Recognizing indigenous farming practices for sustainability: a narrative analysis of key elements and drivers in a Chinese dryland terrace system

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ABSTRACT
Terraced systems are time-tested agricultural landscapes that host multiple societal values, but they are largely overlooked and challenged by land-use changes. We described and analysed the key elements and driving forces of change in a dryland terrace system in China through the narratives of 31 local farmers. We identified 16 key system elements related to farming tools, agricultural inputs, crops and diets and constructions. We distinguished the newly adopted and inherited elements and revealed relationships of complementarity or substitution among them. Land abandonment, the introduction of external inputs and dual-track farming, the mechanization of farming and the simplification of the farming calendar were identified as the main systemic changes. We discuss the importance of dynamic adaption process by integrating new elements with active traditional knowledge. We stress that local networks and the necessity of collective action in-and-outside the local community are crucial to preserve terraced systems. We suggest that understanding local perceptions of change and specific customs should be taken into consideration in policy making processes. We highlight the role of Globally Important Agricultural Heritage Systems initiative (GIAHS), especially in the aspect of empowering farmers to activate the interaction and integration of inherited and newly adopted elements.

Introduction
Indigenous farming systems are time-tested land-use practices that are considered "productive, adaptive and ecologically principled, but are largely overlooked" (Kurashima et al. 2019). In many parts of the world, such systems have shaped landscapes of high natural and cultural value and provide multiple tangible and intangible benefits to people’s quality of life. They have also created rich, localized ecological knowledge that has proven useful for preserving biodiversity, adapting to environmental changes and increasing the social-ecological resilience of agricultural landscapes (Koohafkan and De La Cruz 2011). To illustrate the social-ecological interactions in changing agricultural systems, we draw attention to indigenous farming systems. Indigenous knowledge and farming systems are ‘generated through a systematic process of observing local conditions, experimenting with solutions and readapting previously identified solutions to modified environmental, socio-economic and technological situations’ (Brouwers 1993, as cited in Senanayake 2006, p. 87). Typically, indigenous farming systems follow principles of multiple use (e.g. polyculture), rotational uses over space and time, recycling of nutrients and water resources, low use of external energy, spatial fuzziness with intermingled land-use structures and processes and clear social-ecological gradients (Plieninger et al. 2006).

The importance of conserving traditional indigenous practices for adapting to changing land-use conditions has been emphasized for many agricultural landscapes, particularly in the Global South (McNeely and Schroth 2006; Nair et al. 2017). It is therefore an important task for academics, local people and other stakeholders to explore collaboratively the values of indigenous agricultural systems for sustainable development against the background of globalization and modernization, for instance within the FAO Initiative on Globally Important Agricultural Heritage Systems (GIAHS, http://www.fao.org/giahs).

Dryland terraced landscapes are a particular form of indigenous farming system. Drylands cover 41% of the Earth’s land surface (more than 6 billion hectares), of which only 14% are used for crop cultivation. They are home to 28% of the human population, around 2 billion people (FAO 2019). Many indigenous dryland farming systems that include extensive networks of terraces are found in marginal and barren places, such as the Loess Plateau, North China (Chen et al. 2001), the Colca Valley, Peru (Bocco and Napoletano 2017), and the whole territory of Yemen (Varisco 1991). A terrace system is a typically human-made craft and a highly adaptive strategy that enables local people to practice cultivation in hilly or sloped areas (Bocco and Napoletano 2017).
Functionally, the terraces hold water on the land (Unger et al. 1997; Lincoln et al. 2018), reduce soil erosion (Chen et al. 2001) and allow cultivation of highly productive crops like sweet potatoes in barren environments, thus making full use of the land (Kirch et al. 2009). The steepness of the terrain where most terrace systems are located implies that farming conditions are characterized by small farming plots and high labour intensity. Terraced systems were key to allow civilizations in sloped dryland areas to prosper.

Terrace systems have been shaped by local farmers’ adaptation of their farming practices to the surrounding environment (Varisco 1991; Kizos et al. 2010). The local ecological knowledge systems that developed around terrace farming have remained largely unexplored. The values and functions of a dryland terrace system are defined by the particularities of both the local culture and the ecological conditions. They are the result of the embeddedness of aesthetic values, livelihood strategies and survival wisdom. Dryland terrace systems thus represent niches of cultural diversity and biodiversity worldwide (Barthel et al. 2013).

Driven by the processes of globalization and modernization, many ancient dryland terrace systems are currently being lost (Varotto et al. 2019). Rural depopulation and the abandonment of agriculture lead to a loss of regional identity and the associated traditional knowledge of farmers. Dryland terrace systems are fragile ecosystems; once they are abandoned, revitalizing them is challenging (Ado et al. 2019). Thus, there is a need to document and analyse these systems, including their functioning, the local ecological knowledge that supports them and the current and future options for them, as perceived by local farmers.

Narrative or storytelling approaches offer ways to gather such knowledge of farming practices from local people at the community level (Fernandez-Llamazaes and Cabeza 2018). Narrative analysis is a method to examine the internal coherence of a text and interpret stories told within the context of research and/or shared in everyday life. Storytelling methods, where local farmers are asked to share their life stories and knowledge, make it possible to understand the connections between a society’s cultural values and local ecological conditions. They also serve to identify locally grounded solutions to conservation issues (Maynes et al. 2008). This allows researchers to discover the worldviews of local people from their common practices of integrated knowledge, eliciting stories, meanings and place interpretations (Moon et al. 2019). From the storytelling process, tellers make and create new connections for themselves in understanding the story, which means listeners play a role in helping tellers to recognize some values from the stories (Iseke 2013). We use the phrase ‘narrative analysis’ to refer to the approaches of narrative and storytelling. Narrative analyses have proved useful in a variety of natural resource management and conservation contexts, for instance for learning from innovative coastal community-based projects (Bontje and Slinger 2017) or revealing gender dimensions in rangeland decision-making (Wilmer and Fernández-Giménez 2015). Moreover, narratives can provide the foundation for subsequent quantitative studies.

Dryland terrace systems have rarely been studied so far, and there is a particular dearth of narrative analyses that engage with local farmers to study these systems from a social-ecological perspective. Addressing this lack of research becomes very important in the current context where the disappearance of dryland terrace systems is accelerating. The overarching goal of this study is therefore to elicit the key elements and driving forces of change for a dryland terrace system in the Northern region of China through narrative analysis. Our study has the following specific objectives, namely to:

1. identify the key elements of the dryland terrace system;
2. determine the relationships between these elements; and
3. reveal the major drivers of change that are responsible for the abandonment or preservation of traditional farming practices.

Based on our results, we discuss how understanding the functioning of and threats to dryland terrace systems from the farmers’ perspective – as well as their views and expectations of the future – can inform implementation of FAO’s GIAHS initiative. In particular, we derive policy lessons on how supporting traditional land-management practices can reverse land degradation and biodiversity loss by influencing relevant drivers of change.

Methods

Study area

Wangjinhuang is a rural community with 5 districts (called ‘streets’) in the core zone of a dryland terrace system, located in the mid-east of Shexian County in North China. Its official population in 2018 was 4,540 inhabitants and 1,425 households, but the actual number of permanent residents is below 3,000. The village is located in the Taishan Mountains, China’s geographic boundary between North Plain and Loess Plateau, a steep limestone mountain area with altitudes ranging from 203 to 1,563 m (Figure 1). The area has a semi-humid and semi-arid climate, with frequent droughts and floods. Annual rainfall is 540 mm, annual evaporation is 1,720 mm and the annual average temperature is 12.4°C. The typical biophysical conditions are summarized by locals as ‘high mountains, steep slopes, thick rocks and thin soil’ as well as ‘lack of water and soil’, which indicates
that the area features challenging conditions for agriculture compared to areas on the plain.

To adapt to the difficult environmental conditions, over the course of 700 years, local communities developed a stone-terraced dryland rain-fed mountain agricultural system (Figure 2). The terraced area covers ca. 240 ha (3542 mu in Chinese measurement units), including 46,000 plots of land ranging from 1 to 4,700 m². Typical crops are millet and corn, used as staple food mainly for subsistence, and Chinese red pepper as a cash crop. Domesticated donkeys and mules are also an important element in the traditional agricultural system, used as pack and draught animals. Their manure is used as fertilizer. The combination of these elements results in a characteristic terraced dryland farming system based on donkeys and crops (Yang et al. 2018).

Given its cultural and ecological value, the Shexian Dryland Terrace System became one of China’s Nationally Important Agricultural Heritage Systems (CN-NIAHS) in 2014, as designated by the Chinese Ministry of Agriculture and Rural Affairs. Since then, there have been several actions within the community to preserve the traditional system, carried out by some dwellers, the local government, NGOs and scholars from different academic institutes and universities. In fact, since 2015, the local government has endeavoured to achieve designation as a GIAHS, and in 2018,
a community-based Agricultural Heritage Conservation and Utilization Association was officially established by local residents. Local farmers are the main force for the preservation of the dryland terrace system and therefore, at present, the real concern is how local residents could benefit from the designation of the system as a GIAHS.

**Survey design**

To capture local farmers’ perspectives, we designed a 1-to-2-hour semi-structured interview protocol with a sequence of structured questions and open topics (Table 1). Interviewees were asked about their life history, the most important elements in the dryland terrace system, the changes they have witnessed in the past decades, their land holdings and farming practices and whether any abandonment has taken place, their local beliefs and sacred places and their perspectives on the future. When interviewees were having difficulties to understand the questions, we used prompts to clarify, like bringing up the conversion of fields based on the average work-time calculation in a certain square to estimate the total spatial holdings of one family.

**Data collection**

The target population for our survey was residents engaged in farming. To reach the interviewees, we first identified a key informant who knew the area well and was well integrated in the community and, after testing the semi-structured interview with him, we asked him to introduce us to more interviewees following a snowball sampling approach. The interviewing campaign took place in July 2019. Before starting each interview, we introduced our research aims to the interviewee and informed them that we would record the interview with a voice recorder. We obtained informed consent from all respondents. With the help of students and researchers from the Agricultural Heritage Research Centre of China Agricultural University, we interviewed 30 residents from Wangjinzhuang and one farmer from a neighbouring village (Guaili) who was familiar with the study area. Saturation was achieved and no new information appeared. Among the respondents, 64% were male and 36% female. Respondents were mostly between 30 and 78 years old; people under 30 rarely live in the village or work in the farming sector (Appendix 1). We aimed at reaching residents from all five ‘Streets’ (districts) that form the village. The interviews were carried out mostly in the interviewees’ homes, although some were carried out on the street. Due to the semi-structured nature of the interview, interviewees often answered more than one question at a time, and therefore the structure of the survey was kept flexible to adapt to respondent narratives.

To gain more insight into the community, the lead author attended two local workshops and took observation notes in addition to the interviews. One was an evening workshop in which villagers and the research group discussed how to foster the sustainable development of the village. The other workshop was organized by the community-based Agricultural Heritage Conservation and Utilization Association, the research group and Oxfam Hong Kong Foundation to discuss how to make a positive social impact in the conservation of agricultural systems and the plan to launch a whole-region census of ecological resources. The two workshops provided useful information related to farming practices, land abandonment and statistical information about the village.

**Narrative analysis**

We transcribed the 31 recordings from the interviews and divided each interview transcript into text units, giving them a thematic heading that summarized the main topic of each unit, which we called ‘thematic-plots’ (Greenhalgh et al. 2005; Clandinin 2007; De Fina and Georgakopoulou 2015; Bontje and Slinger 2017; Herman and Vervaec 2019). Plots were rearranged within each interview transcript responding to the related topics and following the general storyline structure of the narrative: (1) brief biography, (2) key elements, (3) farming practices, (4) perceived changes, (5) views on land abandonment and (6) perspectives on the future. Information about the character, beliefs and views of the interviewee was kept for later contextualization and

| Table 1. Topics covered in the survey. |
|---------------------------------------|
| **Open topics**                      | **Most important elements**                           |                                         |
|                                      | 1. Brief life history of each interviewee            |                                         |
|                                      | 2. Perception of the most important element(s) in the dryland terrace system |                                         |
|                                      | 3. Perception of changes in the past decades         |                                         |
| **Structured questions**             | **Landholdings**                                     |                                         |
|                                      | 1.1 Amount of land owned by the family               |                                         |
| **Farming practices**                | 1.2 Distribution and location of the land owned      |                                         |
|                                      | 2.1 Description of the farming calendar              |                                         |
|                                      | 2.2 Crops planted by the family                      |                                         |
|                                      | 2.2 Seed selection process                           |                                         |
|                                      | 2.3 Use of mineral fertilizers or pesticides         |                                         |
|                                      | 2.4 Tools used for farming and transportation        |                                         |
| **Land abandonment**                | 3.1 Amount of abandoned land owned by the family     |                                         |
| **Belief**                           | 3.2 Reasons for abandonment                          |                                         |
|                                      | 4.1 Local beliefs                                    |                                         |
| **Open topics**                      | 4.2 Sacred places                                    |                                         |
|                                      | 1.1 Perspectives on the future of important elements in the dryland terrace system |                                         |
|                                      | 1.2 Perspectives on GIAHS designation                |                                         |
We identified 16 key elements of the dryland terrace system related to farming tools (donkey, micro-tillers, motor vehicles), agricultural inputs (mineral fertilizers, herbicides, high-yield seeds, traditional seeds), crops and diets (Chinese red pepper, corn, millet, herbs, wheat flour and rice) and constructions (water cisterns, stone houses, brick houses, stone walls). These key elements showed close-knit relationships with the farming calendar (solar terms). Of the key elements, 8 were inherited elements and 8 were newly adopted by the current generation (Appendix 2). Through the descriptions provided by the farmers, we drew an elementary framework of the dryland terrace system by coupling these 16 key elements based on their supplementary and substitution relationships (Figure 3) and whether the element was on the rise in the system or being abandoned.

The farmers highlighted the terraced land as the foundation of the dryland terrace system. The terrain is steep and rocky, so farmers built stone walls, creating terraces that are filled with soil collected from ravines. Water is extremely scarce, and water cisterns are built in the public areas of the village and in the houses to collect the rainfall for drinking. Farmers mainly plant drought-enduring crops: millet and corn as staple foods and Chinese red pepper as a cash crop. They use their own traditional seeds. The Chinese red
pepper trees are always planted close to the stone walls to use the roots to strengthen the wall and to conserve soil and water. Donkeys and mules are used as draught animals to undertake the duty of transportation, ploughing and fertilization with their manure, as they are well adapted to the conditions of the terrain. They are sheltered in the farmers’ houses during the night, which are made of stone and have a specific room for the animals. Beside the tangible key elements, the intangible one, the farming calendar, guides farmers in arranging the farm work based on 24 solar terms per year. For example, the Qingming Festival on 4–6 April is the traditional time to plant seeds, and half a month later the next festival Guyu is coming. The timing of the remaining farming practices can be deduced in the same manner. This calendar serves not only for farming, but also for the farmers to perform ceremonies and the routines of community life.

Over approximately the last two decades, newly adopted elements have been introduced into the dryland terrace system that supplement and might completely substitute for some inherited elements. Nowadays, a micro-tiller and motor vehicle are used as a supplement for the donkey and mule for transport and ploughing. Mineral fertilizers are introduced to replace dung from the two animals. Farmers now buy and plant more high-yield seeds for cash crops, and herbicides have become popular. The local diet has also changed, with wheat flour and rice becoming the main staple foods, while previously these were seldom consumed and were not cultivated. Brick houses have largely replaced stone ones, as they have lower construction costs and offer a larger interior space. Farmers, especially the younger ones, have shown their preference for these newly adopted elements, as they are considered to reduce the costs and the time that must be committed to agriculture, thus improving quality of life. However, some inherited elements are increasing in popularity. This is the case of the cash crop Chinese red pepper, whose cultivation is less demanding than that of other traditional crops such as millet and corn, and which can be sold at comparatively high prices. Also, water cisterns are still being built using the traditional method and style. The community and individuals have been investing in more cisterns, both public and private, to increase the whole village’s capability to withstand flood and drought.

**Changes and drivers**

Our analysis revealed four main changes in the dryland terrace system that are influencing the development of the whole system from an ecological and social perspective: land abandonment, the introduction of external inputs and dual-track farming, the mechanization of farming and the simplification of the farming calendar. These four changes were recurrently highlighted by the interviewees and received a lot of attention in their narratives. They are vividly described in the interviewees’ narrations of their farming and living conditions, and with them the drivers that are perceived to be behind them are exposed (Figure 4, Appendix 3).

The first change is the gradually increasing abandonment of terraced land. According to the farmers’ narratives, this abandonment appears on two levels: one where no staple crops are cultivated anymore but cash crops like Chinese red pepper trees are maintained; and the other where the land is totally abandoned and no crops are cultivated. The most important driver is the insufficient earnings that farmers get from agriculture to pay their living costs and, as a consequence, their preference to find a non-agricultural job in the nearby towns and big cities (driver 1). The abandonment is more pronounced on the mountaintops and barren slopes, the difficult accessibility from the farmers’ home and the low input-output ratio is accordingly also mentioned (driver 2). Once there is abandoned land, the neighbouring lands also tend to be abandoned (driver 3) because the stone walls of the terraces that are needed to maintain the land and retain water are no longer well maintained, making farming in the nearby terraces nearly impossible.

The second change is the development of a dual-track farming system, in which farmers grow high-yield seeds with mineral fertilizers and herbicides to be sold at the market, but keep using traditional seeds and organic fertilizers for their own diet. The main driver for the introduction of high-yield seeds is that, costing no more than traditional seeds, they yield 3–5 times more (driver 4). Their growing cycle is also much shorter. High-yield seeds are easily accessible for farmers through the community collective, thanks to the support that the seed industry has received from the government in recent years (driver 5). Linked to this is the popularization and availability of herbicides and mineral fertilizers, associated with the new seeds. However, farmers seldom grow these seeds for their own consumption, as they consider them and the associated use of chemicals unhealthy. The interviewees also explained that the products of traditional seeds taste better than the new ones. Therefore, they normally sell the products of the high-yield seeds to the outside market and plant traditional seeds in a small plot for their daily diet.

The third change is the mechanization of farming tools. Farmers nowadays need to supplement their farming activity with temporary outside jobs. Keeping a donkey or mule, which has to be fed every day, is not possible for them, so they instead use motor vehicles and micro-tillers (a small machine for ploughing). These are also less costly than raising animals (driver 6, Figure 5). Another driver is connected to the modernization of housing. Modern brick houses are
replacing traditional stone ones, reducing the construction costs and adapting to the new preferences of farmers for bigger living spaces (driver 7). In the traditional stone houses, there was always a space for keeping animals, which does not fit in the concept of the modern brick houses.

The fourth change is the simplification of the local farming calendar. The traditional farming calendar
seven-month busy seasons per year, but currently the busy seasons have been reduced to 2–3 months in total. One reason is that, driven by the aridification of the climate, the ploughing and planting season is being moved from the beginning of April to the end of May or beginning of June (driver 8). The time for hoeing has been compressed, saving the time for two instances of hoeing. First-time hoeing now takes place at the same time as thinning. The second and third time normally happen once the grass has grown up during the main rainy season at the end of June to August. Farmers take one month to collect Chinese red pepper and another one for staple food products. The previously mentioned innovations introduced in the farming practices also play a role: the new seeds have a shorter growing period and the use of agricultural chemicals reduces the time farmers need to spend in the field (e.g. the use of herbicides reduces the need to hoe by hand). A third driver is again connected to the farmers’ need to find temporary outside jobs. After the Chinese New Year, around the end of February or beginning of March, the temporary jobs season starts in the cities. Farmers need to use this time to join job-hunting events and normally cannot go back home for farming during that period. Additionally, high-value cash crops like Chinese red pepper do not need continuous management, which allows farmers to spend less time farming and adapt their calendar to their parallel jobs (driver 9). As staple crops (i.e. millet and corn) have low economic input and need more time to manage, farmers who want to have a non-agricultural job usually just keep a small portion of staple crops for subsistence and maintain the cash crops (e.g. Chinese red pepper) to complement their incomes. By doing so, they could save costs from their daily diet and earn extra money by selling the Chinese red pepper, whose unit price is about 40 times more than millet or corn (driver 10).

Discussion

Changes are intrinsic to any farming system, and new elements are introduced all the time to adapt to local demands and promote productivity. However, rapid changes can alter the social-ecological balance of a farming system and put it in a situation of dynamic adaption, where supplementary and substitution relationships between newly adopted and inherited elements are formed (Andersson et al. 2007; Gómez-Baggethun et al. 2010). Assessing how these newly adopted elements influence the dynamics of the traditional dryland terrace system is important for understanding landscape sustainability (Wu 2013). Our study illustrates the changes in farming practices happening in the Shexian Dryland Terrace System and describes the adaptation process for the newly adopted elements. In light of our findings, we argue that these changes pose social and environmental challenges, but they also offer an opportunity to rethink the resilience of the system and the landscape (O’Brien et al. 2009).

Understanding of changes and drivers

Our survey revealed two opposing but co-occurring dynamics of abandonment and intensification of farming activity, resulting in 4 main changes: (1) abandonment of terraced farming land in the less accessible areas, but greater investing in terrace roads and motorized tools; (2) abandoning most family lands, but introducing external agricultural inputs in those lands remaining in cultivation; (3) decreasing the planting percentage of traditional seeds, but keeping the traditional products as their own food and selling the products of new seeds, thus establishing a dual-track farming system; and (4) saving time from farming and simplifying the farming calendar.
but paying extra money to buy mineral pesticides and fertilizers and/or hire workers in the harvest season to gather Chinese red pepper. The co-occurrence of abandonment and intensification processes is common to many agricultural landscapes worldwide (Pleninger et al. 2016; Van Vliet et al. 2016), leading to landscape homogenization and alterations in the balance of the social-ecological systems. Land abandonment in particular, has been studied for its consequences in the loss of cultural and biological diversity and other problems such as soil erosion (Rey Benayas et al. 2007; Otero et al. 2015). To counteract these challenges, it is important to understand the drivers of these changes.

In the landscape change literature 5 main groups of drivers have been identified: socioeconomic, political, technological, natural and cultural (Bürgi et al. 2005). In the case of the Shexian Dryland Terrace System, we found a combination of all of these drivers, interlinked and reinforcing each other. Socioeconomic drivers (e.g. farmers needing to complement their earnings with part-time jobs in nearby cities) and technological drivers (e.g. the accessibility of high-yield seeds and motorized tools that reduce the time farmers need to commit to agriculture) played a very important role in the introduction of newly adopted elements. This phenomenon is also happening in many other agricultural systems in China (Song et al. 2013). The introduction of these newly adopted elements may also be related to cultural driving forces (Millar and Connell 2010; Koohafkan and Altieri 2011). For example, changes in the behaviour and attitudes of the new generations of farmers are accelerating the substitution for inherited practices. Natural drivers such as climate change and topography are also key to understanding the changes in the farming calendar and the abandonment of less accessible terraces. When changes are put in the context of their driving forces, they can thus be regarded not only as challenges but also opportunities for the dryland terrace system. Embedding the drivers into a categorized perspective can help to explain the motivation of local farmers and how the drivers shaped current farming practices.

**Reshaping of indigenous farming practices by newly adopted elements**

The role of informal sources of innovation in the dissemination of agricultural technologies and practices has long been emphasized (Biggs and Clay 1981). Our study exemplifies how a combination of formal (e.g. through agricultural extension) and such informal processes led to the introduction of new elements into the Shexian Dryland Terrace System. These innovations may slow the speed of land abandonment and maintain agricultural work for the short term in this remote and mountainous place. However, the alterations they bring might destroy the dryland terrace system. We now discuss how the newly adopted elements are affecting the social-ecological balance of the Shexian Dryland Terrace System and highlight the need for a more organic integration into indigenous farming practices.

After analysing the farmers’ narratives, we identified the introduction of the micro-tiller its substitution for the donkey as one of the most disruptive changes for the functioning of the dryland terrace system. With this substitution, the basic ecological circle of crops–straw–donkey–organic fertilizer–crops that articulates this farming system has been altered. Although it has promoted farming efficiency and saved time, allowing farmers to do non-agricultural work in towns and cities, this has led to the partial abandonment of the terraces. The lack of animal manure has also increased the use of mineral fertilizers and herbicides, which harden the thin soil of terraces, thereby increasing both flood risk and soil erosion. The other main disruption in the functioning of the dryland terrace system has been the introduction of external agricultural inputs such as high-yield seeds and herbicides, which have allowed the simplification of the traditional farming calendar, in which traditional crops and seeds are planted in different seasons to decrease the risk of natural disasters and crop failure; with the simplification of the agricultural cycle, this purpose is lost and the resilience of the system reduced.

These newly adopted elements have shortened the farming time and allowed farmers to find non-agricultural jobs outside the community, which is especially appreciated by the younger generation, most of whom do not have the same passion for farming as the older generation. This accelerates their incorporation and, unlike their parents and grandparents, younger farmers have received a school education and look down on traditional farming knowledge. For these reasons, the new technologies have not been integrated organically in the system, but sharply replaced traditional knowledge. Once the traditional farming chain is broken, the destruction of local farming mechanisms accelerates, going beyond the control of farmers’ traditional coping strategies. Farmers need time to integrate new information and technologies into their knowledge system, as shown in the case of Miriwoong. Leonard et al. (2013) explored the integration of traditional ecological knowledge in Miriwoong through community-driven adaptation plans. The integration process is a knowledge battlefield between indigenous knowledge and universal knowledge (Busingye and Keim 2009). This means that new elements introduced in the dryland terrace system have to merge with the inherited ones, otherwise they cannot be included within the indigenous knowledge system. The involvement of new elements might be necessary to preserve the system when it might otherwise become obsolete in the face of the new social-economic and natural dynamics (Wu 2013). What is needed is to harness new-adopted elements with the inherited ones in an organic way that also allows the reshaping of indigenous farming knowledge.
Collective ways to approach land abandonment

Our narrative analysis revealed two contrasting motivations among the local labour force. First, the main motivation of the young-and-middle-age generation of farmers is to increase earnings by searching for part-time jobs outside agriculture. In consequence, their lands are abandoned or their farming practices are simplified and mechanized to afford a costlier standard of living. Second, the older farmers are mainly motivated to tend their land and maximize its profitability because they do not want or cannot find outside jobs. For this latter group, the land abandonment by their neighbours poses an extra challenge, as this has direct implications for the maintenance of their own plots and the system’s resilience against floods and droughts.

Land abandonment triggers a chain reaction in the degradation of the social-ecological system. It starts with encroachment of shrubs on the terraces and damage to the stone walls that support them. This increases the maintenance costs for the terraces and makes their preservation much more difficult. An additional complication is the scattered distribution of the pieces of land cultivated by the farmers. Some farmers thus dislike and are afraid of land abandonment by their neighbours, but can do nothing to stop them from abandoning their lands. The relationships between neighbours may thus also be deteriorating. This highlights the interdependencies and social-ecological complexity of the dryland terrace system. Land abandonment is not an isolated phenomenon but has direct and indirect implications for the community. To deal with these conflicting motivations on the abandonment and maintenance of land at a community level, involving the adversarial interests to increase the collective awareness could help transform conflicts into collaboration for the sustainability of the system (Fernandez-Gimenez et al. 2008). We therefore argue that the preservation of the dryland terrace system requires the collective action of the whole community. Fostering social trust, social norms, cultural perceptions and values and the character of social networks, together also termed social capital, will be of particular importance in this process (e.g. Kizos et al. 2018).

Accessibility from home to land is another significant factor that needs to be addressed at the community level. Lacking accessibility is a widespread phenomenon. For example, Uematsu et al. (2010) showed how difficult access to fields could make the land more frequently abandoned for Japanese paddy terraces. Our respondents also emphasized low accessibility from home to land as a determinant of abandonment. With the substitution of motorized vehicles for donkeys, those lands that are not connected with paved roads tend to be abandoned. To integrate the newly adopted motorized tools in a way that counteracts the trend of land abandonment, efforts would be needed to improve the conditions of the so-called ‘terrace-producing’ roads. Due to the scattered distribution of the terraced land among the 5 streets (districts), this effort should be made together at the community level, beyond the isolated efforts that have been carried out on the single-street (district) scale.

In all, coping with the abandonment of neighbouring plots and dealing with terrace roads both require collective actions at the community level. A case study in Japanese farmland illustrates how collective actions decreased land abandonment in rural communities and accumulated high levels of social capital (Takahashi et al. 2018). The custom of collective decision-making in the Wangjinzhuang community (as shown by the collective terrace construction of Yanaogou in the 1960s and the construction of collective terraced roads in the 2010s) could be directed towards taking collective action targeted to mitigating land abandonment. Another case on agricultural abandonment in the Black Forest shows how two similar and almost adjacent communities have fundamentally contrasting opinions about the same issue of landscape change (Bieling 2013). This calls for stronger consideration of local perceptions of change and specific community identities when developing collective action toward landscape conservation.

Potential of Globally Important Agricultural Heritage Systems designation

To protect the multiple values of the Shexian Dryland Terrace System as living agricultural heritage, the local government and some farmers are currently applying for a GIAHS designation, which can help to raise awareness of the general values of a system from outside and calls for the active participation and recognition of local farmers to ensure the sustainability of living agricultural heritage (Kooohafkan and Altieri 2016). Since initiating the designation process, the local government has cooperated with local farmers and NGOs to establish a set of collective actions, centred around the Shexian Agricultural Heritage Conservation and Utilization Association (a cooperation including the village communities, local government and Oxfam Hong Kong). The association provides the main platform of implementing actions such as a survey that allows local people to understand the current status of biodiversity, land-use and the potential for future development. This cooperation of local farmers, local officers and outside researchers could be seen as a model of indigenous governance, similar to the case of empowering indigenous people to reverse biocultural diversity loss in Australian humid tropical forests (Hill et al. 2011).

Our study suggests that the farmers in the Shexian Dryland Terrace System have not received sufficient recognition for their role as custodians of this high value system. Kooohafkan and Altieri (2011, p. 38) have suggested that ‘public recognition of their knowledge and
skills can also help in enhancing the rural poor’s identity, self-esteem and sense of belonging to the global community. If the candidacy of the Shexian Dryland Terrace System to become a GIAHS progresses, it could provide a chance for society at large to acknowledge the multiple values that local farmers sustain with their inherited practices (Fabinyi et al. 2014). This could help counteract farmers’ insufficient economic revenues by highlighting the multiple values they provide through labelling local products (Mann and Plieninger 2017), which could make it easier to get into the broader market and spread the cultural values to the consumers. Tourism, for example, could be attracted by the GIAHS designation and reward farmers for these values, as in the case of the tourism exploitation in the Hani’ Terrace System (Tian et al. 2015). The GIAHS recognition could also increase the locals’ motivation to preserve the landscape with their farming practices and integrate the new elements in a more organic way, blending them with indigenous knowledge.

From the gaps and benefits showed by our study, there are four suggestions we want to contribute to GIAHS policy making. First, GIAHS designations should keep a cautious but open attitude to accommodate the new elements as the agricultural heritage systems are in dynamic changes. Second, analysis of the key elements in the agricultural heritage system can be a useful tool for distinguishing a) which traditional elements are essential to the system and which ones are not and b) which new elements can be adapted in the system without harming the GIAHS values and which ones are harmful in the long-term. Third, to launch a GIAHS designation, it is necessary to focus on addressing those drivers of change that can be influenced locally (e.g. in our case, by providing incentives to keep draught animals that are part of agroecological practices by developing labels for traditional food products). Last but not least, the process of initiating or applying a GIAHS site can be as important as the GIAHS designation itself in terms of supporting collective actions toward terraced landscape conservation.

**Conclusion**

Driven by social-economic and technological changes, farming practices in the Shexian Dryland Terrace System are shifting towards a simplification of traditional practices and farming calendars. Newly adopted practices are abruptly substituting the inherited practices and thereby altering the social-ecological balance in the system. For the benefit of the sustainable development of dryland terrace systems, newly adopted elements need time to be more organically integrated into the indigenous knowledge system, supplementing and not simply substituting the inherited elements and knowledge that are fundamental for the resilience of the system against the employment-migration and natural disasters. This may be done by maintaining the valuable traditional farming practices and coupling them with the new elements to keep the agricultural heritage active. To realize the goal of sustainable development, local people should be fully aware that collective preservation is an effective way to restrain land abandonment, and recognize the values of current indigenous farming practices could help them maintain the dryland terrace system in the long term. The designation of the Shexian Dryland Terrace System as a GIAHS could help local farmers build the confidence to preserve the dryland terrace system. Likewise, the process of developing collective action in the application for designation of a GIAHS project by indigenous farmers, local government and outside researchers is already a means to empower the community to reverse the land abandonment and other degradation of the system.

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