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Study of Institutional and Governance Arrangements for Achieving Water Security in the Hani Rice Terraces

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Rice Terrace Farming Systems

This working paper series share findings produced as part of the research activities under the Rice Terrace Systems in Rural Asia, a research project of the United Nations University Institute for the Advanced Study of Sustainability (UNU-IAS). The project aims to address dual challenges of both excessive runoff and water scarcity due to climate change by providing ecosystem based adaptation measures to strengthen resilience of the Hani Rice Terraces and Ifugao Rice Terraces.

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ABSTRACT

This study aims to analyse the current state of management of the water resources in the Hani Rice Terrace system. Using the evidence indicating the presence of scarcity and periods of concentrated availability obtained from the hydrological response assessment of the selected study sites, a comprehensive threats analysis has been done, considering the overarching social, policy and institutional threats faced by the system. Analysis of the people's perceptions about water scarcity and the current systems of management on the field indicates that the water scarcity evidenced from a physical systems standpoint is being directly affected by the social and policy systems on the field and posing a threat to the long term sustainability of the area. Dealing with the physical systems threat of reconciling water availability with equitable access requires structural and non-structural mechanisms of management that can be used on the field, including institutions building at the micro level for the farmers and having the basin as a unit for macro level management. Water Scarcity Index has been found to be a powerful tool for aiding policy in such cases. Additionally, ensuring the overall sustainability of the system by assessing the development patterns and demographic changes has been suggested.

INTRODUCTION

Rice terrace systems worldwide are known for their rich ecological and traditional value. These systems play critical roles in shaping the landscape and in soil and water conservation. Water, specifically, is central to the existence of these terrace systems and has a complex and dynamic role to play in the local socio-ecological system. However most of these systems face certain common challenges, mainly due to climate change alongwith other technological and evolutionary changes and associated demographic changes brought about due to migration (UNESCO/CLT/WHC, 2013). Sustained and sustainable existence requires a thorough understanding and assessment of the entire system, the existing linkages and associated complexities, particularly in relation to the natural resources, water being one of them. The concept of water security is useful in relating the different components of the system being considered, as it describes the capacity of a population to safeguard sustainable access to adequate quantities of water by preserving ecosystems in a climate of peace and political stability (United Nations University Institute for Water Environment and Health, 2013).

The rice terrace system under consideration lies in the Yuanyang county of the Yunnan province in Southwestern China and has been in existence for about 1300 years (Jiao et al, 2012). The region containing the rice terraces is characterized by high rainfall and a subtropical monsoon climate. Six main ethnic groups currently live in Yuanyang, the Hani, Yi, Dai, Miao, Yao and Zhuang, with the Hani people, especially, having rich traditional ecological knowledge (TEK) and natural resource management principles. In the terrace sys-

tem, water flows according to a four step cascade system, through different landscape elements. The traditional water distribution and management system is highly evolved, an example of this is the traditional ditch and canal system, which is a network of flood ditches, their branches, drainage ditches and trunk canals utilised for effective distribution of water. However in recent years, the shortage of water is being felt on the ground at the local level. Disparities exist between water availability and access, both within and between the upstream and downstream reaches of the terrace system. This seems to be a reflection of the increasing frequency of droughts in the Yunnan province, the big drought of 2012 being a case in point (Fangyi et al 2013).

This paper analyzes the state of the water resource and subsequently the possible management strategies in the selected area of the terrace system. Using interviews and guided questionnaire surveys, perceptions regarding water scarcity are gathered from the ground and related to the results obtained from a comprehensive hydrological analysis done for the area, which indicate the presence of instances of scarcity, to understand the system and social threats. Subsequently the national policies on water and environment protection are looked at to understand the available policy provisions applicable for the identified threats and the appropriate management measures are looked into, defining the boundaries of administration and provisions for micro level interventions. The use of water scarcity index is highlighted, as a tool to aid decision making regarding periods in which action is required and show if interventions can really help solve a given problem in a simple manner.

RESEARCH SETTING AND METHODS

Yuan yang county is located between 22°49'N and 23°19'N and 102°27'E and 103°13'E, in the Yunnan province in south-western China (State Administration of Cultural Heritage of People's Republic of China 2013). The rice terrace system located in the Yuanyang County includes the cultural landscape of the Honghe Hani Rice terraces, which was inscribed as a UNESCO world heritage site in 2013. The county's total population in 2002 was 365,321, with the Hani comprising 53% of this total (Jiao et al. 2012). Forests are an important landscape element and they act as natural reservoirs and conserve water, the rainfall interception rate of the forests in the mountainside of the Hani terraces being more than 30% (Guan, 2011). The area is characterised by uneven distribution of rainfall, with concentrated rainfall over the months of May to October. Added to that, the high mountains and steep slopes in the area make it prone to water shortage during the dry season. A preliminary site visit to the area in 2014 showed that in addition to the issues mentioned above, the area also faced threats associated with access to water, and disparities existed within the different reaches and between the protected area and the other parts of the system located further downstream. The presence of mines below the rice terrace areas were noted, and it was

seen that they were impacting the water availability in the downstream areas due to groundwater withdrawals.

The development of tourism in the area has been carried out by the Chinese government along with the provincial and prefectural government; with a view that tourism development together with poverty reduction would be a good way forward for overall regional development (Gu et al 2012 pp55). The terraces have attracted both domestic and international media, and its inclusion in the UNESCO world heritage list has made the area undergo significant internal and external changes. Infact, literature evidences that the Hani rice terraces have become a popular tourist destination with Jiao et al. (2012) reporting that the average number of tourists visiting the Yuanyang County from 2006-2008 was 441,862 per year, according to the Yuanyang Tourism Office.

Considering all the above factors, the research was conducted by selecting three villages in the upstream reaches, lying within the protected heritage area and two villages in the downstream reaches, all of which were representative of the topographical and demographic characteristics of the surrounding area and were accessible due to the presence of transportaion infrastructure. The hydrological analysis was done by delineating watersheds based on the selection of villages (see Herath et al. 2015).

A review of the current literature on the TEK of the Hani people and understanding the traditional water system, along with a review of the national water law and environment protection law of the People’s Republic of China was carried out at the outset. Key Informant Interviews were conducted with the village leaders (5), aided by structured guided questionnaires to elicit responses on data regarding the population, the water storage structures of the village along with their capacities and other aspects related to water fee and water management, while more open ended interview questions focused on water shortage, perceptions of the future, current methods of water management including the authorities involved in the area and dealing with water scarcity in the future. Purposive sampling was utilised in this case. The questionnaire survey was also conducted for the farmers (9 upstream and 8 downstream) and restaurant owners(4 upstream) to get information on the cropping pattern and growing season, and data regarding the number of tourists, peak tourist season and perceptions on increase of tourism was collected specifically from the farmers with restaurants. Open ended questions on perceptions of water scarcity and management measures were also included in the questionnaire. Snowballing technique was utilised for sampling in this case.

Table 1: Name of selected villages with location coordinates

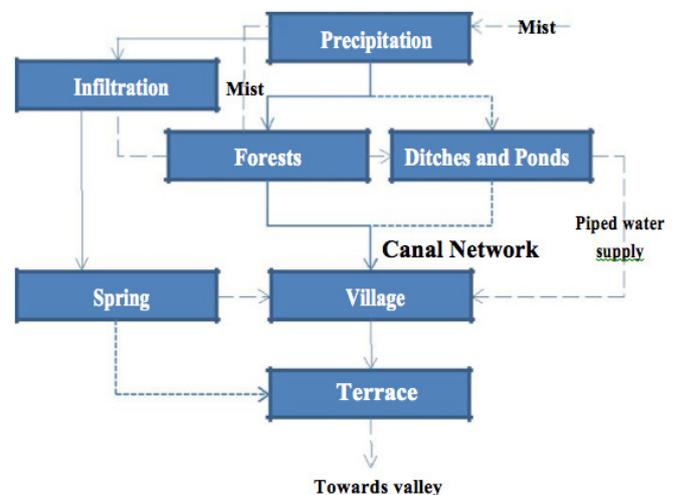
Name of Village	Location	Altitude
Quanfuzhuang	102.76 E, 23.11 N	1833
Dayutang	102.74 E, 23.10 N	1830
QingKou	102.74 E, 23.12 N	1671
Downstream reaches		
Anfenzhai (dazhai) or Anfenzhai big village	102.76 E, 23.17 N	1340
Feimo	102.77 E, 23.20 N	1263

RESULTS AND DISCUSSION

The water system

The important aspects of the water system are the surface runoff that is generated in the form of streams, originating from the forests on the mountain top, the water that infiltrates and comes out as springs in different locations and the mist. In the upstream reaches the surface runoff is channeled into the villages through an extensive network of channels and ditches or ponds. The water from these ponds augment the supply during the dry periods. According to Jiao et al (2012), farmers build artificial channels along contour lines in forested regions to catch surface flows. These flows are then stored in the ponds and channeled into the terraces, while some of it is also diverted to the villages for daily consumption. There are deeper and shallow springs that emerge in certain locations, water from which is diverted through pipes into storage tanks, and this water is primarily used to meet the major domestic and livestock water requirements of the villages.

Figure 1: The water system in the upstream reaches of the terrace system



In the downstream reaches. among the two villages sur-

veyed, Anfenzhai has three main water storage structures that collect spring water, the smallest one being 0.6 m³ in capacity. Feimo however gets water from a spring, located about 6Km away from the village, which is diverted into a big tank with a capacity of 170m³. The tank serves as the water source for the village. This access was given to it by the Government agencies as it was battling with scarcity but it came at a price of 51600 CNY. Additionally they pay fees for management of the system.

Hydrological analysis of the terrace system

The Similar Hydrologic Element Response (SHER) model (Herath et al.,1992), was used to assess the water availability in the upstream and downstream watersheds for 1998-2007 (Herath et al. 2015). Calculation of water demand was done considering four major demand sectors, domestic, agriculture, livestock and tourism (specific to upstream watershed). The water scarcity index (Rws) was used to estimate the trends in water scarcity and it was found that in the upstream watershed there were indications of low to moderate scarcity in February-April, with the index values ranging from 0.1-0.2 and the same can be seen in the downstream reaches. Similar analysis was done under future rainfall conditions, influenced by climate change (RCP 8.5) using downscaled rainfall data for 2030-2040 and using modified demand conditions, and it was seen that wet and dry periods are set to become more pronounced, even more so in the downstream watershed. Hence it can be said that in both the reaches, there is evidence that the water security could be affected during particular periods due to shortage in available water. An important point that emerged from the analysis is that the contribution of groundwater to the overall water availability is high in both the watersheds and the storage in the upstream ponds also helps in supplementing the water supply during dry periods.

Perceptions of water scarcity

The three upstream villages lie in the area designated as the world heritage site and the general surroundings are well maintained. Out of the people interviewed a majority of the respondents indicated that water shortage was not an issue, and might not affect them in the future as well, because of the availability of forests and spring water. However a few key respondents indicated that water shortage is a reality and attributed it to various causes. One of the farmers who owns a restaurant in the Quanfuzhuang village said that during March-April there is shortage of water felt on the ground" and another respondent also acknowledged the shortage of water and attributed it to the development of tourism in the area, as they utilize a lot of water and he felt that "planting trees and building tanks to store water" could be the possible steps taken to avoid shortage". In the downstream areas, water shortage was more evident, with a farmer from Anfenzhai big village saying that "Even though they have had a canal or pipe set up specifically for them,

for three years, the water from the pipe has simply not been enough", and significantly, the village leader of the Feimo village stated that there was severe water shortage in his village, which could be attributed to "no spring water, no wells, high mountains and mining in the downstream areas". The results obtained from the hydrological analysis are corroborated by these responses to show that the shortage of water is an issue. Also, reconciling water availability with access to that water stands out as an important issue that needs to be addressed.

Water management system

According to the respondents, the traditional water management systems, which involved ditch leaders for water allocation and the use of carved wood locks for distributing water, amongst different systems, were no longer in practice. Instead, most upstream respondents stressed that farmers themselves were in charge of the water resources in their area and allocation and dispute redressal was done through negotiations. A farmer from Qingkou mentioned that the allocation depends on "the size of the field. The bigger the land size, the priority is given for receiving water and also the quantity received, followed by the smaller lands. Stones are used to control the flow in this case". In contrast to this, the downstream areas depended mostly on the Government agencies and the water supply company for supply and management. Most villages pay for piped water supply, and as mentioned before, the villagers from Feimo had to pay to get water from a spring allocated to them after they approached the Government following a long battle with water scarcity. In the upstream reaches too, piped water supply was made available to meet additional demands, again supplied by the water supply company (called Zilaishui in the local language). A significant outcome of this was the loss of the traditional water distribution system, which was perhaps responsible for maintaining the delicate balance of the system. The approaches taken to ensure access to water are scattered and seemingly temporary, but it is interesting to see how the management approach has become more top-down and involving figures of authority in the areas downstream where the shortage of water is being felt more. At the same time, the more decentralised management being followed in the upstream areas does not seem to incorporate cooperation between other villages in the surrounding area.

Policy and Governance: implications and threats

A review of the national Water Law and newly introduced Environmental Protection Law provides insights into how water management is enshrined in the law.

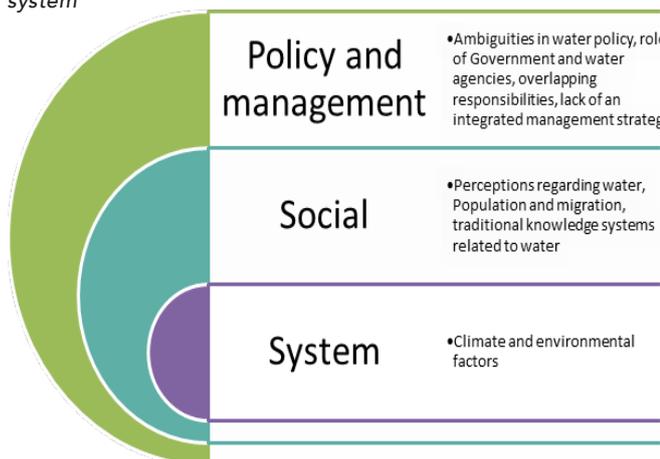
a. Rights to water use and abstraction: The ownership of water resources by the State provides them with the right to abstract and utilize water to ensure access in different areas. The risk here is one of overlapping rights in such a complex

interconnected system. Since the villages with evident water scarcity have become dependent on the State’s help, and the State is obtaining its resource from a sub system which is directly or indirectly a part of the overall water network, with a direct/indirect effect on the villages of the water source as well. Headwater rights was highlighted by a respondent who is a farmer, previously used to be the ditch leader in the Quanfuzhuang village. He mentioned that water is being abstracted from the upstream reaches for supply to a nearby town called Xinjie. It was mentioned that “two pipes were being used to draw water from the collection ponds upstream” and he thought that “it may affect the water available for terraces and the groundwater”. He speculated that this water might be utilized for supply to the town and to downstream villages. Thus there appears to be dichotomy. The same applies to groundwater and its abstraction as the rights to groundwater are not mentioned. This is significant as the issues of depletion through dredging or draining necessitated by mining exist in the downstream reaches affect the entire hydrological system. This also brings the importance of clarity regarding the licensing system for groundwater, wherein some villages are paying to obtain spring water while others don’t.

b. Management Structures and centralized control: The authorities involved in the management of water are many and exist on many levels Article 3 mentions the State Council as the owner of the resources on behalf of the State. Within the council itself, the administrative department for water resources has been mentioned for the licensing system, the water allocation quotas are being managed by the administrative departments for the different trades considered, while groundwater falls under the local people’s Governments. The site itself is managed by the State Administration of Cultural Heritage. Polycentric centres of decision making might be a tried and tested approach going forward, but relooking the boundaries of jurisdiction needs to be considered for effective decision making, apart from the challenges of overlapping responsibilities.

Apart from these threats, the general demographic dynamics in the area is being affected by external factors like tourism, migration, both long term and short term.

Figure 2: Levels of interconnected threats faced by the terrace system



RECOMMENDATIONS

It is clear that the terrace system has challenges that are unique, and sustenance of the system needs an integrated strategy. Looking at the macro perspective, management ideas can be sourced from policy instruments like the national laws. The national water law elucidates that a river basin needs to be considered as the basic unit for the formulation water allocation strategies. In this case, the presence of a basin level strategy would ideally allow officials from departments responsible for the administration of the area to make informed decisions along with the officials responsible for the maintenance of the systems that contribute to the cultural heritage of the site, like the water system. The establishment of a nodal authority would reduce the discrepancies in decision making brought about by overlapping responsibilities and rights in the area. It would allow for collective decision making on issues while allowing comprehensive problem solving and providing a direct common platform for doing so. Possible re-introduction of traditional systems is a measure which needs to be looked into. Addressing issues like groundwater rights and abstraction along with headwater rights can be made easier through this approach as the authorities would have a comprehensive understanding of the system as a whole, which could aid in making informed decisions.

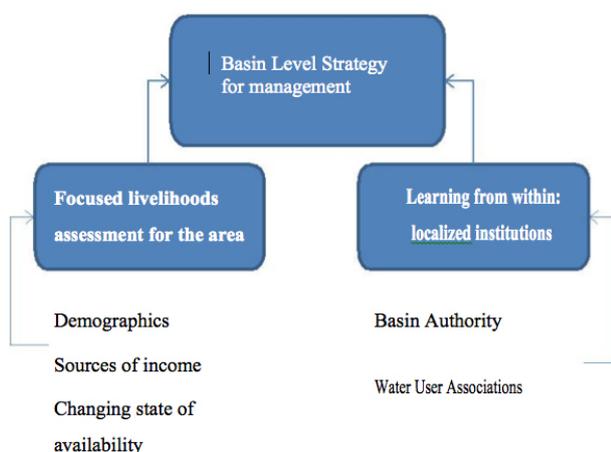
The more micro scale challenges can be resolved by utilising platforms for greater engagement among the farmers themselves. Some of the systems, which exist in other parts of the country that could be replicated here include setting up of Water User Associations or WUAs, like the ones existing in northern parts of China (Huang et al., 2010) or the establishment and utilisation of farmers cooperatives under the provisions of the Cooperative Law (Tang et al., 2015). These platforms could gather and disseminate information related to status of water use and availability along with monitoring and local management. This will be used to inform public opinion and influence decision-making across the different reaches of the terrace system.

Migration and population change also have direct and indirect consequences on the area. With maintenance and cultivation of rice becoming increasingly hard, the area also faces the threat of land use change, of the kind necessitated by labor requirements, growing markets, increasing tourism and the effort of maintaining the system. What is particularly interesting is the fact that the development pathways, which the different reaches may follow would be led by different factors. For example: upstream development might be fueled by increase of tourism and related development, while downstream the development might be more market-driven, with increased presence of companies aiding agricultural production through technological and financial interventions.

Hence livelihoods are an important pillar of the system too, that need to be addressed. A focused livelihoods assessment of the area, with improved estimation of migration statistics and assessment of the level of knowledge among

the younger generation needs to be done. This could feed into the basin development plan for the area, with estimates drawn for the future population, numbers required for maintaining the rice system, the feasibility of maintaining such a big system and any alternative adaptation measures that could be adopted. This information would serve as the backdrop for decision making and negotiations in the area. These factors, aided by structural measures to improve access and the use of decision making tools like the water scarcity index can contribute to ensuring the water security of the system and its overall sustainability.

Figure 3: Management strategy for the terrace system



CONCLUSION

This research aimed to analyse the current state of management of the water resources in the Hani Rice Terrace system. Social threats were recognised through field surveys in the area and perceptions of water scarcity were seen to emerge from the respondents, with stark differences in the upstream and downstream reaches, which corroborated the earlier identified hydrological threats. The other major threats that emerged from the field and from the review of the national laws were related to water rights and abstraction, especially groundwater and reconciling availability and access. Integrated management on the macro scale was examined, including the establishment of a basin level nodal authority, while suggestions for platforms for exchange of information between farmers has also been made. The value of traditional practices needs to be realised and methods for incorporation need to be looked into, in tune with the current needs of the area.

ACKNOWLEDGEMENTS

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