Adaptation against Rural Household Vulnerability at Up Reaches of Koshi River

Yiping Fang, Xueqian Song
Institute of Mountain Hazards and Environment, CAS
Chengdu University of Information Technology
The aim was to examine the extent of rural household vulnerability and the dynamic changes in the major factors involved; and to make recommendations on how to mitigate rural household vulnerability and improve the adaptive capacity to climate change at up reaches of Koshi River.
Method for household vulnerability assessment

The assessment considered four main aspects related to vulnerability:

- **Subsistence condition** (food supply)
- **Development condition** (education and income)
- **Accessibility of water resources**
- **Water disaster threats**.
Overall rural household vulnerability was quantified using 10 key indices

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<th>Objective</th>
<th>First-level indicators</th>
<th>Second-level indicators</th>
<th>Measures</th>
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<tr>
<td><strong>Subsistence condition</strong></td>
<td>Food vulnerability</td>
<td>Grain production per capita (kg/person)</td>
<td>The coefficient of variation is defined as the ratio of the standard deviation to the mean. The coefficient of variation was used to describe the food variability in relation to the mean of the population.</td>
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<td>Meat production per capita (kg/person)</td>
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<td>Dairy products per capita (kg/person)</td>
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<td><strong>Development condition</strong></td>
<td>Knowledge vulnerability</td>
<td>Per capita education expenditure (yuan²/person)</td>
<td>The dimensionless indices of per capita education expenditure ((x_{\text{max}} - x_i)/(x_{\text{max}} - x_{\text{min}})) and illiteracy rate ((x_i - x_{\text{min}})/(x_{\text{max}} - x_{\text{min}})) were used to describe the educational level of rural households.</td>
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<td></td>
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<td>Illiteracy rate of labor force (%)</td>
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<td><strong>Cash vulnerability</strong></td>
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<td>Per capita cash income (yuan²/person)</td>
<td>The difference between the per capita cash expenditure and per capita cash income was used to show the deficit level of rural households.</td>
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<td></td>
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<td>Per capita cash expenditure (yuan²/person)</td>
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<td><strong>Water accessibility</strong></td>
<td>Water vulnerability</td>
<td>Precipitation variability during growing season of grassland and crops (%)</td>
<td>The coefficient of variation is defined as the ratio of the standard deviation to the mean. The coefficient of variation was used to describe the variability in precipitation during the growing season of grassland and crops.</td>
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<td><strong>Water hazards</strong></td>
<td>Water hazards vulnerability</td>
<td>Drought area (hm²)</td>
<td>The dimensionless indices of drought area and flood area ((x_i - x_{\text{min}})/(x_{\text{max}} - x_{\text{min}})) were used to describe the likelihood of natural hazards occurring.</td>
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<td>Flood area (hm²)</td>
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\(^a\) 1 yuan (CNY) = USD 0.1584 in 2012
• \( CVI = \sum (FV + KV + CSV + WV + WHV) \)

• Where, \( CVI \) is the index of composite vulnerability, \( FV \) is the index of food vulnerability, \( KV \) represents the index of knowledge vulnerability, \( CSV \) is the index of cash vulnerability, \( WV \) is the index of water vulnerability, and \( WHV \) represents the index of water hazards vulnerability.
**Study area:** *Shigatze Prefecture in Tibet Autonomous Region (TAR) in China*

**Environmental features**

Area of 182,000 km² in the south of the Qinghai-Tibetan Plateau. The elevation ranges from 1453 to 8848 masl with an average of 4000 masl. There are three main regional climates, the spatial distribution of rainfall is uneven. The prefecture has more than 100 rivers.

**Social-economic features**

18 counties (or cities), 203 villages and towns, and 1668 village committee areas. Total population in 2012 of 748,000. The per capita net income of rural households is 5165 yuan (approx. USD 818.3)

Farming and livestock breeding are the key pillars of the economy. Shigatze Prefecture is a traditional farming area and seen as the ‘granary’ of TAR

The farmers and herdsmen of the Qinghai-Tibetan Plateau are particularly vulnerable because of the extreme elevation, harsh climatic conditions, high dependence on natural resources. They have a limited capacity to cope with climate variability and extreme events, and even relatively small changes may lead to greatly increased pressures on agriculture and livestock production.
Main factors influencing vulnerability

- The mean value of total rural household vulnerability was taken as the dependent variable and the vulnerability of individual components as explanatory variables.
Overall rural household vulnerability appears to be decreasing but with considerable fluctuation over time, especially after 2008, there is a significant increase in vulnerability.

Fig. 2. Rural household vulnerability and change in Shigatze Prefecture
• Education or ‘knowledge’ is a crucially important resource for rural households. The percentage contribution of education to rural household vulnerability reduced significantly.

• The contribution of food vulnerability reduced significantly, mainly as a result of the construction of irrigation schemes and improvement in conditions for agricultural production.
Fig. 3. Balance between household income and cash expenditure

- **Cash income** made the second highest contribution to rural household vulnerability in 2004-2012, markedly higher than in 1986-2001.
Water accessibility made the third highest contribution to rural household vulnerability in both periods, with a slight increase over time.

- Lack of irrigation facilities to compensate when rainfall is low, and of water storage facilities to mitigate floods.

**Fig.5.** Variation coefficient of precipitation and change over time
Significant structural changes

- Up to 2001, the main drivers of rural household vulnerability in Shigatze Prefecture were basic education, access to sufficient food, and reliable access to water.

- After 2004, the main drivers became education, cash income, and again reliable access to water.

Variability in water resources appears to be becoming more important in the light of climate change, while the transformation of focus of rural households from subsistence to development means that education and income are gaining in importance.
Adaptive strategies

- Accelerating the development of education in rural areas
- Promoting an incremental increase in the income of farmers and herdsmen
- Constructing rural irrigation infrastructure
- Establishing agricultural disaster prevention and mitigation systems
Education

• The Chinese government has committed itself to markedly raising educational levels in ethnic minority areas, and has issued a series of policies and reform measures.

• The education level of ethnic minorities is consistently increasing. However, the quality of education in rural areas is still significantly lower than in urban areas as a result of both the educational infrastructure and the level of qualification of staff.

It is necessary to extend compulsory education from nine years at present to 12 years.
Income

• Over the past 50 years, the central and TAR governments have issued several policies aimed at increasing the income of farmers and herdsmen;

• These initiatives are increasing the benefits from agriculture;

• However, the difference in income between rural (agricultural) and urban households remains large.

Suggested activities include developing agriculture and livestock breeding base; diversifying off-farm opportunities through skill training; use of high-value cash crops and agricultural tourism to generate cash income for farmers and herdsmen; accelerating the development of specialized cooperative organizations; and enhancing service organizations for farmers and herdsmen.
Water resources

• The government of TAR has set ambitious targets to provide access to safe drinking water and basic sanitation facilities to 100% of farmers and herdsmen by 2015.

• A lot of projects played an important role in improving access to water for household and agricultural use, and improving sanitation and reducing the spread of epidemics; but progress in urban and rural areas is uneven. The irrigation infrastructure is still very weak in some rural areas and multi-scale combined investment is needed.

Accelerate the construction of control projects to ensure reasonable allocation and efficient use of runoff water resources in the key agriculture and livestock breeding areas; develop small reservoirs and ponds to enhance water storage capacity in the rainy season for farmers and herdsmen; repairing and renovate motor-pumped wells, pump stations, and irrigation facilities for farmers and herdsmen; and improving water infrastructure in pasture areas.
Disaster prevention

• In recent years, increasing attention has been paid to disaster prevention. However, climate change has increased the frequency of weather extremes and, in some regions, led to serious damage in agriculture. The harsh environmental conditions on the Qinghai-Tibetan Plateau reflect the reality of the vulnerability of agriculture, especially grassland-based animal husbandry.

Agricultural disaster mitigation: Suggested activities include strengthening emergency management capacity; enhancing information connectivity and traffic accessibility; improving accessibility to pre-disaster forecasts; developing better horizontal and vertical co-ordination and linkages among different levels of disaster management.
Xueqian Song

Associate Professor, Doctor of Human Geography
School of Management, Chengdu University of Information Technology
No.24 Block 1, Xuefu Road, Chengdu, China
Tel. +86+13558894659
E-mail: 309375590@qq.com