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Article

Factors Affecting Migration Intentions in Ecological Restoration Areas and Their Implications for the Sustainability of Ecological Migration Policy in Arid Northwest China

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Abstract: Ecological migration policy has been proposed and implemented as a means for depopulating ecological restoration areas in the arid Northwest China. Migration intention is critical to the effectiveness of ecological migration policy. However, studies on migration intention in relation to ecological migration policy in China remain scant. Thus this paper aims to investigate the rural residents' migration intentions and their affecting factors under ecological migration policy in Minqin County, an ecological restoration area, located at the lower terminus of Shiyang River Basin in arid Northwest China. The data for this study come from a randomly sampled household questionnaire survey. Results from logistic regression modelling indicate that most residents do not intend to migrate, despite rigid eco-environmental conditions and governance polices threatening livelihood sustainability. In addition to demographic and socio-economic factors, the eco-environmental factors are also significantly correlated with the possibility of a resident intending to migrate. The implications of the significant independent variables for the sustainability of ecological migration policy are discussed. The paper concludes that ecological migration policies may ultimately be more sustainable when taking into account household interests within complex migration intention contexts, such as household livelihoods dynamics and environmental change.

Keywords: migration intentions; ecological migration policy; ecological restoration area; policy sustainability; sustainable livelihood; arid Northwest China

1. Introduction

Managing population size in ecological restoration areas through resettlement policy is one of the strategic measures for both environmental and development aims in China [1,2]. This type of resettlement is always called ecological migration when related to migration policy aimed at rehabilitating the degenerated eco-environment [3]. In China, ecological migration policy has seemingly been designed to achieve rural development and eco-environmental rehabilitation simultaneously through one policy intervention [4]. Many authors approve ecological migration as a preferred approach for protecting arid Northwest China's fragile eco-environment, even though they also recognize its potential problems, such as the mismatch between traditional production style in the sending area and new lifestyles in the receiving area [5,6]. However, other authors argue that the primary environmental rationale behind ecological migration is largely inadequate and that there is insufficient justification to point toward ecological migration as the only possible solution [7,8]. Despite ecological migration policy extant in China since the 1990s, potential migrants' voices are ineffectively heard in the process.

Arid Northwest China accounts for over 20% of China's total land area, which includes Xinjiang Uygur Autonomous Region, the western part of Inner Mongolia Autonomous Region, Hexi Corridor in Gansu Province, and Qilian Mountains and Qaidam Basin in Qinhai Province, with a main landscape of desert, high mountains and great basins forming its characteristic topography [9]. This area is situated in the deep hinterland of Eurasia with scarce precipitation and greatly varied air temperature. In these extremely arid great basins, such as Tarim Basin, Junggar Basin and Hexi Corridor, the local peoples have a long history of utilizing inland river water to irrigate crops and develop sandy and alpine pastures for animal husbandry [9]. Originating in the high mountain snow melt, the water flows eventually to the Gobi Desert.

In the past 50 years, about four million hectares of man-made oases have newly been developed in all of the river basins, and about 622 reservoirs with a storage capacity of 6.6 billion cubic meters have been built [10]. In addition to the fast urbanization in the middle parts of the river basins, the large scale utilization of surface water in the middle reaches and over-exploitation of ground-water in the lower reaches have not only facilitated the steady development of social economy but also resulted in serious eco-environmental problems in the arid area, especially in the lower reaches of these river basins. Problems include shortened runoff courses of most rivers, shrinking or dried up terminal lakes, declining quantity and quality of surface water in the lower reaches, more serious soil salinization and desertification, and seriously degraded or destroyed vegetation [10]. In recent years, strong dust-storms have occurred frequently across the region. They are thought to be a result of continuing deterioration of the environment relating to current practices in water use and agriculture [11].

With the aim to systematically restore the degenerated eco-environment in the inland river basins, especially in the end terminuses, some integrative river basin governance planning or policies have been proposed and implemented, such as that in Shiyang River Basin located in the east of the Hexi Corridor

in Gansu Province. The Shiyang River Basin is one of the earliest to have been developed and is one of the most overexploited inland basins in northwest China [11]. The shortage of surface water and overexploitation of ground-water have caused serious eco-environmental and social problems, such as desertification and environmentally forced out-migration in Minqin County, the lower terminus of Shiyang River Basin.

In November 2007, the Central government approved an ecological restoration plan named "Key Governance Planning for Shiyang River Basin" (Chinese Pinyin: *Shiyanhe Liuyu Zhongdian Zhili Guihua*) with the total investment from 2006–2020 to reach 4.7 billion RMB Yuan (about 0.64 billion US$ in 2007), of which over 1 billion Yuan will be invested in the territory of Minqin. Apart from the costly engineering projects, the management policies involved in the planning can be categorized into three types. First, environmental policies, which mainly include shutting motor-pumped wells, decreasing cultivated land area, and restricting pumped ground-water by controlling electricity supply and IC-card rationing equipment installed on the motor-pumped well's mouth. These measures aim to reduce groundwater and surface water consumption, and allocate more water to desert vegetation restoration in the end terminus. Second, economic policies that include constructing greenhouses for vegetables and warm barns for livestock husbandry, shifting from crop farming to fruit trees or forage grass, and encouraging peasants to do non-farm work through labor-skills training. And the third, ecological migration policy, which plans for out-migration of 10,500 residents from the Minqin County's marginal land neighboring the desert. To implement this plan, the government has drawn up specific stimulation approaches including subsidizing 6000 Yuan per capita on the condition of the household head signing an agreement to abandon the household's local water and land rights.

A relatively long history of desertification-induced out-migration in Northwest China, including a large number of voluntary out-migrants from Minqin County in the past three decades [12], precedes the execution of ecological migration policy [7]. When the ecological migration policy was initially passed in tandem with other kinds of policies as part of the river basin governance planning in recent years, residents remaining behind who suffered exacerbated desertification might be less capable of out-migrating than earlier voluntary migrants, because migration is often expensive, and those most vulnerable to environmental change are usually poor [13]. Still the questions remain: Do the residents have the propensity to migrate? What factors influence their migration intentions? Answering these questions is helpful to successfully implement the ecological migration policy in the ecological restoration area, but there is scant study of these critical questions.

According to the theory of reasoned action proposed by Ajzen and Fishbein [14], migration intention remains the dominant determinant of migration behavior [15]. This paper will utilize Minqin County as a case to study the factors affecting the local residents' migration intentions and discuss their implications on the sustainability of ecological migration policy in arid Northwest China. The findings will implicate China's ecological migration policy, so that population, environment, and development are more harmoniously related in the arid Northwest China area. Furthermore, findings could contribute to the future research and resettlement policy applications in other similarly marginal environments globally. In the following sections, we first describe the study area and data sources. Then, we propose an analytical model and a framework of factors affecting migration intentions in an ecological restoration area. Theories and hypotheses about the relationships between the proposed drivers and migration intention are then reviewed briefly. Finally, results of logistic regression analysis are used as the basis

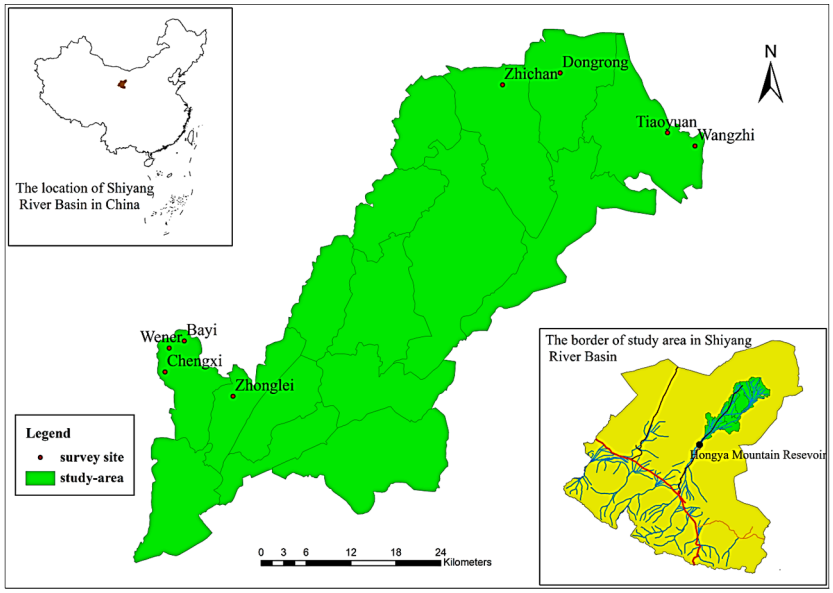
for in-depth discussion of the implications of the significant factors for ecological migration policy in Arid Northwest China.

2. Data and Methods

2.1. Study Area

Minqin County is located in Northwest China (Figure 1), a hotspot of severe water shortage and desertification [16–19]. Minqin County is located at the lower terminus of the Shiyang River Basin, one of the three inland river basins in the Hexi Corridor of Gansu Province, Northwest China. The geographical location lies between 102°52'E～103°50'E, 38°22'N～39°6'N. Minqin County is surrounded by the Badain Jaran Desert and the Tengger Desert from the west, north, and east.

Figure 1. Map of study area.



Since the Hongya Mountain Reservoir at the south edge of Minqin County was constructed in 1958, natural surface water flowing to Minqin County has disappeared. All of the surface water allocated to Minqin County is controlled by the Hongya Mountain Reservoir. Along with urbanization and industrial development growing rapidly in the middle portion of the Shiyang River Basin, water storage in the reservoir decreased from an annual average of 545 million cubic meters in the 1950s to 136 million cubic meters in the 1990s [20]. As surface water volume decreased, a large amount of groundwater was pumped to fill the gap, allowing the cultivated land area and agricultural structure to remain largely unchanged. In 2000, the ratio of consumed groundwater volume to surface water volume reached 7:1 [21]. As the groundwater table continuously decreased, a large amount of vegetation deteriorated, and groundwater quality and soil quality declined.

Because Minqin County is located at the lower terminus of Shiyang River Basin, the oasis remains fertile and productive. Before 2002, although the marginal area was threatened by desertification and decreasing groundwater quality, residents had relatively larger farm areas and could earn more income from agriculture than rural residents in the other part of the Shiyang River Basin. After 2002, and

especially since 2007, since the "Key Governance Planning for Shiyang River Basin" has been implemented, the quantity of basic livelihood assets, such as arable land quota and water availability for agriculture, has decreased greatly in the study area, even though the trend of eco-environmental deterioration has been effectively curbed, and the groundwater table has continued to rise [22].

2.2. Source of Data

The data applying in this study come from two resources. One is a random household structured questionnaire survey conducted by the authors in eight villages in Minqin County from December 2010 to January 2011. It elicited data regarding the respondents' migration intentions and variables affecting these intentions. The information collected includes household demographic characteristics (composition, age, education and migration), household livelihood assets/strategies, and the respondents' subjective evaluation of the local eco-environmental status and trends according to the sustainable livelihood framework [23]. Another is China's fifth and sixth population census data at the county level in 2000 and 2010, which was used to analyze the macro-demographic characteristics and dynamics in Minqin County.

In the questionnaire survey, the households were randomly selected, and the interviewees within the selected households were all adults, nearly always the household head or spouse. The sampling frame for the household survey comprises about 9500 rural households, which are homes to about 40,000 residents, in the 55 villages within nine northwesterly desert-neighbored townships of Minqin County. The multistage Probability Proportionate to Size (PPS) sampling method was utilized to create the household sample. There are four stages in the sampling process. In the first stage, four townships were sampled out of the nine marginal townships in proportion to their population size. At the second stage, eight marginal villages were selected from all villages of the four sampled townships proportionate to their population size. The eight sampled villages were Wen'er, Bayi, Chengxi from Daba Township; Wangzhi, Tiaoyuan from Donghu Township; Zhonglei from Sanlei Township; and Dongrong, Zhichan from Xiqu Township (Figure 1). At the third stage, the investigators randomly selected 40 households in each of the eight villages. We used a systematic sampling method based on the detailed household roster for each of the marginal villages provided by the secretary of the village branch of the Chinese Communist Party (CCP). At the intra-household sampling stage, if the household head or spouse was at home, that person became the interviewee. Otherwise, the interviewee would be a household member over the age of 18 whose birthday was closest to December 1. Face-to-face questionnaire administration was used on site, whereby an interviewer presents the questions orally and completes the questionnaire on the spot. The expected sample size was 320 and the final valid sample size was 308. Geographical homogeneity among the sampled villages allowed this relatively small sample size to satisfy the acceptable sampling error of between 5% and 6% at the 95% level of confidence [24].

2.3. Analytical Model

The binary logistic regression model is always used to explore the factors affecting adoption of some specific agricultural technologies for rural sustainable development in arid Northwest China such as [25–27], and to examine the determinants of migration intentions among developing countries such as [15,28,29]. In this study, we also used a binary logistic regression model to evaluate rural residents' intention to migrate and the predicting factors. In the questionnaire, we asked the respondent

whether he/she has the intention to migrate out of his/her hometown. The options are Yes and No. Migration intention as dependent variable (DV) is measured by dichotomy 1 (Yes) and 0 (No). The Logistic Regression Model used in this paper is as follows:

$$\text{logit } P = \ln(\frac{P}{1-P}) = \alpha + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_p x_p \quad (1)$$

In the above equation, P indicates the possibility of having propensity for migration. x_1, x_2, ..., x_p indicate various factors affecting migration intention. α is the constant indicating intercept in the model, and β_1, β_2, ..., β_p indicate the coefficients of various factors in the model. All the computations in this paper are processed by IBM SPSS Statistics 19.0.

2.4. Predictors

Unlike previous studies which mainly took demographic characteristics and social-economic factors as predominant predictors of migration intentions [28–30], this paper added the predictors of political-economic and eco-environmental factors into the analytical models (Figure 2). This idea is inspired by the sustainable livelihood framework [23]. The rationale for this consideration is that the migration intentions studied in this paper are promoted mainly by the governmental policies portfolio, which will impact the migration intentions directly by ecological migration policy and indirectly by feedback loops among governmental policies, rural household livelihoods assets/strategies, and local environmental change.

The name and definitions of the predicting factors are listed in Figure 2. The type of measure and the descriptive statistics for all these variables in the empirical models are given in Tables 1 and 2, respectively. Explanatory variables and their justifications are discussed below.

Figure 2. Factors affecting migration intentions in the ecological restoration area.

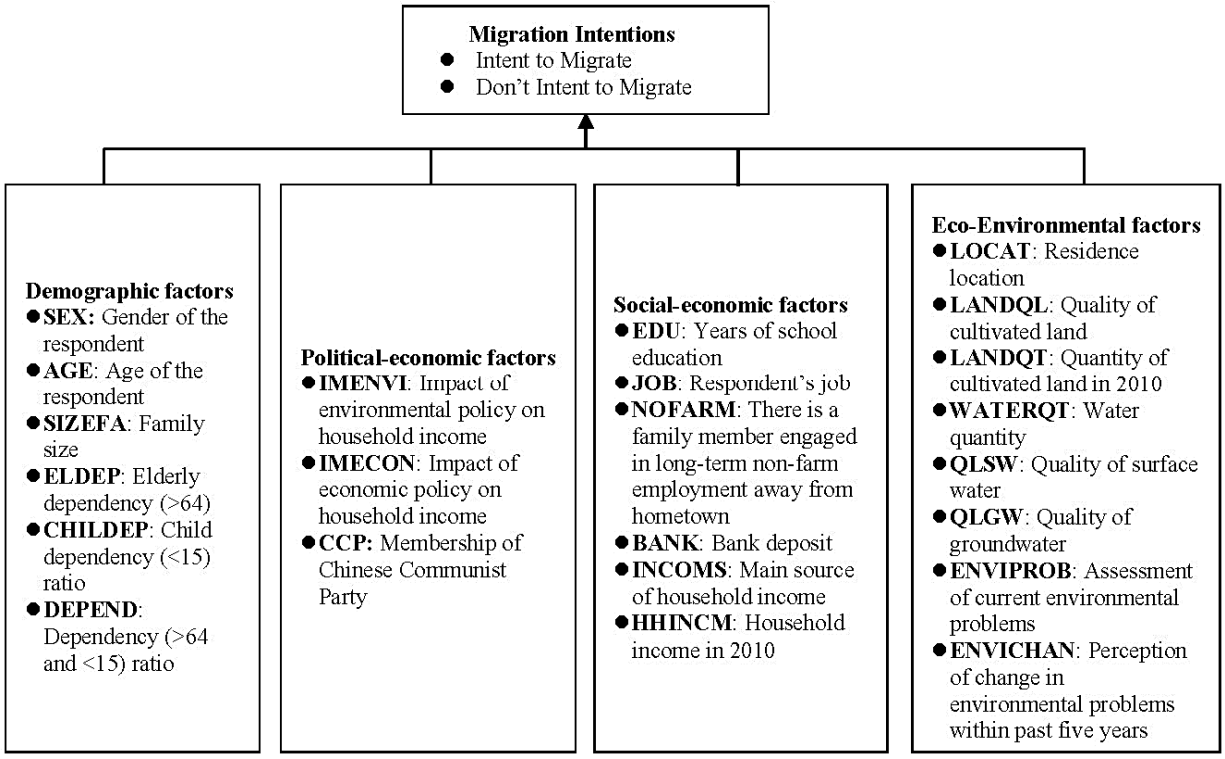


Table 1. Definition of variables used in the analysis.

Variables	Type of Measure	H_0 [a]
INTENT	Dichotomous (1 if yes, 0 if no)	
SEX	Dummy (0, female; 1, male)	+
AGE	Years	-
SIZEFA	Numbers	?
ELDEP	Percent	-
CHILDEP	Percent	-
DEPEND	Percent	-
IMENVI	Dummy (0 if increase, 1 if decrease)	-
IMECON	Dummy (0 if increase, 1 if decrease)	-
CCP	Dummy (1 if yes, 0 if no)	+
EDU	Years	+
JOB	Dummy: full-time farm work (reference), part time non-farm employment (-PNF), full time non-farm employment (-FNF)	+
NOFARM	Dummy (1 if yes, 0 if no)	+
BANK	Ordinal: 0 = "having no bank deposit", 1 = "Below 10,000 Yuan", 2 = "10,000~20,000 Yuan", 3 = "20,000~30,000 Yuan", 4 = "30,000~40,000 Yuan", 5 = "40,000~50,000 Yuan", 6 = "Above 50,000 Yuan"	+
INCOMS	Dummy: farm employment (reference), non-farm employment (-NFE), remittances (-REM), government subsidies (-GOS)	+, ~, -
HHINCM	1000 Yuan (a Chinese unit of currency)	+
LOCAT	Dummy: near dam/ near desert =0/1	+
LANDQL	Ordinal: 1 = "very bad", 2 = "bad", 3 = "normal", 4 = "good", 5 = "very good"	-
LANDQT	Mu (a Chinese unit of area, 1 Mu = 1/15 ha)	-
WATERQT	Dummy: sufficient both for domestic use and agriculture production (reference); sufficient for domestic use, but insufficient for agricultural production (-SDIA); sufficient for agricultural production, but insufficient for domestic use (-SAID); insufficient for both domestic use and agricultural production (-IBDA)	+
QLSW	Dummy: suitable for human daily life (reference); suitable for livestock drink (-SFLS); only suitable for irrigation (-SFIR); not suitable for irrigation (-NFIR). Ordinal: [3,2,1,0]	+
QLGW	Dummy: suitable for human daily life (reference); suitable for livestock drink (-SFLS); only suitable for irrigation (-SFIR); not suitable for irrigation (-NFIR). Ordinal: [3,2,1,0]	+
ENVIPROB	Ordinal: [0,32] = [no problem, very serious problems]= $\sum_{i=1}^{8} ENVIPROB_{ij}$, j = [0,1,2,3,4] = [no problem, a little, not serious, serious, very serious], i = [1,2,…,8] = [sand storms (-SS), land desertification (-LD), land salinization (-LS), groundwater mineralization (-GM), shortage of water resources (SWR), discarding used plastic film in the field (-DUPF), vegetation deterioration (-VD), and converting forest to farmland (-CFF)]	+
ENVICHAN [b]	In Model 1: Ordinal: [–16,16] = [sharply deteriorated, greatly ameliorated] = $\sum_{i=1}^{8} ENVICHAN_{ij}$, j = [–2,–1,0,1,2] = [sharply deteriorated, some deteriorated, no change, some ameliorated, greatly ameliorated], the meaning of i is same as that in ENVIPROB;	-
	In Model 2: Dummy (if sharply deteriorated within past five years = 1, others = 0)	+

[a] H_0 = Hypothesized relationship with Migration Intentions, "+" denotes positive, "-" denotes negative, and "?" denotes indeterminate; [b] Model 1 and 2 are described in Section 2.5.

Table 2. Descriptive Statistics.

Type	Variables	N	Min	Max	Mean	SD
	INTENT	308	0	1	0.26	0.44
Demographic	SEX	308	0	1	0.72	0.45
	AGE	306	18	81	50.41	10.84
	SIZEFA	308	1	9	4.17	1.38
	ELDEP	308	0	100.00	11.48	22.32
	CHILDEP	308	0	60.00	8.76	14.65
	DEPEND	308	0	100.00	21.70	25.72
Political-economic	IMENV	306	0	1	0.90	0.30
	IMECO	304	0	1	0.03	0.17
	CCP	308	0	1	0.11	0.31
Social-economic	EDU	307	0	12	6.98	3.91
	JOB-PNF	304	0	1	0.22	0.42
	JOB-FNF	304	0	1	0.03	0.16
	NOFAM	307	0	1	0.32	0.47
	BANK	308	0	6	0.4	1.08
	INCOMS-NFE	305	0	1	0.06	0.23
	INCOMS-REM	305	0	1	0.01	0.10
	INCOMS-GOS	305	0	1	0.01	0.08
	HHINCM	298	0.6	255	26.83	22.23
Eco-environmental	LOCAT	308	0	1	0.48	0.5
	LANDQL	301	1	5	3.47	0.96
	LANDQT	298	0	50	10.28	4.61
	WATERQT-SDIA	308	0	1	0.79	0.41
	WATERQT-SAID	308	0	1	0.02	0.13
	WATERQT-IBDA	308	0	1	0.15	0.36
	QLSW	306	1	3	1.81	0.69
	QLGW	305	0	3	2.22	0.91
	ENVIPROB	285	2	32	20.87	4.26
	ENVICHAN	271	−16	10	−3.66	5
	Valid N (listwise)	229				

2.4.1. Demographic Factors

SEX, AGE, SIZEFA, ELDEP, CHILDEP and DEPEND measure gender of the respondent, age of the respondent, family size, elderly dependency (>64) ratio, child dependency (<15) ratio, and dependency (>64 and <15) ratio, respectively.

According to Grieco and Boyd [31], gender has a core influence on the statuses of males and females, their roles, and stages in the life-cycle. These help determine people's position in society and, therefore, the opportunities women and men have to consider in moving to the pre- migration stage. Many previous studies suggest that gender roles impact men's and women's migration intentions and behavior differently [28,29]. In this study, males were expected to have more propensities to migrate than females, because the social norms and attitudes tend to be less friendly toward women's active pursuit of

economic activities outside the home. This, in turn, discourages or prevents many women from realizing their migration plans [28].

In many instances, older respondents may not migrate because their attachment to their community tends to be stronger than that of younger respondents [32]. Therefore, AGE was expected to be negative for migration intention. Size of family also determines how the household will manage in times of climate-related events. The larger the family size, the more vulnerable it may be in times of decreasing natural livelihood capital. The needs of a larger household will be difficult to provide for compared to a smaller one where just a few people have to be attended to. On the other hand, larger households might be able to more easily diversify their income by sending one of their members elsewhere for cash labor without losing essential household labor [32]. Therefore, the expected sign of SIZEFA is indeterminate.

De Jong [29] shows that the presence of children or elderly dependents increases intention to migrate for men because of increased financial family resource needs, but reduces intention to move for women because of dependent care responsibility. In this study, the dependent variable is rural residents' migration intention that is prescribed by ecological migration policy as virtually permanent family out-migration. Because of the uncertainty about livelihood approaches after out-migration, especially for higher dependency ratio households that are short of laborers, the ELDEP, CHILDEP and DEPEND were supposed to be negative to migration intention.

2.4.2. Political Economic Factors

The political economic factors mainly include IMENVI, IMECON and CCP, which measure respondents' subjective evaluation of the impact on household income of, respectively, environmental policy, economic policy, and membership of Chinese Communist Party.

Along with ecological migration policy, environmental and economic policies are essential elements in the river basin governance planning. If these policies decrease the household income after implementation, the migration intention will be strengthened. Therefore, IMENVI and IMECON were expected to be negative to migration intention. China is a one-party country. If the respondent had a membership of Chinese Communist Party (CCP) that governs the country, as the result of obedience to government, the migration intentions were expected to be stronger than those of non-members.

2.4.3. Social-Economic Factors

EDU, JOB, NOFARM, BANK, INCOMS, HHINCM indicate years of schooling, respondent's job, a family member engaged in long-term non-farm employment away from respondent's hometown, bank deposit, main source of household income, and household income in 2010.

If the respondent had more education or had a job other than farmer, he/she will have more opportunity to seek a livelihood in a new place [29,30]. Therefore, EDU and JOB were expected to be positive to migration intention. If a household member engaged in long-term non-farm employment away from his/her hometown, there will be a greater social network which is advantageous to out-migration [28,30]. Thus, NOFARM was expected to be positive to migration intention too. If a household had more bank deposits or annual income, it would have more financial capital for out-migration. Therefore, BANK and HHINCM were also expected to be positive to migration intention.

If the main resource of household income comes from non-farm employment (-NFE), the family will depend less on land resource and will have a greater propensity to migrate. If the household income comes mainly from remittances (-REM), the propensity to migrate is uncertain. One possible case is that the family will migrate as it depends less on land resource; another is that the family will not migrate to avoid the possible increase in the consumption portion of the remittance in a new place [29]. If the main resource of household income comes from government subsidies (-GOS), the family will have less propensity to migrate, in case the government subsidies are withdrawn after they leave their place of origin. Therefore, INCOMS-NFE was expected to be positive to migration intention, INCOMS-GOS was expected to be negative to migration intention, and the expected indication of INCOMS-REM is indeterminate.

2.4.4. Eco-Environmental Factors

LOCAT, LANDQL, LANDQT, WATERQT, QLSW, QLGW, ENVIPROB, ENVICHAN denote, respectively, residence location, quality of cultivated land, quantity of cultivated land in 2010, water quantity, quality of surface water, quality of groundwater, respondent's assessment of current environmental problems and perception of change in environmental problems within the past five years.

Historically, the voluntary emigrants from Minqin County resided in the northern towns near the desert [33]. Therefore, households near the desert were expected to have more propensities to migrate than those near the dam. Land and water resources are the critical livelihood assets of rural residents in arid areas. The better the quality of the land or water resources, the less willing families are to migrate [34]. The quantity of the land or water resources will impact the migration intentions in the same way. According to the definition of the eco-environmental factors (Table 1), the indications of LANDQL and LANDQT were expected to be negative, and the indication of WATERQT (-SDIA, SAID, or -IBDA), QLSW (-SFLS or -SFIR), and QLGW (-SFLS or -SFIR) were expected to be positive.

Environmental problems have long been the impetus of out-migration [35,36]. If the surrounding environment has more serious problems, the resident family will be more likely to migrate. Thus, the indications of ENVIPROB were expected to be positive. Government rehabilitation of the degraded environment will affect migration intention also. If the respondents perceived greater environmental amelioration, their families will be less inclined to migrate. So the indication of ENVICHAN was expected to be negative.

2.5. Measurement and Analysis

The measurements of all the predictors are listed in Table 1. In the questionnaire, two Likert Scales [37] (pp. 197–199) were utilized to measure the respondent's assessment of eight environmental problems' current statuses and perception of the change in these environmental problems within the past five years. These environmental problems are the following: sandstorm, land desertification, land salinization, groundwater mineralization, shortage of water resources, discarding used plastic film in the field, vegetation deterioration, and converting forest to farmland. The first scale is 0, 1, 2, 3, 4, indicating no problem, a little, not serious, serious and very serious; and the second scale is −2, −1, 0, 1, 2, indicating sharply deteriorated, somewhat deteriorated, no change, somewhat ameliorated, and greatly ameliorated. The Reliability Statistics, Cronbach's Alpha, for the two scales are 0.656 and 0.754 (computed by IBM

SPSS Statistics 19.0, based on 285 and 271 valid cases, accounting for 92.5% and 88% of the total, separately), which means the two scales have acceptable internal consistency reliability. In the analysis, we measure the respondent's assessment of the current status of eight environmental problems, and the perception of the change of these environmental problems up to two independent variables, which are "Assessment of current environmental problems" (ENVIPROB) and "Perception of change in environmental problems within past five years" (ENVICHAN), with the interval scale of (0,32) and (–16,16) indicating (no problem, very serious) and (sharply deteriorated, greatly ameliorated).

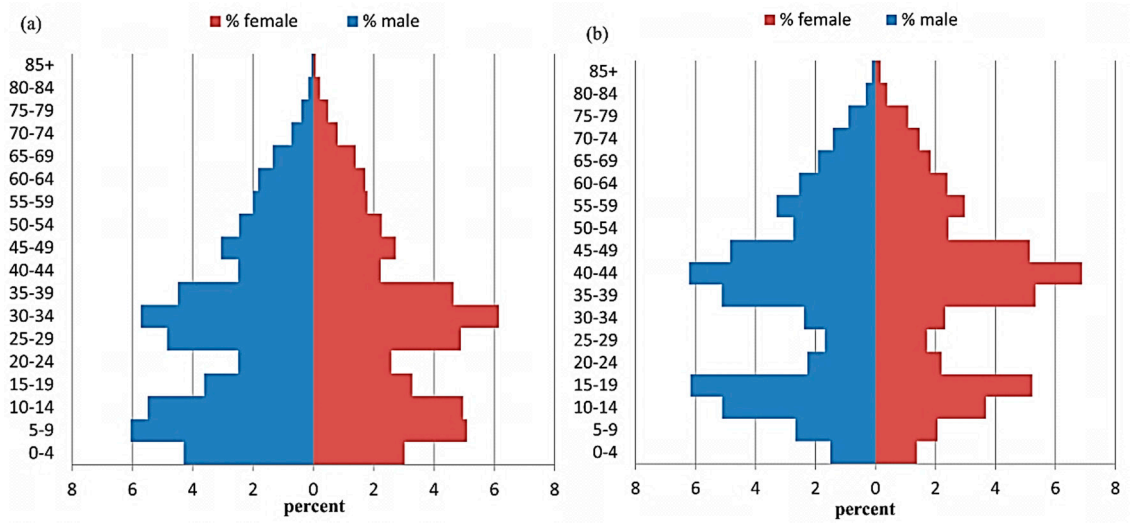
We implemented two models to explore factors affecting intention to migrate. In Model 1, the predictors of ENVIPROB, ENVICHAN, QLSW and QLGW are used as interval scale variables. If they are actually or nearly significant in Model 1, they will be substituted with dummy variables separated by their components (as described in Table 1) in Model 2 for further analysis. Whether or not a variable is included in the models is determined by its forward stepwise p-value. In each step, a factor can be entered into the model when its *p*-value is less than 0.45; it must be excluded when its *p*-value is more than 0.5. The significant variables from the model with higher Model Chi-Square will be used in the final model for final interpretation.

3. Results

3.1. Macro-Demographic Characteristics of Minqin County

By comparing the population size and structure of Minqin in 2000 (Figure 3a) and 2010 (Figure 3b), we observe an astonishing ageing and depopulation process in the study area. The Fifth National Population Census shows the resident population of Minqin in 2000 was 302,085, while the Sixth National Population Census of China shows that Minqin county had 241,251 residents in 2010. This represents over 60,000 fewer residents, a decrease of approximately 20% of Minqin County's population during the first decade of the 21st century. The population age structure also changed significantly. In 2000, the percentage of age 0–14 was 28.9%, while in 2010, it decreased to 16.4%. The percentage of 65+ increased from 5.7% in 2000 to 9.6% in 2010.

Figure 3. (**a**) Population Pyramid for Minqin 2000; (**b**) Population Pyramid for Minqin 2010.



Source: China's 5th and 6th Population Census Data.

3.2. Migration Intentions and Affecting Factors

Only 80 respondents, approximately one quarter of the 308, have intention to migrate. In contrast, 228 respondents do not intend to migrate (Table 3). Younger respondents had a higher ratio of intention to migrate, while respondents over the age of 65 are more willing to migrate than those aged 50–64 (Table 3).

Table 3. Migration intentions by age.

		Migration Intentions		Total	Ratio of Yes to Total
		No	Yes		
Valid	18–29	2	3	5	0.60
	30–39	25	12	37	0.32
	40–49	82	43	125	0.34
	50–64	90	14	104	0.13
	65+	28	7	35	0.20
Missing		1	1	2	0.50
Total		228	80	308	0.26

As Model 1 demonstrates, ENVICHAN (perception of change in environmental problems within the past five years) has a significant relationship with "migration intention". The QLGW (quality of groundwater) is nearly significant. In model 2, we substitute eight dummy variables for ENVICHAN (perception of change in environmental problems within past five years), and three dummy variables for QLGW (quality of groundwater). The Coefficients for the two logistic regression models of the Log Odds of intention to migrate are listed in Table 4. From the Model Chi-Square and corresponding p-value (Table 4), Model 2 is more suitable than Model 1 for explaining the relationships between various independent factors and migration intention. We selected 11 variables with a significance level less than 0.10 and one nearly significant but theoretically important variable (LOCAT) from Model 2 as the independent variables entered in the final model (Table 5).

From the final model, AGE (respondents' age), ELDEP (household elderly (>64) dependency ratio), INCOMS-NFE (household income primarily from non-farm employment), HHINCM (household gross income in 2010 (K Yuan)), LANDQT (quantity of cultivated land in 2010), WATERQT-IBDA (water quantity is insufficient for both domestic use and agricultural production), QLGW-SFIR (groundwater quality is suitable only for irrigation), ENVICHAN-LS and ENVICHAN-VD (perceiving the problems of "land salinization" and "vegetation deterioration" as sharply deteriorating within the past five years) significantly predict whether or not a resident has an intention to migrate (Model $p < 0.001$). The Exp (b), odds ratios, of the final model (Table 5) suggests that the odds of migration intent will increase by 2.5% if the household elderly (>64) dependency ratio increases one percentage point, and by 3.5% if annual household income increases by 1000 Yuan. The odds of having the intention to migrate are four times greater for residents with household income derived primarily from non-farm employment than for residents who earn wages primarily from farm work. The odds of opining that "water quantity is insufficient for both domestic use and agricultural production" relating to a propensity for migration are two times greater than the odds of believing "water quantity is sufficient for domestic use and agricultural production". If an informant opines that groundwater quality is suitable only for irrigation, the odds of having the intention to migrate become nearly three times greater than for those who feel

groundwater quality is suitable for daily life. And if an informant perceives the problem of "vegetation deterioration" or "land salinization" as having sharply deteriorated during the prior five years, the odds of propensity for migration become four to five times greater than the odds of those who do not perceive these problems. Conversely, the odds of having an intention to migrate decreases by 7% if the respondent's age increases one year, and decreases 9% if the quantity of household cultivated land in 2010 increases one Mu (Mu is a China's area unit. 1 Mu = 1/15 ha).

Table 4. Coefficients for various logistic regression models of the Log Odds of intending to migrate.

Variables	Model 1 (Forward Stepwise, "Conditional") CRITERIA = PIN(0.45) POUT(0.5)			Model 2 (Forward Stepwise, "Conditional") CRITERIA = PIN(0.45) POUT(0.5)		
	b	**Exp(*b*)**	**p**	***b***	**Exp(*b*)**	**p**
INTERCEPT	4.139	62.722	0.016	1.879	6.544	0.194
AGE	−0.077 ***	0.926	0.000	−0.075 ***	0.928	0.000
SIZEFA				0.189	1.208	0.163
ELDEP	0.025 **	1.025	0.002	0.038 **	1.038	0.008
DEPEND				−0.011	0.989	0.326
IMECON	−0.976	0.377	0.428	−1.058	0.347	0.361
CCP	0.647	1.91	0.215			
EDU	−0.049	0.952	0.297	−0.039	0.962	0.417
BANK	−0.229	0.795	0.213	−0.210	0.810	0.265
INCOMS-NFE				1.665 *	5.287	0.016
HHINCM	0.030 *	1.03	0.026	0.039 **	1.039	0.002
LOCAT	−0.797	0.451	0.265	−0.854	0.426	0.108
LANDQL				−0.139	0.870	0.462
LANDQT	−0.079 *	0.924	0.058	−0.110 *	0.896	0.016
WATERQT-IBDA	0.848 *	2.334	0.067	1.081 *	2.948	0.025
QLGW	−0.602	0.547	0.136	--	--	--
-SFIR	--	--	--	1.317 *	3.731	0.018
ENVICHAN	−0.09 *	0.914	0.012			
-SS	--	--	--	−0.672	0.511	0.262
-LD	--	--	--	1.208 *	3.348	0.063
-LS	--	--	--	2.062 ***	7.858	0.000
-GM	--	--	--	−0.640	0.527	0.222
-DUPF	--	--	--	−1.182 *	0.307	0.088
-VD	--	--	--	1.296 *	3.656	0.059
Nagelkerke R Square		0.202			0.332	
Model chi-square		34.409			68.097	
Model p		0.001			0.000	
Degrees of freedom		12			20	

* $p < 0.10$; ** $p < 0.01$; *** $p < 0.001$.

Table 5. Final Logistic Regression Model for the Log Odds of intending to migrate.

Type	Variables	B	Exp(B)	Sig.
	INTERCEPT	1.297	3.660	0.166
Demographic factors	AGE ***	−0.070	0.932	0.000
	ELDEP **	0.024	1.025	0.002
Socio- economic factors	INCOMS-NFE *	1.421	4.142	0.033
	HHINCM ***	0.035	1.035	0.001
Eco-environmental factors	LOCAT	−0.575	0.562	0.209
	LANDQT*	−0.098	0.907	0.015
	WATERQT-IBDA *	0.842	2.321	0.057
	QLGW-SFIR *	1.066	2.904	0.026
	ENVICHAN-LD	0.527	1.694	0.272
	ENVICHAN-LS ***	1.569	4.804	0.001
	ENVICHAN-DUPF	−1.025	0.359	0.116
	ENVICHAN-VD *	1.308	3.698	0.049

Hosmer and Lemeshow Test: Chi-square, 7.048; d.f., 8; sig., 0.531. Model chi-square = 62.643 ***; d.f., 12. Nagelkerke R Square 0.294. * $p < 0.10$; ** $p < 0.01$; *** $p < 0.00$l.

4. Discussion

4.1. The Sustainability of Ecological Migration Policy in Arid Northwest China

The history of China's ecological migration could be traced back to the resettlement of residents from poor areas with a harsh substantial environment and fragile ecology in Western China's Provinces of Ningxia and Gansu by the provincial government in 1980s and 1990s [6]. The meaning of "ecological migration" in Chinese literature [1,2,38,39] is different from 'environmental migration' in English literature [40–42]. Although both ecological migration and environmental migration belong to the forced migration category, the main driving forces of the former are government and environment, while, for the latter, governmental force is absent.

There is a relatively longer history of environmental migration in the study area [33]. From the analysis of macro-demographic characteristics of Minqin County, we can see that there is a tremendous depopulation and ageing process in Minqin County from 2000–2010. Although the Key Governance Planning for Shiyang River Basin has been implemented since 2007, the implementation of ecological migration policy by the government began in 2009. That is to say, the 60,000 out-migrants could not result from ecological migration policy. The survey results of this study revealed that most remaining residents in the study area have no propensity to migrate. From the demographic trends in the past, we forecast with a high degree of confidence that the population number in Minqin may reach dynamic equilibrium by the adjustment of local environmental conditions and economic opportunities.

Foggin [7] has argued that the ecological migration policy remains an untested social experiment at an enormous scale—with potentially devastating long-term (generational) social, cultural, and possibly environmental consequences, some of them irreversible. To enhance resilience of the coupled social-ecological system in flexible rather than rigid ways, new governance approaches will need to consider the role of migration: support the needs of migrants, and also of those who remain behind [35]. As suggested by Warner [35], the government should establish new modes of governance to improve

society's ability to manage environmentally induced migration, rather than persuading residents to migrate by a one-time migration subsidy.

Although population pressure' often deemed a major cause of land degradation in arid and semi-arid lands (ASALs) [43,44], recurrent voluntary environmental out-migration could not only weaken the tension between population and environment, but could export environmental impacts elsewhere while also increasing social vulnerability [45]. We do not oppose the strategy of ordered resettlement to reduce population pressure directly, but we argue that rural households' concerns about long-term livelihood sustainability determine their migration intention and behavior. The government might usefully pay more attention to create more profitable economic opportunities and more attractive living environments in other places to decrease population density in degraded arid lands, rather than treat ecological migration as an engineering approach that focuses on a specific size and a limited period.

4.2. The Implications of Household Income Amount and Structure for Ecological Migration Policy

A higher household income means the respondent's family has more money to move. In this study, the respondent will have a higher probability of migration intention when his household has more annual income. This is the same as the result found by De Jong, Root, Gardner, Fawcett and Abad [15] who, nonetheless, also found that the money to move has little or no direct impact on actual migration behavior. That is, improvement of household income can foster migration intention, but does not necessarily guarantee that migration will follow.

This study also reveals that if the main source of household income is non-farm employment, the respondent would have a significantly higher possibility of intention to migrate. This finding differs from the result of De Jong [29], which indicates that, in the case of Thailand, non-farm industry of a household has no significant impact on current intentions to move. Another study of migrations and behavior in a rural Philippine province by the same author [15] shows that for actual migration behavior, prior migration experience becomes a dominant explanatory factor. If a rural household's main income is from non-farm employment, some family members are most probably migrant labors in an urban area. This kind of migrant labor experience would foster more actual migration behavior according to De Jong, Root, Gardner, Fawcett and Abad [15].

Based on the results of this paper and other studies, we suggest that the government could do much to increase rural household income as well as opportunities to get more non-farm income, two significant predictors of migration intention. The increased proportion of non-farm earning in whole household income would not only foster migration intention, but also facilitate actual migration action [15].

4.3. The Implications of Arable Land and Irrigation Water Resources Quota for Ecological Migration Policy

Arable land and water resources remain the critical restrictive factors among natural resources necessary for agriculture, especially in arid areas. The relatively long history of voluntary out-migration in the study area, especially among the northern villages bordering desert, is driven mainly by declining arable land and irrigation water resources. The implementation of the river governance program in Shiyang River Basin has amplified the shortage of arable land and irrigation water resources quota. The remarkable diminution of arable land and water resources for agricultural production has resulted

in immediate reduction of the natural capitals for the rural households' traditional livelihoods. To cope with these tensions, migration may be one of the adaptive livelihood strategies [15,35]. This viewpoint is backed by the out-migration history in the study area.

As the inland river governance planning has dual aims, to rehabilitate the eco-environment and to improve the victims' livelihood, the measures to decrease the arable land and irrigation water resources quota must be accompanied by measures to diversify livelihood and to develop water/land-saving industries. Otherwise, the migration intentions could not be transformed into actual migration actions, and the environmental conflicts might be transformed into social conflicts. The results of this study indicate that the respondents have more odds of intending to migrate when they have less arable land quota or when they deem water resources insufficient both for domestic use and agricultural production. A compulsory ecological migration policy is not recommended; with such a policy, the forced out-migration would be a failure of the social-ecological system to adapt as stated by Warner [35].

4.4. The Implications of Water Quality and Eco-Environmental Conditions for Ecological Migration Policy

The results show that the possibility of a respondent having migration intention will be higher when he/she believes the quality of groundwater is worse, and that the quality of surface water does not have a significant effect on migration intention. These results are consistent with the assertion that groundwater is the major source of irrigation water; the region is limited in surface water resources [46]. In the past five decades, the excessive exploitation of groundwater and the decreasing surface water supplements have caused continuous decline in the groundwater table. Because infiltrated irrigation water is the main source of groundwater recharge, large amounts of saline matter were transferred from topsoil to groundwater in the process of infiltration of the inspissated irrigation water after evaporation. As a result, the quality of groundwater declined gradually and became less suitable for irrigation [21], forcing some people in the victimized areas to out-migrate [33].

Evidently, the eco-environment remains a critical predictor for migration intentions in our case study of marginal communities in the Minqin County. The results show that the perception of change in environmental problems within the past five years impacts migration intentions significantly. This is consistent with the results of increasing studies about the effects of environmental change on population migration [35,47,48]. The main points of these studies could be summarized by stating that positive environmental characteristics decreased out-migration and negative environmental characteristics increased out-migration [49]. Also, some people will be trapped in areas that expose them to serious risk. Even in the context of quite significant environmental change posing serious threats to the sustainability of livelihoods [36], environmental change may further erode household resources in such a way that migration becomes less, rather than more, likely. All of these statements have realistic counterparts in Minqin County, such as the relatively long history of voluntary out-migration and the overwhelming majority of respondents without migration intention in our survey.

Specifically, this study found that changes in the environmental problems of land salinization and vegetation deterioration have significant effects on migration intentions. Land salinization is adversely affecting grain production. Vegetation deterioration is the cardinal symptom of environmental problem in the study area. The antidote to these two problems is increasing surface water supply to Minqin

County. This is one of the main policies in the Key Governance Planning for Shiyang River Basin. However, the aim of the policy is to rehabilitate the deteriorated wild environment bordering deserts, rather than to conserve the arable land for rural residents. In fact, the arable land quota has decreased dramatically as ordered by the governance planning.

Another interesting finding in this study is that the assessment of current environmental problems doesn't have significant effects on migration intentions. This is contrary to the effects of the perception of change in environmental problems within the past five years as discussed above. Using the decision framework for environmental induced migration proposed by Renaud, *et al.* [50] as an analogy, the assessment of current environmental problems is slow onset changes. The perception of change in environmental problems within the past five years is rapid onset changes. A slow onset change may lead to voluntary migration because the environmental effects are more difficult to detect and disentangle from other drivers, particularly economic [36]. A rapid onset change is likely to immediately displace people or communities who have to flee in order to save their lives [50]. As stated by Renaud, Dun, Warner and Bogardi [50], rapid onset hazards are not necessarily of natural origin; their trigger can be caused by social or economic factors such as the arable land quota change in the study area.

4.5. The Implications of Demographic Characteristics for Ecological Migration Policy

The effects of the demographic variables are largely consistent with the previous studies but also reveal some differences. As the surveyed migration intentions in this study are formed within the context of ecological migration policy, migration among respondents would largely take the form of permanent family migration, which is different from the overwhelming pattern of temporary individual migration in other areas lacking rigid resettlement policies, such as the case of Hubei province in China [28]. Therefore, we did not consider migration intention of men and of women as two independent samples as in some influential studies (e.g., [29]). Instead, we used gender of the respondent as a predictor in the analytical models. We found that it has no significant correlation with migration intentions. This result is consistent with Yang [28].

Among the demographic factors, respondent's age as a significant predictor with negative indication is consistent with the previous studies [28,29]. However, the household elderly (>64) dependency ratio as another significant predictors of migration intention with positive indication remains seemingly counterintuitive. From the perspective of the new economics of labor migration (NELM) [51], a household with higher elderly dependency ratio may be more vulnerable to, and more relatively deprived by, a harsh environment with a shortage of labor forces. Therefore, this kind of household can be expected to have a stronger incentive to migrate than one with lower elderly dependency ratio. The results of this study also show that the household child dependency (<15) ratio does not have significant effects on the respondent's migration intention. This could be attributed to no significant difference in the number of children among rural households in China since the implementation of birth control policy from the late 1970s.

5. Conclusions

By employing Minqin County in the terminus of Shiyang River Basin as a case, the predictors of residents' intentions to out-migrate under ecological migration in arid Northwest China are investigated.

As the study area has a relatively long history of eco-environmental degradation and population out-migration, the ecological migration policy faces a population with less ability and intention to migrate. The survey results show that most of the residents in the marginal communities of Minqin County do not intend to migrate; indeed only a small fraction desires to migrate. This is consistent with the larger migration literature. Most people remain in origin areas even in areas of high out-migration. Those who do migrate are usually unwitting migrants: they would prefer to remain in their origin area if they felt they could afford—financially and emotionally—to do so [52,53].

The policy implications for government and the public is that, in addition to demographic and socio-economic factors, the eco-environmental factors of water quantity, groundwater quantity, land quantity and change trends of these problems are also significantly correlated with the possibility of a resident intending to migrate. Additionally, the study provides some evidence that inland river basin governance policies impact rural household livelihood assets and environment quality, both significant predictors of migration intention.

Inland river basin governance policies had mixed and somewhat complex impacts on household livelihoods and environmental integrity, and then on migration intentions. As policies are implemented, water availability and quality, soil quality, and vegetation cover may increase or recover gradually, thereby impeding migration intention. If household annual gross income and the proportion of income derived from non-farm employment are increased by the economic policies, as anticipated by the government, migration intention may increase. However, currently most of the residents' household incomes are derived from household agriculture which impedes the intention to migrate. We argue that ecological migration policy may be ultimately unsuccessful if implemented in a compulsory manner, or even encouraged by the local government out of motivation for financial subsidies from the central government as warned by Wang [54]. The complex interplay among policies, household livelihoods, environmental change, and migration intention deserves further investigation. The Ecological Migration Policy will ultimately be more sustainable when taking into account household interests within complex migration intention contexts, such as household livelihoods dynamics and environmental change.

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Author Contributions

Yongjin Li designed the research, conducted the survey and completed the paper; David López-Carr contributed to the framework of affecting factors and data analysis; Wenjiang Chen contributed to the questionnaire design.

Conflicts of Interest

The authors declare no conflict of interest.

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