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## Farmers' landslide risk perceptions and willingness for restoration and conservation of world heritage site of Honghe Hani Rice Terraces, China

**Abstract** The Honghe Hani Rice Terraces (China) is an ancient world heritage agricultural landscape that has been evolved in centuries as a result of farmers' indigenous practices and knowledge. The area, however, is prone to landslides that can burden the conservation of these landscapes including their social, cultural, economic and aesthetic value. In June 2018, a landslide threatened the villages of Duosha and Mengpin affecting 138 inhabitants and the terraces structure. This event marked the need to understand how farmers coexist with these natural hazards and which are the behaviours people adopt to conserve their environment and safeguard their livelihood. Results from 125 in-person interviews showed that farmers feel threaten by landslide events derived by their personal experience, but their poor perceived preparedness and the inefficient disaster information make them more vulnerable to those events. Nevertheless, they demonstrated a desire to increase their knowledge on terraces restoration and conservation practices. This is an important signal for public authorities and practitioners that need to underpin training activities and create momentum for discussion. The demonstrated high trust in authorities' decisions is a crucial element to pursue the objective and sustain the conservation of the terraces and the tourism economy.

**Keywords** Hani Rice Terraces · World heritage · Landslide · Risk perception · Restoration · Conservation

### Introduction

Climate change, especially the increase of extreme weather events, possesses severe threats all over the world (Gruber 2011). The World Heritage sites (listed by the United Nations Educational, Scientific and Cultural Organization – UNESCO) are increasingly affected by natural hazards, especially landslides and mass movements. In 2017, the 23% of all heritage sites in the world have been registered to be prone to landslides (Pavlova et al. 2017). These events compromise the landscape integrity and authenticity, affect road accessibility and, at the same time, put in jeopardy the human lives and their economies. The recurrence of such threats are a call for action for policymakers, planners, practitioners and communities to manage and sustainably conserve these landscapes to preserve their sociocultural identity and economic profitability. Agricultural heritage sites, such as terraces, are complex socioecological systems developed by long-term interactions between humans and nature (Chen et al. 2020; Wei et al. 2016). However, this relationship does not always see an equilibrium, affecting many agricultural terraces worldwide (Tarolli et al. 2014). Land abandonment, mismanagement and inadequate maintenance are one of the most common problems that can turn into hydrogeological dysfunctions and soil erosion overall (Pijl et al. 2019; Tarolli and Straffelini 2020). Landslides are quite common phenomena affecting agricultural heritage terraces causing severe damages: from the Machu Picchu archaeological site in Peru (Sassa

et al. 2003; Klimeš 2013), the Cinque Terre in Italy (Agnoletti et al. 2019; Brandolini et al. 2018) and the Slovakian and Greek landscapes (Canuti et al. 2009). The impacts of these mass movements for farmers are enormous, to that policymakers at the international and national levels have come to terms with this pressing issue. The Food and Agriculture Organization (FAO) of the United Nations launched in 2002 the Globally Important Agricultural Heritage Systems (GIAHS), to mobilize global awareness and support dynamic conservation and adaptive management practices of indigenous agricultural systems (Zhang et al. 2017). In the GIAHS framework, people's perceptions are recognized to be necessary, since they not only work as precepts but they are also able to intervene in the behavioural process (Hua and Zhou 2015).

Through the studies of risk perception, it is possible to understand how people collect, select and interpret signals coming from the surrounding environment and which are the activities they would implement if resources are available (Slovic 1987). Perception studies have explored a series of indicators affecting the people's understanding of disaster risks, including disaster experiences, knowledge, feeling of danger, preparedness, information, communication and trust among many more. All these parameters have a potential influence in the way people conceptualize the risk and transform beliefs into actions (e.g. from landslide literature Alcantara-Ayala and Moreno 2016; Solana and Kilburn 2003; Xu et al. 2017; Damm et al. 2013; Thiene et al. 2017). Misanya and Øyhus (2015) argued that people who have had recent experiences with landslides tend to be more knowledgeable about the causes and risks involved and thus appear to be more sensitive. Manandhar et al. (2015) in this regard found that people in Thailand attributed landslides to excess rainfall events, ascribable to cause severe consequences for agriculture and individuals' livelihoods. Similarly, Kitutu et al. (2011) observed that most farmers in Uganda had developed knowledge about vulnerable areas prone to landslides, appreciating their morphological and triggering characteristics because of their frequent experience, being able to better cope with these events. Local people's awareness of landslides is the fundamental element of risk perception that might be able to condition their behaviour (Alcantara-Ayala and Moreno 2016; Hernández-moreno and Alcántara-ayala 2017; Roder et al. 2016). Preparedness facilitates landslide response and community resilience (Lin et al. 2008; Klimeš et al. 2019), especially when information on the hazard is communicated adequately and when trust in authorities is ground (Siegrist and Cvetkovich 2000). In Yu et al. (2018), respondents with higher confidence in local authorities perceived lower risk, because different types of hazard information channels and interpersonal communication sources have a disparate impact on risk perceptions (Sim et al. 2018). Nevertheless, mutual trust between local population and scientists could help the implementation of landslide early warning systems

(Michoud et al. 2013) and emergency management activities (Antronico et al. 2019). In addition to these factors, sense of place and individual socio-economic characteristics are also crucial elements able to influence pre-emptive disaster actions. Sense of place reflects attitudes and behaviour in epistemological understandings of social and ecological change and human-environment relationships (Quinn et al. 2018). Sociocultural factors, like religious belief (Sun et al. 2018), marital status (Agho et al. 2010), ethnicity and physical conditions (Werg et al. 2013), have been seen significant in analysing landslide risk attitudes. However, finding appropriate and meaningful indicators to assess individuals' perceptions and preparedness strategies has been a challenge for most studies. Among the preparedness actions, restoration activities are fundamental for the continuity of the agricultural landscape and for preventing landslides' adverse effects (Soldo et al. 2012; Walker et al. 2009). Literature in this regard evidences that economic factors still play a major role in the decision-making process of rural household conservation actions (Stocking and Murnaghan 2001) where the poverty, the market penetration and the food insecurity are the most common challenges (Barbier 1997). Many African farmers noticed that they could easily adapt to the effects of climate change if they had access to the markets, new technologies and credit facilities (Hassan and Nhemachena 2008). Likewise, in Uganda, positive coping strategies used to deal with landslides (and floods) included adoption of suitable farming methods, financial support from the government and other partners, livelihood diversification and using indigenous knowledge (Osuret et al. 2016). In this sense, in the Indian mountain environments, the strategies used for soil loss mitigation not only concern environmental characteristics or market orientation but also have to take account of the community's own culture (Vedwan 2006).

The Honghe Hani Rice Terraces UNESCO World Heritage Site (China) (Fig. 1) is famous for the harmonious relationship between human and nature lasting more than 1300 years in the Ailao Mountains. The Hani people (an ethnic group in Southwest China) shaped the terraced rice fields by adapting wisely to the local mid-mountainous topographic features and subtropic monsoon climate conserving many local rice varieties and practising specific agricultural methods (Jiao 2009). This coexistence mutually changed the landscape and also the communities' behaviours, connecting the needs of both biological entities and shaping their relationship through time (Yuan et al. 2014). The landscape, however, suffers from frequent landslides because of the vulnerable topographic characteristics of steep terrace slopes (on average 25°) and considerable precipitation (1400 mm) concentrated in the rainy season (Jiao 2009). Usually, most of the landslides impact a limited area permitting single households to repair terraces independently. However, in June 2018, in the Laohuzui terraces, one of the most famous and scenic spots, a massive landslide occurred resulting in 1030-m long of rice terrace collapse, directly impacting 138 households, burdening farmers' source of livelihood, their touristic economic activity and the cultural and aesthetic value of the area. These consequences not only directly threatened the sustainability of these environments but also the willingness of farmers to keep this activity, since as demonstrated by Zhang et al. (2017), income from nonfarm job in cities is higher than in GIAHS sites. This occasion fosters the need to understand how farmers conceptualize such risks and which are the conservation strategies

they adopt and which limitations they might face for the future in light of a changing climate. For this purpose, in-person interviews were conducted in the two villages affected directly by the Laohuzui landslide event. In detail, the study explores the villagers' landslide experiences, risk awareness, preparedness, their trust in authorities and the effectiveness of risk communication. These premises have been used to understand locals' willingness to repair damaged rice terraces and their general conservation behavioural actions.

This preliminary study would be able to set the scene to enhance the dialogue and the commitment of policymakers for helping the locals in preserving the Hani Rice Terraces cultural heritage without compromising the indigenous subjective well-being and secure their life and economies.

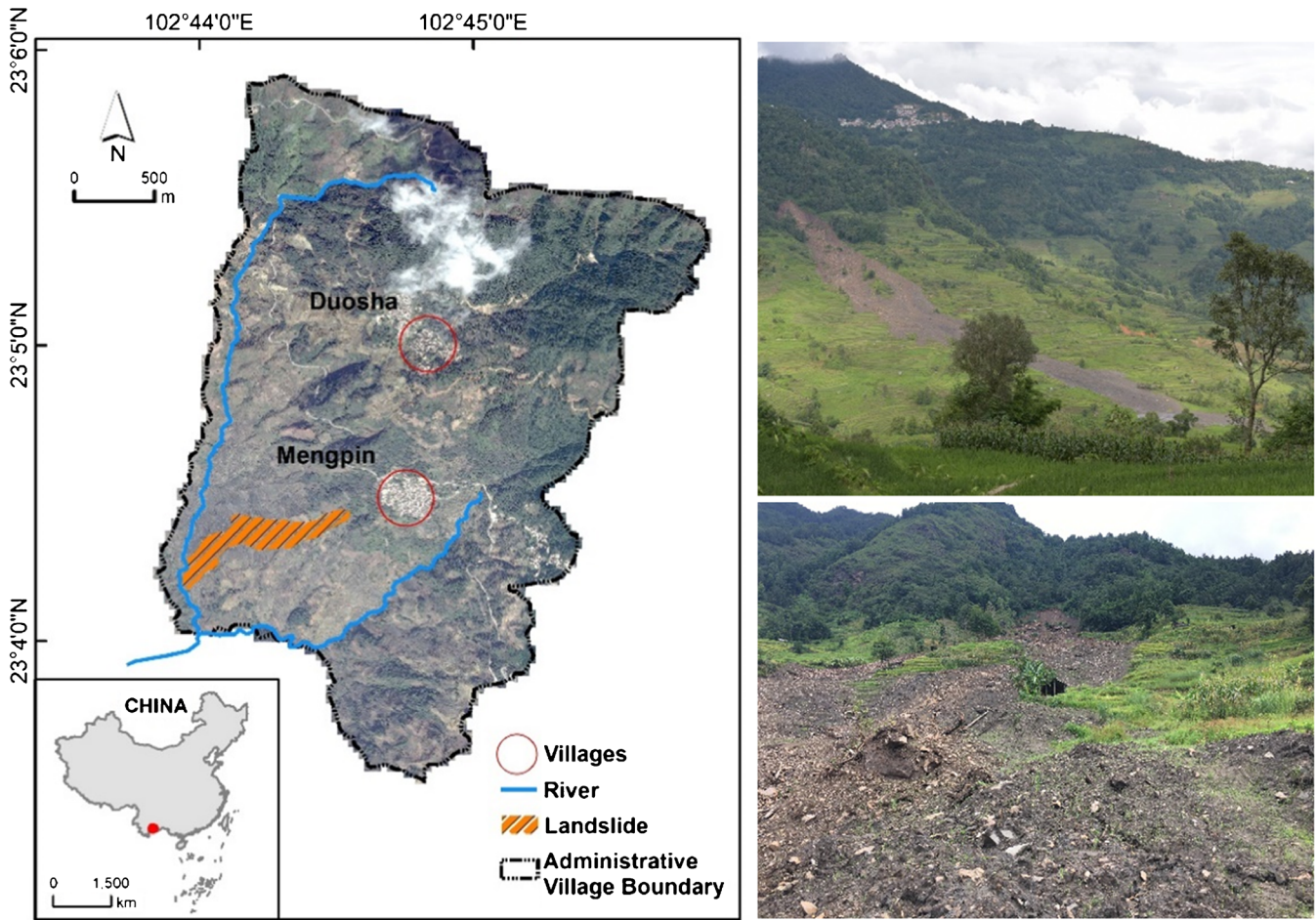
## Materials and methods

### Study area

The Honghe Hani Rice Terraces (HHRTs) was registered in the GIAHS List in 2010 and in the UNESCO World Heritage List in 2013 for their immeasurable ecological value and their agricultural and touristic economic significance (Tian et al. 2015). The HHRTs is located in Yuanyang County of Yunnan Province, Southwest China, between 102.68–102.85 E and 23.01–23.17 N, and is characterized by a subtropical monsoon climate with more than 1400 mm rainfall across the rainy season (May to October) (Jiao et al. 2019a), when the steep and deeply incised fragile mountainous environment is very sensitive to landslides and terrace collapses (Jiao et al. 2012). For example, a huge landslide threatened the previous capital of Yuanyang County seated in Xinjie Township in 1988 and caused its relocation to Nansha Township in 1991, while another 49 villages were found still located in high-risk landslide areas until 1997 (Shao 1998; Zhan and Chen 1997). A total of 235 landslides in Yuanyang County were recorded in 2008 by the Yunnan Geological Investigation Institute of China (Jiao et al. 2019b), and 285 landslides were detected in the core areas of HHRTs from Google satellite images in 2015 (Gao 2019).

On June 26, 2018, at the Laohuzui scenic spot, it has occurred a considerable landslide (Fig. 1) causing damages to the rice terraces belonging to Duosha and Mengpin villagers. Before the landslide event, the automatic weather station registered cumulative precipitation of 104.6 mm between June 20 to 26, and a crack of the earth below the sightseeing stand had also been observed. From 6 am to 12 pm of the same day, the surface on the slope moved and damaged 9.79 ha of terraced land and involved 138 households' fields. The whole mass movement was around 1030-m long, which can be divided into two parts according to its topographic characteristics. The upper part was a landslide with semi-circular chair shape and obvious edge, with the main sliding direction of 240° and a width of 60–100 m. The lower part, with the shape of inverted "V" and a dimension of 15–150-m, was characterized by debris and released water from rice terraces flowing northeast to southwest.

The two villages impacted by the Laohuzui landslide have similar characteristics. According to the national census database of 2016, (available at <http://ynszxc.gov.cn>), the Duosha village cultivated land area is approximately 64 ha and hosts 314 households, with the average family annual income of RMB 6554 (around 983 USD) deriving mainly from farming activities and



**Fig. 1** Left, study sites location. Circles represent the Duosha and Mengpin villages, whereas the orange area shows the Laohuzui landslide occurred in 2018. Right, landslide pictures taken on July 30, 2018 (photo by Xuan Gao)

labour export. The cultivated land of Mengpin is 79 ha hosting 350 households with an average family annual income of RMB 6298 (around 944 USD), coming from farming, livestock and tourism activities. Compared with Duosha, Mengpin is located on the main traffic route and has better external communication. More importantly, its northwest side is adjacent to the Laohuzui Terraces Scenic Spot, which makes the Mengpin villagers more dependent on tourism activities, such as hotels, restaurants and handicrafts businesses.

### Survey description

On June 29, 2018, a field study was initially carried out to investigate the physical features of the Laohuzui landslide after its occurrence. Then, in early July, a pilot survey was conducted, and 20 people have been interviewed in Duoyishu village in the heritage core area. After this preliminary study, the questionnaire has been modified to its final version. The survey has been conducted in-person in Duosha and Mengpin villages on August 2018 by experienced interviewers knowledgeable of the local language, culture and traditions. Respondents were randomly selected and interviewed separately according to their free time. One hundred thirty-nine people were interviewed, but only 125 questionnaires were retained for the statistical analysis in SPSS Statistics 21.0.

The main hypothesis tested regarded risk awareness, recognized to be the core cognitive element of risk perception and defined as the knowledge or the consciousness of risk that an individual or a group is exposed to (Raaijmakers et al. 2008). It has been assumed that people will be more prepared if they are aware of and understand the dangers associated with a prospective hazard event, thereby lowering the impacts of a disaster (Antronico et al. 2017). As Roder et al. (2019) argued, identifying the relationship between a person's awareness and responses of hazards can be used to better design risk management and, in this case, terraces conservation practices. Coupled with personal cognitive perceptions, trust has been analysed being a key component in the management of the terraced landscape. In the HHRTs sites, there are many stakeholders involved in the management of the landscape system: the governments (including administrative and heritage offices), private tourism companies, national and international experts and religious priests. The latter group not only undertake several activities regarding religious celebrations, festival and healing illnesses, but also their leadership has an active role in natural hazard management. As these stakeholders have a direct or indirect role in the management of the Hani Rice Terraces, the role of trust cannot be neglected when understanding the relationship between farmers and their behaviours. At the

same time, perceived preparedness and risk communication factors were also explored. In light of the planning and policy implication of a sustainable management of terrace landscapes, people were invited to express interest (or not) to restore collapsed terraces and to conserve the terraces in general. Other socio-economic characteristics have been collected to understand if some variables could explain farmers' behaviours. The questionnaire produced data from close- and open-ended questions, which were coded for further analyses (Table 1).

### Sample composition

The demographic statistics of respondents are shown in Table 2. In terms of gender, the male to female ratio is about 5:4. For the village of Duosha, the sample is dominated by the Hani people, and Mengpin is represented by the Yi ethnic group. The most represented age group are those in the 40–50-year-old category

**Table 1** Description of the surveyed parameters in questionnaires

Section	Items	Response
Personal factors	Gender	Binary: male or female
	Ethnic group	Open
	Age (years old)	Open
	Terraces area (ha)	Category: small, 0–0.2; medium, 0.2–0.4; large, 0.4+
	Education level	Category: illiterate, primary school, middle school, high school, college or higher
	Family annual income (RMB)*	Category: small, 0–5000; medium, 5000–10,000; high, 10,000+
Landslide experiences**	Past experience	1, never heard about landslide; 2, heard but do not know where; 3, friends or relatives affected; 4, neighbourhood affected; 5, directly affected
	Present experience	
Risk perceptions	Awareness	Five-point Likert scale: 1, extremely disagree; 2, disagree; 3, neutral; 4, agree; 5, extremely agree
	Preparedness	
	Risk information and communication	
	Trust in different stakeholders	
Disaster responses	Willingness for restoration damaged terraces	Five-point Likert scale: 1, very low; 2, low; 3, neutral; 4, high; 5, very high
	Willingness for the conservation of terraces heritage	

\* The ranking has been chosen according to the mean annual income found by the Statistical Bureau (Available at Yuanyang County)

\*\* Past and present landslide experience refers to the 2018 Laohuzui landslide

representing all the people working in the terraced landscape and excluding automatically outside workers. Due to the historical composition and tradition of the Hani farmers, the education is quite low; almost all of the respondents have a middle school degree as highest education level. According to the official census (available at <http://ynszxc.gov.cn>), the sample population reported a high family annual income, being around RMB 6000.

## Results

### Landslide experiences

Since several landslides influenced the study area in the past, we were interested in investigating people's memory about the past and recent events (Table 3). The majority (74.4%) of total respondents affirmed to have been directly affected by landslides in 2018, while 40.8% experienced landslides in the previous years showing a much serious situation in 2018 than before. Similarly, the percentage of farmers who did not hear about any occurrence of a landslide in 2018 was much less than before, dropped from 18.4 to 0.8%, being validated by a personal communication with the village manager. Moreover, landslide situations of the two surveyed villages were different. In 2018, the proportion of farmers in Duosha directly involved in landslides were larger than Mengpin, which was consistent with the damages registered in the administrative village office. The data retrieved that 95 households of Duosha and 43 households of Mengpin were impacted by the Laohuzui landslide. Before 2018, landslides in Duosha were more serious than in Mengpin.

### Risk awareness and perceived preparedness

The Hani farmers' risk awareness of landslides was described by seven different statements (Fig. 2). With a mean value of 4.79 (SD = 0.72), 88.80% of the farmers agreed that landslides were the most severe natural hazard in the Hani Rice Terraces. In addition, more than half of them (52.80%) believed that the risk of landslides became more serious due to the increased frequency (M = 3.98, SD = 1.31). Their personal experience has a significant correlation with their feeling of anxiety. Pearson's correlation (2-tailed) showed a correlation of 0.00 for people's experience in 2018 and of 0.05 for past experience (prior 2018). According to landslide impacts, farmers agreed that these events damage the aesthetic value of the landscape (M = 4.62; SD = 0.97), but perceiving to be personally safe in case of an occurrence. In fact, only 8.8% of people thought that landslides could affect their personal safety (M = 2.91; SD = 1.86). This can be explained by the type of damages usually experienced. Landslide often occurs far from the villages validating the low feeling of anxiety for one's own safety. Farmers perceiving that landslides affect the growing of rice account for more than 60% being concerned of high costs of restoration of collapsed terraces.

A high level of preparedness would contribute to individual and community resilience facilitating and improving response to landslides, thereby reducing their adverse consequences. For this reason, we asked respondents to rate their level of agreement on a set of seven items (Fig. 3). Generally, the average Likert scorings are around 2, underlining an inadequate perceived capacity to be prepared for those events. The figure depicts a more complex overview since almost half of the farmers still believe that preparedness is important (46.40%). In parallel, the results

**Table 2** Socio-demographic characteristics of respondents in the villages of Duosha ( $n = 45$ ) and Mengpin ( $n = 80$ )

Variable	Categories	Duosha N	%	Mengpin N	%	Total N	%
Gender	Male	23	51.1	48	60	71	56.8
	Female	22	48.9	32	40	54	43.2
Ethnic group	Han	0	0	2	2.5	2	1.6
	Hani	43	95.6	0	0	43	34.4
	Yi	2	4.4	78	97.5	80	64.0
Age (years old)	18–30	3	6.7	13	16.3	16	12.8
	31–40	6	13.3	17	21.3	23	18.4
	41–50	9	20.0	22	27.5	31	24.8
	51–60	17	37.8	17	21.3	34	27.2
	60+	10	22.2	11	13.8	21	16.8
Education degree	Illiterate	29	64.4	28	35	57	45.6
	Primary	6	13.3	38	47.5	44	35.2
	Middle	6	13.3	9	11.3	15	12.0
	High	3	6.7	1	1.3	4	3.2
	College and higher	1	2.2	4	5	5	4.0
Terraces area	Small	30	66.7	49	61.3	79	63.2
	Medium	14	31.1	23	28.8	37	29.6
	Large	1	2.2	8	10.1	9	7.2
Family annual income (RMB*)	Low	8	17.8	6	7.6	14	11.2
	Medium	7	15.6	24	30	31	24.8
	High	30	66.7	50	62.6	80	64.0

\* 1 RMB is equal to 0.14 USD (as per June 2019)

demonstrated that almost 70% of farmers did not have any idea on where the landslides might occur ( $M = 2.27$ ;  $SD = 1.51$ ).

The roots of HHRTs are back to 1300 years as well as the traditional ways of coexisting harmoniously with these cultural landscapes. Local ethnic people have been combining for centuries their agriculture cultivations with ecosystem conservation practices (Jiao et al. 2012). Among those, the activities undertaken traditionally to prevent terrace collapse were planting trees on the terrace levee, reinforcing their structure with stakes and bamboo poles, weeding the terrace levee regularly, thickening the base of terrace levee and monitoring water level daily

during the rainy season to divert the water channel in case of emergency. However, only 36% of farmers are familiar with these traditional landslide preventive measures ( $M = 2.72$ ;  $SD = 1.72$ ). In contrast, 51.2% of farmers know contemporary protective measures ( $M = 3.15$ ;  $SD = 1.53$ ) such as using cement and stone to reinforce the terraces and canals, but just 3.2% of the farmers agreed that traditional methods are more effective than modern ones. Farmers felt that conventional practices are in line with regular maintenance activities, while the contemporary engineering solutions are emergency operations that collide with daily routine.

**Table 3** Landslide experiences of survey participants in Duosha and Mengpin villages before and in 2018 with mean value (M) and standard deviation (SD)

Villages	Time	5-point Likert scale measurement (%)					M (SD)
		1	2	3	4	5	
Duosha	In 2018	0	0	8.9	8.9	82.2	4.73 (0.62)
	Before 2018	22.2	8.9	2.2	17.8	48.9	3.62 (1.67)
Mengpin	In 2018	1.3	1.3	10.0	17.5	70.0	4.54 (0.83)
	Before 2018	16.3	17.5	5.0	25.0	36.3	3.48 (1.53)
Total	In 2018	0.8	0.8	9.6	14.4	74.4	4.61 (0.76)
	Before 2018	18.4	14.4	4.0	22.4	40.8	3.53 (1.57)

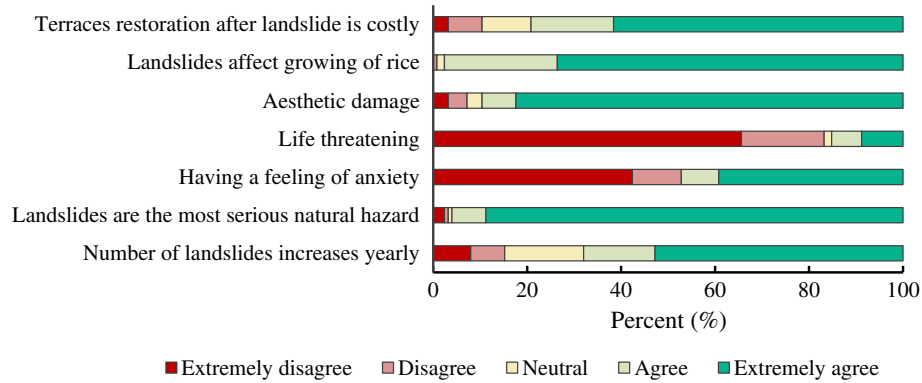


Fig. 2 Farmers' landslide risk awareness on a 5-point Likert scale of agreement

The perceived preparedness of farmers is correlated with their risk awareness (Sign. 0.004, Pearson's correlation value of 0.257), which means that those who have better knowledge of landslides can cope better with the adverse effects in rice terraces.

### Risk information and communication

The farmers' opinions on risk information and communication about the potential landslide risk have been explored by a set of seven items (Fig. 4). Farmers strongly believe that landslide information is important and it has an early warning effect on disaster outcomes ( $M = 4.36$ ;  $SD = 1.12$ ). The effectiveness of risk communication among villagers ( $M = 3.39$ ,  $SD = 1.64$ ) and the notice transferred from the government ( $M = 3.09$ ;  $SD = 1.68$ ) were also moderately agreed. However, the language of communication has been seen to be a limitation. In fact, 60% of farmers are not confident in understanding Mandarin Chinese information, as expressed by the population regarding the warning boards in each village (Fig. 5). It has also been argued that Chinese risk communication delivered by the news (TV and newspaper) is not understandable being a limitation for their preparedness actions, paying lesser attention to risky information. In this context, they are not able to change their farming activities based on the information received ( $M = 2.91$ ;  $SD = 1.40$ ).

Farmers with high-level education have been seen to understand risk information better and effectively communicate adequate information to other villagers. The significance (2-tailed) is 0.007 (Pearson's correlation of 0.239).

### Trust

The farmers' trust in different stakeholders is shown in Fig. 6. First of all, farmers have a higher degree of trust in the government bodies ( $M = 4.48$ ;  $SD = 0.95$ ) than other stakeholders, followed by experts ( $M = 4.02$ ;  $SD = 1.29$ ) and tourism companies ( $M = 3.98$ ;  $SD = 1.32$ ). In contrast, the data shows that more than half of the respondents (58.4%) did not trust religious priests to deal with disasters ( $M = 1.97$ ;  $SD = 1.31$ ). This is ground on traditional belief related to hazardous events. An elderly priestess interviewed claimed that "Laohuzui event is caused by a dragon living under the field, which cracked the field and rose to the sky; if people want to avoid these negative circumstances to the land they have to pray and sacrifice a chicken in order to let the dragon disappear". Hani and Yi people have a strong religious faith, like some other indigenous groups, profoundly respecting the nature and its spirit, dedicating to her farm and harvesting festivals and other celebrations. People, nowadays, rely more on scientific evidence without neglecting the importance of natural forces.

Age (Sign. 0.012, Pearson's correlation value of 0.225) and educational level (Sign. 0.045, Pearson's correlation value of  $-0.072$ ) have been seen significant statistical factors correlated with trust. In this regard, the 51- to 60-year-old farmers and those with high middle school level have the highest trust among the villagers.

### Disaster response: restoration and conservation attitudes

Farmers are the main responsible for the rice terraces management, and their behaviours are crucial for heritage conservation. In this

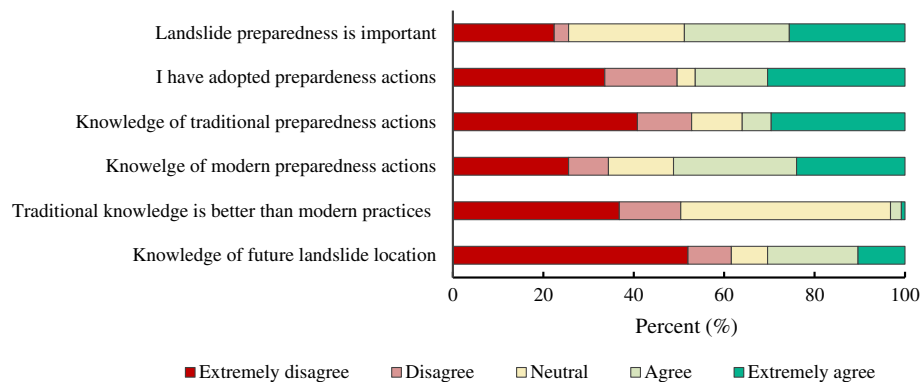


Fig. 3 Farmers' perceived preparedness of landslide events and related knowledge on a 5-point Likert scale

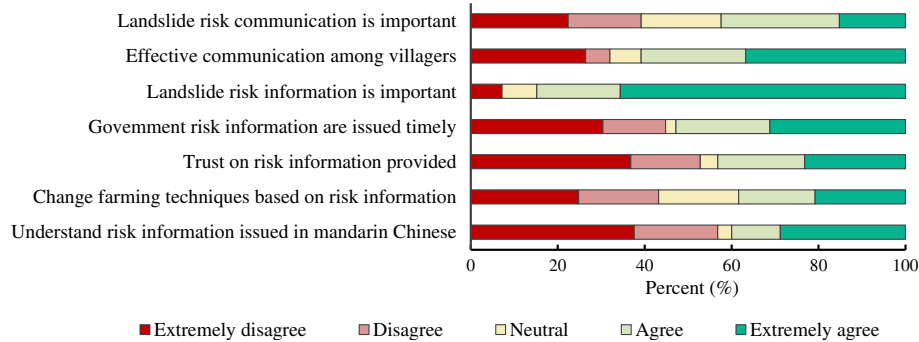


Fig. 4 Risk information and communication of landslide risk on a 5-point Likert scale



Fig. 5 Natural hazards' warning board in Mengpin village office (in Mandarin Chinese language)

regard, people were asked to express agreement on five items to understand the intents of people after a possible landslide event (Fig. 7). The villagers demonstrated a positive attitude towards restoration practices. 57.6% of the respondents are active managers taking personal initiatives after the negative occurrence ( $M = 3.71$ ;  $SD = 1.71$ ), but they are expecting help from villager's peers ( $M = 3.37$ ;  $SD = 1.53$ ) or authorities in charge ( $M = 3.99$ ;  $SD = 1.43$ ) if the damage appears intensely extended, being unable to restore the terraces independently. This is the case after the Laohuzui landslides, where farmers sought help to restore their collapsed fields. More than 20% of farmers have thought to convert their cultivation into dry land or abandon it if the landslide occurrence would be more frequent in the future. The choice to convert the field into a dry land is mainly

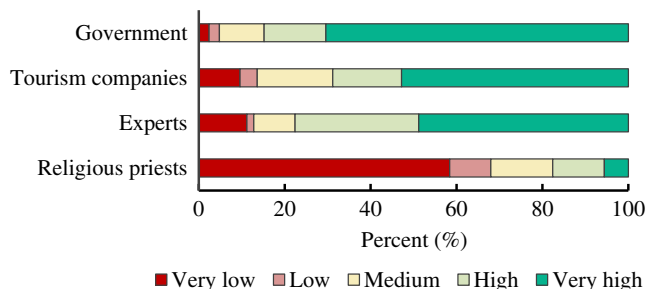


Fig. 6 Farmers' trust in different stakeholders on a 5-point Likert scale

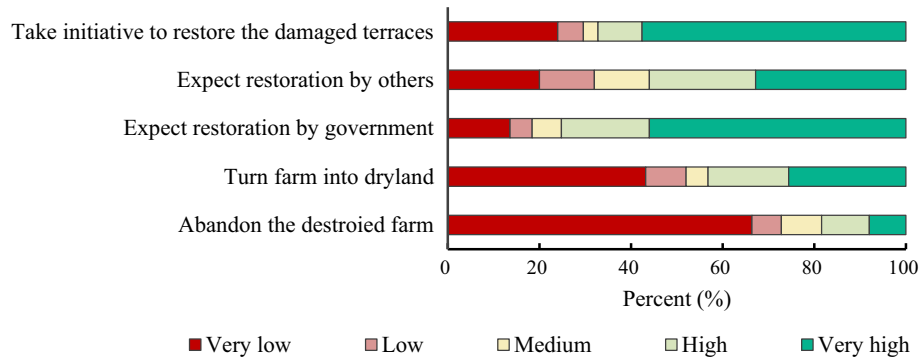
ascrivable to the lack of water resources than for the severity of landslide events. Most of all the farmers cherish the rice terraces, so only when the condition is not allowed for rice cultivation, they have to transfer the land to other use.

Nevertheless, landslide negative consequences seem still not sufficient to quit their farming activities because "rice terraces are precious inheritance which cannot be discharged, and it is too shameful to leave the land and let it become wasteland". Some other farmers in Duosha village agreed that "we have no other workability, and farming is the basic life guarantee for us". From the results obtained, farmers demonstrated a high willingness to protect the heritage sites. Although a great number of native people were not comfortable with the meaning of world heritage, almost everyone expressed that they hope that their hometown would maintain this honour once translated the concept in the local dialect. Interviewees presented high expectations and pride for the Hani Rice Terraces being a heritage site. More than 75% of the farmers expressed optimism on keeping on terrace farming despite landslide occurrence and the increasing expenses for restoring them every time. Unfortunately, due to low-income reasons, they feel that future generations would not take this business being worried about the future of the Hani Rice Terraces putting in jeopardy the sustainability of this landscape. However, a small group of people (10.32%) hold contradictory ideas, considering that in a few decades, the rice terraces' area will become a wasteland due to the severity and the increasing number of the disaster occurrences.

The landslide experience has been seen a predictive factor in farmers' willingness to restore (Sig. 0.004, Pearson's correlation value of 0.254) and conserve (Sig. 0.043, Pearson's correlation value of 0.181) the terraces in light of future possible landslide events.

#### Duosha and Mengpin differences: risk perception and disaster response

Although Duosha and Mengpin are neighbour villages and are under the control of the same administrative office, they have different characteristics, such as ethnic group composition, road accessibility, tourism influence and the ratio of farm lease. To identify whether these characteristics would have played different roles in their farmers' landslide perceptions and responses, the results of Duosha and Mengpin interviews were compared (Table 4). Preparedness ( $M = 2.85$ ) and risk communication ( $M = 3.15$ ) of Duosha were much lower than that ( $M = 3.28$ ;  $3.61$ ) of Mengpin, while the expressed trust ( $M = 4.31$ ) of Duosha villagers was much higher than ( $M = 3.87$ ) Mengpin. These differences could be explained by the village



**Fig. 7** Farmer's response behaviours to damaged terraces due to landslide events based on a 5-point Likert scale

features. Mengpin is located nearby a busy traffic route just beside the Laohuzui Terraces scenic spot, while Duosha is far from the road and needs to climb over the mountain for 30 min (Fig. 1). Although there is a newly built concrete road to reach Duosha, it is still not convenient and is 4–5 times longer than the one through the mountains. Road accessibility seems to influence Duosha farmers to go outside their villages to communicate or receive risk information. At the same time, because the Laohuzui scenic spot is in Mengpin, the influence of tourism business on this village is much prominent than the one of Duosha, being the economic growth highly diverse. The benefits from tourism businesses are greater than the income from farming activities, which makes the residents more prone to abandon agricultural lands and recolonize outside mountains. Besides, 2/3 of the rice terraces of Duosha was subcontracted by the government to a tourism company from 2017 to 2027, transferring the possible losses (climate-related and others) to the company.

Any statistical significance difference has been seen between villagers of Duosha and Mengpin regarding their willingness for restoration or conservation damaged terraces. This means that, apart from the reliance on the government or private companies, farmers demonstrated a high place attachment and willingness to invest time and resources to keep their lands safe and prosperous.

## Discussion

The HHRTs are traditional agricultural systems that have been sustained for more than 1300 years. However, their survival is at risk because of climate extremes to one side that are exacerbating the occurrence of hazard events and also because of the economic difficulties that farmers are facing in the current century. Despite Hani terraces have tremendous economic potential, many farmers are registering huge losses (Zhang et al. 2017). As a consequence, the economic sustainability of these systems is endangered, and as found in this research, many farmers might think to abandon the rice terraces farming activity. The financial sustainability is essential to keep alive these cultural landscapes, and information is a key element to raise awareness and enhance proactive behaviours. To this point, people demonstrated low level of preparedness actions to prevent landslide losses even if their experiences and awareness are high. It seems crucial the need to share modern preparedness agricultural practices that would help farmers in their everyday activities. In this regard, the high trust devoted to governmental authorities is a key element to pursue this action and foster capacity building. As argued by Dalrymple et al. (2016), communication strategies should endeavour trust and effective dissemination activities. If trust is built, it is easier and imperative to create momentum for discussion with

**Table 4** *t* test results to test the different perceptions and responses in Duosha and Mengpin villages

Factor	Village	Mean	Standard deviation	Sig. (two-tailed)
Awareness	Duosha	4.033	0.522	0.264
	Mengpin	3.931	0.468	
Preparedness	Duosha	2.848	0.744	0.007*
	Mengpin	3.275	0.885	
Risk communication	Duosha	3.153	0.649	0.000*
	Mengpin	3.606	0.524	
Trust	Duosha	4.311	0.796	0.001*
	Mengpin	3.873	0.586	
Willingness for restoration	Duosha	3.822	0.643	0.133
	Mengpin	3.62	0.756	
Willingness for conservation	Duosha	4.441	0.593	0.142
	Mengpin	4.25	0.743	

\*Significance is set for  $p < 0.05$



people, sharing risk information and ensuring a two-way communication. Dialogue in local language is essential to stimulate farmers in their daily conservation practices and at the same time increases the social capital of communities and sense of place securing the economic and social development. A “sustainable society” is a “responsible society” and responsible people can act with integrity to lead healthy, secured in their economies and in harmony with their natural environment, without compromising the health of the planet and future generations. Young generations need to be involved in the dialogue and the willingness to maintain the functioning of these landscapes, being able to secure their financial welfare and well-being, but also preserving their aesthetic value in the future.

The differences found between the two villages arise the need to involve land planners in the sustainable management strategy of the Hani Rice Terraces. Because of the difficult transportation systems and poor road connectivity between the mountainous villages, communication results in scattered information. To do not compromise the landscape with new road constructions, alternative ways of communication need to be put in place. For example, a representative for each village needs to be selected and empowered to be the reference person in charge of communicating with the main governmental office regarding preparedness, coping or emergencies actions to be developed. In addition, there should be a communication network among those representatives aimed at sharing land management experiences and landslide risk prevention practices. Landslides in farmlands have tremendous impacts on farmers’ routine lives, caused not only by the natural conditions such as steep slope, weak layers, unstable fault, earthquakes or intense precipitation patterns but also by the human conditions and activities (Bogaard and Greco 2016; Segoni et al. 2018). For example, farmland abandonment, mainly cause by the research of external income, results in landslide events. To solve this problem and keep the local rice terraces farming, policymakers should enrich the diversity of livelihoods of villagers, making them involved in tourism development and create new opportunities for employment. A new political agenda is needed to consider the environmental and social changes of the community and incorporate disaster risk management into the investment plan strengthening institutional and legislative arrangements. Future research can be focused in understanding the financial effort required by the government to secure the maintenance of these protected landscapes and on how to build a culture of prevention to help future generations sustainable development.

## Conclusions

Because of the landslide event happened at the Laohuzui site in the Honghe Hani Rice Terraces UNESCO World Heritage Site (Yunnan Province, China) in June 2018, 125 villagers were interviewed in Duosha and Mengpin villages because they were directly affected. Since the farmers always face landslides in daily life, their overall risk perception is well developed, but it does not translate into effective preparedness measures. However, farmers displayed a high willingness to restore and maintain the terraced landscape even if they are facing financial burdens in the current years. Information dissemination and communication should be organized more effectively, getting engaged the population into the disaster planning and prevention agenda by using the local language. The high trust of farmers in the disaster management actions should be translated into a call for action, creating momentum of discussion and training. For this purpose, villages’ network can meet the need to create internal communication where farmers can share their good practices and lessons learned. As owners

of the rice terraces and also as victims of landslides, local farmers could mitigate the risk of landslides and contribute to the great effort on the Honghe Hani Rice Terraces heritage conservation.

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## Authors’ contributions

X.G., G.R. and Y.J. conceptualized the paper and prepared the survey material. X.G. performed the analyses and with the help of G.R. validate and interpreted the results. X.G. and G.R. drafted the manuscript under the supervision of Y.J., Y.D., Z.L. and P.T. P.T. supervised the entire work. Funding information This research was funded by the National Natural Science Foundation of China, grant nos. 41271203 and 41761115.

## Compliance with ethical standards

**Conflict of interest** The authors declare that they have no conflict of interest.

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