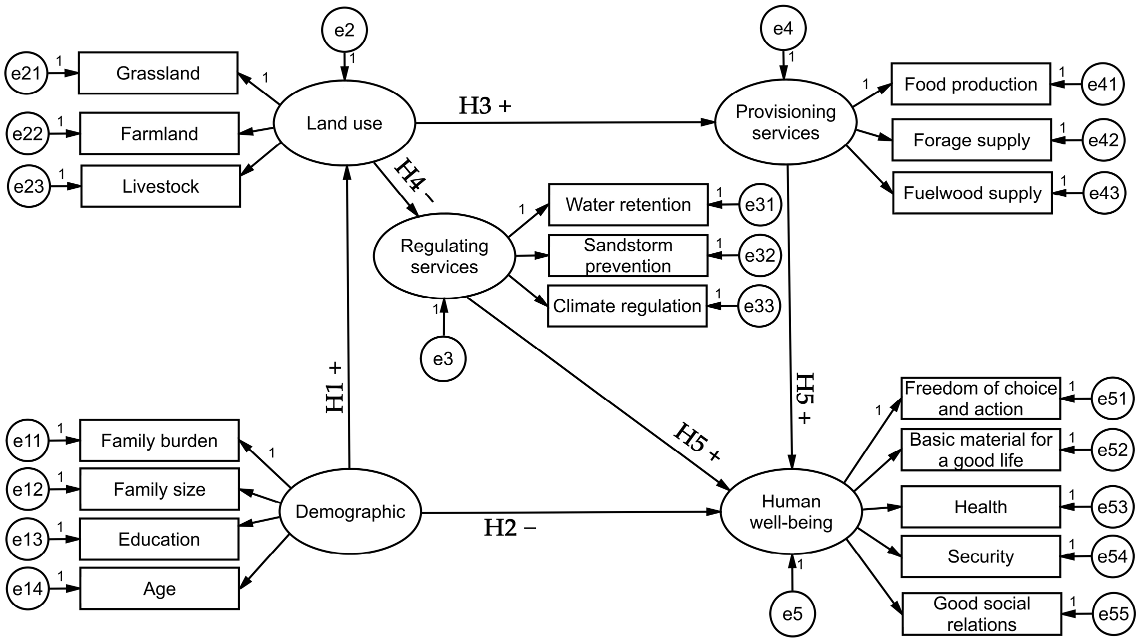

Figure 3. Structural equation model used for the drivers analysis of the relationship between ecosystem services and human well-being. Latent variables are showed in ellipses, while observed variables are presented in rectangles. "H1-5" represents five hypothesis, and "+" or "−" indicate the influence between latent variables is positive or negative.

Demographic factors, such as family size, gender, age, and education, can change over a certain period of time, pushing families to change their land use strategies [33], thus directly impacting on HWB. We formulated the following hypotheses on family's demographic factors:

Hypotheses 1 (H1). *Changes in demographic factors can positively affect the land use of households.*

Hypotheses 2 (H2). *The increase of demographic factors may have a negative impact on HWB.*

Changes in land use by households in this region are mostly manifested as changes in land use intensity, such as leasing pastures, increasing or decreasing investment in artificial grass, and increasing or decreasing livestock. These changes will eventually influence the structure and function of the ecosystem around the family, causing changes in ESs [8,26]. We formulated the following hypotheses on family land use:

Hypotheses 3 (H3). *Changes in family land use positively affect the provisioning ESs, increasing their supply.*

Hypotheses 4 (H4). *Changes in family land use negatively affect the regulating ESs, reducing their supply.*

Families acquire ESs such as food production, forage supply, firewood supply, water retention, sandstorm prevention, and climate regulation, from the surrounding ecosystems. The supply of these services directly influences the well-being of the families [3,14]. We formulated the following hypothesis on ESs changes:

Hypotheses 5 (H5). *Changes in ESs positively affect the well-being of families.*

2.5.2. Structural Equation Model

The SEM is a multivariate statistical method that can describe the relationship between observed variables (or manifest variables) and latent variables. By combining factor analysis and path analysis, the SEM can process multiple dependent and independent variables simultaneously [34]. Thus, it was employed to investigate the effects between the latent variables of demographic factors, land use, ESs, and HWB. The SEM consists of two parts: a measurement equation that describes the relationship between observed variables and latent variables, and a structural equation that describes the relationship between latent variables.

The equations of the measurement model can be expressed as follows:

$$\begin{aligned} X &= \Lambda_X \xi + \delta \\ Y &= \Lambda_Y \eta + \varepsilon \end{aligned}, \tag{1}$$

where X represents a vector composed of exogenous variables; Y refers to a vector composed of endogenous variables; ξ is a vector composed of exogenous latent variables; η is a vector composed of endogenous latent variables; Λ_X and Λ_Y denote the relation between exogenous/endogenous variables, respectively, i.e., the factor loading matrix of exogenous/endogenous observed variables on exogenous/endogenous latent variables; and δ and ε are the random error terms of the measurement equations. In the SEM, the interaction among latent variables can be described by both direct effects (i.e., path coefficients) and indirect effects. The direct effects, measured by the structural variable, refer to the path coefficient from the cause variable (exogenous or endogenous variable) to the result variable (endogenous variable); the indirect effects, given by products of structural coefficients composing a path linking the cause variable to the result variable through one or more mediator variables (endogenous variable). The structural equation can be expressed as follows:

$$\eta = B\eta + \Gamma\xi + \zeta, \tag{2}$$

where B represents the relation between endogenous latent variables; Γ represents the impact of exogenous latent variables on endogenous latent variables; and ζ is the residual term in the structural equation, which indicates the unexplainable part in the equation. The variables and the descriptive statistics used in the structured model are shown in Table 2.

The AMOS 24.0 (IBM SPSS Amos 24.0.0) was employed to fit the model. In order to ensure the validity and reliability of the SEM, the Kaiser-Meyer-Olkin (KMO) and the Bartlett's sphericity test on the 18 observable variables obtained from the questionnaire survey. The values of the KMO and the Bartlett's sphericity test were 0.66 and 901.37, respectively, with a significance level $p < 0.01$, confirming that it was appropriate to proceed with the factor analysis using the selected variables. The average variance extracted (AVE) and the combinations reliability (CR) were used to test the internal consistency, reliability, quality, and convergence validity of the variables; they indicated the high convergence validity of the dataset (see Appendix A Table A2). Moreover, to check the model fit, we used goodness-of-fit indices including RMSEA, CMIN/DF, GFI, PGFI, PNFI, and PCFI (see Appendix A Table A3).

Table 2. Definition of the variables and descriptive statistics of the questionnaires.

Latent variable		Observed Variable (Unit)	Variable Name	Max	Min	Mean	Standard Deviation	Variable Description
Demographic factors	X1	Age (years)	x11	86	29	54.88	10.31	Age of the household head
		Education (years)	x12	16	4	8.11	2.72	Average years of education of family members
		Family size (people)	x13	10	1	3.75	1.66	Number of family members
		Family burden	x14	3.00	0.00	0.76	0.79	The ratio of non-labor force to labor force in a family
Land use	X2	Grassland (hm^2)	x21	333.33	1.00	88.99	78.07	Average grassland owned by a family in 2007–2016
		Farmland (hm^2)	x22	10.67	0.13	3.03	2.22	Average cultivated land for artificial grasslands, maize, and other crops planted by a household in 2007–2016
		Livestock (sheep)	x23	662.50	10.00	164.58	112.21	Average livestock feeding of a family in 2007–2016
Provisioning services	X3	Food production	x31	5	1	3.25	0.79	Changes in provisioning services in 2007–2016 (from 1= strong decrease, to 5 = strong increase)
		Forage supply	x32	5	2	3.53	0.61	
		Fuelwood supply	x33	4	1	3.31	0.53	
Regulating services	X4	Water retention	x41	5	1	2.99	1.03	Changes in regulating services in 2007–2016 (from 1 = strong decrease, to 5 = strong increase)
		Sandstorm prevention	x42	5	1	2.95	0.93	
		Climate regulation	x43	5	1	3.48	0.87	
Human well-being	Y	Freedom of choice and action	y1	22.98	3.03	13.37	4.03	See Appendix A Table A1
		Basic material for a good life	y2	20.27	4.02	10.55	1.94	
		Health	y3	19.00	2.25	14.86	2.90	
		Security	y4	17.00	2.25	12.99	2.81	
		Good social relations	y5	18.00	3.83	13.59	2.71	

3. Results

3.1. Changes in Herders' Well-Being

The comparison of the changes in HWB of herders' families in the last 10 years is shown in Figure 3. Overall, we found that the HWB level of Uxin's herdsmen slightly increased, from 58.24 in 2007 to 63.78 in 2016. Besides good social relationships, other types of HWB subcomponents also slightly increased (Figure 4, data of Figure 4, see Supplementary Materials).

(1) Freedom of choice and action

From 2007 to 2016, the level of freedom of choice and action of the local residents improved from 11.66 to 13.37, with an increment of 14.70% and a contribution rate to total HWB change of 31.87%. In addition, in the same period the per capita annual net income of the herders increased from 3623.70 CNY to 5009.93 CNY, and the well-being level increased from 3.23 to 3.60, with an increment of 11.07%. Moreover, the living space per capita increased from 3.02 to 3.78, showing an increase of 14.02% in the contribution rate of this well-being level to total HWB change.

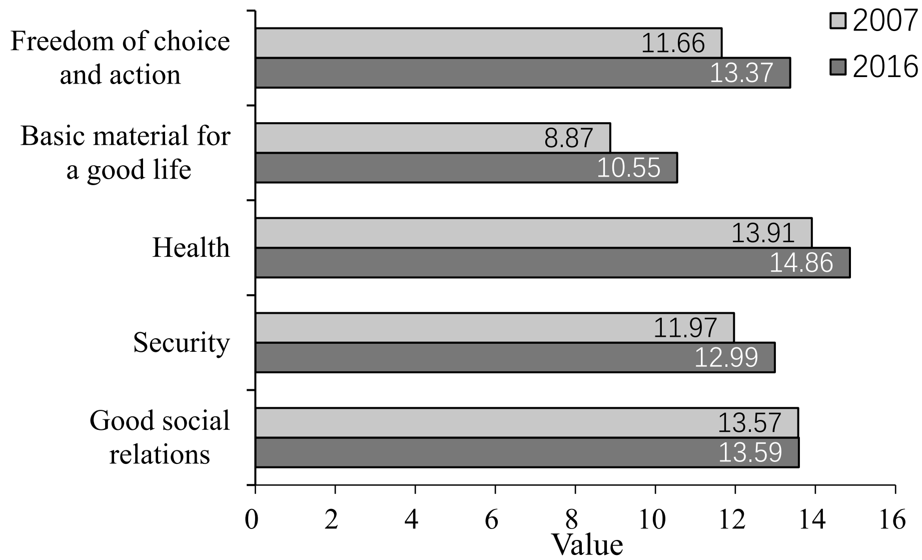

Figure 4. Level changes of five sub-components of HWB classified by MA in Uxin from 2007 to 2016.

(2) Basic material for a good life

In the period 2007–2016, the level of basic material for a good life increased from 8.87 to 12.23, with an increment of 18.87% and a contribution rate to total HWB change of 31.12%. In addition, the arable land area per capita increased by 0.45 hm^2, and the level of well-being increased from 0.16 to 0.27. Arable land satisfaction improved by 33.85%, and its contribution rate to total HWB was equal to 9.06%. Compared to 2007, the number of livestock increased by 8.03% in 2016. Moreover, the satisfaction of livestock breeding increased by 28.49%, and the contribution rate of this index to the total HWB was equal to 13.51%. According to the survey findings, a large number of families still used branches as fuel, rather than coal and natural gas. The affordability of fuel supply increased from 1.04 to 1.14, with an increment of 9.01%, while the affordability of electric power supply increased by 0.18 in the period investigated.

(3) Health

The level of health was found to increase from 13.91 to 14.86 during the 10-year period investigated. More into detail, the satisfaction in the consumption of vegetables and meat increased from 3.27 to 3.85 (with an increment of 17.93%) and from 3.04 to 3.34 (with an increase of 9.75%), respectively. In fact, it was observed that the vegetables consumption of families was higher than meat consumption, indicating a change in the health perception of herders. A slight improvement was observed in herders' satisfaction over their physical and mental health, with a change of 1.61% and no change, respectively.

(4) Security

The level of security increased from 11.97 to 12.99 during the 10-year period investigated. More into detail, the life safety index increased by 0.59 (with an increment of 18.20%); the property safety index increased from 2.76 to 3.09 (with an increment of 0.33), with a contribution rate to total HWB of 11.96%. In addition, the indices of local crime incidence and of reliability of government protection slightly increased by 0.01 and 0.09, respectively.

(5) Good social relations

The level of good social relations showed a small increment, from 13.57 in 2007 to 13.59 in 2016. The close neighborhood index decreased by 0.29 (corresponding to 9.78%) compared to 2007. They showed a negative contribution rate of 5.43% to total HWB. The indices of satisfaction for family relations and of trust for local villagers showed no changes. However, the cohesion with local villagers increased from 3.55 to 3.86, with a contribution rate to total HWB of 5.72%.

3.2. The Relationship between Demographic Factors, Land Use, Ecosystem Services, and Human Well-Being at Family Scale

The direct effects of the SEM are shown in Table 3. Demographic factors positively affected land use, as indicated by the path coefficient of 0.530 ($p < 0.05$). Thus, it can be ascertained that demographic factors promoted land use, verifying H1. However, unexpectedly, the path coefficient between demographic factors and HWB was not significant. Family land use showed a positive impact on the provisioning services (the path coefficient was equal to 0.433, $p < 0.05$); thus, H3 was accepted. The path coefficient of the land use for regulating services was equal to -0.188 ($p < 0.1$), indicating that an increase in land use reduced the regulating services, thus validating H4. The path coefficients of the impact of the provisioning and regulating services on HWB were equal to 0.518 and 0.609, respectively. These results indicate that changes in ESs positively affected HWB, thus verifying H5.

Table 3. Interactions between household demographic factors, land use, ecosystem services, and human well-being.

Latent Variable			Land Use	Regulating Services	Provisioning Services	Human Well-Being
Demographic factors	→	Direct Effect	0.530 **			−0.167
		Indirect effect		−0.100 **	0.230 **	0.058 **
Land use	→	Direct Effect		−0.188 *	0.433 **	
		Indirect effect				0.109 **
Regulating services	→	Direct Effect				0.609 ***
		Indirect effect				
Provisioning services	→	Direct Effect				0.518 **
		Indirect effect				

Note: * significant at 0.1 level, ** significant at 0.05 level, *** significant at 0.01 level.

As shown in Table 3, the indirect effects of demographic factors on provisioning services and on regulating services were equal to 0.230 and −0.100, respectively, and their indirect effect on HWB was equal to 0.058. Similarly, the indirect effect of land use on HWB was equal to 0.109. We found that the demographic factors of the herdsmen's families can directly increase land use intensity. Furthermore, they can increase the output of provisioning services and reduce regulating services, thus improving the family's well-being.

3.3. Drivers Analysis in Measurement Models

The fitting results of each measurement model are shown in Table 4. In the demographic factors measurement model, the path coefficients (i.e., factor loadings) of average years of education, family size, and family burden were equal to 0.401, 0.369, and 0.351, respectively ($p < 0.05$). The path coefficient of household head's age was equal to −0.475, showing a negative correlation with demographic factors.

In the land use measurement model, the path coefficients for the measurement variables of grassland, farmland, and livestock were equal to 0.627, 0.186, and 0.969, respectively ($p < 0.01$).

In the provisioning services measurement model, the path coefficients for food production, forage supply, and fuelwood supply were equal to 0.424, 0.364, and 0.237, respectively, indicating that most of the herder households are concerned about ESs such as grain production and forage supply.

In the regulating services measurement model, the path coefficients of water retention, sandstorm prevention, and climate regulation were equal to 0.681, 0.411, and 0.463, respectively, indicating that herdsmen are particularly concerned about water retention, among other ecosystem services.

By fitting the measurement model of HWB, it was found that the path coefficients of freedom of choice and action, basic material for a good life, health, security, and good social relations were equal to 0.234, 0.458, 0.973, 0.252, and 0.444, respectively ($p < 0.01$).

Our analysis showed that health had the highest loading among all the well-being indices. Moreover, local herders are concerned about their physical health and about health care, which was reflected by the adoption of a balanced nutrition pattern based on an increased consumption of fiber-based foods.

Table 4. Fitting results of measurement equations.

Observed Variables			Latent Variables	Standardized Regression Weights/Estimate	C.R./ t Value
Household age	x11	←	Demographic factors	−0.475 ***	−3.629
Average years of education	x12	←		0.401 ***	3.400
Family size	x13	←		0.369 ***	3.435
Family burden	x14	←		0.351 ***	
Grassland (hm^2)	x21	←	Land use	0.627 ***	2.761
Farmland (hm^2)	x22	←		0.186 ***	
Livestock (sheep)	x23	←		0.969 ***	2.627
Food production	x31	←	Provisioning services	0.424 **	3.129
Forage supply	x32	←		0.364 ***	
Fuelwood supply	x33	←		0.237 **	2.337
Water retention	x41	←	Regulating services	0.681 ***	4.782
Sandstorm prevention	x42	←		0.411 ***	4.240
Climate regulation	x43	←		0.463 ***	
Freedom of choice and action	y1	←	Human well-being	0.234 ***	
Basic material for a good life	y2	←		0.458 ***	4.150
Health	y3	←		0.973 ***	3.766
Security	y4	←		0.252 ***	2.933
Good social relations	y5	←		0.444 ***	3.689

Note: ** significant at 0.05 level, *** significant at 0.01 level.

4. Discussion

4.1. Relationship between Family Demographic Factors and Land Use Changes

Changes in household demographic factors enhance the intensity of land use. Previous researchers found that household head age [35], family size [33], and education [20] affect family land use decision-making [36]. In our model, we showed that changes in household demographic factors have a positive impact on family land use (see Table 4). In the demographic factors and land use measurement models, the age of the household head is negatively correlated with land use, while the years of education, family size, and family burden are positively correlated with land use. The increase in household head age indicates that there is a lack of labor force in the family, so they tend to adopt more conservative land use strategies to reduce the intensity of land use and increase the supply of regulating services by vegetation recovery. Family members have more years of schooling, which indicates that they have more land use choices, such as hobby farm tourism, rather than relying only on animal husbandry, reducing reliance on provisioning services [37]. Households shift their primary land use activities to off-farm work or migrate to urban areas [33], and this phenomenon is observed in many rural areas of China [38]. On the one hand, the number of household members reflects the adequacy of labor force; household will increase their investment in land use to reduce their family burdens. For example, they increased mechanical power in artificial pasture or grazing pressure on nature grassland [39], which lead to an increase in the provisioning services and a decrease in the regulating services.

Therefore, these demographic factors lead to changes in land use strategies, which in turn affect the supply of ESs. In addition, the land use measurement model suggests that when families felt the pressure of living, their primary solution was to increase livestock breeding. Besides this, renting grassland was also a widely popular strategy. However, the least employed land use method by local herders was the increase in the area of artificial grassland; this might be due to the requirement of high labor skills on pasture (or crop) cultivation, and to the lack of funds to increase cultivation or irrigation machinery. Overall, policy-makers need to consider new policies to better consider family land use under the influence of demographic characteristics, to provide different operational schemes, such as technical guidance, vocational training, agricultural loan, etc. It will contribute to the synergy between poverty alleviation and ecological restoration in China or other developing countries.

4.2. Relationship between Land Use, Ecosystem Services, and Human Well-Being

Land use has a negative impact on regulating services and positive influence on provisioning services (Table 3), indicated that there were tradeoffs between provisioning and regulating services. As an eco-restoration area, the restricted by prohibition of open grazing policy since the early 2000s, herdsmen families in Uxin change their land use strategy from traditional grazing pattern to intensive land use, for example, increasing the area of artificial grassland for forage to reduced grazing pressure on nature grassland [40]. However, the expansion of artificial grassland directly decreased the supply of water retention, and had a negative impact on vegetation restoration in the surrounding ecosystems, which in turn indirectly reduced sandstorm prevention. The steady decline in regulating services is often ignored until their associated thresholds are broken through, which impairs the sustainability of ESs and directly affects local HWB [41]. Therefore, it is necessary to implement a high-efficiency water-saving technology (e.g., through drip irrigation or plastic film) to reduce water consumption rates and to improve artificial grassland productivity for ecological rehabilitation [42]. Ecological conservation measures such as payments for ecosystem services should also be performed in this area, to relieve grazing pressure and reduce water consumption by livestock feeding.

Our results show that the HWB of the herdsmen in Uxin is moderately dependent on ESs. According to previous works, the provisioning services affect all parts of HWB [2], and most scholars believe that they have a positive impact on human well-being [3,6,9]. Our study also draws the same conclusion, which supports the "expectations of environmentalists" [12]. However, concerning the relationship between regulating services and HWB, different scholars around the world have reached contradictory conclusions [6]. We found that regulating services have a positive impact on HWB. The path analysis performed in our study shows that regulating services are more important than provisioning services for HWB (see Table 3). Researchers have suggested that possible reasons for these findings may be the mismatch between supply and demand of regulating services, or the preference for ESs by local dwellers [43]. According to the results of our questionnaire survey, under the warming and drying trend of regional climate [44], most herdsmen believed that regulating services are more important, because improvements in water retention and sandstorm prevention will lead to vegetation restoration, and would directly affect the output of provisioning services (e.g., food and forage) [45].

ESs also have different degrees of impact on the sub-components of HWB. For example, MA considers provisioning and regulating services to have a strong impact on basic material conditions and health [2]. Hossain et al. considers that provisioning services have a strong relationship with basic material conditions, and a weak relationship with safety and health indicators [15]. Delgado and Marí found that regulating services have a significant positive correlation with basic material conditions [14]. In Ciftcioglu [3], provisioning services are moderately correlated with all sub-components of HWB, while regulating services are moderately correlated with safety and health. In line with MA [2], we found that ESs are strongly related to basic material conditions and health, and, unlike Ciftcioglu [3], they are weakly related to security and to freedom of choice and action (see Table 4). A possible reason of this result is that, compared with freedom of choice and action, far from medical resources, health may be a higher concern for family holders, while, in the understanding of local herdsmen, the basic material conditions represent real wealth. According to our results, we recommend that ecological compensation performed through multiple channels, including improvement of the traffic, and medical services enhances HWB in this area.

4.3. Uncertainties

In this research, we analyze the relationship between family demographic factors, land use, ESs, and HWB in the social-ecological landscapes of Uxin, in Inner Mongolia. However, in order to fit this SEM, the limited observed variables are used in model fitting, may lead to the uncertainty results of the relationship between ESs and HWB, and a comprehensive measuring method is required to involve the multidimensional index system in future studies. Additional research should also be performed to explore the linkage between other indicators of well-being (e.g., life expectancy) and cultural services, such as aesthetic landscape, cultural heritage values, discriminating features, and sense of place. Moreover, due to potential time lag effects between ESs and HWB, in this case, a decade research scale may still restrict our study from determining the complicated link between ESs and HWB. Thus, an appropriate next step would be long-term follow-up questionnaire survey, may help to improve the comprehension of the relationship between ESs and HWB.

5. Conclusions

In Uxin, changes in family demographic factors have enhanced land use intensity, resulting in an increased output of provisioning ESs, and simultaneously reducing regulating services. In addition, regulating services contributed more to HWB than provisioning services. Changes in land use intensity would eventually improve the well-being of the herdsmen families. Understanding of the relationship between family demographic factors, land use, ESs, and HWB, is important for decision-making to improve HWB and the provision of multiple ESs in the study area.

Supplementary Materials: The following are available online at https://www.mdpi.com/article/10.3390/su13094847/s1, Data of Figure 3 and Data of Figure 4.

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Appendix A

Table A1. The indices, weights and questionnaires used in human well-being evaluation in Uxin.

Human Well-Being Subcategory	Weight	Indicator Layer	Questionnaire	Options
Freedom of choice and action	8	Per capita annual net income	Per capita annual net income of your family	Normalized the values to the range of 0–1
	5	Free choices of employment	Find a satisfied job is	1. Very difficult; 2. Difficult; 3. Unsure; 4. Easy; 5. Very easy
	6	Affordability to quality housing	You have affordable access to spacious and quality house	1. Strongly disagree; 2. Mildly disagree; 3. Unsure; 4. Mildly agree; 5. Strongly agree
	4	Affordability to quality healthcare	You have affordable access to quality healthcare	1. Strongly disagree; 2. Mildly disagree; 3. Unsure; 4. Mildly agree; 5. Strongly agree
Basic material for a good life	3	Arable land	You are satisfied with your arable land	1. Strongly disagree; 2. Mildly disagree; 3. Unsure; 4. Mildly agree; 5. Strongly agree
	5	Per capita cultivated land	Per capita cultivated land	Normalized the values to the range of 0–1
	4	Number of livestock	Per capita annual net income of your family	Normalized the values to the range of 0–1
	6	Livestock breeding	You are satisfied livestock breeding of your family	1. Strongly disagree; 2. Mildly disagree; 3. Unsure; 4. Mildly agree; 5. Strongly agree
	3	Affordability to electric power supply	Affordability to electric power supply is	1. Very difficult; 2. Difficult; 3. Unsure; 4. Easy; 5. Very easy
	2	Affordability to fuel supply	Affordability to fuel supply is	1. Very difficult; 2. Difficult; 3. Unsure; 4. Easy; 6. Very easy
Health	5	Vegetables consumption	You are satisfied with your household's vegetables consumption?	1. Strongly disagree; 2. Mildly disagree; 3. Unsure; 4. Mildly agree; 5. Strongly agree
	4	Meat consumption	You are satisfied with your household's meat consumption?	1. Strongly disagree; 2. Mildly disagree; 3. Unsure; 4. Mildly agree; 5. Strongly agree
	6	Physical health	You are satisfied with your household's physical health (including illness and injury)?	1. Strongly disagree; 2. Mildly disagree; 3. Unsure; 4. Mildly agree; 5. Strongly agree
	4	Mental health	You are satisfied with your household's mental health?	1. Strongly disagree; 2. Mildly disagree; 3. Unsure; 4. Mildly agree; 5. Strongly agree
Security	5	Life safety	Your household's life safety in daily life is secure	1. Strongly disagree; 2. Mildly disagree; 3. Unsure; 4. Mildly agree; 5. Strongly agree
	4	Property safety	Your household's property safety in daily life is secure	1. Strongly disagree; 2. Mildly disagree; 3. Unsure; 4. Mildly agree; 5. Strongly agree

Table A1. *Cont.*

Human Well-Being Subcategory	Weight	Indicator Layer	Questionnaire	Options
	5	Local crime incidence	The local crime incidence is low	1. Strongly disagree; 2. Mildly disagree; 3. Unsure; 4. Mildly agree; 5. Strongly agree
	3	Reliability of government protection	The police and judicial system can be trusted	1. Strongly disagree; 2. Mildly disagree; 3. Unsure; 4. Mildly agree; 5. Strongly agree
Good social relations	4	Close neighborhood	This is a close-knit neighborhood	1. Strongly disagree; 2. Mildly disagree; 3. Unsure; 4. Mildly agree; 5. Strongly agree
	5	Family relations	You are satisfied with your family relations	1. Strongly disagree; 2. Mildly disagree; 3. Unsure; 4. Mildly agree; 5. Strongly agree
	4	Trust	Most people in this village are honest and can be trusted	1. Strongly disagree; 2. Mildly disagree; 3. Unsure; 4. Mildly agree; 5. Strongly agree
	5	Cohesion	Suppose someone in your village had something unfortunate happen to them, there are always some others would be ready to help?	1. Strongly disagree; 2. Mildly disagree; 3. Unsure; 4. Mildly agree; 5. Strongly agree

Table A2. Reliability and validity test.

Latent Variable	Observed Variable		Standardized Load Value	Composite Reliability (CR)	Average Variance Extraction (AVE)
Demographic characteristics	Age	x_{11}	0.706	0.743	0.427
	Education	x_{12}	0.645		
	Family size	x_{13}	0.453		
	Family burden	x_{14}	0.768		
Land use	Grassland	x_{21}	0.858	0.795	0.578
	Farmland	x_{22}	0.474		
	Livestock	x_{23}	0.880		
Provisioning services	Food production	x_{31}	0.565	0.686	0.424
	Forage supply	x_{32}	0.675		
	Fuelwood supply	x_{33}	0.705		
Regulating services	Water retention	x_{41}	0.747	0.759	0.513
	Sandstorm prevention	x_{42}	0.634		
	Climate regulation	x_{43}	0.761		
Human well-being	Freedom of choice and action	y_1	0.835	0.849	0.533
	Basic material for a good life	y_2	0.760		
	Health	y_3	0.732		
	Security	y_4	0.715		
	Good social relations	y_5	0.585		

Table A3. Summary of model fit information.

Fit Index	CMIN/DF	RMSEA	GFI	PGFI	PNFI	PCFI
Criterion	<3	<0.08	>0.9	>0.5	>0.5	>0.5
value	2.149	0.071	0.910	0.601	0.567	0.633

Table A4. Fitting results of structural equation model.

Latent Variable			Standardized Path Coefficient/Direct Effect	C.R./t Value	Hypothesis Test
Land use	$\alpha_1 \leftarrow$	Demographic	0.530 **	2.158	support
Provisioning services	$\alpha_2 \leftarrow$	Land use	0.433 **	2.096	support
Regulating services	$\alpha_3 \leftarrow$	Land use	−0.188 *	−1.713	support
Human well-being	$\alpha_4 \leftarrow$	Provisioning services	0.518 **	2.142	support
Human well-being	$\alpha_5 \leftarrow$	Regulating services	0.609 ***	3.016	support
Human well-being	$\alpha_1 \leftarrow$	Demographic	−0.167	−1.333	reject

* Significant at 0.1 level, ** significant at 0.05 level, *** significant at 0.01 level.

References

1. Bennett, E.M.; Cramer, W.; Begossi, A.; Cundill, G.; Díaz, S.; Egoh, B.N.; Geijzendorffer, I.R.; Krug, C.B.; Lavorel, S.; Lazos, E.; et al. Linking biodiversity, ecosystem services, and human well-being: Three challenges for designing research for sustainability. *Curr. Opin. Environ. Sustain.* **2015**, *14*, 76–85. [CrossRef]
2. Millennium Ecosystem Assessment. *Ecosystems and Human Well-Being: Synthesis*; Island Press: Washington, DC, USA, 2005.
3. Ciftcioglu, G.C. Assessment of the relationship between ecosystem services and human wellbeing in the social-ecological landscapes of lefke region in north cyprus. *Landsc. Ecol.* **2017**, *32*, 897–913. [CrossRef]
4. Wang, B.; Zhang, Q.; Cui, F. Scientific research on ecosystem services and human well-being: A bibliometric analysis. *Ecol. Indic.* **2021**, *125*, 107449. [CrossRef]
5. Díaz, S.; Demissew, S.; Carabias, J.; Joly, C.; Lonsdale, M.; Ash, N.; Larigauderie, A.; Adhikari, J.R.; Arico, S.; Báldi, A.; et al. The ipbes conceptual framework—Connecting nature and people. *Curr. Opin. Environ. Sustain.* **2015**, *14*, 1–16. [CrossRef]
6. Santos-Martín, F.; Martín-López, B.; García-Llorente, M.; Aguado, M.; Benayas, J.; Montes, C. Unraveling the relationships between ecosystems and human wellbeing in spain. *PLoS ONE* **2013**, *8*, e73249. [CrossRef] [PubMed]
7. Martín-López, B.; Iniesta-Arandia, I.; García-Llorente, M.; Palomo, I.; Casado-Arzuaga, I.; Del Amo, D.G.; Gómez-Baggethun, E.; Oteros-Rozas, E.; Palacios-Agundez, I.; Willaarts, B.; et al. Uncovering ecosystem service bundles through social preferences. *PLoS ONE* **2012**, *7*, e38970. [CrossRef] [PubMed]
8. Wang, X.; Dong, X.; Liu, H.; Wei, H.; Fan, W.; Lu, N.; Xu, Z.; Ren, J.; Xing, K. Linking land use change, ecosystem services and human well-being: A case study of the manas river basin of xinjiang, china. *Ecosyst. Serv.* **2017**, *27*, 113–123. [CrossRef]
9. Wang, B.; Tang, H.; Xu, Y. Integrating ecosystem services and human well-being into management practices: Insights from a mountain-basin area, china. *Ecosyst. Serv.* **2017**, *27*, 58–69. [CrossRef]
10. Yang, S.; Zhao, W.; Pereira, P.; Liu, Y. Socio-cultural valuation of rural and urban perception on ecosystem services and human well-being in yanhe watershed of china. *J. Environ. Manag.* **2019**, *251*, 109615. [CrossRef] [PubMed]
11. Wu, J. Landscape sustainability science: Ecosystem services and human well-being in changing landscapes. *Landsc. Ecol.* **2013**, *28*, 999–1023. [CrossRef]
12. Raudsepp-Hearne, C.; Peterson, G.D.; Tengö, M.; Bennett, E.M.; Holland, T.; Benessaiah, K.; Macdonald, G.K.; Pfeifer, L. Untangling the environmentalist's paradox: Why is human well-being increasing as ecosystem services degrade? *Bioscience* **2010**, *60*, 576–589. [CrossRef]
13. Duraiappah, A.K. Ecosystem services and human well-being: Do global findings make any sense? *Bioscience* **2011**, *61*, 7–8. [CrossRef]
14. Delgado, L.E.; Marín, V.H. Well-being and the use of ecosystem services by rural households of the río cruces watershed, southern chile. *Ecosyst. Serv.* **2016**, *21*, 81–91. [CrossRef]
15. Hossain, M.S.; Eigenbrod, F.; Johnson, F.A.; Dearing, J.A. Unravelling the interrelationships between ecosystem services and human wellbeing in the bangladesh delta. *Int. J. Sustain. Dev. World Ecol.* **2017**, *24*, 120–134. [CrossRef]
16. Xu, Z.; Wei, H.; Fan, W.; Wang, X.; Zhang, P.; Ren, J.; Lu, N.; Gao, Z.; Dong, X.; Kong, W. Relationships between ecosystem services and human well-being changes based on carbon flow—a case study of the manas river basin, xinjiang, china. *Ecosyst. Serv.* **2019**, *37*, 100934. [CrossRef]
17. Duraiappah, A.K.; Asah, S.T.; Brondizio, E.S.; Kosoy, N.; O'Farrell, P.J.; Prieur-Richard, A.-H.; Subramanian, S.M.; Takeuchi, K. Managing the mismatches to provide ecosystem services for human well-being: A conceptual framework for understanding the new commons. *Curr. Opin. Environ. Sustain.* **2014**, *7*, 94–100. [CrossRef]
18. Liebenow, D.K.; Cohen, M.J.; Gumbricht, T.; Shepherd, K.D.; Shepherd, G. Do ecosystem services influence household wealth in rural mali? *Ecol. Econ.* **2012**, *82*, 33–44. [CrossRef]
19. Tadesse, G.; Zavaleta, E.; Shennan, C.; FitzSimmons, M. Local ecosystem service use and assessment vary with socio-ecological conditions: A case of native coffee-forests in southwestern ethiopia. *Hum. Ecol.* **2014**, *42*, 873–883. [CrossRef]
20. Hicks, C.C.; Graham, N.A.J.; Cinner, J.E. Synergies and tradeoffs in how managers, scientists, and fishers value coral reef ecosystem services. *Glob. Environ. Chang.* **2013**, *23*, 1444–1453. [CrossRef]
21. CCICED. *Ecosystem Service and Management Strategy in China*; China Council for International Cooperation on Environment and Development: Beijing, China, 2011.

22. Viglizzo, E.F. Eco-services and land-use policy. *Agric. Ecosyst. Environ.* **2012**, *154*, 1. [CrossRef]
23. Bryan, B.A. Incentives, land use, and ecosystem services: Synthesizing complex linkages. *Environ. Sci. Policy* **2013**, *27*, 124–134. [CrossRef]
24. Primdahl, J.; Andersen, E.; Swaffield, S.; Kristensen, L. Intersecting dynamics of agricultural structural change and urbanisation within european rural landscapes: Change patterns and policy implications. *Landsc. Res.* **2013**, *38*, 799–817. [CrossRef]
25. Yee, S.H.; Paulukonis, E.; Simmons, C.; Russell, M.; Fulford, R.; Harwell, L.; Smith, L.M. Projecting effects of land use change on human well-being through changes in ecosystem services. *Ecol. Model.* **2021**, *440*, 109358. [CrossRef]
26. Xu, Y.; Tang, H.; Wang, B.; Chen, J. Effects of land-use intensity on ecosystem services and human well-being: A case study in huailai county, china. *Environ. Earth Sci.* **2016**, *75*, 416. [CrossRef]
27. Mudaca, J.D.; Tsuchiya, T.; Yamada, M.; Onwona-Agyeman, S. Household participation in payments for ecosystem services: A case study from mozambique. *For. Policy Econ.* **2015**, *55*, 21–27. [CrossRef]
28. Mao, J.; Zhang, K.; Liu, G. Enlightenment of world food programme (wfp) "2605" project on strengthen the achievements of grain for green project. *Prot. For. Sci. Technol.* **2006**, *6*, 63–65. (In Chinese) [CrossRef]
29. Buckley, M.C.; Crone, E.E. Negative off-site impacts of ecological restoration: Understanding and addressing the conflict. *Conserv. Biol.* **2008**, *22*, 1118–1124. [CrossRef]
30. Carpenter, S.R.; Mooney, H.A.; Agard, J.; Capistrano, D.; DeFries, R.S.; Díaz, S.; Dietz, T.; Duraiappah, A.K.; Oteng-Yeboah, A.; Pereira, H.M.; et al. Science for managing ecosystem services: Beyond the millennium ecosystem assessment. *Proc. Natl. Acad. Sci. USA* **2009**, *106*, 1305–1312. [CrossRef]
31. Ouyang, Z.; Zheng, H.; Xiao, Y.; Polasky, S.; Liu, J.; Xu, W.; Wang, Q.; Zhang, L.; Xiao, Y.; Rao, E.; et al. Improvements in ecosystem services from investments in natural capital. *Science* **2016**, *352*, 1455–1459. [CrossRef]
32. Yang, W.; Dietz, T.; Kramer, D.B.; Chen, X.; Liu, J. Going beyond the millennium ecosystem assessment: An index system of human well-being. *PLoS ONE* **2013**, *8*, e64582. [CrossRef]
33. Wang, Y.; Bilsborrow, R.E.; Zhang, Q.; Li, J.; Song, C. Effects of payment for ecosystem services and agricultural subsidy programs on rural household land use decisions in china: Synergy or trade-off? *Land Use Policy* **2019**, *81*, 785–801. [CrossRef]
34. Byrne, B.M. *Structural Equation Modeling with Amos: Basic Concepts, Applications, and Programming*, 2nd ed.; Taylor & Francis Group: New York, NY, USA, 2009; ISBN 978-0-8058-6372-7.
35. Nainggolan, D.; Termansen, M.; Reed, M.S.; Cebollero, E.D.; Hubacek, K. Farmer typology, future scenarios and the implications for ecosystem service provision: A case study from south-eastern spain. *Reg. Environ. Chang.* **2013**, *13*, 601–614. [CrossRef]
36. Cruz-Garcia, G.S.; Sachet, E.; Blundo-Canto, G.; Vanegas, M.; Quintero, M. To what extent have the links between ecosystem services and human well-being been researched in africa, asia, and latin america? *Ecosyst. Serv.* **2017**, *25*, 201–212. [CrossRef]
37. Robinson, B.E.; Zheng, H.; Peng, W. Disaggregating livelihood dependence on ecosystem services to inform land management. *Ecosyst. Serv.* **2019**, *36*, 100902. [CrossRef]
38. Liu, Y.; Fang, F.; Li, Y. Key issues of land use in china and implications for policy making. *Land Use Policy* **2014**, *40*, 6–12. [CrossRef]
39. Zhang, J.; Li, X.; Buyantuev, A.; Bao, T.; Zhang, X. How do trade-offs and synergies between ecosystem services change in the long period? The case study of uxin, inner mongolia, China. *Sustainability* **2019**, *11*, 6041. [CrossRef]
40. Zhang, J.; Niu, J.; Buyantuev, A.; Wu, J. A multilevel analysis of effects of land use policy on land-cover change and local land use decisions. *J. Arid. Environ.* **2014**, *108*, 19–28. [CrossRef]
41. Bennett, E.M.; Peterson, G.D.; Gordon, L.J. Understanding relationships among multiple ecosystem services. *Ecol. Lett.* **2009**, *12*, 1394–1404. [CrossRef] [PubMed]
42. Jia, X.; Fu, B.; Feng, X.; Hou, G.; Liu, Y.; Wang, X. The tradeoff and synergy between ecosystem services in the grain-for-green areas in northern shaanxi, china. *Ecol. Indic.* **2014**, *43*, 103–113. [CrossRef]
43. Wei, H.; Liu, H.; Xu, Z.; Ren, J.; Lu, N.; Fan, W.; Zhang, P.; Dong, X. Linking ecosystem services supply, social demand and human well-being in a typical mountain–oasis–desert area, xinjiang, china. *Ecosyst. Serv.* **2018**, *31*, 44–57. [CrossRef]
44. Lv, Y.; Fu, B.; Feng, X.; Zeng, Y.; Liu, Y.; Chang, R.; Sun, G.; Wu, B. A policy-driven large scale ecological restoration: Quantifying ecosystem services changes in the loess plateau of china. *PLoS ONE* **2012**, *7*, e31782.
45. Butler, C.D.; Willis, O.K. Linking future ecosystem services and future human well-being. *Ecol. Soc.* **2006**, *11*, 30. [CrossRef]