The Impact of the Anti-poverty Relocation and Settlement Program on Rural Households' Wellbeing and Ecosystem Dependence：Evidence from Western China

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Abstract: To evaluate the effect of the anti-poverty relocation and settlement program (the ARSP) on improving both human wellbeing and ecosystem conservation, we examine the relationship between household wellbeing and dependence on the ecosystem to generate income by using a unique dataset of 1306 rural households in Shaanxi province. We find that there are significant differences between two modes of income generation (MIGs) that we classify as "high wellbeing, low dependence" and "low wellbeing, high dependence" in livelihood strategies, income composition, and dependence on ecosystem services. We suggest that non-agricultural production activities can help rural households achieve "high wellbeing, low dependence". Furthermore, rural households that use different MIGs have significant differences in relocation characteristics. Relocated rural households as well as those under centralized resettlement, voluntary relocation, and new stage relocation, which are more likely to realize non-agricultural transfer, fall closer to the "high wellbeing, low dependence" MIG.

Key words: anti-poverty relocation and settlement program (ARSP); household wellbeing; ecosystem services (ES); mode of income generation (MIG); household livelihood; south Shaanxi province

1. Introduction

China's rapid economic growth over the past 20 years since its reform and opening-up has been accompanied by a reduction in the number of citizens living in poverty. Over 60 million poor people have escaped from poverty, and the poverty incidence has declined from 10.2% to less than 4% (Xi, 2017). However, the remaining poverty is mostly concentrated in several mountainous areas, and cannot be fully alleviated by public interest policies. Poverty and ecological vulnerability often occur in these geographical areas (Zhang et al., 2014; Wang and Li, 2015), which also suffer from inaccessibility to markets and from antiquated technology, as well as from an inefficient flow of economic resources to agriculture and forestry production (Levin, 2006). This leads to their exclusion from economic growth and makes escape from poverty difficult. Considering the endogenous poverty trap and the closed resource-based economy in these regions, scholars and policy practitioners generally believe that breaking this poverty trap requires interventions; migration and relocation of population are two interventions that have received most attention (Howard et al., 2001). Due to the conflict between the pursuit of individual economic interests and the reasonable use of ecological resources, and given that the essence of escaping from poverty is the modernization of sustainable household livelihoods, the government must play a crucial

part in the process of poverty alleviation (Ludi, and Slater, 2009; Soltani et al., 2012; Sati and Vangchhia, 2017). At this point, during the 13th five-year plan period, the anti-poverty relocation and settlement program (ARSP) is regarded as an essential component of poverty elimination and a solution to the development dilemma that "natural resources are not capable of maintaining the livelihoods of local people".

To examine the effect of the ARSP from the perspective of targeted poverty alleviation, we must not only evaluate its effects from a micro view, but also focus on the modern transformation of sustainable livelihoods of relocated rural households, especially the connection between household wellbeing and ecosystem dependence. On the one hand, the government tries to increase incomes and alleviate poverty of rural households by enhancing their self-development capacity through urbanization. On the other hand, because of the conflict between the public nature of ecological resources' and individual rural households' economic interests, the government aims to reduce dependence on ecosystems and to restore and protect local ecosystems by relocation and non-agricultural labor transfer. In policy implementation, as externalities are internalized in the participants' behavior, rural households, the basic production and consumption units, have the dual function of major participants and essential stakeholders in use of ecosystem services (ES). Their livelihood behaviors directly determine the sustainable relationship between ecosystem conservation and individual income growth (Li et al., 2015). Thus, the key to evaluating whether and to what extent the ARSP can improve both human wellbeing and ecosystem conservation, which is the original intention of the ARSP, is the analysis of sustainable livelihoods of rural households, and the clarification of the impact of the policy on "household wellbeing and ecosystem dependence" MIG from a micro-perspective.

Analysis of the "household wellbeing and ecosystem dependence" MIG (hereinafter referred to as "wellbeing-ecosystem") requires assessment of the changes in value of ecosystem service and levels of human wellbeing. Since the 1990s, ecosystem services have become a major research focus for economists, including their supply, consumption, function and value calculation. With the development of "natural capital" theory (Daily, 1997), scholars began to associate ES with human activities, and gradually turn their attention to the benefits that ecosystems provide to humankind (Ouyang et al., 1999; Zheng et al., 2013). There has been extensive research of ES across different regions, time, scales, and types, and the findings have helped in understanding the value of ES and the importance of ecosystem conservation (Wang et al., 2014). With the launch of the Millennium Ecosystem Assessment project, scholars began to focus on the close relationship between ES and human wellbeing. ES is interpreted by some researchers as the benefits that humans extract from the ecosystem (Xiao et al., 2016), which means that human wellbeing depends on ecosystem services. However, the wellbeing level also affects the function and supply of ecosystem services by changing the intensity of consumption by humans of natural resources (Butler and Oluoch-Kosura, 2006). Consequently, how to realize a trade-off between ecosystem and human wellbeing is one of the current directions for ES research, and effective

measurement of the benefits provided by ecosystems to human beings is an essential component of scientific decision-making. Many scholars have assessed the benefit of ES under multiple decision backgrounds and at different research scales (Larondelle and Haase, 2013; Jordan et al., 2010; Smith et al., 2013), and some recent studies have focused on the assessment of human dependence on ES at a micro scale (Yang et al., 2013; Li et al., 2019). However, changes in ES dependence do not necessarily reflect changes in household wellbeing, nor do they address the strengths and weaknesses of different livelihood modes or propose improvements. Therefore, it is essential to examine rural residents' "wellbeing-ecosystem" MIG from a household perspective.

Using a survey in Shaanxi province, this paper analyzes the impact of the ARSP on the rural household's "wellbeing-ecosystem" mode in terms of its income generation. First, we reconstruct the sustainable livelihoods framework and establish an analytic framework for rural households' "wellbeing-ecosystem" against the background of the ARSP. Second, according to the income of relocated rural households and the index of dependence on ES (IDES), we divide rural households' "wellbeing-ecosystem" modes into four types. We compare and analyze differences in livelihood strategies, income composition, and ES dependence of different types of households. Finally, we use a multinomial logistic model to examine the impact of participation in the ARSP and different relocation characteristics on the rural household's "wellbeing-ecosystem" mode of income generation (MIG).

2. Analytical Framework

Research on the ARSP has focused on resettlement modes (Zhang et al., 2014), policy reform and innovation (Wang, 2016), as well as livelihood assets and livelihood strategies (Li et al., 2013) of rural households. Although there are many studies of ecological benefits of the ARSP, they basically take ecological migration as the research object, and evaluate its ecological effects by constructing a macro-ecological index system or using case analysis. In order to evaluate the impact of the ARSP on poverty alleviation and ecosystem dependence, integration of human wellbeing and ES is necessary. Current studies suggest useful methods and instruments for quantitative measurement of the relationship between ES and human wellbeing (Yang et al., 2013; Wang et al., 2017; Li et al., 2019). However, research on the relationship between ES and human wellbeing still has the following deficiencies. First, discussion of the relationship between human wellbeing and ES from a household-perspective is lacking. Current research primarily focuses on large-scale description, which ignores the use of and dependence of individual decisions on ES. But rural households are both participants and stakeholders, which directly determines the sustainability of the ARSP's dual goals of poverty alleviation and ecological protection. Therefore, in order to better evaluate the effect of the ARSP, it is necessary to examine the relationship between human wellbeing and ecosystem at the micro level. Secondly, current micro-scale studies do not reflect the mechanisms by which factors affect rural households' wellbeing and ecosystem services. However, the change in wellbeing level and

ecosystem service values are closely related to the changes of rural households' livelihoods. The sustainable livelihoods framework can incorporate the whole picture of livelihoods, including vulnerability, background livelihood, assets, and livelihood strategy, as well as the dynamic changes that rural households make in their livelihood strategies under rational decision-making when the external environment changes. Thus, the sustainable livelihoods framework can be used to explore factors affecting rural households' wellbeing and ecosystem services and reveal otherwise hidden influences.

In understanding the nature and causes of poverty in terms of livelihood vulnerability, sustainable livelihoods are the key to poverty alleviation (Sati and Vangchhia, 2017). In resource-dependent economic systems, poverty and environmental degradation often interact, which is typical of a closed system. To achieve lasting poverty reduction in such a system, naive groups need to acquire necessary assets and capabilities for sustainable livelihoods rather than passively seeking relief. The sustainable livelihoods framework emphasizes the elements of rural households' livelihoods and the linkages among them, as well as the development path by which rural households may transform their livelihoods upon encountering external environmental changes. It also provides a powerful analytical method for exploring the impact of relocation factors on wellbeing and ecosystems. In this paper, the "wellbeing-ecosystem" mode is considered to be the result of livelihood transformation by rural households, and we modify other elements within the sustainable livelihoods framework in combination with the background of the ARSP. The new analytical framework is shown in Figure 1.

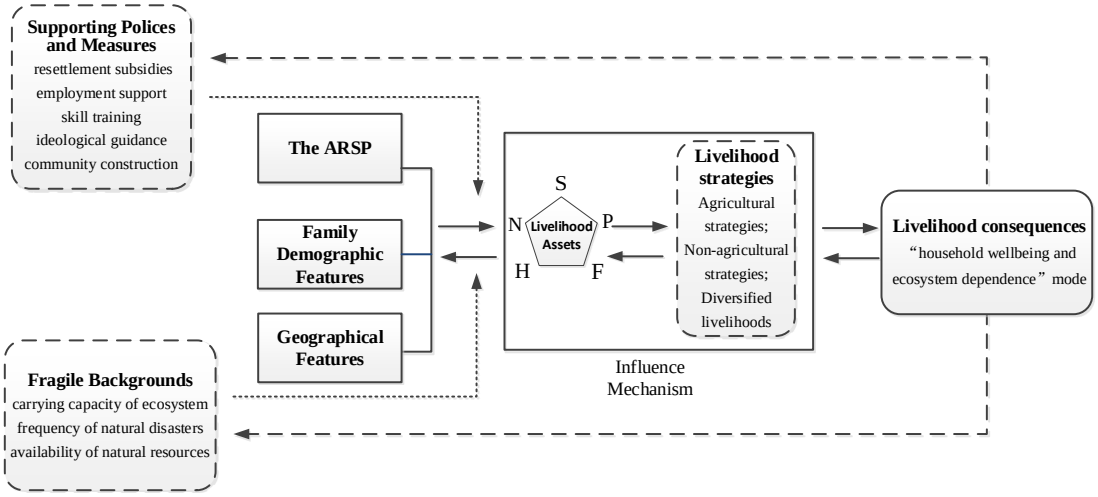

Figure 1. Analytical "household wellbeing and ecosystem dependence" framework of modes of income generation (MIG) in the context of the relocation and settlement program.

In the context of the ARSP, the external environment can be divided into two categories: vulnerability background and supportive policies. The vulnerability background of the project implementation area is mainly reflected in the carrying capacity of the ecosystem, frequency of natural disasters, and availability of natural resources. Compared with the original area, the resettlement area, located in a relative

flat area outside the steep mountains, is a better environment with fewer disasters. Supportive policies mainly include resettlement subsidies, employment support, skill training, ideological guidance and community construction. Changing the external environment affects assets available to and production choices of rural households.

Livelihood assets determine the capacity of relocated rural households to proactively respond to risks and adapt to the environment when facing external shocks. Livelihood assets are generally classified into five categories: natural assets, physical assets, human assets, social assets, and financial assets (Ellis, 2000). With the better conditions in the relocation area, relocated rural households have more opportunities to obtain and utilize external resources for their livelihood asset accumulation; they can reorient their livelihood mode to adapt to the local environment and diversify income sources. However, the ARSP also brings risks to the relocated rural households. On the one hand, the transfer of land use rights causes the loss of a "natural asset". On the other hand, under the economic structural transformation, relocated rural households are facing greater pressure and challenges in livelihood reconstruction because of their poor professional skills.

In order to avoid falling into the livelihood trap, the choice of livelihood strategy is critical. Livelihood strategy refers to livelihood activities that people adopt to achieve livelihood goals according to available assets. As a result of the loss of land use rights, rural households are more motivated to choose non-agricultural livelihood activities in the relocation area. Adopting diversified livelihood strategies may not only help rural households obtain diversified incomes that can reduce the risk of sharp income reduction when facing changes in the external environment, but also effectively reduce people's dependence on the ecological environment avoid excessive use of resources, and contribute to generating a virtuous cycle between rural households and the ecology.

Figure 1 shows a general framework of our "wellbeing-ecosystem" formation in the context of the ARSP. It shows how rural households reallocate livelihood assets to develop new livelihood strategies and influence households' income and the local ecological environment in the face of external environmental changes caused by the ARSP. In the next part, we clarify specific impacts of the ARSP on the "wellbeing-ecosystem" modes of income generation (MIGs) by relocated rural households.

3. Materials and Methods

3.1. Data Sources

Our data were taken from Ankang municipality of southern Shaanxi province, China, where we conducted structured household surveys about the livelihoods of rural households. Ankang municipality is the Qinba biodiversity ecological function zone and the core water conservation area for the middle route of south-to-north water diversion project. However, because of its fragile ecological environment, frequent natural disasters that result in severe economic losses every year, Ankang municipality, located in the concentrated serial poverty areas of Qinba mountain, is one of the poorest area in China. In order to solve its development dilemma, Ankang municipality was

classified as the key area of the Shaanxi relocation and settlement program, which began in 2011. Pingli county, Hanbin district, Ningshan county, Ziyang county, and Shiquan county in Ankang municipality, shown in Figure 2, were selected for this survey, and each have the dual roles of crucial counties for ecological protection and poverty alleviation and development at the national level.

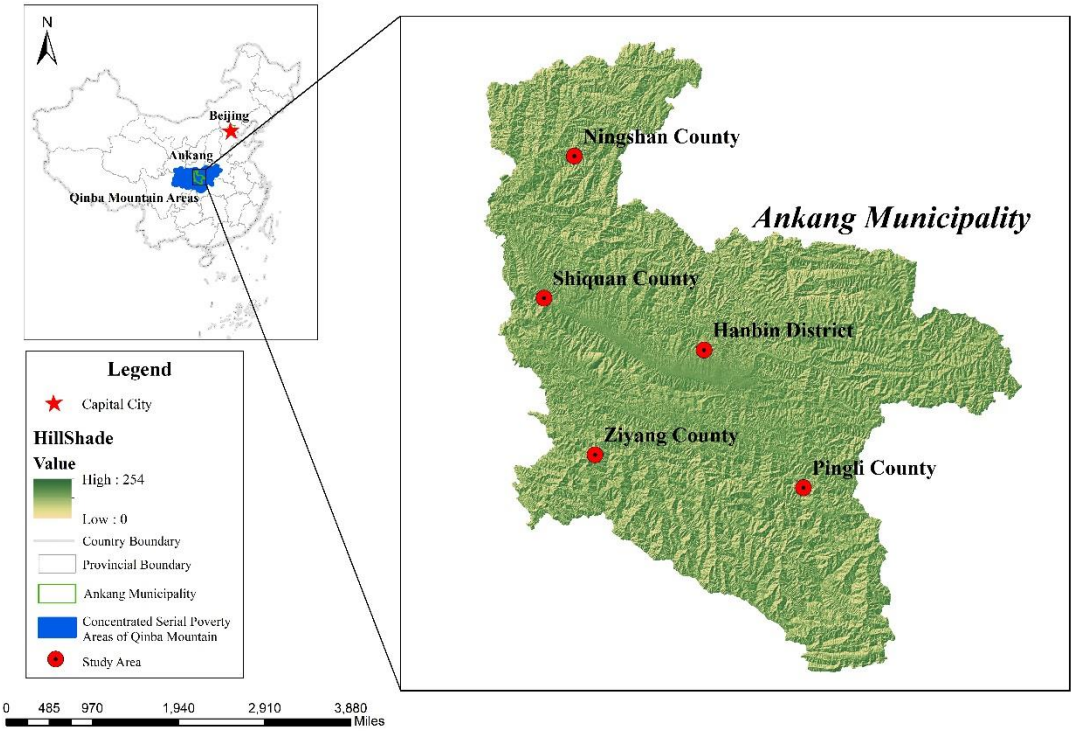

Figure 2. Study area in Ankang municipality.

The research team first selected three townships from each target county (district) that satisfied three criteria: being close to (or in) the nature reserve, implementing the ARSP, and carrying out an ecological compensation project such as the sloping land conservancy program (SLCP). Then we selected 25 villages in each township, including three villages implementing the SLCP, ten villages belonging to resettlement communities, and twelve randomly selected villages. Next, according to the Hukou registration list, we randomly selected two groups in each village. Finally, we interviewed household heads or their spouses from each sampled villager group, aged between 18 and 65 and permanent residents of that village. The interview was about household demographic features and household income and expenditure, livelihood asset conditions and livelihood activities, as well as relocation and settlement characteristics. Ultimately, with a series of data quality control measures, 1,306 valid questionnaires were obtained, of which relocated households accounted for 29.1% and non-relocated households accounted for 70.9%.

3.2. Mode Classification

3.2.1. Household Income

Household income, used as an indicator of wellbeing of rural households, is

defined here as the net income of the household, namely the residual of the gross income from various sources minus all expenses and losses for a year. Although income is not the optimal index for household wellbeing, it can partly reflect the living standard that a household can support. There are many examples of using income to define the level of human wellbeing, such as the World Bank's international poverty standard based on the monetary net income, which is currently the main standard that monitors poverty levels. Domestically, every year since 1986, China has updated its national poverty line based on income and consumption level of households; the national poverty line in 2018 was 3,535 yuan annual per capita net income (based on the 2,300 yuan fixed price in 2011).

Many studies have shown that absolute income has a strong positive correlation with human wellbeing (Binder and Coad, 2011; Knight et al., 2009). The Easterlin paradox also points out that below a threshold of about $15,000, an increase in annual per capita income would significantly improve human wellbeing, while beyond that point, the increase in human wellbeing is limited, and the pursuit of economic growth will lead to negative consequences (Easterlin, 1974). Considering that most areas in our survey site are at the low and middle income level, where a household's wellbeing is greatly affected by its income, and in view of the availability of data, we chose household income to quantify the wellbeing of rural households. The higher the household income, the higher the household wellbeing.

3.2.2. IDES

IDES (index of dependence on ES) is used to describe dependence of rural households on ES. Yang et al. (2013) defined IDES as the ratio of net income derived directly or indirectly from the ecosystem to total net income earned from ecosystems and social systems. Compared with other quantitative indicators, IDES considers products from agro-ecosystems and other highly managed systems, and uses net benefits rather than gross benefits. Given that there are agro-ecosystems in our survey site and different development costs mislead decision-making, we choose IDES, which facilitates comparison among different households to express the dependence of wellbeing of rural households on the ecosystem.

The income source of net benefit derived from ecosystems includes agricultural income, nongjiala income and ecological compensation income. Agricultural income comes from wild plants and livestock as well as other agricultural products in farmland and orchards. Nongjiale income is from ecotourism, entertainment, and hospitality Ecological compensation income comes from participating in ecological compensation projects (e.g., the Grassland Ecosystem Conservation program and Grain-for-Green program). In addition to income from the ecosystem, rural households also receive income from other economic activities, including remittances (income from migrant workers), government subsidies and from business activities unrelated to ES. The higher the value of IDES, the greater the dependence on the ecosystem.

3.2.3. Four "wellbeing-ecosystem" MIGs

Referring to Wang, et al (2017), we take the household income and the ecosystem service dependence index (IDES) of rural household as axes and use the four-quadrant representation to classify the "wellbeing-ecosystem" mode of income generation (MIG). We take the median value as a reference to reduce the effect of extreme values.

According to household income and IDES, there are four "wellbeing-ecosystem" types as shown in Figure 3. Mode I is "high wellbeing, high dependence" (H-H) mode, represented in the first quadrant and having a net value of total household income > 12,428.5 yuan and an IDES > 0.7183; Mode II is "low wellbeing, low dependence" (L-L), represented by points in the third quadrant with a net value of total household income < 12,428.5 yuan and an IDES < 0.7183; Mode III is "high wellbeing, low dependence" (H-L), shown in the second quadrant, which has net value of a total household income > 12,428.5 yuan and an IDES < 0.7183; Mode IV is "low wellbeing, high dependence" (L-H), shown in the fourth quadrant, which has a net value of total household income < 12,428.5 yuan and an IDES value of > 0.7183. Among these four modes, H-L is regarded as optimal; H-H and L-L are suboptimal; and L-H is the worst.

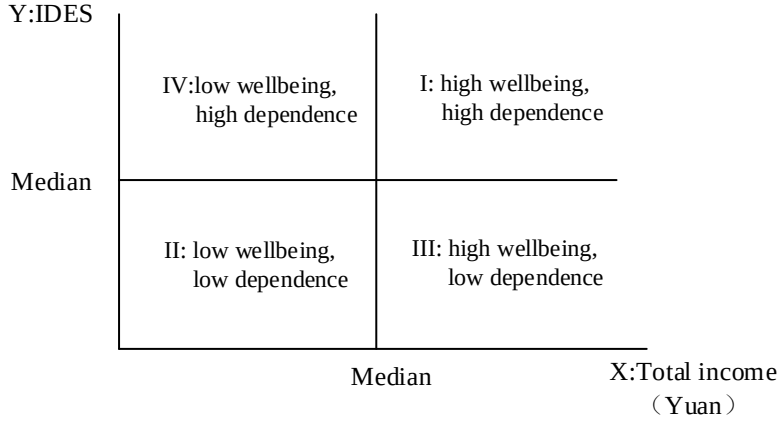

Figure 3. Classification of "household wellbeing and ecosystem dependence" modes of income generation (MIGs).

3.3. Analytical Method

3.3.1. Comparative analysis of different MIGs

To analyze the current livelihood conditions of rural households in the different modes of Figure 3 in the context of the ARSP, we first compare the four types in terms of livelihood strategies, and then compare the income composition and ecosystem-service dependence of rural households of four modes, which decompose the MIG and are determined by the livelihood strategies. Comparative analysis of this four-type subdivision can define the characteristics of different MIGs and is conducive to the formulation of more accurate and effective measures of the effect of ARSP in guiding rural households to transform to become the "H-L" type.

3.3.2. Effects of the ARSP on "wellbeing-ecosystem" MIGs

Due to the categorical nature of the dependent variables, a multinomial logistic model is used to examine how the ARSP influences the "wellbeing-ecosystem" mode. The model is expressed as follows:

$$\text{Prob}(Y_i = j) = \frac{\text{EXP}(x_i^j B_{ij})}{1 + \sum_{k=0}^{m} \text{EXP}(x_i^j B_{ij})} = F_j(X_i, B) \qquad (1)$$

$$j = 0,1,2...\text{m}; i = 1,2,3,...\text{N}; B_0 = 0$$

where, $\text{Prob}(Y_i = j)$ stands for the dependent variables, the values of which are the probabilities that household i falls into mode j out of the m MIGs; x_{ij} stands for the independent variables, which include the explanatory variable (relocation factors) and control variables (household livelihood assets, household demographic characteristics and geographical features); while B_{ij} represents the corresponding coefficients of the model to be estimated.

The regression method includes two parts: first, we examine the contribution of participating in the ARSP to the "wellbeing-ecosystem" mode. Next, based on the sample of relocated households, we analyze the effect of different relocation characteristics (relocation types, resettlement modes and relocation time) on the "wellbeing-ecosystem" mode. Since it is hard to determine the causal relationship between the ARSP and the MIG, endogenous problems need to be dealt with before estimating the regression coefficients.

3.4. Factors influencing the "wellbeing-ecosystem" mode of Figure 1

The factors affecting the "wellbeing-ecosystem" mode are divided into four types: relocation factors, household livelihood assets, household demographic characteristics, and geographical features. Relocation factors are the explanatory variables that we focus on, and the other three types of factors are control variables. The specific settings and values are listed in Table 1.

Table 1. Settings and values of independent variables.

Variables	**Variables Setting**		**Values**	
			Mean	**Standard Deviation**
Relocation Factors	**Relocated households**		0.2779	0.4482
	Relocation features	Relocation types	0.7328	0.4431
		Resettlement modes	0.6171	0.4868
		Relocation time	0.3526	0.4784
Household Livelihood Assets	**Natural assets**	Arable land per capita	1.2186	1.5747
		Forest area per capita	10.336	18.1731
	Physical assets	Own assets	2.819	1.7223
		House Value	9.9653	7.0149
	Social capita	Social support net	4.356	4.0341
	Households head features	Gender (nominal head)	0.108	0.3105
		Gender（actual head）	0.134	0.3408

		Age (household head)	50.617	12.6417
	Average education years		6.2098	2.7548
Household Demographic Characteristics	**Number of laborers**		2.7374	1.3899
	Household composition	Elderly + adult	0.17	0.3758
		Adults	0.3637	0.4812
		Adults + child	0.2841	0.4511
		Elderly + adult + child	0.1302	0.3366
Geographical features	**Distance to the town**		10.3355	7.9632
	Adjacent reserve		0.3496	0.477

Relocation factors include whether the household is relocated and its relocation characteristics. A relocated household is a household that has participated in the ARSP. Relocation characteristics refer to relocation types (voluntary or involuntary relocation according to construction of engineering projects), resettlement modes (centralized or non-centralized resettlement), and relocation time (early stage or new stage relocation). For distinguishing between early and new stages of relocation, we take the implementation time of the ARSP in southern Shaanxi province in 2011 as the cutoff. Relocations before this time are called "early stage" relocations, while those after 2011 are called "new stage" relocations. Compared with early stage relocations, the scale of the new stage is much larger and involves stronger subsidies and support measures.

Household livelihood assets include natural assets, physical assets, and social assets. Human assets are classified as a household demographic factor. Since income is one of the dimensions of the "wellbeing-ecosystem" mode, financial assets are neglected in order to avoid endogeneity problems. For the three items that make up household livelihood assets, arable land per capita, and forest area per capita are natural assets; households' own assets and house value are physical assets; social assets are defined by the scale of the social support network, which refers to numbers of households that are willing to provide help to a household that urgently needs a large sum of money. Households' social networks, a crucial way to obtain help when households are at risk, can mitigate sharp decreases in wellbeing and the resulting deleterious use of ecological resources, especially in rural China.

Household demographic characteristics include those of the household head (age and gender), average years of education of the household, age household composition, and number of laborers in the household, all of which affect decision-making by rural households. As the most powerful person in the household, the head of household's personal characteristics, such as age and gender, play important roles in the household's activities. Generally, households with older or female heads tend to have higher dependence on ES (Wang et al., 2017; Tan and Wang, 2012). Thus, the age and gender of the head of a household represent that household's features, and given that the nominal head may work away from home for a long time, we study both the nominal

head and the actual head, who has the power to make decisions for the household when the nominal head of the household has migrated out. For household composition, we consider four possibilities: families with elderly and adult laborers, families with adult laborers, families with adult and child laborers, and families with elderly, adult, and child laborers.

Household geographical features refer to the distance to the town and whether the household is adjacent to a reserve. The distance to the town reflects local transportation conditions and the availability to the household of markets, which has a major effect on whether a rural household engages in non-agricultural operations. Whether the household is adjacent to a nature reserve influences the scope of production activities. Rural households that are far from nature reserves usually have greater access to natural resources and tend to have a wider choice of production activities (Li et al.,2019).

4. Results

4.1. Comparative analysis of different MIGs

4.1.1 Comparison of rural household livelihood strategies under different MIGs

The livelihood strategies of rural households with different modes of income generation are listed in Table 2. Livelihood strategies mainly include three types: agricultural strategies, where rural households' income is from crop farming, animal breeding, and forestry; non-agricultural strategies, where rural households obtain income from non-agricultural production activities, such as secondary and tertiary industries; diversified livelihood strategies, where rural household income sources include both agricultural and non-agricultural activities. In general, agricultural households and households with diversified livelihoods account for a relatively large proportion, while non-agricultural households make up the smallest proportion, less than 10%. L-H households make up the largest proportion of agricultural rural households, while H-L households are a relatively large proportion of non-agricultural households and households with diversified livelihoods. From the MIG perspective, diversified livelihood activities make up the largest proportion among H-L households, followed by non-agricultural households and agricultural households, while among L-H households, agricultural households are the most common and there are no non-agricultural households.

Table 2. Comparison of rural household livelihood strategies under different "household wellbeing and ecosystem dependence" modes of income generation (MIGs).

Livelihood Strategies	I.H-H	II.L-L	III.H-L	IV.L-H	Total
Agricultural strategies	135	77	27	276	515
	（12%）	**（7%）**	**(2%)**	**(24%)**	**(45%)**
Non-agricultural strategies	19	37	31	0	87
	（2%）	**(3%)**	**(3%)**	**(0%)**	**(8%)**
Diversified livelihood strategies	118	126	276	31	551

	（10%）	**(11%)**	**(24%)**	**(2%)**	**(47%)**
Total number	272	240	334	307	1153
	（24%）	**（21%）**	**（29%）**	**（26%）**	**（100%）**
	Pearson χ^2(6) = 473.3932		**pr = 0.000**		

The superscript letters in brackets represent the percentage of the livelihood strategy in a mode. H-H means "high wellbeing, high dependence" MIG; L-L is the "low wellbeing, low dependence" MIG; H-L represents "high wellbeing, low dependence" MIG; L-H represents "low wellbeing, high dependence" MIG. MIG is mode of income generation.

Table 2 shows that local rural households focus on agriculture and diversified livelihoods when constructing their livelihood strategies, and fewer rural households construct non-agricultural strategies. It also can be seen that there is a correlation between livelihood strategies and MIG. Rural households with "H-L" MIG adopt more diversified livelihood strategies, while most of those with "L-H" MIG adopt agricultural strategies.

4.1.2. Comparison of rural household income composition under different MIGs

Table 3 provides a comparison of rural household income composition under different MIGs. Overall, agricultural income is much higher than other types of income, and ecological compensation income is the lowest. H-H households have the highest agricultural income, non-agricultural income and ecological compensation income, and H-L households have the highest remittance income and government subsidies. In terms of the MIG, unlike the H-L MIG where household income comes mainly from remittances, the most part of L-H household income comes from agriculture. Moreover, agricultural income, remittance, and government subsidies for L-H households are significantly lower than for H-L households, and the remittance income is significantly different between L-H households and H-L households.

Table 3. Comparison of rural household income composition under different "household wellbeing and ecosystem dependence" MIGs.

Income Composition	I.H-H （N=272）	II.L-L （N=278）	III.H-L （N=340）	IV.L-H （N=317）	Average （N=1207）
Agricultural income	25,877.38 〔2,3,4〕	1,367.12 〔1,3〕	7,428.22 〔1,2,4〕	3,700.41 〔1,3〕	9,210.71
Non-agricultural income	11,922.79 〔2,3,4〕	–156.12 〔1〕	1,107.06 〔1〕	113.56 〔1〕	2,992.54
Ecological compensation income	942.83 〔2,3,4〕	433.16 〔1,3,4〕	668.26 〔1,2〕	613.97 〔1,2〕	661.73
Remittance income	1,673.16 〔3,4〕	2,895.50 〔3,4〕	13,039.14 〔1,2,4〕	103.47 〔1,2,3〕	4,744.13
Government Subsidies income	1,998.55 〔3,4〕	1,229.92 〔3〕	4,932.87 〔1,2,4〕	998.68 〔1,3〕	2,385.49

The superscript letters in brackets show categories of MIG that are significantly different at the 5% level from other livelihood types, using Scheffe's test. H-H means the "high wellbeing, high dependence" MIG; L-L is the "low wellbeing, low dependence" MIG; H-L represents "high wellbeing, low dependence" MIG; L-H represents "low

wellbeing, high dependence" MIG.

The above results indicate that agriculture is the main source of rural household income. In addition, although there are differences in the income composition of the same type of MIG, rural households for which income is mainly from agricultural activities are more likely to have strong dependence on ES. The significant difference between "H-L" and "L-H" households comes from the differences in agricultural income, remittance income, and government subsidies.

4.1,3. Comparison of rural household dependence on ecosystem services under different MIGs

Table 4 shows IDES and various sub-indicators for rural households under different "wellbeing-ecosystem" MIGs. In general, the provisioning services index is much higher than the cultural services and regulating services indices. L-H households have the highest provisioning and regulating services indices, while H-H households have the highest cultural services index. Compared with the L-H MIG, the three sub-indices of IDES in H-L households differ slightly, and the provisioning and regulating services indices of H-L households are both significantly smaller than those of L-H households, while there is little difference in their indexes of cultural services.

Table 4. Comparison of rural household IDES under different "household wellbeing and ecosystem dependence" MIGs.

Indics	I.H-H (N=272)	II.L-L (N=278)	III.H-L (N=340)	IV.L-H (N=317)	Average (N=1207)
Total IDES	0.9173 〔2,3〕	0.3675 〔1,4〕	0.3231 〔1,4〕	0.9203 〔2,3〕	0.6241
Provisioning services	0.6807 〔2,3〕	0.2721 〔1,4〕	0.2563 〔1,4〕	0.7285 〔2,3〕	0.4796
Cultural services	0.1963 〔2,3,4〕	-0.0045 〔1〕	0.0287 〔1〕	0.0233 〔1〕	0.0574
Regulating service	0.0403 〔2,4〕	0.0998 〔1,3,4〕	0.0381 〔2,4〕	0.1685 〔1,2,3〕	0.0871

The superscript letters in brackets show categories that are significantly different at the 5% level from other livelihood types, using Scheffe's test. H-H means "high wellbeing, high dependence" MIG; L-L is "low wellbeing, low dependence" MIG; H-L is "high wellbeing, low dependence" MIG; L-H is "low wellbeing, high dependence" MIG.

Table 4 shows that rural households depend strongly on provisioning services. Moreover, the three sub-indices of rural households in high dependence cases (H-H or L-H households) are higher than the others. In addition, instead of relying on provisioning services, rural households can still become H-L by other livelihood activities (local non-agricultural operations and migrating for work, etc.), while strong dependence on the provisioning services not only increases the burden on the ecosystem, but also prevents rural households from reaching a higher level of wellbeing, which would make them L-H.

4.2. The impact of relocation factors on rural households' "wellbeing-ecosystem" MIG

The probability of the four "wellbeing-ecosystem" MIGs is taken as the dependent variable in the regression model. The results are shown in Table 5. Regression model 1 tests the impact of participation in the ARSP on "wellbeing-ecosystem" MIGs with the total sample of 1,306. Regression models 2~4 introduce relocation types, resettlement modes, and relocation time, respectively, to assess the effect of different relocation characteristics on "wellbeing-ecosystem" MIGs based on information from 355 relocated households.

Regression model 1 shows that compared to L-H households, participation in the ARSP has a significant positive impact on becoming H-L. More arable land per capita and more assets, larger social support networks, more laborers, younger heads of the households, as well as being closer to the town and adjacent to a reserve, all have significant effects on achieving H-H status. Less arable land and forest area per capita, as well as having the head of household work away from home for more than half a year, contribute significantly to being L-L. Higher house value, more laborers, and being adjacent to a reserve significantly increase the likelihood of being an H-L household.

The results of regression models 2~4 show that compared to the L-H model, centralized resettlement, voluntary relocation, and new stage relocation increase the likelihood of being H-L. The results of regression models 2 and 3 show that higher house value, being closer to the town, and being adjacent to a reserve are the main contributors to being H-H. In addition, regression model 4 shows that higher house value and being closer to the town increase the likelihood of being H-H; higher house value, fewer laborers, older head of household, and more elderly and children in the household make a significant positive contribution to being L-L; less assets but higher house value, more laborers, and longer time spent working far from home all significantly increase the likelihood of being H-L.

Table 5. Effects of relocation factors on the "household wellbeing and ecosystem dependence" MIG

Dependent Variables	Regression Model 1			Regression Model 2			Regression Model 3			Regression Model 4		
	I.H-H	II.L-L	III.H-L	I.H-H	II.L-L	III.H-L	I.H-H	II.L-L	III.H-L	I.H-H	II.L-L	III.H-L
Relocated households (predicted)	0.77	0.14	2.10***	/	/	/	/	/	/	/	/	/
Voluntary relocation	/	/	/	0.34	0.05	1.28**	/	/	/	/	/	/
Centralized resettlement	/	/	/	/	/	/	0.03	0.71	1.51***	/	/	/
Relocation time	/	/	/	/	/	/	/	/	/	-0.38	-0.09	1.41***
Livelihood assets												
Arable land per capita	0.27***	-0.48***	-0.06	0.24	-0.49	-0.22	0.32	-0.59*	-0.18	0.30	-0.44	-0.06
Forest area per capita	-0.01	-0.02**	0.01	-0.01	-0.05	0.02	-0.01	-0.05	0.01	-0.01	-0.06	0.02
Own assets	0.16**	-0.23***	-0.08	0.16	-0.26	-0.38**	0.17	-0.25	-0.39**	0.16	-0.23	-0.36**
House value	0.01	0.02	0.05***	0.08**	0.16***	0.11***	0.08**	0.09**	0.10***	0.09**	0.10**	0.11***
Social support net	0.06**	0.03	0.04	0.05	0.02	0.03	0.05	0.01	0.01	0.06	0.01	0.00
Household Demographic features												
Average education years	0.10**	-0.01	0.09**	0.03	-0.12	0.03	0.01	-0.11	0.02	0.01	-0.12	0.01
Number of laborers	0.27***	-0.11	0.34***	0.17	-0.44*	0.39*	0.17	-0.47*	0.38*	0.18	-0.45*	0.45**
Gender(nominal head)	-0.24	0.23	0.17	-1.39	-1.19	0.29	-1.40	-1.03	-0.07	-1.30	-1.85	0.27
Gender(actual head)	0.28	1.38***	2.02***	0.08	1.58	1.98**	0.05	1.48	1.90**	0.04	1.54	2.16**
Age (households head)	-0.02*	-0.01	0.00	-0.01	0.04*	0.01	0.00	0.05*	0.02	0.00	0.04*	0.01
Elderly + adult	-0.37	-0.71	0.14	1.76	3.14*	0.40	1.89	3.30**	1.02	1.95	3.09*	0.51
Adults	-1.08	-0.49	-0.13	0.49	3.01*	0.01	0.53	3.31*	0.40	0.42	2.93*	-0.07
Adults + children	-0.93	-0.64	0.29	1.06	4.26**	1.27	1.16	4.55***	1.92	1.19	4.15**	1.23
Elderly + adult + child	-0.02	-0.73	0.70	1.54	2.82	0.68	1.64	2.86*	1.21	1.69	2.88*	0.59
Geographical features												
Distance to the town	0.05***	-0.01	0.01	0.08**	0.00	0.07*	0.08*	0.01	0.08**	0.10**	0.00	0.03

Adjacent reserve	0.93***	-0.27	0.46**	1.15**	-1.17*	0.04	1.19**	-1.31*	-0.14	1.32**	-1.18	0.33

①Pseudo R^2 =0.148。②H-H means “high wellbeing, high dependence”; L-L is “low wellbeing, low dependence”; H-L is “high wellbeing, low dependence”; L-H is “low wellbeing, high dependence”. ③***，**，* stand for respectively $p < 0.01$, $p < 0.05$, $p < 0.1$,

Our analysis of different MIGs shows that there are significant differences between H-L and L-H households. H-L households have greater livelihood diversification and non-agricultural. As a result, the largest part of the income of H-L households comes from remittances, and they have significantly lower dependence on the ecosystem, especially provisioning services of the ecosystem. By contrast, livelihood diversification of L-H households is lower and there are no L-H households with non-agricultural strategies; inefficient agroforestry accounts for the largest proportion of L-H households' income, and their ecological dependence as well as the sub-indices, provisioning services index and regulating index, are significantly higher than for H-L households. This significant difference suggests that livelihood diversification and non-agricultural livelihood strategies could help rural households achieve high wellbeing and reduce their dependence on local ecosystem. Therefore, increasing non-agricultural production activities rather than specialized agricultural livelihood strategies could make rural households achieve H-L MIG.

Thus, the ARSP can significantly increase the probability that a rural household's MIG is H-L; that is, compared to non-relocated households, relocated households are more likely to have H-L MIG. H-L MIG is more likely under centralized resettlement, voluntary relocation, and new stage relocation. In contrast to involuntary relocation, such as engineering relocation and disaster-avoiding relocation, households in voluntary relocation have higher expectations for the results of resettlement, and tend to be more proactive in adapting to changes in the external environment. They are also more likely to transform their livelihood strategies to become non-resource-dependent. Unlike scattered resettlement (e.g., “entering cities and towns”[①] and “flower arrangement”[②]) centralized resettlement communities have better infrastructure and public services, facilitating provision of employment training and poverty alleviation projects, which help rural households to benefit from supporting measures and policies. Rural households in centralized resettlement communities can obtain more employment opportunities and market information, and increase the chance of sending migrant workers and setting up non-agricultural operations. The early stage of relocation is generally spontaneous or small-scale resettlement. By contrast, the government plays a leading role in the new stage of relocation, and provides relocated rural households with

[①] Relocated households purchase houses to settle down in cities and towns, where they work or do business, with house purchase subsidies provided by the government.

[②] In areas where centralized resettlement is not available, the local government resettles the relocation households in a scattered way by repurchasing vacant houses and allocating farmland in an existing community.

greater assistance and financial support (e.g., job guidance and training, concessionary loans for self-employed, etc.) to help them realize the transition to sustainable livelihoods.

5. Discussion

The public nature of ecological resources and individual economic interests create a conflict between the improvement of rural households' wellbeing and the conservation of local ecosystems. The ARSP is designed to produce "win-win" outcomes of ecosystem conservation and poverty alleviation. We have evaluated the effects of the ARSP in terms of "household wellbeing and ecosystem dependence" and find that participating in the ARSP as well as centralized resettlement, voluntary relocation and new stage relocation are conducive to reducing local ecosystem dependence and increasing wellbeing of rural households, making it easier to attain the H-L MIG. In addition, our results show that the key to the ARSP being able to stimulate relocated rural households to enter the H-L category is helping relocated rural households increase non-agricultural production activities.

Participation in non-agricultural production activities can reduce stress on the relocated rural household, and help conserve local ecosystem. Relocation within the local county or town makes it difficult to maintain the ecological capacity of that place at an appropriate level, and the ARSP cannot achieve its desired effect (He and Dang, 2015). Although trans-regional relocation can relieve the pressure on a local ecosystem, households relocated across regions face difficulties in acquiring land, adapting to new environments, and achieving sustainable livelihoods (Zhao et al., 2018). Thus, the number of households that are willing to accept trans-regional relocation is quite limited. In order to reduce the negative impact of being relocated to the nearest region, the government encourages households to work in secondary and tertiary industries, such as exporting labor and animal husbandry with compensation and training (Jin and Shen, 2017). In our survey site, rural households are mainly relocated within their local area, and land in the relocation areas is so scarce that there is no way that the relocated households can obtain further provisioning services from the ecosystem (Li et al., 2019). Although our results suggest the ARSP can resolve the development dilemma that "natural resources are not capable of maintaining the livelihood of local people", the declining dependence of relocated rural households on ES is largely due to the scarcity of land resources in relocation areas. Therefore, in order to relieve the pressure on the ecosystem in the resettlement area, and to solve the mismatch between relocated rural households and land resources, non-agricultural guidance and follow-up support from the government to help rural households become non-agricultural are particularly critical.

Non-agricultural transformation helps relocated rural households resolve risks to their wellbeing occasioned by the ARSP. Relocated rural households may not only risk loss of natural assets, such as land, but also face problems due to inadequate production skills, damaged social networks, social marginalization and other human and social asset disruptions in relocation areas (Rogers and Xue, 2015). However, from another perspective, the relocation area has superior conditions. Compared with non-relocation households, relocated rural households are more likely to acquire and utilize various external resources to accumulate livelihood assets, which is conducive to reconstructing their livelihood strategies and helping them adapt their livelihoods so they can emerge from poverty (Chen et al., 2016). Relocated rural households making the transition to a non-agricultural livelihood strategy broaden their income sources and reduce ecological dependence, but this process does not happen automatically, and some external intervention is necessary (Li et al., 2013). By preferential policies and vocational training in relocation areas, the government can provide financial, technical, and tax support that enables rural households to transform their livelihoods and helps them improve their self-development capacity. Relocated households of centralized resettlement, voluntary relocation, and new stage relocation are more likely to accept and enjoy the policy benefits that promote their non-agricultural transfer and help them achieve sustainable development. Considering that there are only 8% specialized non-agricultural rural households in the survey site (see Table 2) the government should continue to improve local market environments as well as infrastructure and educational resources to produce non-agricultural transfer of labor force locally.

The micro-perspective of our paper helps fill the gap in research related to ES and household wellbeing. It provides a useful analytical approach to the trade-off between ES and human wellbeing, as well as a reference for assessment of ecological or anti-poverty development policies. Although non-agricultural transfer is essential in achieving the optimal MIG, we do not examine its function quantitatively. In addition, our results refer to the specific context of the ARSP in southern Shaanxi province and may not represent other locations. However, we maintain that the absence of quantitative measurement of the function of non-agricultural transformation will not affect our findings; all the ARSP implemented across the country are subject to almost the same problems with common features and objectives. Therefore, our findings have implications for the adjustment and improvewment of subsequent policies in other regions.

6. Conclusions

Our survey of rural households in Ankang municipality has enabled comparative analysis of different MIGs and assessment of the impact of the ARSP on modes of

income generation from a micro-perspective. We find that there are significant differences between "high wellbeing, low dependence" and "low wellbeing, high dependence" MIG livelihood strategies, income composition, and dependence on ecosystem services. In addition, the implementation of ARSP can effectively improve both human wellbeing and ecosystem conservation to resolve the development dilemma that "natural resources are not able to maintain the livelihood of local people". Rural households that participate in the ARSP as well as in voluntary relocation, centralized resettlement and the new stage of relocation are more likely to achieve "high wellbeing, low dependence" status. Moreover, the results also suggest that the government needs to help rural households transition from specialized agricultural livelihood strategies to non-agricultural activities in the promotion of the ARSP, which plays an important role in attaining "high wellbeing, low dependence".

We have shown that specializing in inefficient agroforestry is not an ideal approach to improving rural households' wellbeing while reducing their dependence on the ecosystem. Therefore, apart from continuing to promote voluntary, centralized and systematic relocation and resettlement which are principles of the ARSP that the government has stressed, subsequent policies and support from the ARSP, such as strengthening employment guidance and non-agricultural skill training, should be implemented to help rural households attain sustainable livelihood strategies. The local government should also develop labor-intensive enterprises by lowering entry barriers for small and medium-sized enterprises and providing financial support, so as to create as many jobs as possible and involve more relocated households in the process of industrialization. Community and family services (e.g., security and cleaning service) have great demand elasticity in the quality of the labor force, and can provide employment opportunities for households with lower labor qualities. Thus, as a means of solving the employment problem of relocated rural households, tertiary industries should also be supported by the government, especially the various service businesses in the resettlement community. In addition, more targeted policies and management options should be based on the characteristics of rural households with different MIGs. H-H households need to further improve their agricultural production technology to develop efficient modern agricultural production; L-L households should increase their non-agricultural employment capacity and it is suggested that they be offered additional subsidies when implementing ecological compensation projects. H-L households should be encouraged to keep learning new technologies and to make full use of information to keep enhancing their capacity for self-development; the local government should pay more attention to L-H households, with stronger support policies for technical training, as well as financial support.

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