

Appendix 1 for

Unraveling human drivers behind complex interrelationships among sustainable development goals: a demonstration in a flagship protected area

This document includes:

A1 Household surveys

A2 Changes in livelihoods in Wolong

Fig. A1 Livelihood changes during the study period from 2009 to 2014. (a) The percentage of households with member(s) working in local off-farm sectors in Wolong; (b) The average cropland area each household cultivated in Wolong; (c) The percentage of households with member(s) temporarily working outside Wolong; (d) The average number of livestock (as measured by equivalent number of sheep) raised by pastoral households in Wolong.

Table A1 Survey instrument for constructing the human well-being index based on the Millennium Ecosystem Assessment framework. Reproduced from (Yang et al. 2013).

Table A2 Summary of variables included in the linear regression models that relate changes in SDG indicators (human well-being index, household income, and fuelwood collection) to livelihood changes and other socioeconomic factors (sample size = 186).

A1 Household surveys

The data for evaluating the impacts of the livelihoods on SDG intercorrelations in Wolong at the household level were all derived from survey data. Since household members often make joint or coordinated decisions regarding livelihood affairs, data characterizing livelihoods and SDGs were mainly collected at the household level. We collected household survey data in Wolong in 2010 and 2015. It contains detailed demographic (e.g., household size, members' age, education, and occupation) and socioeconomic (e.g., cropland area, number of livestock, livestock selling prices, and income sources) information of local households in 2009 and 2014 respectively. In the surveys, we included questions (Table A1) to collect information for the construction of human well-being index. We conducted these surveys in the form of face-to-face interviews. During these interviews, we selected household heads or their spouses as interviewees because they usually have the best knowledge about their households' affairs. Before performing the formal surveys, we conducted pretests to assess respondents' comprehension of our survey questions and how difficult they were to answer. Based on interviewees' responses in pretests, we iteratively revised our survey instruments to ensure that interviewees understood and were able to answer our questions correctly. In total, 287 and 245 households completed our formal surveys, with a response rate of 95%, and 96%, respectively. Of the 287 households randomly sampled in 2010, 186 households were revisited in 2015. We asked the survey questions using Mandarin Chinese. The survey instruments and data collection procedures we used in this study were reviewed and approved by the Institutional Review Board of Michigan State University (<https://hrpp.msu.edu/>).

A2 Changes in livelihoods in Wolong

We observed that cropping in Wolong decreased from 2009 to 2014 (Fig. A1). The average amount of cropland cultivated by each household decreased from 3.4 mu (1 mu = 0.067 ha) in 2009 to 2.9 mu in 2014. About 39% of the cropland loss was caused by the lasting (or post-disaster) impacts of landslides after the 2008 Wenchuan Earthquake and the rest (61%) was caused by land appropriation for infrastructure construction.

The proportion of households having laborer(s) with temporary or permanent off-farm jobs inside Wolong maintained a high level, albeit decreased somewhat after the earthquake: 75.6% in 2009 and 65.2% in 2014 (Fig. A1). Our survey data show that the government-initiated infrastructure construction was the main source of local off-farm jobs in Wolong, with 74% in 2009 and 63% in 2014 of local off-farm jobs were related to infrastructure construction projects. The decline in the local off-farm labor job opportunities might be explained by the completion of some reconstruction projects during the period (Aba Administration 2016).

The other two major types of livelihoods, labor migration and livestock husbandry, increased from 2009 to 2014 (Fig. A1). The proportion of households with member(s) temporarily working in cities increased from 26.8% in 2009 to 48.2% in 2014. The proportion of households that raised livestock during the study period was stable around 30%, but the average number of livestock raised by pastoral households increased from 80.2 in 2009 to 107.8 in 2014.

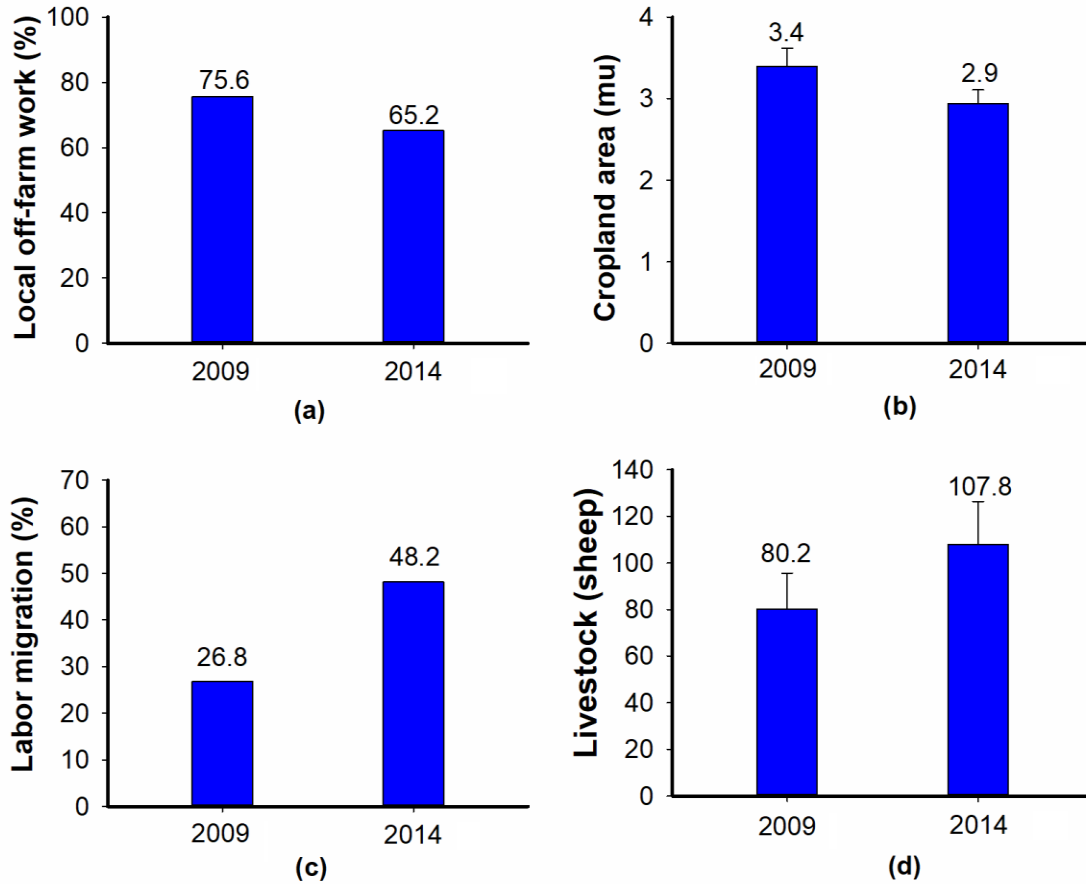


Figure A1 Livelihood changes during the study period from 2009 to 2014. (a) The percentage of households with member(s) working in local off-farm sectors in Wolong; (b) The average cropland area each household cultivated in Wolong; (c) The percentage of households with member(s) temporarily working outside Wolong; (d) The average number of livestock (as measured by equivalent number of sheep) raised by pastoral households in Wolong.

Table A1 Survey instrument for constructing the human well-being index based on the Millennium Ecosystem Assessment framework. Reproduced from (Yang et al. 2013).

Dimensions	Indicator and description
Basic material for good life	Q1.1: To what extent it is available to purchase necessities for daily life (Options: 1. Very inconvenient; 2. Inconvenient; 3. Unsure; 4. Convenient; 5. Very convenient)
	Q1.2: Your household can afford enough food with nutrition to keep alive and healthy
	Q1.3: Your household can afford to access basic facilities (e.g., television, washer) and services (e.g., transportation)
	Q1.4: You are satisfied with your housing condition (including size and quality)
	Q1.5: Overall, you are satisfied with your household's basic goods and services (e.g., food, clothe, living conditions, transportation) for life
Security	Q2.1: Your household's life safety in daily life is secure
	Q2.2: Your household's property safety in daily life is secure
	Q2.3*: The local crime incidence (e.g., theft, robbery, murder, other violent incidents) is low
	Q2.4*: The police and judicial system is always ready to help
	Q2.5: The police and judicial system can be trusted
	Q2.6*: It is safe to access basic goods and services such as food, water, and medicine etc. for life
	Q2.7: Overall, you are satisfied with your household security (e.g., life and property)
Health	Q3.1*: You are satisfied with your household's physical health (including illness and injury)?
	Q3.2: You are satisfied with your household's mental health (including stress, depression, and problems with emotions)?
	Q3.3: How often your household members do not get enough rest or sleep? (Options: 1. Always; 2. Often; 3. Sometimes; 4. Seldom; 5. Never)
	Q3.4: How often your household members are not healthy or do not have enough energy for everyday life? (Options: 1. Always; 2. Often; 3. Sometimes; 4. Seldom; 5. Never)
	Q3.5: How often do your household members have negative feelings such as blue mood, despair, anxiety, depression? (Options: 1. Always; 2. Often; 3. Sometimes; 4. Seldom; 5. Never)

	Q3.6*: How often do your household members have the opportunity for leisure activities? (Options: 1. Never; 2. Seldom; 3. Sometimes; 4. Often; 5. Always)
	Q3.7: Overall, you are satisfied with your household's health status
Good social relations	Q4.1: This is a close-knit neighborhood
	Q4.2: Most people in this village are basically honest and can be trusted
	Q4.3*: There are many opportunities to meet neighbors and work on solving community problems
	Q4.4*: How active do you think your household members in your community groups or village or township? (Options: 1. Very inactive; 2. inactive; 3. Neither inactive nor active; 4. Active; 5. Very active)
	Q4.5: Do you agree that people here look out mainly for the welfare of their own families and they are not much concerned with village/neighborhood welfare?
	Q4.6*: Suppose someone in your village/neighborhood had something unfortunate happen to them, such as a family member's sudden death, there are always some others would be ready to help
	Q4.7: Overall, you are satisfied with your household's social relationships with others
Freedom of choices and actions	Q5.1*: Do you think that your household members are always treated equally without regard to gender, race, language, religion, political beliefs, socioeconomic status and more? (Options: 1. Never; 2. Seldom; 3. Sometimes; 4. Often; 5. Always)
	Q5.2: Your household has affordable access to quality and nutritious food for an enjoyable life
	Q5.3: Your household has affordable access to quality medical care
	Q5.4: Your household has affordable access to quality education
	Q5.5: Your household has affordable access to spacious and quality house
	Q5.6*: It is difficult to find a satisfied job
	Q5.7: How often do you feel that you want to help others but limited by your socioeconomic or physical conditions that you cannot help them?
	Q5.8: Overall, you are satisfied with your freedom of choice and actions

Notes: Unless response options are specified after indicator contents, the options are designed in the five-category Likert scale (i.e., strongly disagree, mildly disagree, unsure, mildly agree, and strongly agree). *: Indicators not included in the final confirmatory factor analysis due to low variation or internal consistency with other indicators in the same categories.

Table A2 Summary of variables included in the linear regression models that relate changes in SDG indicators (human well-being index, household income, and fuelwood collection) to livelihood changes and other socioeconomic factors (sample size = 186).

Variables	Description	Mean (SD)
<i>Outcome variables</i>		
Well-being change	Change in the overall human well-being index value from 2009 to 2014.	0.271 (0.182)
Household income change	Change in log-transformed household gross annual income from 2009 to 2014 (Yuan ^a)	0.77 (1.53)
Fuelwood collection change	Change in the amount of fuelwood collected by the household from 2009 to 2014 (Kg)	-984.5(4725.4)
<i>Livelihoods and their changes</i>		
Local off-farm labor work in 2009	The number of laborers earned income through working in local off-farm sectors in 2009.	1.102 (0.775)
Change in local off-farm labor work from 2009 to 2014	Change in the number of laborers working in local off-farm sectors from 2009 to 2014.	-0.054 (1.089)
Cropping in 2009	The number of laborers earned income through working outside the reserve in 2009.	0.409 (0.739)
Change in cropping from 2009 to 2014	Change in the number of laborers working outside the reserve from 2009 to 2014.	0.317 (1.081)
Labor migration in 2009	The area of the household's cropland in 2009. (Mu ^b)	3.491 (3.228)
Change in labor migration from 2009 to 2014	Change in household's cropland area from 2009 to 2014. (Mu)	-0.481 (3.016)
Livestock husbandry in 2009	The number of livestock (as measured by equivalent number of sheep) raised in 2009.	1.898 (8.624)
Change in livestock husbandry from 2009 to 2014	Change in the number of livestock from 2009 to 2014.	4.056 (18.71)

Socioeconomic and demographic characteristics

Human well-being in 2009	Overall human well-being index value in 2009.	0.363 (0.15)
Household income in 2009	Log-transformed gross income in 2009. (Yuan)	10.033 (1.391)
Fuelwood collection in 2009	The amount of fuelwood collected by the household in 2009 (Kg)	3117 (4273.9)
Household size in 2009	The number of members in the household in 2009.	4.796 (1.525)
Change in household size from 2009 to 2014	Household house size change from 2009 to 2014.	-0.215 (1.626)
Number of laborers in 2009	The number of members involved in income-earning activities in 2009.	3.387 (1.496)
Change in number of laborers from 2009 to 2014	Change in the number of laborers from 2009 to 2014.	-0.183 (1.718)
Laborers' education in 2009	The average schoolyears of laborers. (Year)	5.979 (3.037)
Change in laborers' education from 2009 to 2014	Change in laborers' average schoolyears from 2009 to 2014.	1.164 (4.21)
Respondent's gender	The gender of the respondent in our survey (0, female; 1, male)	0.602 (0.491)
Respondent's education	The schoolyears of the respondent. (Year)	5.688 (3.560)

^a 1 Yuan = 0.14 USD as of 2015; ^b 1 mu = 1/15 hectare.

References cited in Appendix 1

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