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Traditional Ecological Knowledge and Sustainable Food Sourcing: Dayutang Village, Hani Rice Terraces

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Abstract

Reflecting on the importance of dynamic agricultural management techniques in addressing climate change and food security, this paper examines the Hani rice terraces of southern Yunnan as a Globally Important Agricultural Heritage System (GIAHS). It identifies local inhabitants' traditional ecological knowledge (TEK) as a key source of their success, and uses research conducted in Dayutang Village, Yuanyang County from May 4- June 2, 2015 through participative observation and guided conversation to explore the role of Hani TEK in sustainable food sourcing around the village. The TEK used in food sourcing in Dayutang is shown not only to provide villagers with stable and diverse diets, but also to connect various ecological niches into a resilient whole. This paper then elaborates upon the impact of modern changes upon this food sourcing system, and identifies the emergence of a new 'hybrid' form of TEK. Discussing TEK as a complex, adaptive knowledge system, it recognizes some key methodological difficulties of approaching it through the reductionist research paradigm. Finally, it concludes by considering the implications of the complexity and epistemological foundation of TEK on future research methodologies, and suggests 'critical awareness' as an alternative to reductionist approaches.

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Acknowledgments

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All guided conversations and informal interviews were conducted in Mandarin Chinese, and have been translated here by the author. No names have been included in the paper, in an effort to protect participants' identities.

Introduction

Concerned with the environmental ravages caused by modern agriculture and increasing food scarcity around the world, the UN Food and Agriculture Organisation (FAO) recently began to identify indigenous agricultural sites around the world that have a global significance for their ability to balance agriculture and environmental protection. The Hani rice terraces in southern Yunnan are one such system, and also a UNESCO World Heritage System, renowned for over a thousand years for the unique water-filled terraces that cascade down its mountainsides. These terraces, beyond their agricultural productivity, have shown remarkable resilience to climate change. They therefore have important knowledge to offer, particularly in modern China, where food security remains a key priority.

An important factor in the success of these terraces is the complex knowledge system of traditional ecological knowledge of the local Hani and Yi inhabitants. Expressing itself in the many ways in which they interact with the land, this knowledge, accumulated by generations of local inhabitants living and working with the land, connects different parts of the socio-ecosystem into a densely interconnected and resilient whole.

This paper examines one such expression of TEK – sustainable food sourcing in and around the terraces. Using information gathered over the course of a month of field research (May 4- June 2, 2015) in Dayutang Village, Yuanyang, this paper demonstrates how the local Hani inhabitants' knowledge of food sourcing both provides villagers with stability and diversity in their diets, and also serves to balance and interconnect different ecological niches to maintain a healthy and balanced ecosystem. Furthermore, it explores some of the modern changes that are impacting food sourcing around the village, and how these changes are interacting with older

knowledge to create a new, 'blended' TEK. Finally, this paper shares some of the key difficulties in researching complex, dynamic knowledge systems like TEK, and offers suggestions into what this could mean for future research methodologies.

I: Globally Important Agricultural Heritage Systems (GIAHS)

At the core of the China's rapid economic growth during by the 'reform and opening up' period was a dramatic increase in agricultural productivity.[1] Decollectivization and the easing of price controls and marketplace restrictions led to increased yields and more efficient distribution networks,[2] spurring mass industrialization and a transformation of China's economy and society. Ironically, it was the success of the agricultural industry itself that led to the structural changes that prioritised growth of secondary and tertiary industries at the cost of the agricultural sector.[3] However, although the influence of agriculture is waning in the face of rising service and industrial sectors, in 2010 agriculture in China still held a 37% share in employment, and constituted 10% of GDP.[4] It therefore remains a significant player in the economy, particularly in providing a livelihood for people in rural areas.

However, agriculture in China today is facing serious challenges. The average age of farm labourers continues to rise, and mass migration from rural to urban areas in search of work in manufacturing and service industries has depleted many farms of young workers.[5] Furthermore, China's rapid industrialization has led to serious environmental degradation, despite firm policies in Beijing to mitigate the negative

[1] Huang, J., J. Y. Lin and S. Rozelle. 2000. "What Will Make Chinese Agriculture More Productive?" Working Paper 56: Center for Research on Economic Development and Policy Reform. Stanford University. 4.
[2] Ibid. 6.
[3] Huang, J., X. Wang and H. Qiu. 2012. "Small-Scale Farmers in China in the Face of Modernization and Globalization." *IIED/HIVOS*, London/The Hague. 6.
[4] Ibid. 6.
[5] Ibid. 35-43.

externalities of its growing economy. Pollution, desertification, flooding, drought, soil erosion and the exhaustion of arable land all threaten China's modern agriculture industry.[6]

China's challenge of feeding its population is further pressured by the growing urgency of food security in the international arena, where uncontrolled resource exploitation and a changing climate have led to an emerging and "dangerous geopolitics of food scarcity",[7] in which countries are struggling to secure their rights to remaining resources in the face of an uncertain future. Within these domestic and international contexts, maintaining agricultural productivity and food security continues to be a key priority for the Chinese government, monitored closely by domestic and international agencies alike.[8] Exploring and investing in dynamic and sustainable methods of agriculture has therefore become vital for China's stable and sustained economic growth.[9]

GIAHS, an initiative founded by the United Nations Food and Agriculture Organization (FAO), aims to do just that. Searching for unique agricultural management systems that exhibit holistic and adaptive management strategies, the FAO has identified 27 pilot sites around the world of "remarkable land use systems… evolving from the co-adaptation of a community with its environment, and its needs and aspirations for sustainable development".[10] These GIAHS sites are internationally recognized for their holistic management of environment, agriculture and society, creating intimately connected and balanced 'socio-ecosystems'. These pilot sites have

[6] Chang, P.T.C. 2011. "China's Environmental Crisis: Practical Insights from Chinese Religiosity." *Worldviews* 15 (2011) 247-267. 249.
[7] Brown, L.R. 2009. "Plan B 4.0: Mobilizing to Save Civilization." *Earth Policy Institute.* W. W. Norton & Company. New York/London. 9.
[8] Huang, J., J. Y. Lin and S. Rozelle. 18-22.
[9] Dela Cruz, M.J. and P. Koohafkan. 2009. "Globally Important Agricultural Heritage Systems: A Shared Vision of Agricultural, Ecological, and Traditional Societal Sustainability." *Resources Science* 31(6): 905-913. 907.
[10] Ibid. 907-908.

over long periods of time successfully adapted to internal and external changes, and remain functional, productive, and adaptive today.

The importance of these sites stems from their unique approach to agriculture, which views agricultural productivity and environmental protection as part of an integrated whole. Instead of viewing these two issues as mutually exclusive entities engaged in a zero-sum game where the advancement of one only comes at the expense of the other, these pilot sites use environmental protection to secure and increase agricultural yields. Their complex understanding of the symbiosis between their way of life and the health of their surroundings has created a resonance between agriculture and environment, turning a zero-sum game into a win-win situation. Future developments in agriculture must harness the power of this approach in order to be both viable and sustainable. The FAO therefore aims to apply the rich knowledge gained from GIAHS pilot sites to the improvement and reinforcement of agricultural development strategies around the world.[11]

II: The Hani Rice Terraces, Yuanyang

The Hani Rice Terraces in Yunnan, China, are one of the GIAHS pilot sites. Located in the Hani and Yi Autonomous Prefecture close to the Vietnamese border, these terraces cover some 2100 km^2 of land along the southern region of Honghe's Ailao mountain range.[12] The primarily Hani population view the forested mountains, villages, terraces, and river valley as inseparable parts of an integrated whole – "without the forests, there would be no water for the terraces."[13] Their villages are mainly nested between the upper slopes of the mountains, which remain heavily

[11] Dela Cruz, M.J. and P. Koohafkan. 910-913.
[12] People's Government of Honge Prefecture, Yunnan Province, P.R. China. 2010. Proposal for Candidate System: Globally Important Agricultural Heritage Systems (GIAHS) Programme. *FAO*.
[13] Patrol Officer, Guanyinshan Nature Reserve. May 11, 2015. Guided Conversation.

forested, and the lower slopes, which have been transformed into many thousands of water-filled terraces, in which diverse varieties of rice are grown. The climate remains temperate throughout most of the year, with the mountain air and wind moderating temperatures to an annual average of 14°C.[14] The rainy season falls between July and August each year.

The movement of water is the primary reason for the success of this region, connecting the vertical profile of mountain, village, terrace, and river. Water from the river valley and terraces evaporates and rises along the slope of the mountain in clouds, condensing in the forested mountains and falling as precipitation. This precipitation is then channelled through the forests, accumulating nutrients as it flows to fishponds, and to the villages to be used for drinking, washing, and other everyday purposes. All wastewater is then directed to the terraces, where it feeds the rice crops as it flows via gravity to the river valley below. It arrives clean, filtered by the terraces, and so the cycle continues. This cyclical movement of water over the mountain slope has enabled local farmers to produce rice and other crops, use the forest's resources, and live sustainably for over 1300 years. The system was even noted in writings from the Tang and Ming dynasties for its agricultural management techniques.[15]

This integrated system not only benefits the villagers with its agricultural productivity, but also protects and nurtures incredible biodiversity throughout the terraces.[16] Many varieties of bird, snake, salamander, lizard, insect, frog, and mole can be seen throughout the forests, villages, and terraces, and the plant biodiversity in both wild and cultivated areas is extraordinary. These diverse forms of life are

[14] Yuan, Z. et al. 2014. "Exploring the State of Retention of Traditional Ecological Knowledge (TEK) in a Hani Rice Terrace Village, Southwest China." *Sustainability* 2014(6): 4497-4513. 4501.
[15] People's Government of Honge Prefecture, Yunnan Province, P.R. China. 3.
[16] Yuan, Z. et al. 4497.

supported by the agricultural system in the terraces, and in turn from an intimate food web that further interconnects forest, village, and terrace, balancing out potential pest populations and providing vital sources of food for the villages.

This interconnectivity, beyond ensuring that the terraces remain productive, has proven to be a key component of the system's sustainability and resiliency to climatic changes. In 2010, the Hani rice terraces system withstood the most severe drought of the past 60 years with only a moderate decline in crops yields, while in surrounding regions, "agricultural productivity was devastated."[17] The reason for this impressive resiliency lies not in any isolated factor, but in the connected nature of the system as a whole, which provides it with enough flexibility to adapt to internal and external shocks. The Hani rice terraces therefore hold a strong relevance on a national and global scale, providing key information on adapting to the effects of climate change and maintaining agricultural productivity in a world of increasing food insecurity.

III: Traditional Ecological Knowledge (TEK)

The GIAHS initiative identifies TEK as a core element of the success of its pilot sites, "centred on… linking ecological and social processes that determines the resiliency of the ecosystem."[18] Instead of the reductive or 'scientific' approach of seeking to understand a system's behaviour through the functioning of its individual parts, TEK "seeks to comprehend such complexity by operating from a different epistemological basis"[19] – it operates holistically by observing the entire system. TEK

[17] Zhang, Y. et al. 2011. "Study on Hani Terraced Field Complex Ecosystem and its Mechanism in Climate Change Adaptation in China." *Minzu University of China*, Beijing.
[18] Dela Cruz, M.J. and P. Koohafkan. 909.
[19] Freeman, M. M. R. 1988. "The Nature and Utility of Traditional Ecological Knowledge." Environmental Committee, Municipality of Sanikiluaq, N.W.T.

is therefore not a simple sum of its individual parts, but instead the product of the interactions between all different components of the system. This produces a deeply interconnected understanding of the system as a whole, and through it the behaviour of its parts and how they influence one another. TEK is not, however, esoteric or theoretical in its basis. It is a heavily practical, experience-based knowledge that is strongly rooted in its physical location.[20] This cumulative knowledge, over hundreds or even thousands of years, has transformed communities and their surrounding environments into intensely interconnected socio-ecosystems.

Due to its complex and interconnected nature, TEK in these socio-ecosystems is not expressed as, and cannot be defined as, a clear-cut entity. Yuan et al. in a 2014 study of the retention of TEK by Hani communities in the rice terraces noted that, "in the ethnic community, [it] is expressed indirectly".[21] Although it cannot be specifically defined, TEK can therefore be studied through its various expressions or manifestations. Yuan et al. in their study 'measured' TEK by examining the retention of key forms of this knowledge as identified by local residents. These included festivals, spiritual practices/beliefs, folk songs, and water management. However, within the rice terraces Hani TEK has innumerable other expressions, from food sourcing and preparation to architecture and waste disposal. It is impossible to produce an exhaustive list of everything that it comprises, for it manifests itself in the many ways in which the Hani inhabitants are connected to the land.

The complex and difficult to define nature of TEK is at the core of its effectiveness in holistically managing the socio-ecosystem it has evolved in. However, the fundamental epistemological difference between its holistic, complex approach and the overwhelming academic preference for reductivist research, which

[20] Ibid.
[21] Yuan, Z. et al. 4500.

studies the behaviour of individual parts to better understand the whole, also makes TEK extremely vulnerable to misinterpretation and distortion, particularly by outside researchers. Indeed, in many cases "existing academic literature regarding TEK… [privileges] the components of indigenous knowledge that conform well to Western ideals over the spiritual basis of indigenous knowledge."[22]

This means that any ethical study of TEK must be approached critically by both author and reader, and must draw attention to and making explicit the main assumptions behind the research, which inevitably affect the definition, collection, and interpretation of data.[23/24] This implies a sound knowledge of the methodology used, and how it acknowledges and addresses these underlying assumptions. Section IV presents both the methodology and methodological issues that were raised during the research for this paper, whilst Section VII explores methodologies for approaching the interpretation of TEK as a form of adaptive knowledge. The reader is encouraged to explore each section critically and with care.

IV: Methodology

All in-depth research involves defining what comprises data, collecting said data, and ultimately interpreting its significance in both local and wider contexts.[25] This section discusses the first two stages: data selection, and research methods for collection. Later on, once further information has been presented in Sections V and VI, Section VII encourages the reader to critically interact with, and reflect upon, its

[22] Simpson, L. 2005. "Traditional Ecological Knowledge among Aboriginal Peoples in Canada." 1649-1651. *Encyclopedia of Religion and Nature*. London & New York; Continuum. 1650.
[23] Wilson, K. 1992. "Thinking about the Ethics of Fieldwork." In: *Fieldwork in Developing Countries.* Ch.12 (179-199). Ed. Deveraux, S. and J. Hoddinott. New York: Harvester Wheatsheath. 180.
[24] Ulrich, W. 2002. "Boundary Critique". *The Informed Student Guide to Management Science*. Ed. Daellenback, H.G. and R.L. Flood. London: Thomson Learning.
[25] Wilson, K. 181.

interpretation. In this way, this paper hopes to involve the reader in considering with the author each stage of the critical research process.

Choosing a Location

The research for this project took place over the course of a month (May 4 – June 2, 2015) in the village of Dayutang, Aichun Township, Yuanyang County. Dayutang village has a population of approximately 2000 living in some 250 households, most of whom work in the terraces and all of whom are Hani ethnic minority. The predominant language spoken is Hanihua, the Hani language, although children must learn and speak in Putonghua at school. The village is located deep in the Hani rice terraces, an hour's drive away from the large town of Xinjie, which is itself 6 hours south of Kunming by bus. This town was chosen upon recommendation from Professor Wang Jianhua of Yunnan Minzu University, as it remains a 'virgin' village relatively untouched by huge recent developments in tourism. Villages impacted by this tourism were deliberately avoided, as tourism in the Hani rice terraces is a vastly complex phenomenon and well beyond the scope of this paper.

Topic and Method Selection

In an infinitely complex world, one must inevitably simplify – draw boundaries for what to include in and exclude from research – in order to create functional models for analysis. These models are indispensable for our understanding of the world, and yet we must accept that they are "flawed in principle",[26] for they "have to "frame" the problem in a certain way, and this framing will inevitably introduce distortions."[27] Acknowledging the flawed nature of any research model

[26] Cilliers, P. 2001. "Boundaries, Heirarchies, and Networks in Complex Systems." *International Journal of Innovation Management* 5(2); 135-147. Imperial College Press. 3.
[27] Ibid. 3.

involves accepting its fundamental limitations, and justifying the boundary judgments that were used selecting the data and methods for the model.

As previously discussed, TEK exists as a set of interconnections and relations between indigenous people and their land, making it very difficult to define. In the Hani rice terraces its expression is multifaceted, and even years of concentrated study would not be able to produce an exhaustive profile of its many manifestations. This study, which took place over the course of a month, can therefore only provide a single perspective among diverse others on the role of Hani TEK in the terraces. Acknowledging this limitation, this paper simply aims to enrich and complicate our current understanding of this unique knowledge system, and does not intend to offer any authoritative or overarching statements about its nature or current state.

Boundary judgments for topic and method selection were made on practical grounds where possible, in order to minimise any potential influence of the author's biases. This project had several such limitations that contributed to and reinforced this selection process. For example, the research period was limited to a month, and the relative inaccessibility of Dayutang village provided distinct geographical restrictions. Furthermore, the villagers all spoke the Hani language, with less than a handful being able to speak a heavy dialect of Putonghua. As the author could not speak Hanihua and understood their dialect of Putonghua with difficulty, this language barrier proved formidable. Finally, the gender roles in the village meant that women were excluded from many spiritual practices.

The possibility of studying an abstract area of TEK such as spirituality was therefore immediately put aside. There would have been insufficient time for an in-depth study, the gender roles would have limited access to important areas of study, and the language barrier would have led not only to the increased probability of the

author asking guiding questions,[28] but also to significant likelihood of misinterpretation. It was therefore decided that a direct and experience-based methodology of study would minimise potential misinterpretation and distortion. In order to employ such methodology, the aspect of TEK studied would have to be practical and everyday element of villagers' lives.

Sustainable food sourcing fit these limitations well. As a highly practical part of villagers' lives, it was woven into their daily routines, meaning that it could be studied on a daily basis. Furthermore, it could be experienced directly through participative observation, minimising language and other potential distortions. Finally, it was a rich expression of Hani TEK and its holistic approach to resource management, and demonstrated well how this knowledge served to connect different parts of the socio-ecosystem into an integrated whole.

Research Methods

For the aforementioned reasons, research methods were mainly based upon direct, experience-based learning. The author lived in Duoyishu Patrol Station of Guanyinshan Nature Reserve, near the edge of Dayutang Village. Each day was spent in participative observation of villagers' everyday lives, and included foraging for food, cooking, cleaning, gardening, and going into larger towns on market day. The patrol officers with the nature reserve also served as vital sources of information regarding the surrounding environment, and opened up different sites and aspects of the nature reserve, and its relationship to the village, for study. A field journal was kept and taken everywhere, and each activity recorded in detail.

[28] A guiding question is one in which the author knowingly or unknowingly frames the question in a way biased by his/her previous knowledge and opinions, thus encouraging the subject to respond in a particular way.

A rich source of information came from ‘water-chasing’, where the author spent many hours following water-channels into less accessible and remote areas around the village. These water-channels act as ‘arteries’, transporting not only water but also people from one area to another, and dozens run through the mountain, village, and terraces. Any walk along them yielded rich encounters with local farmers tending to terraces, and with villagers foraging or gardening. Water-chasing was therefore crucial in gaining a deeper, ‘off the beaten track’ understanding of the many ways in which Dayutang residents used their surroundings to find and cultivate different types of food.

Many efforts were taken to minimize the risk of miscommunication caused by the language barrier between the author and village residents. As the research was primarily experience-based, it was possible to directly take photographs of practices or items the author wanted to know more about. These photographs, and other questions arising from the day, would be presented at dinner at the patrol station, where they would be discussed using a mix of Hanihua among the villagers, and Putonghua with the author. Dinners were lively affairs, with usually between five and twenty workers and their family members present, meaning that it was possible to both receive diverse opinions and fact-check simultaneously. This created a ‘living’ database of information that was continuously accrued, built upon, and double-checked throughout the research process.

V: Sustainable Food Sourcing in Dayutang

Dayutang’s villagers are mostly self-sufficient, relying on the careful management of the resources around the village for their diet. Food sourcing is therefore a central aspect of villagers’ lives, and a dynamic expression of their long-

standing knowledge of their surrounding environment. It connects villagers to their land. Indeed, it is rare to see a villager returning from anywhere without bundles of edible plants they have gathered along the way, wrapped in large leaves or vines.

The TEK expressed through food sourcing in Dayutang has two key roles: it provides villagers with food, and helps to nurture and protect important ecological niches, which all play a crucial role in the vitality of the ecosystem as a whole. Through sourcing food and maintaining these sources, villagers therefore connect these different niches to maintain a balanced and biodiverse ecology throughout the mountainside on which they live. This section discusses each of these niches, what they contribute to the villagers' diets, and how they relate to the health of the overall ecosystem.

The Terraces

The terraces around Dayutang extend from the bottom of the village deep into the valley below, and are the primary source of livelihood and food for villagers. Each terrace has a thick mud wall that is reinforced 2-3 times each year, and these walls contain the mud and water in which rice grows. The walls each have one groove in their side at a certain height, and water exceeding this height flows through the groove and into the terrace below. Narrow concrete water-channels also run through the terrace system as a series of 'arteries', distributing water horizontally and vertically. In the rainy season, when torrents of water threaten to wash the terraces away, these concrete channels divert and direct this excess water to the river valley below.

These terraces are home to many different types of rice, although in the Dayutang area *hongmi*, or red rice, is favoured. Rice is planted in January each year, in small upper terraces close to the village. In May, when the seedlings have reached knee height, they are transplanted to the lower terraces, where they have more space

to grow. The rice is typically harvested in October, threshed, and stored. The terraces around Dayutang are all family-owned, and the rice grown goes directly to villagers, and not to corporate holdings. This means that for most families, the rice that they grow is their main source of food.

The uniform green of the rice in the terraces hides a diverse ecology - water-snails, clams, frogs, tadpoles, small fish, dragonfly larvae, and other insects can all be found living in the water beneath. These are also a source of food for the villagers – all are edible, although water-snails and clams in particular are a delicacy, and are collected by the farmers as they work in the fields. Furthermore, they serve to balance the effects of the rice monoculture,[29] creating food webs that control potentially harmful insect populations and maintain oxygen and nutrient levels in terrace water.

The Forests

The forests are one of the most important components of the rice terrace system. They are absolutely vital in collecting water from clouds, fog and mist, and channeling it down to feed the terraces. In fact, the importance of healthy forests has been long recognized by the Hani people, and every village, Dayutang included, has an ancient sacred forest that must not be harmed in any way, which is used for Hani rituals and festivals. However, even beyond this sacred forest, all of the forests around Dayutang are also protected by national law, as part of Guanyinshan Nature Reserve.[30] Much of these forests are reclaimed farmland that has been replanted with trees to ensure a steady supply of water for the terraces. The importance of the forests

[29] Monoculture is the mass cultivation of a single type of crop. The lack of biodiversity may increase the risk of pests and the degradation of soil, unless carefully managed.
[30] Much of the forested area of Guanyinshan Reserve as protected by the central government in 2002. Further swathes of land around Dayutang were added to this protected area in 2010. Farmers were compensated for the loss of their land with payments of rice.

is such that one patrol officer from the nature reserve estimated that every tree planted gave back 200-300 yuan worth of economic benefit to the area.[31]

Fortunately, the flexible nature of the protections surrounding the forests mean that Dayutang villagers may still use them as vital foraging grounds. Villagers are allowed to enter the forest freely, providing they do not cut down trees, and may even collect fallen firewood.[32] It is common to find villagers foraging here for wild berries, mushrooms, chutes, roots, *yucan* (the cores of thistles), palm-tree hearts, seeds, and many types of fruit. Potatoes grow along the sides of the small paths that wind through the forests, and edible ferns carpet the forest floor. A common pastime for village children and youths is to spend the day wandering through the forest, collecting edible seeds and large dragonflies, which are speared on the ends of bamboo sticks, and can be fried with mint and *hanidousi*, balls of pungent bean paste that the Hani use to flavour their food.

The forests provide a safe haven for a range of organisms including local birds, which then feed on the insects in and around the terraces. They therefore contribute to the complex web of life around Dayutang that controls outbreaks of pests. Furthermore, rich nutrients from decomposing matter in the forests enrich the water that flows into the terraces, providing a natural fertilizer. The forests also provide a plentitude of clear, running water to Dayutang, which is safe to drink and use for everyday purposes. Water is thereby supplied to the village free of charge.

'Big Fish Pond'

Dayutang village is surrounded by groups of fishponds, which extend up into the forests and down into the terraces below. These fishponds are constructed

[31] Informal interview with Guanyinshan Nature Reserve patrol officer. May 18, 2015. Duoyishu Patrol Station.
[32] Although some households have electric plates, blackouts are common, and therefore wood-fired woks are the main method of cooking in Dayutang.

similarly to terraces, with mud walls and grooves to control water level. They can be as small as a typical rice terrace,[33] or large enough to easily accommodate the bathing of thirty local boys and a herd of water buffalo. These fishponds act as small reservoirs of water for the terraces, abundant sources of food, and an important nursery and breeding ground for the local ecosystem.

The name 'Dayutang' literally means 'big fishpond', and this reflects the centrality of these fishponds in villagers' everyday lives. Besides the different types of fish that are cultivated, the ponds also provide various other types of food throughout the year. Villagers often come to these fishponds to forage for water-snails and clams, and drag large bamboo baskets through the water to catch frogs, tadpoles, water-beetles, dragonfly larvae, and small fish, which are cooked in a traditional Hani dish. Frogs and fish can also be caught by a group of people wielding a net, a technique that the young boys of the village favour. Lotuses and other water-based plants are grown in and around the fishponds and can be boiled and eaten.

The vegetation growing around the sides of these fishponds becomes a nursery for small aquatic life, and nurtures a rich insect population make up the base of the food web, feeding larger organisms that then control other insect numbers. Dragonflies and their larvae are ubiquitous, and true to their name (*odonata*, or 'toothed ones' in Latin), are voracious predators of smaller insects and potential pests like mosquitoes. These fishponds therefore feed and nurture vital chains of predators that control pests all around Dayutang, from the fishponds themselves to the village, terraces, and forests.

Polyculture in the Village Environs

[33] Indeed, to enrich the upper terraces in which rice seedlings are grown before transplantation, the upper terraces are converted into fishponds in May, when the transplantation of rice seedlings is complete.

Polyculture, as opposed to monoculture, is the simultaneous cultivation of many different types of crops, instead of just one. This can be seen widely in and around Dayutang, with terraces growing various plants appearing in the forests in patches, occupying narrow ditches between houses, perched upon roofs of buildings, and even nestled among the lower rice terraces. Fed by water from the forests and fishponds, this polyculture is a vital source of diversity for villagers' diets. As one local woman stated, "if you can grow it here, then it is grown here. It is not bought from the outside."[34]

The crops depend seasonally, but a common setup is to have corn and beans growing together on the terrace, with vines, small ferns, or mint growing around the edges. However, plenty of different plants are grown – leafy greens, spring onions, garlic, various plants for preservation and pickling, red and green peppers, radish, runner beans, squash, pumpkins. Every villager, regardless of their occupation, grows their own food on these small terraces, from patrol officers to the local seamstress. This polyculture, besides being an important source of food, also helps to manage pest populations – the diverse plant life cultivates similarly diverse insect and predator life, which then regulate each other as part of Dayutang's rich food web.

Livestock

Livestock in the village are an important source of protein in villagers' diets, and also serve to connect the village to other areas of the environment, such as the forests and fishponds. In attempting to travel anywhere by car, the predominant traffic around Dayutang includes horses, water buffalo, geese, chickens and their chicks, cows, dogs, cattle and ducks. Pigs, the most common livestock, are fortunately kept in pens outside each house.

[34] Interview with 'Ayi'. May 13, 2015. Dayutang Village.

Each family rears at least one pig, which serves as a living waste disposal system. Any organic waste or food waste is fed to the pigs, alongside various plants and palm-leaves that can be found on the roadside and in the forests. Families consequently do not pay out of pocket to feed the pigs, and they are therefore cheap and important sources of food. When a pig is slaughtered, the lard is boiled and poured into iron pots where it solidifies, to be used as cooking oil. Dung from the pigs can also be collected and used as fertilizer for the crops grown around the village.

Water buffalo are vital for the cultivation of rice, as they provide the brute force needed to draw ploughs through thick mud. When not working in the terraces, they wander through the village and forests looking for fresh grass to eat, and can be found wallowing in the mud in the shallows of fishponds on hot days. They are easy to locate by the hollow ringing produced by bells that they wear around their necks, and are herded home in the evenings by their owners. Their dung is spread out and dried, packed into baskets, and used as fertilizer for the terraces. They are also eaten, often boiled with a fruit similar to banana, which can be found around the village.

Dayutang residents also raise ducks, which are herded out to the terraces each day to feed. By doing so, they perform the important ecological service of balancing insect and other wildlife populations in the terraces. They are herded home at dusk, so that their eggs can be collected and eaten. Chickens are also omnipresent in Dayutang and forage on their own either in the wild, or digging through rubbish on the sides of the street. They also return to their owners' house to nest at night, meaning their eggs are available for the villagers.

There are no pet dogs in Dayutang. Dogs primarily exist in two kinds – aggressive guard dogs protecting property, and dogs that are terrified of people, scavenging on food scraps, dirty diapers, or whatever else they can find on the side of

the road. Ultimately, all dogs can be eaten, and this is done on special occasions, or simply if there are a lot of people to feed. In this way, the villagers supplement their diets with a variety of livestock at remarkably little cost to themselves, allowing these animals to scavenge on their own, consume the village's waste, or control pest populations in the terraces.

VI: Modern Changes

China has transformed rapidly over the past decades, and these huge economic and social changes have not left Dayutang untouched. The modern economy has brought with it a huge increase in choice of food for the villagers, and formal schooling and the call of the city are leading to a new mobility and movement. All of these changes have had a significant impact on traditional methods of food sourcing, thus changing villagers' interactions with, and understandings of, the environment. The increasing opportunity to source food from outside markets is reducing the reliance of villagers on traditional foraging and gardening. Similarly, changes in mobility are affecting villagers' place-based knowledge of the land. These changes not only affect villagers' diets, but the role they play in nurturing and maintaining the various ecological niches discussed in the previous section.

Changing Choices

Although Dayutang residents today remain largely self-sufficient, they have several alternative sources of food that they can call upon for diversity in their diets. Shengcun is a relatively large town half an hour away by van, and has a market every fifth day, with fresh produce from all around. Xinjie is by far the largest town in the area, and is an hour away by van. It even has supermarkets, where Dayutang residents

can buy drinks, various snacks and other processed foods, as well as everyday household items. Both towns sell lychee, mango, and other fruits that are not grown in the area.

There are also food trucks that drive through the village irregularly, with loudspeakers advertising their wares. They sell tomatoes, cauliflower, bananas, watermelon, and other fresh produce, although some may also sell *baozi* (steamed buns with filling) and other prepared foods. Dayutang also has two small 'general stores', which are located on the bottom floors of houses, and consist of simply a fridge/ freezer and a cabinet or some shelves. They provide villagers with snack food, ice cream, frozen pineapple, and cigarettes.

Although surrounded by these increased choices, Dayutang residents rarely choose to take advantage of these new resources. They do not often buy snacks or processed foods, and their main purchase from these outside sources is fresh fruit, which is shared with guests and friends, and much enjoyed. Mushrooms, ferns, and other produce are also bought on market days, but for most meals, Dayutang residents still cook with lard from their iron pots, and use locally sourced plants and meat to fill their plates and bowls. This is not some grand statement against modernity – it is simply practicality. With irregular public transport[35] and the road in various states of disrepair/blockage, traveling into Shengcun and Xinjie from Dayutang is not convenient, and the food trucks come around infrequently. It is much easier to simply take advantage of the rich sources of food that surround the entire village. As aforementioned, collecting this food is often a convenient aside to everyday business.

However, the small amounts of processed foods that are bought, either from general stores or from the larger towns, are already having a significant impact on the

[35] Transport from Dayutang to other towns consists of a series of grey vans that pass by irregularly. These can be hailed from the side of the road. It costs 5 yuan to get to Shengcun from Dayutang, and 15 yuan to get to Xinjie.

environment around Dayutang. The village does not have an organized waste disposal system, and every household deals with its own waste. Everyday rubbish is either burned outside the houses, or thrown into the concrete water-channels, which conduct it through to the terraces. Larger rubbish is taken and dumped "where there are no people",[36] in relatively remote locations.

This system functioned will when village waste was all organic, as rubbish either burnt completely, or decomposed when disposed of in these ways. However, plastic bags, bottles, and packaging, primarily from processed foods, are currently building up in water channels, ditches, and on the sides of roads. They do not burn well, and will not naturally degrade. When asked if this buildup of plastic is a problem, one local woman replied, "of course it is a problem. Obviously it is a problem."[37] However, with no alternative rubbish collection or disposal system, the villagers have nowhere else for their rubbish to go, and so the dumping all through the village and its surroundings continues. This accumulating plastic threatens to disrupt the water-channeling system that is at the core of the success of the rice terraces system in connecting forest, village, and terrace.

There are also some residents of Dayutang who are taking full advantage of outside sources of food, to the extent that they rely exclusively on food bought in markets and towns, and do not collect or cultivate their own. There are very few of these households in Dayutang, and they consist of wealthy families that earned significant money in the cities before returning to settle down in their hometown. "They do not grow their own vegetables, they do not have gardens, and they buy everything from other towns," one local woman returning from her terraces stated

[36] Interview with 'Ayi'. May 19, 2015. Dayutang Village.
[37] Conversation with five local women. May 14, 2015. Dayutang village centre.

with disapproval.[38] These households are losing their knowledge of, and are not participating in, the maintenance of various aspects of the environment around them, as they no longer need to connect to it on an everyday basis as their primary source of food.

Mobility and Movement

A noticeable change wrought by recent years is in a rapid increase in the mobility of villagers, particularly in their ability to leave the village to find work elsewhere. In Dayutang, this begins at an early age. The nearest middle school is half an hour away in Shengcun, and the nearest high school even further away in Xinjie town. This means that from middle school onwards, all children live in town at their schools, avoiding costly and time-consuming transport and coming home only in the weekends. In order to go through the formal education system, children are therefore separated from the village and way of life that are so vital to understanding their environment and how to source food within it. They also become accustomed to different flavours and tastes – "we don't like some of the Hani traditional dishes anymore. They just taste bad", one recently graduated young woman stated, "so we don't cook them."[39]

This separation of villagers from their hometown continues after high school ends. Although few young people from Dayutang go to university, those that do mainly go to larger cities like Lijiang, Kunming, and Dali.[40] Those who do not go to university all go to larger towns or cities in search of work in various capacities - construction, service, or "anything they can find".[41] However, young people are not the only ones taking advantage of the cities. Local farmers, who mainly keep their

[38] Conversation with a local woman. May 22, 2015. Dayutang Village.
[39] Conversation with young local woman. May 14, 2015. Duoyishu Patrol Station.
[40] Conversation with young local woman. May 16, 2015. Fishponds above Dayutang.
[41] Guided conversation with patrol officer. May 23, 2015. Dayutang village.

rice and do not sell it, also need a source of income for their families. During seasons when the terraces do not need work, these farmers, both male and female, also leave for the cities to find work. “It leaves the village mostly with old people and children”, one construction worker stated.[42]

Few people in Dayutang seemed worried about this phenomenon. Farmers must return every month or two for the planting, transplanting, weeding, and harvesting seasons, and so spend a significant amount of time in the village working with the land. Youths eventually return home to help on the family’s terraces, when their parents grow too old for the hard labour. There is a tangible sense of pride of the terraces and surrounding environment among all villagers, and often one of the first questions they ask me is, “how do you like the air here?” or “isn’t the landscape here beautiful?” Although there are some who come back to the village live in ‘fancy’ houses, most returnees come back to accept the responsibility of caring for the terraces that have been in their family for generations.[43] And, as one patrol officer said, “they all come back.”[44]

VII: TEK as Adaptive Knowledge

As shown, the modern changes of increased choice and mobility in Dayutang are having tangible effects on Hani traditional methods of food sourcing, an important expression of the villagers’ TEK. However, this changing face of TEK does not indicate a ‘loss’, as much as it demonstrates the adaptive nature of this knowledge system. Many researchers have recently acknowledged that as modern changes

[42] Guided conversation with four construction workers. May 12, 2015. Road into Niuluopu village.
[43] All terraces are owned by families, with lineages of up to 33 generations. Although ownership was disrupted during the upheavals from the 1950-1980s, land has since been returned to families. Today, the only reason a family parts from its terraces is if they are forced to sell them out of absolute poverty, but this is an extremely rare occurrence.
[44] Guided conversation with patrol officer. May 11, 2015. Guanyinshan mountain.

influence the societies that hold TEK, this knowledge will be transformed into a 'blended' or 'hybrid' version of its previous self.[45] Indeed, its dynamic ability to change is such that "any approach attempting to preserve TEK in fossilized forms is bound to fail."[46] Change is part of its nature.

It is important to understand that recognising TEK's adaptive and 'hybridising' nature is not forcing a concrete definition upon it – if anything, it makes it even more difficult to define, as the huge variety of expressions of traditional knowledge each interact with and transform upon contact with modern changes. This complexity is further compounded by the fact that each expression of TEK is not isolated, but interacts with other expressions to create a densely interconnected and constantly changing whole.

In this paper, it is indicated that TEK in Dayutang is changing through the recent developments in food sourcing. The modern changes of increased choice of food sources are complicating what it means to 'source food', and how to do so sustainably. Increased mobility is decreasing the time that many people spend with the environment around the village. However, modern changes are similarly complicating other manifestations of TEK in the village, from agriculture to water management and spirituality.[47] Indeed, the future probability of a 'blended' TEK in the Hani rice terraces has been recognized by other studies.[48]

Implications for Future Research

Due to reasons discussed in sections IV and V, this paper has restricted its study to only a single expression of TEK in Dayutang. It has examined traditional

[45] Gomez-Baggethun, E., E. Corbera and V. Reyes-Garcia. 4.
[46] Ibid. 5.
[47] For detailed descriptions of these changes, please contact the author for a copy of the organized field notes from the field research period.
[48] Yuan, Z. et al. 4498.

methods of sustainable food sourcing, and how these methods, and the knowledge behind them, are transforming today. However, as the boundaries of TEK continue to become increasingly complex in the face of modern changes, it seems important to conclude this paper with a wider examination of what the future holds, as the traditional knowledge systems in Dayutang continue to transform and adapt. Is it possible, then, to use the information gained from examining sustainable food sourcing to identify the broader implications of modern changes on TEK in Dayutang?

Unfortunately, the answer is no. The assumption that by understanding the behaviour of a part we can better understand the behaviour of the whole falls squarely in line with the reductionist approach familiar to the scientific tradition. TEK, which, as aforementioned, operates on a completely different epistemological basis:

> "The scientist is concerned with causality... If causes of observed effects can be measured and understood, then predictive statements about future outcomes can be made... But the non-western forager lives in a world not of linear causal events but of constantly reforming multidimensional interacting cycles, where nothing is simply a cause or an effect, but all factors are influences impacting other elements of the system-as-a-whole."[49]

Attempting to 'force' this linear method of causal analysis upon a complex topic such as TEK, which has its foundations in another way of thinking altogether, therefore leads to the danger of simplifying, misinterpreting, and distorting information. As previously discussed in section IV, TEK is particularly vulnerable to this type of academic 'imperialism', and irresponsible analytical methodology has led to some communities to become wary of and even hostile towards outside researchers

[49] Freeman, M.M.R.

studying TEK, "concerned that their knowledge could be taken out of context, misused and appropriated."[50]

As the complex nature of TEK is compounding in the face of modern changes, it becomes even less possible, and even less methodologically sound, to study just one aspect and make conclusions about the whole. In his reflection on the ethics of fieldwork, Ken Wilson wrote:

> "The experience of fieldwork has made me believe that there is no single, authentic indigenous voice or reality that the researcher can discover and present to the world. Such things can often be the stuff of romantic myths, at best useless, at worst dangerous."[51]

This paper explores a fascinating expression of the 'indigenous voice' of Hani TEK in Dayutang through an in-depth examination of sustainable food sourcing. However, it cannot attempt to present to the reader a comprehensive interpretation and analysis of what this means for the 'voice' as a whole. The very nature of this 'voice' of Dayutang's traditional knowledge is that it cannot be concretely defined, and cannot be understood through a single aspect, particularly as it continues to change. Using the information gained in this study to make conclusive statements about the overall state of TEK in Dayutang overrides the logic of the subject itself, placing the author's desire for concrete results and statements above the intangible, holistic nature of the topic under study.

Does that mean that this study is inconclusive, and has no wider implications to offer? Absolutely not. Current knowledge of TEK exists as a combination of the many diverse perspectives and expressions of TEK that have been studied, both in the Hani rice terraces and around the world. The addition of even one more perspective,

[50] Simpson, L. 1650.
[51] Wilson, K. 181.

however small it may seem, adds to the richness of this database, and therefore to our understanding of TEK today. Furthermore, in demonstrating the limitations of researching TEK using a reductionist approach, this paper contributes to a richer and more nuanced understanding of its complex nature, and how it can be approached in future research.

Recent advances in the study of complex phenomena[52] have indeed shown that it is impossible to know enough about dynamic systems such as TEK to understand any patterns of causality, control their systems, or accurately predict their future. However, within this paradigm of complexity is a new understanding of successful research, not as being able to elucidate causal relationships, but in developing an "increased understanding, in order to participate personally, critically, and meaningfully in such a 'complex' world."[53] One conducts research to generate a critical awareness of the phenomenon under study, and this critical awareness, not grand statements or predictions about the future, is what defines successful research.

This paper has emphasized the importance of studying TEK in Dayutang through its own logic as an inherently complex and dynamic system, and not through other epistemological paradigms, however deep-rooted in academia as they may be. As previously discussed, approaching TEK as a complex, adaptive knowledge system requires critical and honest research and interpretation processes, undertaken interactively by both author and reader. Through applying this kind of methodological rigour and academic humility, future research into TEK in Dayutang, the Hani rice terraces, and around the world will generate a critical awareness not only of the

[52] E.g. Chaos and complexity theory, boundary critique, fractality, and critical systems heuristics.
[53] Levick, D. and R. Woog. 2000. "From Systems Boundaries to Fractality: Broadening the Practitioner's Paradigm." *1st International Conference on Systems Thinking in Management*. 341-346. 342.

notorious difficulties of researching this knowledge system, but also of its infinitely beautiful, complex nature.

Conclusion

Sustainable food sourcing in Dayutang village is a key component of villagers' everyday lives, and a dynamic expression of the traditional ecological knowledge that the villagers have of their surroundings. This knowledge enables villagers to nurture and preserve key ecological niches, connecting them together into a healthy and holistic ecosystem that encourages agricultural productivity and resiliency in the face of climate change. The dynamic socio-ecosystem in and around the rice terraces is therefore a prime example of a Globally Important Agricultural Heritage System, with its exemplary resource management and resiliency. Much can be learnt form such a system on the domestic and global levels, in a world of unsustainable agricultural techniques and increasing food scarcity.

However, even beyond the lessons to be learnt from its socio-ecosystem, the TEK in Dayutang offers key insights into what successful research into complex phenomena entails. Being complex in nature, and further complicated by its recent and dynamic 'hybridisation' with modern changes, TEK cannot be fully understood using the predominant reductionist paradigm. It must instead be understood as a complex, adaptive system, where it is impossible to use causal relations to determine how a single aspect of the system affects the whole; its interrelated, nonlinear and dynamic nature does not allow for this type of logic. However, if TEK is approached in its own right using a methodology aimed not at identifying causal relationships but at generating critical awareness, future research will yield both a richer understanding

of TEK, and the development of a dynamic and adaptive methodology for studying other such knowledge systems.

Suggestions for Further Research:

The water management system: directing and distributing water from forest to river valley.

Tourism in the Terraces: Recent developments and impacts (suggested towns: Huangcailing, Duoyishu, Shengcun, and Anzhenkong).

Guanyinshan Nature Reserve: responsibilities and impacts, both on forest regeneration in the upper slopes and on villagers and villagers' lives.

Sacred forests, praying for rain, and other Hani spiritual practices and how they relate to spiritual ecology and traditional ecological knowledge. A note of caution – some of these practices are prohibited for women.

"Meili Jiayuan" in the Hani rice terraces: the government-sponsored mass development of housing for rural people. Development in Yuanyang through this policy is changing towns rapidly, and will continue to do so for the next few years.

Appendix: Subjective Account

The ISP field research period was one of the most challenging and enriching experiences of my life. With only two days' notice, I appeared somewhat suddenly and alone at Duoyishu Patrol Station on the evening of May 4th. I was promptly and riotously greeted by ten nature reserve patrol officers, who took me under their wing after numerous toasts of *baijiu*. With their friendship and guidance, and that of their families, I settled into Dayutang life.

We usually ate two meals a day, and the food was delicious. We would wander through the mountains and terraces catching water-snails, beetles, and dragonflies. We picked seeds and fruit, gorged ourselves on berries, and boiled thistle-cores for dinner. We gutted and fried frogs, fish, and tadpoles, and put pigs on the fire, whole. One memorable evening, my host told me, "dinner's going to be late, they're still trying to find the dog". I must admit, it tasted quite good.

Dayutang is a very remote village, with the cobbled roads to larger towns in various states of disrepair or occupation by large piles of rubble, bricks, or dirt. I had access to internet three times throughout the month, which meant that I had to plan my research well in advance. We experienced regular blackouts, which had little effect, as most villagers use wood-fired woks to cook their food. I used my computer only for work, and spent the rest of the time immersed in village life.

The language barrier was tough. Everyone spoke Hanihua, and the few that spoke Putonghua were very difficult to understand (for example, '*kai che*' would be pronounced '*kan tsan*'). I strongly recommend attempting to learn the local language; stumbling through greetings in Hanihua, no matter how bad, opened many doors.

The steady pace of rural life changes one's perspective – I found that seemingly insignificant things suddenly assumed huge importance. I developed a deep and mutual loathing towards two rambunctious geese who lived in a ditch down the road; for a week I was obsessed with the nefarious reasons behind the building of a roadside toilet just out of town. I surveyed piles of rubbish, ran from snakes, and screamed despair alongside the local women at the cliffhanger ending to a particularly melodramatic television soap.

However, the most transformative part of the field research experience was finding out, first hand, what my values and ethics regarding field research and

methodology are. As part of the current mess that is academia, students today are under a lot of pressure to produce grandiose research (advocating for human rights here, or denouncing this or that there), with far less stress placed on their ethics or methodological soundness. I, too, feel this pressure – using research as a means to an end (graduate school, honours, etc), and not as an end in itself.

I struggled internally for most of the month. I read everything I had managed to download about research ethics, complexity theory, and critical systems heuristics. I talked to myself a lot. Over the course of the month and with much struggling, I discovered and consolidated my position on research ethics, and learned to see the elegance of sound research as an end in itself. The final paper, while not having dramatic conclusions, is work that I am proud of for its integrity and methodological honesty, which I believe give it its own kind of beauty.

Ken Wilson (see bibliography) writes, "*The most 'ethical' researcher is not necessarily the most vocal and eloquent advocate for a particular cause – however noble this might initially seem – but rather is the one who makes the most rigorous application of methods enabling objective understanding*." These are words that I plan to fight for, both in my personal and professional life.

Primary Resources

Patrol Officers of Duoyishu Patrol Station, Guanyinshan Nature Reserve (10 persons). Guided conversation and informal interview, May 4 – June 2, 2015. Patrol Station, Dayutang Village and various parts of Guanyinshan Nature Reserve.

Temporary Workers of Duoyishu Patrol Station, all local women (24 persons). Guided conversation and informal interview, May 13 – June 2, 2015. Patrol Station, Dayutang Village, and upper slopes of Guanyinshan Nature Reserve.

'Aphi'/Grandmother. Guided conversation and informal interview, May 4 – June 2, 2015. Dayutang Village.

'Ayi'/host mother. Guided conversation and informal interview, May 4 – June 2, 2015. Patrol Station, Dayutang Village, Xinjie, Huangcailing and Shengcun townships, Guanyinshan Nature Reserve, and surrounding areas.

Tourists from Mongzi city (13 persons). Guided conversation and informal interview, May 9, 2015. Fish pond/reservoir near Hadoupu.

Construction workers (4 persons). Guided conversation, May 12, 2015. Road to Niuluopu Village.

'Jiejie'/young local woman. Guided conversation and informal interview, May 4 – June 2, 2015. Patrol Station, Dayutang Village, Xinjie township, village environs.

Village women (5 persons). Guided conversation and informal interview, May 15 – June 2, 2015. Aichun Village centre, local residences.

Construction workers (2 persons). Guided conversation, May 28, 2015.

Officials from Guanyinshan Nature Reserve. Informal interview, May 6 and 23, 2015. Dayutang and Duoyishu villages.

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