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Climate change perspectives in an Alpine area, Southwest China: a case analysis of local residents' views

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ABSTRACT

This study explores mountain residents' perceptions and knowledge of climate change and its impacts, examines their attitudes and behaviors to adapt to climate change impacts and ecological migration, and analyzes some factors which influenced their perceptions by means of a detailed questionnaires survey of 202 local residents in Mt. Yulong Snow region, Southeastern Tibetan Plateau. Results show that: (1) overall, most local perception of climate change and its impacts correspond with patterns of observed climate change from climate records; (2) residents' perception intensity of climate change shows a highly significant correlation with their age and villages' elevation gradient. By contrast, residents' perception intensity to climate change impacts has a significant correlation with their age, whereas their perception intensity to adapt to climate change impacts highly correlates with villages elevation on the whole; (3) over half of the respondents think that climate change did not affect crop' growing and their yields, but residents hold a favorable opinion to crop insect pests' increasing slightly and crop growth period's extending. Meanwhile, almost all respondents believe that climate change seriously affected mountain tourism economy, their living and spiritual world, and hold a higher recognition attitude; (4) because of persistent drought in recent years, mountain dwellers are forced to adjust industrial structure, develop water-saving agriculture economy, participate actively in mountain tourism, and work outside the home in order to adapt to climate change impacts and make up for meager farm income. Additionally, location residents also expect to get government's compensation and relief for mitigating natural disasters damages.

1. Introduction

The globally averaged combined land and ocean surface temperature show a warming of 0.85 [0.65 to 1.06] °C, over the period 1880 to 2012. The total increase between the average of the 1850–1900 period and the 2003–2012 period is 0.78 [0.72 to 0.85] °C, based on the single longest dataset available (IPCC, 2013). Further climate warming will be accompanied by other changes, including the amount and distribution of snow, ice, and rain and the risk of extreme weather events such as dry spells and/or droughts, heat waves, and forest fires. Climate change presents the most complex challenge (Convertino et al., 2013). The high-mountain and high-latitude regions worldwide are especially vulnerable to impacts from climate change. Climate change research has been more and more mentioned by many states and scientists on the important agenda, in which research direction and field gradually transformed from the past climate system studies to current impacts of climate change, mitigation measures, vulnerability assessment and adaptation strategies researches (Biesbroek et al., 2010; Spence et al., 2011; Egan and Mullin, 2012). In the past, government managers depend mostly on scientific research on climate change, and often overlook some changes in the regional socio-economic systems in the prediction of climate change impacts and legislation of adaptation strategies and policies (Adger and Kelly, 1996; Mendelsohn et al., 2006). Previous research indicates that local people can more perceive and adapt to aspects of climate variability and change than others based on personal observations (Deressa et al., 2009; Spence et al., 2011; Howe et al., 2013a,b). Local residents' observations are themselves embedded in the local cultural and social context that is so important in shaping the outcome of environmental changes. Local residents' observation and understanding, especially in mountain areas, has a unique

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understanding in regional temperature, precipitation, snow cover, glacier, phenology, groundwater, monsoon, ecological system, agriculture environment change, etc, which is mostly absent from scientific studies and models and make up some shortcomings that scientific research has been neglected to some extent (Wilbanks and Kates, 1999; Morgan et al., 2002; Byg and Salick, 2009; Jones et al., 2011; Wood et al., 2012; Howe et al., 2013a,b). Thus, researchers within the field of mountain climate change adaptation should recognize the value of exploring the cognitive dimensions of human–environment interactions (Jones et al., 2014).

Tibetan Plateau (TP), as the world's third pole and the roof of the world, its climate change shows very strong in its physical properties. Some studies suggest that warming in the TP has been much greater than the global average over the last 100 years and recent warming shows more significant (Liu and Chen, 2000; Yao et al., 2006), resulting in snow line rise, glacier retreat, glacial lake expansion, permafrost degradation, shrinkage of wetlands, serious soil erosion, landslides, glacial lake outburst risk increasing. In the TP, regional transportation is not convenient, economic base is obsolete, ecological, economic and social system is also very fragile, residents' prevention, response, resistance and adaptation abilities to climate change impacts become more limited (Shrestha et al., 2000; Du et al., 2004; Xu et al., 2009). Meanwhile, climate change impacts are affecting sustainable development of regional socio-economic system (Beniston, 2003; Doria et al., 2009; Zheng and Byg, 2014). On the other hand, there are not only the materials and practical implications of climate change in the TP, but also substantial spiritual implications. Due to many landscape features such as snow-covered peaks are endowed with spiritual and cultural value, considered physical manifestations of different deities and spirits, and they form a unique understanding and worship to mountain people in Tibetan cosmology (Julie, 2005). This spiritual dimension is also likely to affect how people perceive, evaluate and respond to climate change (Huntington, 2002).

Taking into account the above factors, in order to better understand climate change and effectively address climate change impacts at the local scale, and to provide social scientific basis for local governments' decision-making to climate change adaptation, this study takes Mt. Yulong Snow at the southeastern edge of the Tibetan Plateau as a case study and uses data from a survey of 202 mountain households to examines their perceptions and altitudes of climate change and its impacts in the Mt. Yulong Snow. There are three main objectives of this research note:

1. to understand residents' perceptions and knowledge of climate change and its impacts,
2. to explore some factors affected residents' perceptions toward climate change, and its impacts and adaptation and analyze in-depth their spatial and temporal characteristics,
3. to examine and analyze residents' willingness and attitudes of ecological migration based on climate change adaptation.

2. Methods

2.1. Study area

Mt. Yulong Snow (27°10′–27°40′N, 100°9′–100°20′E) with a highest peak "satseto" of 5596 m a.s.l located in the southeastern edge of the TP and covers the land area of 960 km^2. Mt. Yulong Snow is the southernmost glacierized area of mainland Eurasia and situated less than 25 km from Lijiang Ancient Town (World cultural heritage) in the south and 250 km away from Three Parallel Rivers of Yunnan Protected Areas (World natural heritage) in northwest (Wang et al., 2010) (Fig. 1). In Mt. Yulong Snow, the relative height reaches 3196 m with obvious elevation gradient and its climate characters belong to plateau mountain monsoon climate in warm-temperate zone with low-latitude. The world's mountain glaciers are mostly located at high altitude areas in mid-low latitude. Their presence formed a unique cultural structure and the specific understanding and worship of mountain people. Snow and glacier resources in Mt. Yulong Snow are not only natural landscapes, but also important carrier of mountain cultural landscapes. For local residents, Mt. Yulong Snow is the Holy Mountain, while "Sanduo", a protective god, is the incarnation of Mt. Yulong Snow. Regional climate change affects not just local vulnerable ecology, agricultural, tourism environment, but also influences glacier and snow cultural landscape, human spiritual activities in alpine areas. In Mt. Yulong Snow region, agriculture population occupies for 93.62% of total population, economic is relatively backward, agricultural foundation is very weak, which result the relatively weak abilities for adapting to climate change impacts.

Elevation, topographty and exposure determine local temperature, precipitation, and wind (Byg and Salick, 2009), and then climate change affects the temporal and spatial distribution of local cultivated area, crop type and economic structure. The studies were conducted in five villages in Yulong County and Guchen District near the sacred Yulong snow mountain, including Jibao and Qingyun villages in Gucheng District, and Heishui 1 and 3 villages, and Wenhua village in Yulong County (Fig. 1). The surveyed A, B, C, D, E villages locate in the basin, foot of mountain, medium mountain area, high mountain area, and high and cold mountain area with the elevation of 2370, 2460, 2680, 3050 and 3200 m, respectively (Fig. 1, Table 1). Because of the hotter climate and relatively plentiful water resource, the village A in lower altitude can grow rice, wheat, vegetable, walnut, apple, snow peach, grape, and loquat and so on. The village B at mid-altitude is relatively mild. Residents can grow wheat, corn, bean and vegetable. However, in the village E at alpine area, the weather is cold, residents engage mainly in livestock and poultry breeding, only very small numbers of residents grow some corn on the side of the road, in which some farmers maintain their livelihood by relying on government assistance and compensation. Because residents' income is lower with single source, this also forces some residents to engage in illegal collection of medicinal plants (*Snow lotus, Cordyceps sinensis, Rhodiola crenulata*, *Gastrodia elata, Fungus etc.*). The survey indicates that water and heat conditions, transportation, land resources, accessibility, agriculture, residents' income, and other aspects of human settlements conditions, etc. appear a clear decreasing trend with increasing elevation in the study area (Fig. 2).

2.2. Methods

To study climate change and its impacts, 202 individual interviews from five villages were conducted with local residents and spent a total time of two months in Yulong County and Guchen District near the sacred Mt. Yulong Snow during May and June 2010 (Fig. 1). Due to the constraints of location, environment and land resource conditions, the number of village households showed a decreasing trend with the elevation gradient increasing. In order to ensure the higher representativeness of the samples, the sample proportion from each village exceeded 60%, especially more than 75% in two villages with high and cold mountain area. At the same time, over 85% of above 30 years old people were included in the survey to ensure that participants could perceive better climate change between the past and present. Taking into account the differences in education level, the younger respondents are interviewed by national language, while the interviews to the elder are conducted by trained local assistants in Naxi dialect (a local student). In the survey, we used in-depth semi-structured individual interviews so that questionnaire could be analyzed by means of statistics data. At the same time, we complemented some