Globally Important Agricultural Heritage Systems (GIAHS) of China: the challenge of complexity in research

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Abstract. The challenge of researching Globally Important Agricultural Heritage Systems (GIAHS) as complex systems forms the subject matter of this study. Complex adaptive systems are those that combine natural ecological processes with human interactions to produce a mutually supportive agro-ecological system. In China, these highly varied systems have the added dimension of long historical time, in that they have evolved over many centuries and thus add a historical dimension to the natural and human dimensions of complexity. In preparing research on GIAHS, it is clear that seeing GIAHS sites as whole systems is an essential starting and ending point. Examining the adaptive capacity of a GIAHS with its multiple scales and complex interdependencies is a major challenge for researchers accustomed to specialized disciplinary thinking. A GIAHS represents a mature agro-ecological system with human agency as a central component that has been honed over many centuries, and has already adapted to many perturbations and changes. The beauty of the GIAHS is in the integration of custom, knowledge, and practice, and it should be studied for its ‘‘wholeness’’ as well as for its resilience and capacity for ‘‘self organization.’’ The agro-ecological approach opens the possibility of researching a system as a whole and of taking its complexity seriously. This study reviews the essential features of the GIAHS as a complex adaptive system where uncertainty is normal and surprise is welcome and, in a case study of Qingtian rice–fish culture system, focuses on new perturbations, namely loss of young people and the introduction of tourism.

Key words: agro-ecology; complex adaptive system; Globally Important Agricultural Heritage System (GIAHS); Qingtian County, China; rice–fish culture system; self-organizing system; tourism; traditional ecological knowledge; uncertainty.

Introduction

Conceptualizing the agricultural heritage systems of China as complex adaptive systems is one step in enabling the research community to examine the ubiquitous rice terrace agriculture in Southern China from a holistic perspective. Thanks to the leadership of Li (2001) and Li et al. (2011), a Chinese agro-ecological perspective has been developed that largely encompasses the ecological and human dimensions of farming systems. To this point, the research community has generally been bound by a scientific approach to research. Although social science is included, it forms a separate field, where there are “two solitudes” of research with little integration. As a result, there is limited advancement in terms of researching human and ecological systems as a whole. Taking an agro-ecological approach, which includes the human and physical components of farming, and treating this approach as a complex adaptive system, which introduces such elements as uncertainty, multiple perspectives, self organization, and surprise, we may be able to get closer to understanding farming systems as a whole. This study attempts to address this issue in theoretical terms by employing complex adaptive systems thinking to studying rice–fish terrace agro-ecosystems in Southern China, formally designated as Globally Important Agricultural Heritage Systems (GIAHS) by the Food and Agriculture Organization of the United Nations (FAO). GIAHS is a designation by the FAO of selected
sites around the world of outstanding symbiosis between man and nature, which produces an enduring production and social system that is adaptable and dynamic. By the end of 2014, there were 11 GIAHS designations and 39 national designations of agro-heritage sites in China. This study first provides some observations on the limitations of a “science only” approach and then offers a conceptualization of GIAHS as agro-ecological systems and how we might approach studying them as complex adaptive systems. Examples from Qingtian County in Southern China provide evidence of how we might think about this task. We conclude with some suggestions as to how to go forward with this scale of inquiry.

Research agendas are generally formulated by national and regional policy, tempered by the research capacities of the educational and research institutions involved, and finally shaped by the expediencies of the day. In this lengthy process, the research that emerges is thus influenced by many factors and is the result of a long process of negotiation and compromise. What results is not always very good research.

In this study on researching GIAHS, the first objective is to review some of the common arguments that determine the form that research projects take and how suitable these are for the complex problems that we face today. On the one hand, limited time and resources (expediencies) are often the determinants of research approaches rather than the problematique (the research question) itself. On the other hand, a poorly formed problematique can shape the research response in such a way as to predispose the outcome to be predictable, modest, or unenlightening. Central to this discussion is the influence that the research frame has on the quality of the outcomes. Research is most often formulated into projects with time limits and resource allocations that most researchers find inadequate. As a result, research is simplified to fit the time frames of institutions and funding agencies and is often compartmentalized to suit the requirements of discipline-based masters and doctoral programs, for example.

Simplification has become the main objective in most education-based research. Simplification means fragmenting the problems we face to make them smaller and more manageable and deliverable in terms of research. The result is the production of a myriad of research “bits and pieces,” which may be laudable in themselves, but are far short of the holistic picture that may be required to answer problems of social and/or environmental importance. In addition, such research is often based on case studies and produces knowledge about specific places at different scales and for different points in time, rendering them almost impossible to aggregate into any semblance of holistic knowledge. This scatter-gun approach, generated by the principles of objectivity and simplicity, is highly pragmatic, but hardly enlightening in terms of understanding systems as a whole.

This study argues for research approaches to complex problems that eschew the temptation of simplicity and that create new ways to come to terms with complexity. It is about taking complexity seriously (Kay and Schneider 1994, Hayles 2000). In this context, complexity is considered to be far more than a complicated situation. The vast number of interactions and scales in both natural and human systems means that the number of interdependencies are huge, uncountable, and probably unknowable. This produces outcomes that are unexpected and difficult to trace and explain, especially with linear logics and limited statistical methods, even with super models (Puccia and Levins 1985). For example, in a complex system, uncertainty becomes the norm and surprise is common (Holling 1986, Casti 1994, Funtowicz and Ravetz 1994).

By addressing the challenge of researching GIAHS in China as complex systems, we review the nature of systems themselves and how they might be better understood as whole systems and not simply as a collection of component parts. In this way, we explore new ways of thinking about research (Funtowicz and Ravetz 1993, Waltner-Toews 1997, Kay et al. 1999). We conclude with suggestions about how we might move forward with research into the scales and designs that combine traditional knowledge systems and contemporary agro-ecological science to provide new insights on how systems work and what they reveal about sustainability in an ever-increasing era of uncertainty (Connell 2010). In this way, we hope to deepen our conceptual insight for researching the many GIAHS-type agro-ecological systems in the world.

The Research Challenge of GIAHS

GIAHS in China provide an excellent opportunity to consider them as agro-ecosystems and to consider how one might approach researching them as complex adaptive systems in order to gain insights, not only about the strengths and vulnerabilities of the systems themselves, but also for how to develop techniques that measure such elements. Rice terrace systems are taken as the focus of this study, as they dominate the land-use patterns of Southern China and are also generally present in the Southeast Asia region (Li 2001, Huang et al. 2006, Vafadari 2013). Methodological insights from researching GIAHS will not only be intrinsically useful in China and South Asia, but will also have great value in a shared knowledge pool about peasant-based agricultural heritage systems in the world (Van der Ploeg 2008).

Any GIAHS is three-dimensional by definition. At a minimum, the three dimensions include an ecological domain, a human domain, and a historical domain. Each domain is highly integrated with the other two, but the historical dimension is more difficult to research because of the general lack of historical records and memory.
With the exception of F. H. King’s (1911) classical work, *Farmers of Forty Centuries*, there are few documents in English that account for early Chinese agriculture, especially the rice–fish terrace systems of Southern China.

The ecological and human dimensions are in full view today, as a testimony to the past, and can be measured, monitored, and analyzed in many ways to produce a variety of insights and knowledge (Checkland and Scholes 1990, Berkes and Folke 1998).

The importance of history

Every current GIAHS site represents a long history of development, trial and error, and innovation, as village communities have adapted to changing conditions and have dealt with shocks and stresses in both the human and ecological systems. The picture of a GIAHS today is the result of many adjustments made in the past and is a received system, honed and tested, like a gift from the ancestors. In this way, a GIAHS is a big picture of a system, made up of many functioning parts, and as much as possible, our research objective should be to always keep the big picture clearly in mind. Examining a component part should be done with the intention of understanding its place and contribution to the big picture.

In China, the first GIAHS was designated by the FAO in 2005, and designations have been increasing incrementally ever since, such that there are 11 GIAHS sites today (Min 2009, Min et al. 2012, Min and He 2013). Four of the Chinese GIAHS are rice terrace systems in combination with fish and ducks, and these are taken as the main GIAHS type in this study for considering the question of complexity in current research. The Chinese GIAHS are spread across the country and demonstrate innovative and ingenious methods for producing food and materials in a variety of difficult environments, often among ethnic groups with strong cultural connections to place (see Fig. 1).

In effect, a GIAHS site is made up of many component parts, including external forces as well as on-site systems and subsystems (Fuller and Min 2013). Local government policy, the traditional trading system with other communities, and the context provided by the state are all potentially important external forces that

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**Fig. 1.** The highly dispersed location of Globally Important Agricultural Heritage Systems (GIAHS) in China.
may have played a role in forming the current shape, function, and structure of the GIAHS. Such influences are also present today. The point is that each component part, or subsystem, has historical roots and is the product of many generations of work, trial and error, and innovation, both internal and external. This is one level of complexity in the GIAHS. The presence of history, although difficult to measure in standard ways, is constant and is of great importance in studying a GIAHS today. It is significant therefore that we are very limited at taking into account the historical dimension in our current research designs, as this awkward third dimension is often difficult to account for.

Human and ecological systems in various combinations have survived by enduring stresses, and adapting to shocks such that the resilience of such systems is a key feature that enables us to witness the GIAHS in many working forms in contemporary China (Holling 1986, Berkes et al. 2003, Folke et al. 2005). GIAHS have already shown remarkable traits of sustainability. Are such traits still present and sustainable today? It becomes an important question therefore to understand how the contemporary GIAHS adapt or transform (or not) and in what ways, to the threats and opportunities in the modern world of rapid urbanization in China and Southeast Asia. A huge opportunity is present to monitor the changes in the GIAHS that are underway in some parts of the agro-ecosystem and to see how this affects other parts of the same system, as well as the system as a whole (Gunderson et al. 1995).

A complex system is like a pond. Many features, both physical and human, are visible on the surface and other elements are hidden from the human eye beneath the water. There is a high degree of interdependency such that if there is a disturbance in one part of the pond, the ripples are carried with diminishing force to all other parts of the pond. Thus, all parts of the pond system are affected, directly and indirectly, by a disturbance or change in the pond ecology or human use of water. This simple analogy enables us to imagine most systems in this way, with large interdependent physical and human components that we can think of as the two main systems, both of which (in the case of GIAHS) have deep historical dimensions (see Fig. 2).

In each system, there are a myriad of other subsystems as well as meso- and microsystems such as the water cycle in the physical system and village governance in the human system. These we can call subsystems and this conceptual structure enables us to imagine the system as a complex whole with strata at different scales: the whole system, the two core systems (both with a historical dimension), and a myriad of subsystems.

Subsystems can be arranged conceptually to suit the needs of the researcher for study in their known or anticipated relationships to each other (see Fig. 3). Landscape, for example, is considered a key feature of the GIAHS in Fig. 3 and can therefore be placed in the center of the figure to show that it is the subject of study. The complexity of the potential influences on landscape is well illustrated, such that a change in landscape quality or function (e.g., land use) can have many impacts on related subsystems. In the example of water, we know that water usage in the rice terrace system is affected directly by the availability of water that is stored naturally in soil beneath the forest cover on the higher reaches of mountains ridges and is largely controlled by the tree canopy, soil type, and undergrowth on the upper parts of the terraced slopes. Outsider development agencies with little knowledge of this subsystem of water storage might be tempted to suggest harvesting the trees to relieve, temporarily, the poverty present in the villages or to expand the area under cultivation in an effort to produce more food. In effect, such economically motivated actions would destroy or seriously threaten the whole subsystem and impact the system as a whole. One question is, in what ways? Which parts of the system would react negatively and which parts might show hitherto unknown qualities of resilience? In this study, we understand resilience to be a return to the old normal, whereas a new normal would reflect subsystem adaptation. Such reactions are unpredictable. Perhaps the system or subsystem would adjust and reach a new normal. Perhaps it would collapse altogether. What emerges from this line of thinking is that systems are relatively unknown, and that surprise is common. In this sense, we may begin to consider that uncertainty is a normal occurrence, and that researchers might have to adjust their positivistic thinking to accept systems as not only complex, but as where uncertainty is normal (Robinson and Fuller 2010). In addition, discovering new information and insights by surprise is an important way to advance our knowledge base and should be more readily accepted by science.

These basic scenarios are used to illustrate the high degree of interdependency of the whole system and the need to have an understanding of the system as a whole. This interdependency is represented by the nested subsystems in Fig. 3. Resolving problems in one part of the system may well produce unintended conse-
quences in another, seemingly unrelated, part of the system. Seeing the system as a whole is essential in conceptualizing research into ecological forms of agriculture.

GIAHS are Complex Systems

GIAHS, studied as agro-ecological systems, are complex in that they are multidimensional, multifunctional, and combine traditional knowledge and ecological functions which themselves can be called subsystems. GIAHS are complex in that we know only a little about how and why they work as a whole. At this point in time, there seems to be some sort of balance or equilibrium between the human and ecological systems that has been brought about, we suppose, over hundreds of years of adjustment and change. Whether the system was at its optimal state before the opening up of China in the 1980s is a moot point. Certainly, the village system was relatively closed and knowledge of the outside world was limited, such that adjustments and occasional change came mostly from local adaptation. This has changed a great deal in the ensuing 30 years as villages have been opened up through out-migration, remittances, reports by migrant villagers of other ways of life, television, the cell phone, and increased transport connectivity to towns and cities. Most school systems have been centralized such that there is an ever increasing focus on towns and cities as the normal and desired way of life. In a sense, villages that have migrant workers in cities many hundreds of miles away have been in this way incorporated into city spheres of influence. Stories of city life are legion, and the compulsion to go and try the life there is overwhelming, especially for village youth. This rapid and all-encompassing rate of change will potentially have huge influences on GIAHS as typical agricultural heritage systems. For example, to what extent is the traditional knowledge of rice terrace systems and related water management practices being passed on, and if not at all, what next? The combined effect of opening up, out-migration, and urbanization forms the context in which GIAHS exist today. Although relatively isolated, they are no longer protected by their geographical location, cultural differences, or social indifference to national trends. All villagers are affected by the household responsibility system, the one-child policy, and the hukou system (the hukou system in China is a household registration system, which is used to record and preserve the basic information of households and members), as communications by the Communist Party network are effective at all levels, especially the village level, in Chinese society. In this sense, all GIAHS sites are part of the overall system in

\[ \text{Fig. 3. Conceptual depiction of the subsystems comprising the human (left circle) and physical (right circle) components of a GIAHS. Landscape is placed centrally to indicate that it is influenced by all systems and subsystems within the GIAHS, with all the cognate subsystems affecting the landscape arranged close by, while subsystems that may have an indirect affect on landscape are conceptually placed on the edge of the configuration. Unknown subsystems are indicated with a question mark.} \]
China and are not exempt from the trends of change and related challenges that most rural communities in China face.

**GIAHS are dynamic agro-ecological systems facing change**

Conceptualizing the GIAHS site as a complex system enables us to design research that will measure some of the impacts of these external incursions and the ability and tactics of the GIAHS community (natural and human) to respond. With this context in mind, where national policy and programs are filtered down through many layers of government and party interpretation, the GIAHS site has its first major external challenge. No longer protected by benign neglect, the GIAHS has to respond and adapt to trends and incentives introduced formally through official channels and implemented village-wide. Consequently, new and different research questions arise, for example, “can village systems self-organize?” Assessing the interaction between the traditional village system and the formal acts of government is an exercise in governance and requires methods in political science blended with systems thinking to bring new knowledge to bear on this issue (Folke et al. 2005).

In addition to the governance question, there are several other influential forces of change in the external environment that bring pressures to adapt to in GIAHS. The most common force is that of labor migration. Almost all villages in China are subject to out-migration of one sort or another, and although this phenomenon often occurs later in GIAHS sites, it is nevertheless present. As most GIAHS are labor intensive, the loss of labor at critical times of the farming year forces adjustments to the farming system or to family arrangements, such as the substitution of labor between the sexes or by age cohorts. It might even mean the introduction of small labor-saving machines such as the rototiller and the electric rice thresher, both of which can be used in the bigger terraces and rice paddies to save labor. The basic question therefore arises as to whether such changes in farming technology are acceptable as adjustments to the system or if they are to be seen as deleterious system changes potentially leading to collapse and even de-designation as agricultural heritage sites.

A second force of change that is common to most traditional agricultural systems is the loss of youth in contemporary villages. Young people become the main migrants to cities and are known, over time, to be less interested in a farming life. Similarly, girls are less likely to want to marry a farm boy, which compounds the incentive to seek a life outside the village for both sexes. The loss of youth is seen as critical, as it directly threatens the sustainability of the system. How does the system adapt to this threat, which in essence is now the same as the first example, that of a chronic shortage of labor, especially at critical times of the year, as well as the loss of traditional ecological knowledge (TEK)? The introduction of machines will influence some male youth to stay, as will some modest scientific farming methods that complement the traditional system. It is also noticeable that in many villages, when terraces are abandoned by out-migrating families, a new form of management appears where an overseer is located by the local government to manage the amalgamation and use of abandoned fields. Labor, some from surrounding villages, is hired by the overseer and is organized on a village-wide basis. Families can retain their own fields for home consumption, while working as hired labor for the village. Most of these workers are of middle to old age and consist of both men and women. This is an adjustment that retains the essential features of the GIAHS. The landscape morphology is the same and potentially remains a key attraction for tourism. The rice–fish system remains intact at both the family and village collective level. Local varieties are retained and personal preferences can be grown in one’s own fields (for example, red rice for home consumption). Could this be considered an acceptable adjustment to the traditional agro-ecosystem? The answer to this depends on one’s disciplinary and political perspective and also depends on what happens next. If hired labor is employed to farm many fields and if these fields can be joined together in some way, then a bigger scale of commercial farming is possible. Is this the first step in land amalgamation, a form of passive land assembly that some scholars would see as land grabbing? Is it the “thin end of the wedge” for the modernization of agriculture?

These examples illustrate the uncertainty in complex adaptive systems research. They also demonstrate the high degree of connectivity of the elements in the system. In the first example, the issue starts out as labor migration, but then becomes a question of the local system adapting by taking on labor-saving techniques such as the introduction of new and appropriate technology or the adjustment of labor roles in the household. In the second example, the loss of youth can produce the response from the system of trying new ways of organizing labor through assembling abandoned land. The future trajectory of both examples is unknown, but should be monitored as examples of resilience and spontaneous endeavor in rural development. Researching these connections and implications is a process of discovery, an inductive rather than a deductive approach to research. How the GIAHS will cope with the incursions of urbanization and its inexhaustible demand for labor and its response to the loss of youth has yet to be defined as a research problem in China.

A third example of a disturbance from outside the system site is that of tourism. The exponential growth of tourism in China is, like all the other changes going on,
quite remarkable. Rural tourism is an integral part of this and depends on the growing interest of the burgeoning Chinese middle class in their own culture, manifest in history, landscapes, and the performing arts. Clearly, GIAHS are part of this phenomenon and will continue to grow their share of the rural tourism market whether promoted as eco-tourism, cultural tourism, or even as food tourism (Sun et al. 2013). The raised-stack GIAHS in Xinghua has 10 000 people a day visit the yellow rapeseed (Brassica napus) landscape in the Yangtze delta in April every year. One thousand cars are parked on the road to a village in Qingtian County, Zhejiang Province on a weekend for people to see the newly created “auspicious” shapes implanted in the rapeseed landscape there (see Fig. 4). These examples provide the villagers and thus the researcher with the challenge of seasonality, as rapeseed landscapes last for about one month in the spring of the year. This invasive phenomenon is one aspect of the incursion of tourism into the farming system. How has the system adapted to this evident overload of tourists? Is rice transplanting delayed or worked into the new rhythm of weekend invasions? Are young people becoming more interested in providing tourism services than in farming, and will tourism help to keep them in the village or will it help to drive them away? If an adjustment is being successfully made, then a one-month infusion of energy and income could be very helpful in sustaining the heritage system.

Tourism in GIAHS sites is an unknown quantity. Given the proliferation of GIAHS and Nationally Important Agricultural Heritage System (NIAHS) sites in China, there is ample opportunity to research tourism impacts on system sustainability, by looking closely at the connections between tourism and its demands on labor, local culture, human resources, and physical accommodations (roads, car parks, restaurants, and toilets). What, for example, is the carrying capacity of village tourism? Can tourism bring benefits to GIAHS or will it inevitably lead to system change, which some would call a system decline in the traditional sense? What’s more, how do we know that what appears to be system decline is not in fact another adjustment in the system to accommodate change and opportunity, in which case it is self-organizing to a new normal, not necessarily declining? Not all tourism is seasonal and threatening, much of it is passive and inconsequential, prompting diversification of livelihoods in the village and motivating villagers to keep their landscapes functioning and their villages tidy (Reid et al. 1995, Sun et al. 2011).

Longxian: an agro-ecosystems case study

The rice–fish GIAHS in Longxian village in Qingtian County, Zhejiang Province illustrates the benefits of a complex systems approach to the impact of tourism at the site.

The Longxian landscape of rice–fish terraces is well maintained (see Figs. 5 and 6), despite the loss of most of the village youth. Almost all households keep fish in streams or ponds near to their houses, and the rice–fish culture is well developed and well known (see Fig. 7: foreground) Most tourists come to consume the fish, either as fresh fish at lunch or dinner or to purchase the dried carp that is considered in the region to be a great delicacy. Although very helpful as sources of income for ~10–12 families in the village, tourism has limited benefits. Most of the real benefits, as with most village tourism enterprises, go to the local town or city where tourists reside overnight and spend their money on tourism transport, gifts, food, and entertainment. Most other benefits go to the tourism companies, which are not usually rural based. Despite this, in Longxian, the village is prosperous. This is because most of the households in the village have at least one member working overseas in Mediterranean Europe and the volume of remittances has been such that two-thirds of the village houses have been rebuilt or handsomely renovated. Three- to five-story buildings are the norm, and for the most part, their architectural style is that of the classical Mediterranean villa with balconies, flat roofs, ornamental railings, and bright pastel colors (see Fig. 7: background). They are referred to locally as “vanity houses.” This is in complete contrast to the dark stone, one- to two-story farm houses common to most villages in the area in the past several hundred years. Many former Longxian residents now live overseas and visit the village and their well-appointed second homes only at Spring Festival. Many of them come to their ancestral village as tourists.

In these circumstances, sustaining the rice–fish economy becomes a form of cultural preservation as well as of economic development. However, without an open systems approach to researching the sustainability of this rice–fish system, the phenomenon of overseas...
capital is easily overlooked. It becomes evident that more and more of the system is being sustained by those interested in the heritage value of the system and living up to the considerable reputation of being designated a GIAHS by the FAO. This is laudable in itself, but is far from the original intent of conserving the rice–fish system on a more viable economic basis to attract tourists and add to the income of impoverished farm households. In a general way, all these factors add to the sustainability of Longxian: the continuing economy of rice–fish culture, the tourism benefits, government paternalism, and the huge infusion of wealth and well-being of overseas villagers who consider Longxian to be their Chinese ancestral home, their hometown. In this sense, Longxian is an example of a self-organizing system, in that the GIAHS designation is only a part of a series of changes, mostly self-induced, in the conservation and development of the village system.

It is intended that these examples demonstrate the value of taking a systems approach to research, where all perspectives are of potential value and surprise is welcome. Learning is about what we want to know, not only about proving what we think we know. Given the abundance of feedback loops in systems research, there is ample opportunity to redefine the question based on what we learn in the first steps. Research in Longxian somehow has to take into account that the system is primarily sustained by outside-generated wealth, not simply by indigenous knowledge, farming culture, or
government support. Outside-generated wealth can be a silent variable forming part of the context of the study, or it can be a central factor helping to redefine the research question. The context here is not about poverty, but about new and unexpected sources of wealth. In this context, what might we expect of the future of the GIAHS as an ongoing rice–fish system? On the one hand, it may go forward as an effective system offering many environmental goods and services, especially the conservation of biodiversity, and in effect become sustained as a form of multifunctionality by state and external agencies. On the other hand, economic wealth coupled with sentimentality might lead to various forms of subsidy for the much admired traditional system that would move it forward to being a living museum, the destiny of many such heritage sites worldwide (George et al. 2009).

**Complex Systems: the Opportunity**

**Team research**

Given the complexity of GIAHS (despite their apparent simplicity), we have a golden opportunity to undertake research that is holistic, meaning systemwide and multiscaled. The challenge is considerable, but we can manage well and discover more if we create new frameworks and techniques that allow us to connect the operational parts (e.g., links between the hydrological system and human agency) and to examine connections that occur spontaneously while in the field. Perhaps newly created research consortiums such as the East Asian Research Association for Agricultural Heritage Systems (ERAHS) can adopt this practice, as all members are involved in GIAHS research and are already finding out the same truths and meeting some of the same problems. A team approach to treating a GIAHS as a complex adaptive agro-ecological system is one route to follow, as it allows specialists and generalists to work together to study the component parts and to place them in the context of the dynamic whole.

**Generalists**

Young researchers focusing all their research effort on one feature may inadvertently bring about negative consequences for other parts of the system if they are unaware of the system as a whole and how it works in general. At the research proposal stage, all researchers should be asked to explain how their study will affect the system or any of its cognate parts. For many, this might well become the research question itself (Waltner-Toews 2004). Unfortunately, with disciplinary specialization, few hydrologists have time to consider the legality of land-ownership or the villagers’ knowledge of suitable land uses. Few livelihood specialists can take the time to consider the herbal medicines to be found in the forests. Many economists and model builders don’t even go to the villages they are asked to study, as their simulations are thought to fully represent reality, even though, often, their list of assumptions is far longer than their list of findings.

What we need are researchers who are trained in a broad range of disciplines and who are interested in the whole as well as specific parts. These we might call generalists, and their skill sets will be different than the specialists. Generalists, when appropriate, can think outside the box and can inductively seek new insights from different sources. Importantly, such generalists see value in different perspectives on the same phenomena, such that multiple perspectives are respected and considered in the research, even though these data may not be considered strictly scientific (Rosen 1991). Perhaps above all, the new GIAHS scientist can work with specialist scientists to gather objective knowledge about an issue so as to place this issue into context with other insights and perspectives from villagers and officials alike. In this way, scientific research can be commissioned to answer specific questions set by the generalists who, in the end, must place the new knowledge into the system as a whole and account for its potential impact on adjacent subsystems. The generalist must have an understanding of complexity, agro-ecology, and natural resource management, as well as human systems. This is not to suggest that the new scientist, the generalist, has to be superhuman, but he/she has to be good, very good, and well-trained to have an open mind and broad skills. In the foreseeable future, he/she will be trained in agro-ecology and should be able to comprehend whole systems and endeavor to bring all parts and parties into the explanation. Such research will also be incremental, but the increments will be about the whole, not about single parts.

**Multiple perspectives**

Involving farmers, villagers, and key informants in the research process can also be helpful in developing multiple perspectives on target issues and to discovering surprise elements in the system. This type of research process reduces the autonomy of experts and introduces knowledge that is often discounted as unscientific or subjective. In effect, village life operates on a number of subjective standards and values and there is every reason therefore to take them into account when exploring a GIAHS problem. In this way, we may be able to build a comprehensive knowledge system incorporating many sources of knowledge, belief, and understanding. Accounting for whole systems is probably unreachable at this point in time, but we should move in that direction. Studying GIAHS as whole agro-ecological systems using complex adaptive systems ideas would take us a long way toward this goal, but it will not be possible without creative leadership and
trained researchers. The whole research establishment, especially reward mechanisms, must be tolerant of new methods and perspectives, as long as scientifically solid experiments are conceived and undertaken. Above all, Western hegemony in the journal publishing world has to open up to allow the reporting of “new science” or “post-normal science” where uncertainty is normal and surprise is welcome (Ravetz 1999). The GIAHS provide a great opportunity to achieve this set of goals, otherwise many GIAHS-type environments will be swept away on a tide of economic opportunism, or become ossified as living museums. The word system is in the title of the GIAHS and, like complexity, must be taken seriously in agro-ecological research.

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