Recent Chinese History in Ecosystem Perspective

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> Somewhere, it seems, a great lawgiver has inscribed on a tablet of stone that water cycles, deforestation, animal populations, soil nutrient gains and losses are reserved for Science, while History must confine itself to tariffs, diplomatic negotiation, union-management conflict, race and gender. Science is supposed to deal with Nature; the scientists even have a journal proclaiming that fact in its title. History, on the other hand, must deal with People, Society, and Culture.
>
> Donald Worster, "The Two Cultures Revisited: Environmental History and the Environmental Sciences"

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How Chinese Historiography Misses an Important Point

In October, 1999, a group of Chinese intellectuals and social critics held a conference on ecology and literature at Nanshan, Hainan. The topic was developmentalism and the crisis of the Chinese environment. The ten signers of the report that was published in the journal *Tianya* addressed a few "received truths" that they considered dangerous and misleading, including the idea that environmental damage was a necessary byproduct of increases in the standard of living brought about by development; the idea implied in the "environmental Kuznets curve" that in the process of economic development, things will always get worse before they get better,[1] and the idea that China's current environmental problems are the residue of misguided developmental policies carried on by the former high-socialist regime and its Stalinist and Maoist models of development [Yan 2004]. To someone currently steeped in the literature on development, environment, earth systems, climate change [not mentioned at all in the Nanshan report] and such, it all seemed rather mild and so-whatish. But it was clearly something new for the majority of Chinese intellectuals.[2]

The most interesting things about this seminar is not that it happened, that a group of prominent Chinese literary figures began an attempt to bridge the East Asian version of the Two Cultures gap first publicized by C.P. Snow (1963), but that it took so long for them to get around to it, and *a fortiori*, that most Chinese intellectuals and scholars of Chinese society and history have still not gotten around to it. Despite the widespread perception that China's environment is in a crisis, despite the widespread recognition that developmentalist policies both pre- and post- Thirteenth Plenum have contributed to the depletion of unrenewable resources and the pollution of renewable ones, despite the complaints of everyone from farmers to tourists and the spate of books about Wars Against Nature and Rivers Running Black, there has been very little attempt to actually bridge the gap that Worster mentions in the epigram above, to take the findings of both science and history seriously, and combine

[1] The Environmental Kuznetz Curve is named after the plain Kuznetz curve, which states that early stages of economic growth in create greater inequality, while advanced growth brings greater equality.

[2] But see, for example, the account of one Huang Wanyu in Judith Shapiro's *Mao's War Against Nature*, as well as recent writings and political activity by Liang Congjie, Dai Qing and others.

them in an analysis that tells us how we got here and, consequently, might point to a way in which we might end up somewhere a little better in a few decades, or if we don't, in the words of the old UC drinking song, at least "know the reason why."

This article is an attempt to get a conversation going about how we got here and what ought to be done, through a serious effort to unite concepts and results from the Two Cultures. I proceed as follows. First, I examine how the topics of environment, ecology, earth systems and the sustainable use of resources came to be ignored by those promoting developmentalist ideologies of the twentieth century, particularly during the PRC period. I suggest that the hegemonic narratives of recent Chinese history both in China and in the English-speaking world have had the effect of obscuring or effacing the ecosystem processes that have been going on during the past several decades, that the events emphasized and the periodization of history derived from these events prevents us from understanding the underlying system processes.

Next, I examine some conceptual and theoretical tools from ecosystem sciences and social system sciences that, combined in a single analysis, might help us develop a new historical narrative, one that does not replace social history with natural history, but rather integrates the different models into a single understanding of what has happened in the period under study.

Third, I will use a rather eclectic combination of these different theories and concepts to analyze a very small sample of environmental and ecosystem phenomena over differing temporal and spatial scales. In the analysis of each phenomenon, I will pay attention to the earth system and the world system models of analysis (Hornborg and Crumley, various), and also the differing ideologies or environmental ethics that have regulated behavior of different actors in each system at different times. In a sense, this analysis looks at ecosystem and socioeconomic system in two ways. First, it sees these interacting systems as objects of my own description and analysis; second, it sees them as conceptions held by the actors in the various systems themselves as they shape and regulate the behavior of those actors. In this section, I will draw three preliminary case studies including, at the largest scale, the nationwide effects of the Great Leap Forward; at a regional scale, food and water in North China, and at a small scale, deforestation from my own field research site of the Upper Baiwu

Valley, Yanyuan County, Sichuan.

The Hegemonic Narrative of History of Twentieth-Century China. Perhaps the best way to get an idea of a hegemonic historical narrative is to look at history textbooks. [For the Conference version of this paper, I will provide a short summary here of how recent Chinese history is presented in a middle-school and a high-school textbook now used in China. A friend has mailed me some high-school texts, but they aren't here yet and Yingjin is pressing me to turn the paper in].

In addition, of course, to the comprehensive narratives to be found in textbooks, there are the myriad monographs that make up historical research, as well as a large number of personal historical narratives that have become popular since the 1980s, most of them written about trials and tribulations endured by members of either the Communist Party elite or the non-Communist intellectual elite.

One salient characteristic of almost all these narratives, historical or autobiographical, is the centrality, both temporally and substantively, of the event of the Cultural Revolution in shaping the lives both of the narrators and of the nation. A crude but telling search of the University of Washington's library catalogue yielded 29 results for 文化大革命 and 20 for 文革 in Chinese titles, and 459 for "cultural revolution" among English Titles; a similar search for 大跃进 gave two titles, both published at the time, and 28 in English containing Great Leap Forward, many of these using the term metaphorically or ironically to refer to times other than the 1958-1960 social, industrial, and agricultural events that were the largest turning point in the history of the Chinese socio-ecological system.

There has come to be a kind of collective nostalgia among Chinese intellectuals for what are now called "the seventeen years," the times between 1949, when the Communist victory and the establishment of the PRC brought peace and the promise of prosperity to the nation and its citizens, and 1966, when all hell broke loose and fifty years were lost in ten during the time when the members of the scribbling classes were condemned to manual labor. According to this nostalgic narrative, during the seventeen years, there was considerable artistic freedom, socialist construction proceeded apace, universities grew, many endemic and epidemic diseases were eliminated, people got schools in their communities, and most

importantly, everyone but a few incorrigible class enemies was a loyal and enthusiastic supporter of the Revolution and the Socialist Construction. In retrospect, there were certain forewarnings: campaigns against counterrevolutionaries, arbitrary persecutions of certain outspoken voices, and most notably the Anti-Rightist campaign, which imprisoned or otherwise persecuted many intellectuals, were seen as foreshadowing, in a mild and tenuous fashion, the horrific events that came in year 18+. Many of the autobiographical narratives in fact begin with someone or someone's father being arrested as part of the Anti-Rightist campaign.

Then, according to the hegemonic narrative, came the apocalypse. The Cultural Revolution represents, in this narrative, everything turned upside-down, with intellectuals sent to do manual labor, urbanites in the countryside, students persecuting teachers, radical rebels persecuting earnest bureaucratic Party authorities, economic growth knocked off course, manners and civility replaced by barbaric confrontational behavioral styles. The ten years of turmoil were the ten years lost from economic development, the ten years when China isolated itself from the rest of the world, the ten years when socialism, which had such good intentions, turned into a nightmare caricature of itself and Chairman Mao, whose 70% good had brought the nation out of chaos toward order and construction during the 17 years, showed his 30% bad side and the nation convulsed. As analyzed by Davies (2002: chapters 2 and 3) the personal narratives written about the Cultural Revolution in Chinese and published in China are somewhat different from those written in English and published elsewhere; the primary themes of the domestic narratives are the horrible and unnecessary sufferings of the intellectuals at the hands of an increasingly unrealistic and paranoid group of revolutionary leaders around Chairman Mao, and the role of the Cultural Revolution in shaping the success and failure of individuals in the time that came afterwards. The main tropes of the English-language accounts are youthful enthusiasm, subsequent disillusionment, and final triumph in the realization of the American Dream by migration, marriage, and of course successful book authorship, along with the implicit criticism of the Marxist-Leninist project as a whole, not just its fanatical version practiced during the Ten Lost Years themselves.

After the national nightmare was over, goes the story, the period of Reform and Opening began, when China began to re-rationalize, to figure out what had gone wrong, put

the past behind it, and begin to catch up. From proletarian literature to wounds literature to just plain literature, from collective agriculture to the industrializing countryside, from the whitewashed walls and guarded gates of chessboard-patterned danwei to the high-ceilinged lobbies of gleaming glass- and steel- towers, from unisex to fashion, from hidden sex to flaunted sex, from local autarky to a hundred million floaters, from national autarky to a $232B trade surplus with the United States in 2006 (Census Bureau 2007), from art and literature serving the masses to Chinese film directors' being hailed as the only real creative forces in the cinema world (NYT), the hegemonic story is one of China gone rightside-up again. And although the Reform and Opening Period, which by now has already lasted longer than the Seventeen Years plus the Cultural Revolution put together--China after Mao has lasted longer than China under Mao--much of today's historical and cultural narrative is still about coming out from the shadows of the Cultural Revolution. There are, of course, plenty of cautions and warnings about the current state of affairs. There is the urban-rural gap, with villages being "spectralized," (Yan 2004), there is the development gap between the coast and the interior (World Bank 2006, Khan and Riskin 1998, Rvaillon and Chen 2005, Wei 2002), there is rising crime and constant corruption. In overseas narratives there is the threat of China actually becoming powerful again, often in more scholarly versions with a nod to the counter-cycling of Europe, America, and East Asia as world-system centers (Frank 1998, etc). And there is always the problem of democracy, or the problem of the lack of democracy, depending on your perspective.

And there is the environment. The literary critics of Nanshan are of course joined not only by foreign social and environmental scientists, tourists and other bloggers, and doomsaying futurologists in predicting that China's continued economic growth at the 9 or 10% rate of the last two decades will put unprecedented strains on not only its own resources but those of the global biosphere. They are also joined by an increasingly powerful Chinese environmental legal and bureaucratic establishment (Day 2005, Ross 1998, Jahiel 1998, SEPA website) in decrying the direction in which unbridled economic development is taking the country. The crisis, however we got there and however we are going to get out of there, has been recognized.

But I would suggest here that two elements of the current intellectual climate are

preventing us from going beyond recognition of the crisis to understanding of the process that has gotten us to the present state, and from understanding to thinking what we should do about it. One of these is the divide between natural sciences and social and human sciences that still pervades much of the world discourse on the environment, and in particular the discourse on the environment in China. For example, Elizabeth Economy's wonderfully titled and widely heralded *The River Runs Black* is all about policy, and what science she includes seems written for numerophobic members of the newspaper-reading and policy-making public. Books like Václav Smil's *China's Environmental Crisis*, which do explain the science, get much less notice from the general public, though they are well-received in China-studies specialist circles.

The second problem is with the periodization of PRC history, and perhaps modern Chinese history in general. The relationship between policy cycles (Skinner and Winckler), or alternating good and bad periods in history over different time scales, has very little to do with the course of the history of China's ecosystem in recent times. As I show in the third section of this article, the cycling of the Chinese ecosystem and many of its sub-systems have been out of phase with the cyclical or secular shifts in Chinese political policy that have shaped and punctuated the hegemonic historical narrative. In fact, as the critics gathered at the Nanshan seminar recognized, the Cultural Revolution, so bad in so many ways according to the hegemonic narrative, was neither particularly bad nor particularly good when it comes to its effect on ecosystems and resources.[3] As they state, blaming the current state of the environment either on what happened during the Cultural Revolution, or on what happened during the entire period of high socialism, or on what happened afterward, is missing the point. But at the same time, their lumping all the problems and dumping them at the feet of developmentalism in general, while a step in the right direction, is too simple. It is appealing to make a sharp and dichotomous contrast between pre-modern ideologies of resource conservation and ecosystem health, and modern ideologies--capitalist, socialist, or whatever--of developmentalism that sacrifice renewability, sustainability, and systemic health on the altar of increasing personal incomes, but that is too crude a formulation. There were different

[3] A lot could be written about the term "resources" and especially about the customary Chinese translation, 资源

ideologies in the pre-modern period in China, some of them more conducive to maintaining medium-term ecosystem health than others (Shapiro 2001: 7-11, for example, also Schoppa 1989), and as Elvin has argued in several places (1988, 2004 etc.), while there may have existed local practices that promoted what Eugene Anderson (personal conversation) has nicely called "everyday sustainability," the macrosystemic long-term trends toward capture of ever increasing amounts of resources for administrative and military uses, along with the added Malthusian pressures that we ignore at our peril[4] already led to severe pressures and degradation of many resources well before any ideology of developmentalism came on the scene. There are also different kinds of local cultures that Elvin's materialism or the Nanshan scholars' developmentalism comes up against--different local ideologies about resources and the proper methods of stewardship differ from each other and have different results. Finally, there are different kinds of developmentalism. The Stalinist kind that dominated the 1950s and the early 1960s was disastrous for the environment, but it was a disastrous in a different way than was the Maoist developmentalism of the Great Leap Forward or the quasi-capitalist cosmopolitan developmentalism adopted by the regime in the years of Reform and Opening. Each of these different modes of developmental ideology ran up against local cultural practices and ideals in different ways and on different scales. This led to environmental results whose timing and temporal scales do not map easily onto the periodization of history in the hegemonic narrative. If we look at recent Chinese history from the broader perspective of the whole socio-ecosystem, not just from the narrow vantage point of the political history of particular classes (particularly the intellectual classes; see Gao 1999), perhaps we can get not only a more general but a more realistic picture of what has happened in China in recent decades.

In terms of ecosystem cycling (whose models are explained more fully below), the long

[4] The objection to Malthusian analyses is of two kinds. The kind asserted by Lee and Wang (1999) deals with the Chinese ability to control population by what Malthus called preventive checks, contrary to Malthus's original assertions. They do not deny that population pressure existed. The other objection is that analyses of pressure on the environment that invoke only population and not distribution of resources blame the poor for their own condition. While distribution is a huge factor in pressure on resources (one that Malthus himself explicitly recognized, by the way), this does not deny the fact that, holding inequality of distribution constant, twice the population puts twice the pressure on resources.

cycles of Chinese history since the Song had seen an ever more precarious balance between resources and their exploitation, leading to a very fragile condition--at least in some of its larger subsystems-- of the system from about 1800 on, a semi-permanent condition in which local and regional subsystems had lost redundancy and diversity and as a consequence declined in resilience, so that political and social events such as the Taiping Wars and especially the Warlord Era and the Anti-Japanese war triggered major perturbations in which the system barely recovered its precarious stability. Then the Great Leap Forward sent the entire system and just about all its subsystems at any spatial scale, into a severe ecological crisis, causing the greatest famine in world history in the short run, but amounting to a fundamental shift, or flip, in the nature of the ecosystem in the medium run. After the recovery of the early 1960s, the events of the Cultural Revolution and of the Reform and Opening period constituted a series of shocks at different scales that have not led to any more system-wide flips, but may be testing the resilience of the post-Great Leap Forward system in the same way as the pre-GLF system was tested by the events of the 19th and early 20th centuries.

It seems to me that the focus on the Cultural Revolution in contrast to all that came before and most of what has come after is a direct result of who writes history, whether it be the successful US citizens who have written such varicolored works as *Wild Swans* (Chang 1991)*, Red Azalea* (Min 1995)*, Spider Eaters* (Yang 1997), or even *The Man Who Stayed Behind* (Rittenberg and Bennett 1993), or the faceless bureaucrats in the Ministry of Education who are writing the colorfully-illustrated history primers for China's newest generation, the grandchildren of the Red Guards. These people are far from the earth, even if they were forced to be near it between 1969 and 1976. Those who have always been closer to the earth would have seen things differently; we get a hint from Gao Mobo's *Gao Village*, for example. This is not to deny the very real suffering visited on the intellectuals and others during the Cultural Revolution. But it is to question whether this should be the whole story; other horrors also haunt the historiographic imagination. On the whole, Chinese history is written by, for, and about the intellectuals or the intellectuals' imaginations of the people on the land. So far, the earthbound subaltern has barely been heard. And of course I do not intend to speak for her. What I do intend to do is to fill out the ideas put forth by the

intellectuals of Nanshan with content that combines science and history.

Socioecosystems, Social System Models, and Ecosystem Models

Calling for an ecosystem analysis of recent Chinese history is one thing; doing it is quite another, and quite complex. In this section I introduce and eclectic subset of the wide range of concepts and theories that might be useful in bringing such an analysis to reality.

We begin with the idea "complex human ecosystems" as a subset of the more general category of complex adaptive systems, nicely if not briefly summed up by Thomas Abel (2007: 56-57), following Simon Levin (1998) and others: "material and energetic self-organizing systems that are multiple-scaled in space and bounded in time, exhibiting complex dynamics that includes pulse, collapse, cycle, and chaos. As ecosystems, they are spatial entities that capture and use energy and materials, structured by information from many scales. As complex systems they are self-organizing phenomena with emergent properties. As "human ecosystems," they are dominated by the material assets, social organization, and culture models at their disposal."

In looking at complex human ecosystems, we begin to bridge the two-cultures gap. We see the parallels and interactions between social theories and ecological ones. On the social side, we have concepts from theories such as the central-place and core-peripery models used to such lasting effect by G. William Skinner and his students (Skinner 1964-65, Skinner 1985, Skinner Hendrickson and Yuan 2000), as well as the great variety of world-systems theories made famous by Wallerstein, Frank, and numerous of their followers (for example Chase-Dunn 1998, J. Friedman 2007 etc). The most important spatial concepts derived from the conjunction of these two sets of theories are three: First, human systems are systems of nested systems involving cross-scale interactions, just as the market towns and their hinterlands form an interlocking, hexagonal grid. Second, any system or sub-system, wherever it sits in the hierarchy of systems above and below it, has a core and a periphery, and interactions of whatever sort between subsystems in the core and those in the periphery are asymmetrical in terms of their exchanges of people, goods, and information. Third, the structures of the hierarchies of nested systems differ depending on what kinds of things are being exchanged,

as exemplified by Skinner's discussion of the overlain but different structures of marketing and administrative hierarchies of Late Imperial China.

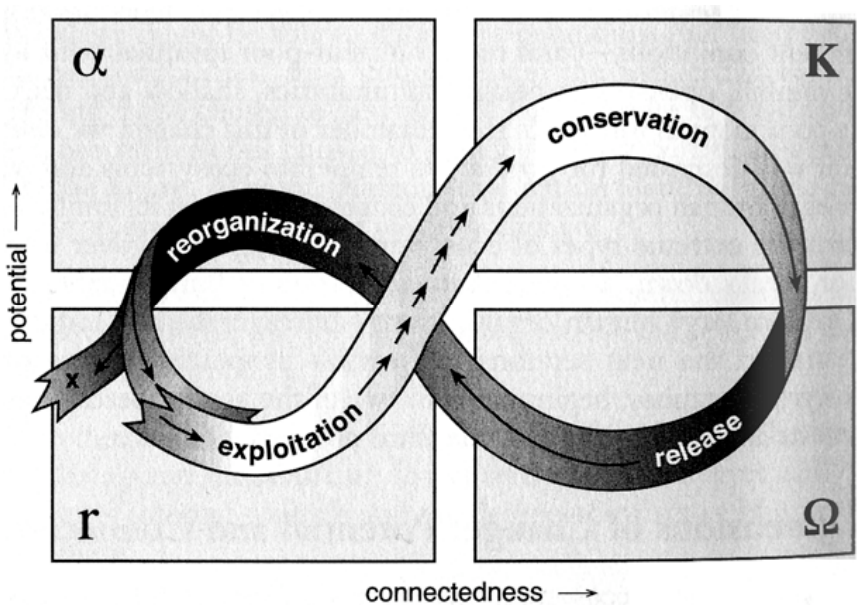
On the ecological side, there are fairly direct counterparts to these social ideas about nesting, core-periphery, and functionally-different structures within systems of systems. Both nesting and core-periphery ideas are useful, for example, in looking at watersheds as ecosystems; each watershed has its sub-sheds that drain into it and is in turn the sub-shed of a watershed at any but the highest level. And because water, at least, moves downhill, there is a built-in asymmetry to flows of energy, water, nutrients, and organisms between upstream and downstream parts of the watershed. But if we look at the watershed structure of an ecosystem alongside the structure of patches within the system, we will find they do not map exactly onto each other, no more than the administrative hierarchy maps exactly onto the marketing hierarchy of local systems. In fact, not only does Skinner occasionally use the concept of ecosystem as both metaphor and context of his local-systems analysis, in fact the 10 macroregions and most of the delineated subregions in his spatial models of China were initially based on watershed structures, though further analysis has indicated that sometimes trade routes and administrative influences overruled strict topography in structuring the flows of people, information, and goods in and out of markets and their peripheries. This has, of course, in turn, strengthened the point that different functional hierarchies are differently structured, this time broadening the systemic scope of comparison to include both systems delineated by social theories and those delineated by natural science theories.

The spatial aspect of complex human ecosystems, when taken by itself, is the easy part. But no system stands still. Socioeconomic systems and ecological systems all have their temporal dynamics, and it is not only because we are dealing with history here, but also because we are dealing with reality, that we need to consider how systems pulse, evolve, change, and transform over varying time scales. Any system at any spatial scale changes in different ways over different time scales in response both to its own inner dynamics and to disturbances that affect the system from outside. One way to put any spatial model into realistic, temporal motion is to consider a series of concepts in turn: cycling, emergence, disturbance, predictability, surprise, sustainability, and resilience. By considering any particular system in light of these properties, and then looking at the ways different actors

have used or ignored the reality of these properties in their actions on and within the systems, we can come closer to understanding the historical processes of China since the middle of the 20th century.

Cycling. Every system has its periodicities at different temporal scales. An agroecosystem experiences cyclical differences in the rates and directions of the flows of solar energy, nutrients, and water over the course of a year. These cycles are driven by a combination of changes in the amount of solar energy reaching the system both through direct insolation and through conduction by air and water, as well as by the genetic predispositions of the various species to grow, mature, reproduce, and decay. Similarly, the cycles of budgeting, tax collection, and expenditure work themselves out over a yearly fiscal cycle. But as we can all readily observe, things are not the same from the peak of one cycle to the peak of the next. Water temperatures in the North Pacific undergo not only yearly maxima and minima, but also decade-scale oscillations in the height and depth of those maxima and minima, and these, in turn affect the major distribution of economically and ecologically important species of fish (Mantua et al. 1997). Similarly, the yearly rounds of legislative and administrative activities of US federal and local governments are distributed over longer cycles of quadrennial elections, and possibly also across cycles of alternating dominance of the two major parties, whose periodicity is different at different scales. These, in turn, are superimposed on cycles of ascendancy of the two political parties, which alternate in at fairly unpredictable, decadal scale pattern analogous to, but probably not caused by, the Pacific Decadal Oscillation in ocean temperatures (Kevin Phillips?). At even longer scales, we have climate variability on the order of the Medieval Optimum of approximately 800-1300 and the Little Ice Age of 1550-1850, or the famous Dynastic Cycle of Imperial Chinese history.

Recently, the work of C.S. Holling and his followers has posited a particular form of cycling, perhaps applicable to all kinds of social and ecological systems, and known as the Adaptive Cycle. Illustrated in the diagram here,



Source: Gunderson and Holling 2002: 34.

it consists of two "loops" and four phases. The "front loop" is the growth part of the cycle, consisting of the r phase of "exploitation," as a system is organizing its resources and building more complex structures and sub-systems within it. Eventually, in a kind of inflectional transition characteristic of logistic growth (which can be seen, in fact, as another way to model the front loop of the adaptive cycle), the complex organization of the system, and the concomitant locking up of resource flows into ever more rigid structures, leads to the K or conservation phase, when the system requires all its internal and external energy inputs just to maintain itself, causing it to become rigid and lose resilience (see below). Less and less impervious to major disturbances, the system loses its ability to restore itself, and when a shock is big enough, it enters the "back loop," and transforms or collapses into the rapid and destructive release phase, only to reorganize itself, usually in a somewhat different form.[5]

[5] fn. The similarity of the Holling cycle to the materialist dialectic of history posited by Marx and his followers, as well as to and Stephen Jay Gould's "punctuated equilibria" model of the evolution of species, probably deserves an entire article in its own right, but here I merely note the intriguing formal commonalities without implying any lack of substantive differences. There are also other versions of ecosystem cycling by the Odum family and others that are similar to Holling's model. For simplicity here, close attention to just one model will suffice.

Emergence. Emergence has both a scalar and a temporal meaning, both of meanings emerging (why not?) from a process that is an important part of the exploitation phase of an ecosystem or other cycle. Namely, there are properties of any system at a higher scale that are not a simple additive function of, and cannot be explained totally by, processes at a lower level. The conception of emergence is directly opposed to that of reductionism, and posits, for example, that the properties of living systems--cells, tissues, organisms, ecosystems, cannot be predicted even if we know everything about the physical and chemical properties of the atoms and molecules that compose the living systems. These properties of living systems emerged historically as part of the process of the evolution of life, of species, and of ecosystems involving the interactions of multiple species. A social parallel can be found in the workings of states, which emerge de novo in the historical process of pristine state formation (Fried 1967), and cannot be predicted either from the psychological or physiological characteristics of the humans that inhabit the states or from the social organization of the villages, tribes, and chiefdoms out of which the states emerged.

In other words, when a system organizes or re-organizes itself at the beginning of an ecosystem cycle, properties emerge that were not there previously. Moving back to the three spatial dimensions of the space-time continuum, this means that a higher level adaptive human ecosystem has properties that do not exist in its component systems at lower levels. For example, the flow of exchanges between patches within an ecosystem (forests, meadows, cultivated fields, wetlands) has characteristics different from the flow of exchanges within any particular, relatively uniform patch. In a more sociopolitical vein, the environmental protection bureaucracy in China began at the central level (Jahiel 1998) out of the perceptions of leaders and intellectuals at the national level who "saw the big picture" of interconnections between local ecological phenomena.

What emergence means for the study of cycles is that the workings of cyclical phenomena will produce deviations in any particular cycle, that feedbacks within a system will not be entirely negative, that the system is liable to change from aspects of its own inner workings that emerge out of the internal processes themselves, without any outside disturbance. Again, we see a similarity here to the Hegelian-Marxian dialectical idea of synthesis--something new that emerges out of the thesis-antithesis interaction.

Disturbance. Of course, no system evolves only as a result of its own internal processes, even those that are emergent in comparison to lower levels. Because all systems are part of larger systems, they all react to changes coming in from outside. Even the biosphere reacts to yearly changes in insolation as well as those correlated with the sunspot cycle. We can refer to exogenic influences on any system as disturbance.

Any major disturbance will disrupt or alter the course of the adaptive cycle of an ecosystem. A natural disaster or an invading army--I always liked the Chinese phrase 灾害 which explicitly lumps natural and man-made events into the single category "disaster,"--may cause the collapse of a civilization or a major polity--as drought has been posited as the cause of the collapse of the Classic Maya (Diamond 2005) or the First World War collapsed three major empires--or perhaps only of a local socioecosystem, as Hurricane Katrina appears to have done in New Orleans. Even though systems are thought to be most resilient during their exploitation phases, the cycle can be aborted even then, and sent into a premature backloop, by a disturbance if it is major enough.

But what is most intriguing for our analysis here is the "intermediate disturbance" hypothesis, which has been applied to ecosystem dynamics since the 1970s (Connell 1978, Grime 1973). This states that intermediate levels of disturbance, as represented in the most classic case by intermittent fires in Western US forest ecosystems, actually promote diversity and thus long-term resilience within the system. Applied more broadly, this calls into question the post-modern "deep ecology" or "eco-fascist" notion that humans are always a problem for ecosystems. It has been shown quite conclusively that human-managed ecosystems can contain greater amounts of biodiversity (and hence be more resilient) than systems in the same location unmodified by humans (Peña 2005: 90). This suggests that a certain amount of human management of a system may promote long-term stability and/or resilience. In terms of the Holling adaptive cycle, this can be seen in terms of intervention during the front loop of a system's cycle, retarding the otherwise inevitable inflection and process toward the brittle conservation phase. This finding this extremely important when we are dealing with a territory such as China that has such a long history of intensive human exploitation.

Predictability. The most important thing to remember about adaptive human ecosystems as complex systems is that they are complex; involving a huge number of inputs (energy, water, nutrients, policies, prices), and actors (individuals, species, patches, subsystems, institutions). To model such a system mathematically is, at the current state of our knowledge and our computing capacity, impossible; we must not only do the usual simplification that is part of any modeling process (Levins 1966) but also with the fact that it is impossible even with considerable sophistication to predict the behavior and future values of even a key subset of variables in the model. This has been demonstrated repeatedly in attempts to predict, and to manage on the basis of predictions, such ecosystem components as fisheries (Francis n.d. Holling and Meffe 1996), when the emphasis in management is on the maximization of a single variable. A pair of recent critics has even gone so far as to label environmental management modeling nothing more than "Useless Arithmetic", which so oversimplifies the web of variables in a socio-ecosystem that in can never consider enough factors to make a reliable prediction (Pilkey and Pilkey 2007).

Out of the experience of this kind of failure of prediction and management has come the idea of "second-stream science" (Holling and Meffe 1996), the idea that the goal of system modeling and prediction is not to be able to foretell the state of a system at some determined point even in the near future, but rather to set forth plausible ranges of key system variables, or, in another version, to formulate a series of plausible scenarios for the future state of the system.

There are parallels here between the move away from such one-variable models as Maximum Sustainable Yield in Fisheries, and the rejection of the social-engineering models of High Modernism from architecture—Crystal Palace to Bauhaus (Berman 1982, Harvey 1989) to the designed utopian societies promoted by Communist Parties everywhere in the world, including China. Not enough can be accounted for; too much is left hanging loose that might go wrong, and this, if it does not guarantee failure, at least makes any particular planned outcome very unlikely. Another way to conceive of this is that the Chinese Revolution was an adaptive cycle that had an unusually short r phase (for a system of such great spatial scope and complexity) of exploitation, because its structures consolidated and

locked up energy and human capacity so tightly, that it quickly entered the brittle phase of consolidation, and became extra-vulnerable to shocks extra-quickly. But more of this below.

Surprise. Because human adaptive ecosystems are so complex as to be unpredictable, it follows that certain changes are going to be unforeseen in any model we can possibly formulate, apply, or comprehend. And so no matter how much we plan for contingencies that we can foresee, there will be others, and these are what Lance Gunderson (2003) calls "ecological surprises." Hurricane Katrina was one such; despite the best climate models and models of levee strength and storm surges, no one could predict a hurricane of exactly that magnitude, let alone the convergence of climatic, social, and political factors that led to the events they way they unfolded. The outbreak of World War I, just when the Europeans were feeling a new era of peace, prosperity, and harmony was upon them, is another example of a surprise. Not all major ecosystem changes fall into this category; some are results of the conservation phase of the cycle coming to the point where any large-scale disturbance will cause a major change of state in the system. But as long as systems are unpredictable, surprises will happen.

Sustainability. This is probably the most over-used, over-defined, and in the end potentially meaningless term in the whole lexicon of environmental studies. But, as I once facetiously suggested, sustainability is like God, not only because if it did not exist, people would have to invent it, but also because people worship it.

A Foucaludian genealogy, or perhaps more modestly just a detailed etymological history, of the term sustainability is long overdue, but we will have to content ourselves here with a brief set of issues. First, the term came to its greatest prominence after 1987, when the long outcry of the eco-activitists (Leopold 1949 , Carson 1962, etc), that we could not go on like this--and this was before there was much attention to climate change--reached the mainstream in the so-called Brundtland Report, Our Common Future, which defined the term "sustainable development" as "development which meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland et al. 1987:), a laudable if possibly internally self-contradictory goal.

The whole idea in a nutshell is, of course, that change is bad and change is good. Development is necessary, and has been since the 1950s, because people are poor and because this poverty is accompanied by asymmetry between the rich and the poor. Even if there has been argument between developmentalists and world-system theorists over the causes of this asymmetry, everyone agrees it is a bad thing. But to change it means to increase the per capita use of resources which, along with the growth in population--which had just barely reached its own inflection point when Brundtland and her colleagues were writing Our Common Future, meant an "unsustainable" pressure on renewable and unrenewable resources.

Still governments and international organizations, and this includes very much both the CCP state and the United Nations, while recognizing that resources will be exhausted quickly by the continued increase in rates of use, and refusing to give up the social justice ideals implied in the concept of development, quickly latched on to "sustainable development" as a mantra, a possibly Orwellian move toward fixing a thing by fixing the vocabulary for the thing. The rather absurd results are graphically and sometimes hilariously demonstrated in Li Yongxiang's work on sustainable development in Yunnan (Li 2005).

If we want to talk about sustainability in any rational sense, however, we need to ask the questions of what is to be sustained and for how long. Are we sustaining a level of consumption, a level of resource extraction, a rate of growth, the existence of an adaptive human ecosystem? And on what time scale. Almost any ecosystem can be sustained for a year or two--the Great Leap Forward was a success in increasing food supply for the one season of 1958--and we are not wise enough to know whether we can or cannot sustain anything for a millennium. The proper time scales for thinking about sustaining any of these things are from a few decades to a century or two, but the combination of resource depletion and climate change (not unrelated phenomena, of course), make this seem unlikely. As pointed out to me by my colleague Eugene Anderson, however, many local ecosystems were sustained quite successfully for hundreds of years; perhaps it is not the concept of sustainability but its application to current rates of consumption that makes it into an absurdity.

Resilience. The last in the long string of conceptual tools we need to re-examine recent

Chinese history is resilience, another concept that grew out of the work of C.S. Holling and his students and followers, and one that has given rise to a minor scholarly association of its own, the Resilience Alliance (http://www.resalliance.org/1.php). The Resilience Guys, as they are sometimes referred to, begin by defining resilience as the ability of a system to absorb disturbances and return to a functioning state. This concept is deliberately vague because of two dangers of making it too specific. First, ecology has gone beyond the ideas of system equilibrium and of succession to a mature state. If a disturbed system always returned its exact previous state like some ecological 不倒翁, we would have no need for all these fancy concepts, and could go on studying Chinese history as if only the intellectuals and their 1966-76 sufferings really mattered. The Resilience Guys replace the 不倒翁-type concept they call "Engineering Resilience" with a broader one of "Ecosystem Resilience," in which the idea of return after disturbance to the status quo ante is replaced by that of return to a functioning state (Gunderson and Holling 2002: 27-28).

But this concept is difficult to grasp clearly. Every system returns to a functioning state eventually; the question is really the extent of the release and reorganization that is necessary before the functioning of the exploitation phase can start happening again. A system which returns to a state very like the previous one, without much loss of organization or function, is more resilient than one which goes through a long period of release and reorganization, "flipping," to use Holling's original term, to a state very unlike its previous one.

Exactly which features of a system promote resilience is a topic for discussion, but two of them seem especially a propos here. One is functional redundancy, in which the elimination of one actor or set of actors from a system (such as the local extinction of a particular species) can be compensated for by another actor or set of actors (Low et al. 2003). The other, closely related characteristic is diversity, whether it be genetic diversity within a species, or species diversity within a patch, or patch diversity within an ecosystem. Diversity reduces the chance that a disturbance will wipe out an irreplaceable part of the system and knock the whole system out of functioning. Social and technical parallels are easy to find in everything from Boeing airplanes (triple redundant navigation controls) to heterarchic approaches to organization for environmental restoration (Walker and Salt 2006).

Consequences of these Concepts. It is my semi-informed opinion that a culture or a polity

whose thinking and behavior tend toward management of their ecosystem for medium-term sustainability, for ecosystem resilience, for diversity and for redundancy, is likely to endure longer with less of the inevitable human suffering of large-scale release and reorganization, than a culture or polity whose thoughts or ideologies ignore or, worse, oppose these concepts. Anthropologists and ecologists have recently been collecting examples of systems of what they call TEK--traditional environmental knowledge or traditional ecological knoweldge--that possess these characteristics, that specifically mandate and guide sustainable resource use and ecosystem resilience (Berkes 1999, Turner 2005, etc.) These systems tend to posses characteristics in common with the more scientifically formulated systems of ecosystem thinking and resilience thinking. And they are opposed, in many of their formal and substantive characteristics, to systems that arise out of modernist ideas that the world, or any human adaptive ecosystem within it, can be remade, redesigned, re-engineered to maximize one particular variable, whether it be something as specific as the steel production of the Great Leap Forward or the Grain production of the Cultural Revolution, or whether it be something more multifaceted such as Gross Industrial Product or Aggregate Personal Income.

Such modernist developmentalist ideologies dominated the thinking of the 20th century. Stalinist socialism (which was the only kind that actually had a crack at "improving the human condition" [Scott 1998]) belongs, along with all the others, in this same category, the category of ideologies advocating the idea that systems--whether they be systems of social organization reducible to class struggle or systems of production reducible to increasing industrial output--could in fact be engineered in a quantitative way. They opposed these supposedly liberating systems to older, more socially entrenched systems that emerged more slowly and organically out of longer processes of history, not only on the grounds that these older systems were oppressive brakes on the progress toward human happiness, imposed by the selfish greed of their respective ruling classes, but also, and more importantly for our analysis here, because these older systems were based on folk systems of knowledge and belief, folk systems that had not had the benefit of science and were thus inferior attempts to understand and thus to manage the world.[6] In some senses the failure of so much of what

[6] Reminding a really old China hand of the argument about Idoeology and Organization replacing Culture and Society advocated by Franz Schurmann in 1966.

was tried in the 20th century was the failure of Holling's "first-stream science," a reductionist attempt to manage and change the world by manipulating a very few variables. It is ironic that what I and my colleagues--all of whom believe in and practice science as a system of knowledge--are trying to do now is to undo the harm that was done to the world in the name of this kind of simplistic "science."

Which brings us, finally, back to late 20th century China. I want to examine a series of case studies, occurring over various temporal and spatial scales, as the clashes between the "science" of "scientific socialism," and the older, less precise, but perhaps wiser ecological and environmental thinking of the ages. In doing so, I do not mean to assert that China should have been left in its late-19th or early 20th century ecosystem state, one that was certainly nearing the asymptote of the logistic growth curve or the most rigid, brittle, and unresilient point of the conservation or K phase of the Holling adaptive cycle. What I do want to assert is two things. First, the way out was not through developmentalism as reductionistic science, and it is still not that direction, but rather in the direction of ecosystem understanding. Second, the focus of Chinese historiography on a single variable, that is the perception of society from the viewpoint of political and intellectual elites, has hampered our understanding of what really went on, and will continue to hamper it unless we start thinking more of China in ecosystem terms. Thanking the reader's indulgence for a long conceptual introduction, now on to the case studies.

Case Studies of Ecosystem Changes in China at Different Scales

1. Great leap forward and maximization of industrial-agricultural output

Centuries-scale Instability and the Turn to Developmentalism. That such a relatively small amount has been written about the Great Leap Forward (see above) is in itself an indication that China studies still pays insufficient attention to an ecosystem perspective. From an ecosystem perspective, however, the Great Leap Forward is the single central event in the history of 20th century China. It was conceived as a developmentalist solution to a long-scale ecosystem problem, it began with a project to alter the ecosystem in a

developmentalist way, and it led to both a short-term ecological crisis and a long-term flip in the Chinese ecosystem as a whole.

This is not to say that China's ecosystem would be fundamentally different if the Great Leap Forward had not happened. Long before the Great Leap, the Chinese ecosystem was in a fragile state, a Malthusian squeeze on resources that had been brought about over the course of centuries by a series of connected and well-understood phenomena. Population growth, having experienced a long-term upward trend from the Han Dyansty through the late Ming , suddently exploded in the Qing period (Harrell 1995, Lee and Wang 1999, etc.), attributable at least in part to the introduction of New World cultivars such as corn, sweet potatoes, and potatoes, that enabled areas that were previously left in forest, grassland, or wetlands--all of them providing important ecosystem services--to be cultivated, and thus enabled an upturn in fertility over a scale that ranged for about a century and a half after the founding of the dynasty. In many areas, however, the conversion of such ecosystem reserve lands to cultivation meant a downturn in the resiliency of the local or regional ecosystems. When disasters struck, the local ecosystems were no longer buffered against medium-term changes, such as erosion and loss of land to deforestation, or greater susceptibility to floods and droughts.

In addition to the population squeeze, institutional breakdown beginning in the late years of Qianlong also meant that the social institutions that were themselves set up as insurance against disasters--such as the granary system and the system of river conservation management--were no longer able to deal with local natural disasters, turning these disasters into ecological and demographic calamities.

This situation of ecosystem instability in the late stages of the consolidation phase of the adaptive cycle probably lasted for about 170 years or so in most of China Proper, with of course enormous regional variations in the frequency, duration, and severity of the environmental crises and ensuing famines and social unrest. An unbuffered ecosystem and an unstable sociopolitical system fed on each other, but there was just enough resiliency left in both that they managed to stumble on in that state through rebellions, revolutions, wars, famines, droughts, and other sorrows, until consolidation of the sociopolitical system by the victory of the Communist Party in 1947-1951. The CCP then began the sensible, even

necessary task of trying to eliminate the instability in the ecosystem.

To do this, the CCP turned to a developmentalist program. As I mentioned above, their program for development both shared characteristics of other developmentalist paradigms and differed from them. In the broadest sense, the Communists were part of the general 20th-century modernist ideal that the world could be remade to the benefit of humans by building rational systems of production that would meet the twin goals of increasing the amount of resources available for human consumption as they cycled over various time periods through the ecosystem, and decreasing the short-term variation in availability of these resources to individual humans and human communities. In this, the CCP was very little different from the economic development or modernization theorists that dominated Western discourse in the post-WWII period. But at the same time, the CCP developmentalist paradigm differed from the Western one in two ways. First, it was committed to egalitarianism, considering redistribution to be an important means to meet the goals both of increased resource availability and decreased variation in that availability. Second, it inherited an earlier Chinese ethic of the mobilization of water resources as a means to political power.

The first task was to damp out the variations caused by ecological and political instability, as well as those caused by economic inequality, and the Communists turned in the early 1950s to two programs to accomplish these goals. The first, about which an enormous amount is written, was the series of changes in property rights that proceeded from the 1947-51 Land Reform through the 1956 full collectivization of agriculture. The second was what have euphemistically been called "water conservation" programs, in attempt to both make a larger amount of surface water available for irrigation use through storage in reservoirs and controlled release, and to damp down the variations caused by rainfall irregularities through much the same means. Irrigated area in China increased from about 17% to 25% of the total cultivated area between 1949 and 1956 (Smil 1993:45).

It will require further research with lots of primary sources to assess the effects of the sociopolitical and infrastructural changes of the 1949-57 period on resource sustainability and ecosystem reslience. My preliminary guess is that the sociopolitical changes, including not just changes in property rights, but more importantly re-establishment, in a more technologically advanced manner, of some of the social buffering services provided by the

Qing before the late 18th century, probably took little away from the resilience of the system, and in fact probably established the important kinds of buffering services against local famine and other kinds of system breakdown that are considered so important by theorists from Lance Gunderson (2003) to Amartya Sen (1982). By re-establishing the ability to transport food and other necessary goods from one sub-system to another, this increased the resilience of local systems to local ecological surprises (Gunderson 2003). The short-term impact of the increased irrigation was undoubtedly positive, as reflected in increasing grain-harvest figures, and even increasing *per capita* output in spite of rising population, for the 1949-57 period (Perkins 1969: 34); the potential long-term effect is impossible to assess because of what happened next.

Developmentalism Gone Mad or Developmentalism's logical conclusion? It is easy to write about the "madness" of the Great Leap Forward. Everything from doling out enormous amounts of free food for supposed free-riders in production brigade cafeterias, to farm families turning in their woks and stir-fryers to make enough steel to surpass England, to crops planted so thickly they could serve as impromptu benches for farmers to rest on during their infrequent work breaks, to preventing conception by swallowing tadpoles, to millions of semi-literate short-stories, all speak to the blue ant mythology that has grown up around the event. It is also easy to write about the immediate tragedy of the Great Leap Forward. "The Greatest Famine in World History," with anywhere from 16.5 to 30 million deaths in excess of those that would be expected from the mortality rates prevailing in the previous few years, is also no exaggeration (Banister 1987, Smil 1999). Harvests that dropped nearly in half from 1956 to 1960, requisitions to feed the urban population even from villages that were already short of their own food, the compounding effects of the "3 years of natural disasters," which although exaggerated by the official accounts and by no means the cause of the famine, nevertheless had magnified effects because of the way resilience was taken entirely out of the system by the policy changes, all are facts about the period that are widely documented.

The causes of the famine are still being argued, sometimes in what I consider rather unproductive ways. Václav Smil put it well, as usual, in his 1999 article: "But no amount of additional information and no new and more sophisticated demographic analyses can change

the fundamental conclusion: Mao's delusionary policies caused by far the largest famine in human history. Yet in contrast to other great famines of the 20th century (Ukraine 1932-3, Bengal 1943-4), the causes of the Chinese famine and an attribution of responsibility for its depth and duration have never been openly discussed in the afflicted nation. Beyond a narrow circle of China experts, the famine has also been virtually ignored by Western scholars and politicians." But whether it was "utopian urgency" as Judith Shapiro maintains (2001: 67-93), the "bandwagon effect" of bureaucratic polity, as espoused by Dali Yang (1996: 67), or the simple policy of collective mess halls, advocated by Chang and Wen (1997), we can understand it better if we trace it to a deeper cause in a developmentalist understanding of the relationship between human effort and the ability to extract resources from an ecosystem.

Paradoxically, the Great Leap actually arose, I think, from a kind of system thinking. Mao and the CCP leadership were engaging in a particular version of what Holling and Meffe (1996) have called "first-stream science," the application of materialistic ideas about causality to manipulating a system to maximize the short-term output value of one or a very few variables, without regard to the interaction between these variables and the rest of the components that make up the system. Analogous to managing a particular fishery for "maximum sustainable yield," without looking at the effects of this kind of management on the complex food web in which the fishery is embedded (Pilkey and Pilkey 2007, Hilborn et al. 2003), the architects of the Great Leap Forward decided to maximize China's economic output by concentrating on two variables: grain output and steel production. The specific policies deployed in the Great Leap derived from these two goals.

Maximizing grain output meant both increasing the area under cultivation and increasing the yield per unit area. The former led to some amount of deforestation and desertification in marginal lands that probably should not have been farmed, but according to most analyses was not a major component of the Great Leap effort. The latter, however, meant increasing several kinds of inputs. Soil fertility could be maximized by deep plowing--in some places it was reported that people were asked to turn over the soil to a depth of one meter. With this supposed increased availability of soil nutrients, more plants--wheat seeds or transplanted rice seedlings, for example--could be grown per unit area, which led to the second part of the agricultural formula, close planting. But to support all these plants, more

water was needed, and this led to the mobilization of labor to increase reservoir storage capacity in Henan in the winter of 1957-58 (Yang 1996: 36). This, in turn, led to thoughts about ways to increase the efficiency of agricultural labor, which led to the formation of specialized teams, people's communes, the militarization of society, collective mess halls, the idea that true communism was upon us, free food, over-consumption, and consequent shortages, which were exacerbated in the following years not just by exhaustion but by the shoddy nature of irrigation works, most of which did not survive the ensuing famine years.

Ironically, then, but fittingly, the Great Leap Forward and the whole human disaster that it caused were begun with a kind of bad ecosystem science, trying to maximize the output of one variable in the system, and rather than realizing that this would lead to the disruption of other variables and to a system state that was not at all sustainable, even on a scale of a few years, manipulating many other variables in the system in service of maximum output of that variable. Altering the course of water through various systems, both in traditional dry-grain and traditional rice-growing regions, set in motion a chain of events that led to the eventual calamity of Dali Yang's title.

The other goal of development in the Great Leap Forward, the maximization of steel production, proceeded similarly, but with much longer-term effects. In order to maximize steel output (which would do for industrial production what grain output would do for agricultural production), not only did collective labor have to be reorganized, but also fuel had to be procured to run the furnaces. And since in many areas traditional steel-making fuels such as coal or coke were unavailable, the authorities turned to wood to fire the furnaces. This meant large-scale deforestation in some areas; Richardson (1990) estimates that 30% of the forests standing in Henan in 1957, for example, and 10% of the much larger forest supply in Sichuan, were clearcut in service of the goal of maximizing steel output (I discuss the local effects in one valley in Sichuan in Case 3 below).

The misguided understanding of the way ecosystems work at local and larger regional scales certainly led to "the greatest famine in world history." But if this were the whole story, I would not have called the Great Leap Forward the central event of 20th-century Chinese history. 30 million excess deaths were quickly made up for by a fertility bump starting as soon as 1964 ( ); steel production did, after all, reach and surpass United Kingdom levels: in

1992, China produced about 6 times as much steel as the UK (UK Steel.org), and grain production, once it recovered from the historic lows of 1960, quickly made great strides toward record heights in the 1970s and 80s (though at some cost in ecosystem resliency, as discussed in Case 2 below), to the point where, as Gerhard Heilig's wonderful web page demonstrates, if things are handled properly in the next few decades, China can feed itself in the long run (Heilig 1999).

Longer-term Real Ecosystem Effects. The important, long-term effects of the Great Leap Forward are those on the ecosystem, and they are things that China cannot easily recover from, even if it can continue to feed itself. The key variable here is the loss of forest cover. Looked at in the aggregate for the country as a whole, the situation appears not to have been particularly dire. Although we do not have very reliable statistics, Fang et al. have demonstrated that from 1950-1962, the total area of forests in China fell by a net of about 5%. But this is a net of area lost and area replanted, and in fact the area lost was mature, old-growth stands, meaning that the amount of carbon lost to the atmosphere was more like 10%, and also meaning, in not very quantifiable terms, that forests in a lot of areas were converted from multi-species to single-species plantations, with a large accompanying loss in biodiversity.

The situation in northwest Yunnan, one of the country's most heavily forested areas, is aptly described by Weyerhaeuser et al.: "Historically, in the lower areas of the watershed, from the river level (between 1200 and 1900 m.a.s.l.) up to mid-level elevations (2500 m.a.s.l.), agriculture – including various forms of swidden as well as sedentary agriculture once created a diverse landscape mosaic. However, population pressure and agricultural expansion – often aided by the extreme pro-cultivation policies of the Maoist era – have led to a decrease in tree cover on lower slopes and have opened up marginal land, often on steep slopes." This has led to erosion, a great increase in sediment loads (Amanda Henck, pers. comm), and has perhaps contributed to the frequency and severity of downstream flooding

And unlike the policies of extreme communization, deep plowing and close planting, or local steel production, which were recognized as follies as soon as a few tens of millions of people had starved to death, the depredation of forests continued well into the 1970s, when

both forest cover and carbon volume continued to decrease. There was an upturn in forest cover in the 1980s, but again this is misleading, at least in the short run. In the mid-1990s, the Ministry of Forestry changed the definition of a forested area from one with 30% tree cover to one with 20% tree cover; figures can be adjusted for this, of course, but it results in the inclusion of lower-quality land in the overall statistics.

Once forests are gone, even if they are replaced by reforestation projects of dubious utility (Weyerhaeuser et al. 2005, Trac n.d.), this alters the way ecosystems function at a variety of scales. One of the most dramatic of these, of course, was the floods of 1998 in the Middle Yangtze macroregion, which were the most destructive in decades, and were widely attributed to deforestation in the Upper Yangtze region, resulting in a region-wide ban on large-scale logging in that part of the country beginning in the fall of that year.

The "water conservancy" programs of the Great Leap Forward period have also continued unabated; when dams built hastily at the time with unstable materials (i.e. mud) by unskilled labor quickly gave out, they were replaced by better-engineered, more expensive and durable water projects, which led in many cases to rivers that run dry for most of the year (Wang 1999). In addition, starting from that time, dams were built with regard to maximizing a particular variable (as hydroelectric power generation in the case of the famous Sanmenxia dam in 1957-61 (Shapiro 2001: 48-65), often without regard to how well they would work in particular environments; the controversies over the world's largest hydroelectric dam at Sanxia on the Yangtze, now nearing completion, have echoed the fact that this kind of mentality that refuses to consider the systemic effects still persists from the Great Leap Forward Era (Dai and Sullivan 1999, etc.).

Implications.

It is clear that the Great Leap Forward is a test case of an ecosystem surprise, a rapid shift from a system that was maintaining itself in the consolidation phase of the adaptive cycle, perhaps backing off from the edge of disaster and adding some resiliency through judicious conversion of resources to human use, when it was sent into a rapid phase of release, a chaotic time when nothing worked. The chaotic and rapidly changing nature of human suffering at that time can be looked at as typical of an ecosystem in the omega, or release phase of the adaptive cycle. Things then reorganized themselves, but they were not the same; both the

biophysical and the institutional factors that existed in the mid-1950s had been transformed by the system's rapid loop (Yang 1996).

In ecosystem terms, we can thus say that China is a post-Great Leap world. Even though the so-called "excesses" that are so easy to make fun of went away quickly, and even though the famine eventually stopped--as they all do[7]--China does not work the same way anymore. The ecosystem services that were provided by wetlands, forests, fallow areas are no longer there as buffers that insure the system against the effect of shocks. They have, instead, been replaced by artificial enhancement of the ability to cycle system resources through the humans. They work, but they are apparently quite fragile by comparison with the former system.

This is not all bad; this is not intended to be a paper about gloom and doom. The point here is that we have entered a different basin of stability or ecological regime. Buffering against local surprises is achieved not by local patch diversity or crop diversity, or by the obviously impossible measure of keeping population well below carrying capacity; rather buffering is achieved by greater control over particular resources (as when soil fertility is restored with chemical fertilizers or water is captured by dams and held in reservoirs until it is needed or until it can be released slowly to prevent floods), and by the increased interdependency of subsystems within the system (as when water is to be transferred from the Yangtze to the Yellow River drainage or food from a region producing a surplus is exported to a food-deficit region [Berkoff 2003]). In the time scale of decades, given the high-level Malthusian squeeze that we began with before 1950 and the population growth since then, some version of this combination of local efficiency and intra-subsystem dependency was probably necessary, and has meant a more comfortable life for many people. There probably were other ways to get to this point that would have been much less destructive than the route through the Great Leap, and that would have made the inevitably altered environment more pleasant to live in. But one can live there now. What we don't know yet is how resilient it might be to internal pressures such as the decreasing per capita supply of water or to external shocks such as the decreasing availability or rising price of oil, or the decreased possibilities

[7] Reminding me of a saying beloved by one of my wife's teachers during her medical residency: "All bleeding stops." Likewise with famines.

for food imports. But it is clear that the Great Leap Forward marked the turning point that really set the course for the next half-century.

2. Agriculture and Water on the North China Plain

The macro-cycle described in the previous case study certainly affected all agricultural regions of China, and the large-scale disturbances associated with socialist construction and the Great Leap Forward affected all areas within China's borders. But individual regions or sub-systems at various levels have undergone historic ecosystem cycles and disturbances different from those experienced by their counterpart systems. The total ecological history of one of these sub-styesms thus consists of the superimposition of these locally particular histories on the local effects of the national-scale history, in a manner similar to the superimposition of regional economic cycles on empire-wide cycles discussed by Skinner (1985). I want to illustrate this by referring to the recent ecological history of the North China Plain, with particular emphasis on the interaction of water resources and agricultural production.

The region and its water resources: There are several ways to define the region we are talking about here, and the boundaries differ according to the criteria for delineating them, illustrating the principle that ecosystems are not closed systems and do not have readily definable borders. According to Skinner (1977: 214-15), we are talking about the most of the North China macroregion, all of its core areas and some of its southern peripheries. Hyrdologically, we are talking about the Yellow River basin after the river emerges from the Loess Highlands, along with the Hai Basin and the lower Huai Basin , often referred to as the 3-H (Huang, Hai, Huai) basin area (McCormack 2001, Nickum 1998[8]). Administratively, we have almost all of Hebei, the eastern two-thirds of Henan, non-mountainous parts of Shandong, and the northernmost portions of Anhui and Jiangsu, as well as the large municipalities of Beijing and Tianjin.

According to the classifications of the Chinese Ministry of Water Resources, most of

[8] Guys seem to like to make wordplays on "Water Margin," I assume because they have read 水浒传。

the North China Plain falls in either the "perennial irrigation zone," where agriculture always requires supplemental water (defined as the are with yearly average precipitation less than 400mm) or the "unsteady irrigation zone," with rainfall between 400 and 1000 mm per year and, more importantly, high year-to-year variability in rainfall amounts and timing (Lohmar et al. n.d.). In all parts of the North China Plain, however, 60-75% of yearly precipitation comes in the months of June through August (Smil 1993: 40). But because of the as-yet poorly understood yearly variability in the Northeast Asian Monsoon (David Battisti, personal communication), there is is corresponding irregularity and unpredictability of rainfall in the North China Plain area, so that both floods and droughts have been common historically (Smil 1993: 41, 50).

The area's other primary water resource is a ground water, consisting primarily of a complex quaternary aquifer system that underlies both the piedmont plain, which extends eastward from the eastern escarpment of the Taihang range, and the alluvial plain that extends from the eastern edge of the piedmont to the sea (Foster et al 83).

Agriculture on the North China Plain. Agriculture has been practiced on the North China Plain since neolithic times, and for over two thousand years, much of the area has been farmed intensively. As part of the "central origin" (zhongyuan) home of ancient Chinese civilization, it was the birthplace of Chinese water conservancy efforts as well as of much of its agricultural technology, and indeed since the times of the legendary Yu, who tamed the waters and founded the Xia dynasty, political power has been associated with being able to control the water on the North China Plain. At the same time, water control before late imperial times was associated more with flood control than with irrigation in this area; Tuan (1969: 54) suggests that one of the major technological achievements of very early times was the channeling of water to convert marshes into farmland, which was a reduction in both patch diversity and species diversity, but made for more stable agriculture at population densities well below carrying capacity. During the later Han period, floods were the major calamity mentioned in historic sources (Tuan 1969: 84). But by late imperial times the major calamity was drought; this probably reflects climate change less than it reflects the gradual intensification of agricultural production. At a relatively low intensity, diversity of crops probably protects against drought, since some crops can be selected for drought resistance, but

flood envelops everything and washes it all away. As production increases and single staples take a greater and greater proportion of land, there is less room for diversity, and when the rain fails, everything fails. Of the traditional staple crops in the area, winter wheat was dependent on a good spring rainfall, and thus tended to be vulnerable to a late start to the rains, while millet, sorghum, and barley among the traditional crops, as well as the new world cultivars corn and sweet potatoes, are planted in the spring-summer season when rainfall is generally more plentiful if not reliable. Tregear (1965: 222) follows Buck's estimates (1937: 34) that only about 10% of agricultural land on the North China Plain in the early 20th century was irrigated; for most of the North China Plain for most of its history, farming depended on rainfall; most surface water was not diverted for irrigation, nor was ground water pumped for the purpose.

This meant that, despite the high average agricultural productivity for a traditional system, agriculture on the North China plain was very vulnerable to year-to-year fluctuations in rainfall. A time series for several stations from 1880 to 1998 compiled by Yan shows year-to-year variations from under 400mm to over 900mm. At the lower end of this range droughts severely affected agricultural production; there were ten years between 1960 and 1990 when over 20% of North China was reported to have been affected by drought (Qian and Zhu 2001). Major droughts also happened fairly regularly, and caused massive famines in 1877-78, 1920-21, and 1942, along with disastrous floods in 1855, 1887-89, and 1938 (Tuan 1969: 165-66).

Irrigation, Green Revolution, and Food Security. The developmentalist principles that have guided most modern nations' policies in the 20th century, the PRC's among them, lead them to try to insure stable and controllable surface water supplies to guard against droughts and floods. Hence a major effort of the PRC government, beginning in the 1950s, was to transform more of the area of the North China Plain from rainfall to irrigated agriculture (Tregear 224; Smil 2004, Perkins 1973). This was first accomplished by large-scale construction of dams and reservoirs to trap and control surface water, but from about 1968 to 1976 (Smil 2004: 158), tube wells were drilled everywhere to tap the then rather high water table to supplement surface water with abundant ground water for irrigation. This, along with first the import and then the large-scale domestic production of chemical fertilizers, allowed

North China farmers to raise their agricultural yields greatly--they could irrigate a winter wheat crop and then still grow a rain-fed summer crop of corn in many areas, and everywhere they could replace their traditional, relatively drought-tolerant but low-yielding grain varieties with Green Revolution-type varieties that had much stricter input requirements but, when the inputs were available--water and fertilizer--produced much higher yields. As a result, by the end of the collective period, the percentage of irrigated land on the North China Plain had grown to approximately XXX and in the western regions over 50% (Hu et al. 2005) , the area planted to high-yielding varieties was approximately XXX, and the grain output of the region had grown from YYY mt in 1952 to about 68+ mt in 1978 (Hong Yang 1998). From a developmentalist perspective, and also I should stress from a humanitarian one, the stabilization and irrigation of the land of the North China Plain represented a move toward food security for the first time in several hundred years.

Food security, however desirable in its own right, nevertheless conflicted with sustainability and resilience concerns. The hydrological results of conversion to irrigation were three. First, many rivers ran dry in the wintertime; the Yellow River since 1980s has not reached the sea for 120 days or more in however many years. Second and most important, use of groundwater for irrigation began to draw down the water table of the aquifer. In the northwestern part of the North China Plain (the area including the cities of Beijing, Baoding, Shijiazhuang, and Handan), on the piedmont up against the Taihang escarpment, the water table fell over 20 meters between 1960, when the first wells were dug, and the end of the century; in a strip between there and the Yellow River, the deep confined aquifer (which in some places is overlain by a brackish water layer and thence by a shallow aquifer) fell over 40 meters during the same period. In the neighborhoods of major cities, where industrial and domestic uses compound the demands of water for irrigation, water table drops of 60 meters or more were not rare (Foster et al. 2003). In some areas, this led to cones of subsidence, where land drained of its water content becomes depressed around a single well or around a group of wells, as in an urban environment, and with the increasing demands of industry and domestic use, and very little reduction in the irrigation demand, rates of depletion of the North China aquifer range from a half a meter to over a meter per year. As Goodwin (1999, quoted in Lohmar et al. 2004; see also Hu et al. 2005) put it, "If one extrapolates linearly from the

record of the annual decline in ground water from 1980 to 1996, then one could come to the conclusion that ground water resources on the North China Plain will be depleted by 2030." Third, depletion of the fresh water aquifer also leads to seawater incursion in the coastal areas, bringing about soil salinization which could make certain parts of the plain unsuitable for certain crops.

Ecosystemic Consequences. So food security for a growing population came about at the cost of ecosystem sustainability above the decade scale. It is not necessary, of course, to posit that the linear extrapolation from the last four decades of drawdown is the inevitable future of water in the North China Plain ecosystem. Since the current system is not sustainable--the water will run out, sooner or later, unless something is done—two kinds of solutions have been proposed. One can either reduce the demand or increase the supply, and thus balance the equation. There are ways to reduce water use and thus conserve water, including raising water prices to encourage farmers to save, metering water use by both agricultural and urban users, requiring retrofitting of industrial plants for more efficient water use, or switching to crops such as tree fruits which, although they require a lot of water, can be irrigated by efficient systems such as drip irrigation because of their high value-added. Some "gray water" can be reused, and industrial or urban effluent can be cleaned up to make it reusable, a promising route to take since China has very little sewage treatment today, and the measure has public health benefits as well as hydrological ones. Or water could simply be rationed. Whether enough water could be conserved to reverse the drawdown of the aquifer and restore flow to the major rivers is a purely quantitative question that I will not explore in detail here; the best projections seem to indicate that the water table could be stabilized at about its current, undesirably low, level (Lohmar et al. n.d., Foster et al. 2004).

The other way to balance the equation is to increase the supply. Sci-fi solutions such as artificial recharge of the aquifer (from where?) or seawater desalinization (impractically expensive for anything other than drinking water) aside, the way to do this is to bring in surface water from outside to replace or supplement the water from local surface or ground sources. Hence another in China's long line of environment-enginnering megaprojects: the South-to-North Water Transfer Scheme, or *nanshui beidiao* 南水北调. This project, already begun over the objections of many environmental groups, will bring water from the Yangtze

River drainage across the macroregional boundaries into North China by two routes--the so-called Eastern Route along the Grand Canal, and the so-called Middle Route from the Danjiangkou Reservoir on the Upper Han River.[9] Each of these will transfer about 40 Gt per year to the North China Plain, feasible because of the much greater availability of water in the areas south of the Qinling-Huai divide. Surprisingly, in contrast to its sister megaproject, the Sanxia Dam, many relatively neutral observers see the potential effects of the Water Transfer as having net positive effects on the environment; backing away from the current or projected hydrological disasters of the North China Plain is often seen to outweigh the potential harm from building the middle route--raising the Danjiangkou Dam and causing local shortages and minor population relocations in the Hanzhong region, or of the Eastern Route--extra fossil fuel burnt to run the pumps necessary to elevate the water in North Jiangsu and the import of already polluted water to the regions the Grand Canal passes through (Liu 1998, Berkoff 2003).

Ecosystem analysis. So it is possible, at least over the time scale of a few decades, to mitigate the most severe effects of re-engineering the North China ecosystem for higher agricultural productivity, lower year-to-year variability, increased industrial production, and higher urban and rural standards of living. But it is not done without cost, and here I would like to look at the implications of what has happened, and of the ideologies behind what has happened, for understanding the recent history of the North China Plain as an ecosystem.

First, the North China macroregion was already in a phase where it was losing redundancy and resilience by the late imperial period. Particularly with the population growth during the early and middle Qing, the redundancy that leads to resilience was already being taken out of the system. Areas in the flood plains close to rivers began to be farmed, eliminating these areas as natural overflow basins in times of flood, as well as requiring higher and higher levees and more and more dredging, making potential floods more catastrophic, as happened when the Yellow River flooded naturally in 1855 and 1887-88 and artificially in 1937 when the Nationalist armies bombed the dikes in a futile effort to stop the Japanese Army's advance. Adoption of more and more intensive crop regimes, and the

[9] A proposed "Western Route" connecting the upper reaches of the Yellow and Yangtze Rivers in Qinghai, was a sci-fi solution if anyone ever propose one, and has been postponed until way in the future.

tendency away from crop diversity to monocropping also reduced the resiliency of local farms in the face of pest infestations or droughts. Thus we find an increasing frequency of times when natural climate variability led to human disasters, because the buffering capacity of the system--its resilience--was sacrificed in the interests of increasing overall output. The system was brittle by the 19th century, in a state when a major shock might lead to release and reorganization. The North China Plain in the Republican Era shared this characteristic of brittleness with most of the other regions of the empire; unlike its economic cycles, its ecological cycles were in phase with the cycles of the larger system of which it is a part.

Despite its fragility and its vulnerability to shocks, the North China ecosystem appears not to have undergone any fundamental release and reorganization in the last few centuries. And certain modern interventions may, in fact, in the manner of intermediate levels of disturbance, have contributed to the medium-term stability o the system. Adding capacity to surface-water irrigation systems made the overall ecosystem and its human communities less vulnerable to floods, and we can also say that tapping a modest amount of ground water, particularly the unconfined surface aquifer that is recharged naturally at the rate of about 50 mm per year (Foster et al. 2004: 87), contributed to the system's ability to absorb shocks of climate variability, rather than detracting from that ability. Similarly, though the cities of the North China Plain had always been partially dependent on imported foodstuffs from the Lower Yangtze Macroregion (Perkins 1968), building railroads that allowed quick import from other regions in years of drought or flood also buffered the regional system from the effects of climate variability and other shocks.

The real ecosystem problems came with the Green Revolution innovations--new varieties, irrigation, fertilizer, pesticides--which increased the productivity of the system but meant that it lost first its resilience and then it centuries-scale sustainability. It lost its resilience because the high productivity of the new varieties is dependent on all these outside inputs. If any one of them becomes unavailable, the system becomes much more vulnerable to shocks. This could happen for economic reasons--farmers could be priced out of the market for seeds or pesticides, or it could happen because of the disruptions caused by a war or other major political event. But as long as the inputs are available, the system is sustainable in the medium-run. Fertilizer and pesticides, of course, are sustainable as long as

we have fossil fuels to crack nitrogen and manufacture complex organic chemicals, that is, they are sustainable until oil and coal run out, which means at a century scale. So barring a war or other major political upheaval, North China agriculture will have enough nitrogen and phosphorus. Water, however, which is a key piece in this puzzle, is very hard to import (but see above under nanshui beidiao) and there is little room left for conservation, so in order to preserve its high agricultural productivity, the North China Plain must draw down its water table and dry out its rivers. There is no backup in a drought year. It seems certain that water will be conserved by a variety of measures, and that the South-North Transfer Project will be completed, but this puts further strains both on other parts of the regional system, such as industries and municipal water supplies, and also on the nation-scale system that is subjecting itself to further brittleness just by building the transfer canals and committing 40gt of water to North China per year.

Looking at the last 50 years in terms of the adaptive cycle, it seems like the North China system was right at the verge of collapse and release when certain technological innovations increased productive capacity, widening the gap between productive capacity and current population demands, at least for awhile. But population of the area soon closed the gap again, and now the system can only be maintained by keeping in place--or increasing the use of--the technological innovations that were necessary to raise the productive capacity, and making those technological innovations continue to work depends on maintaining the supply of water, which is insufficient, so the aquifer keeps getting drawn down and the rivers continue to run dry. In the situation of current adequate food production nationwide, any major shortfalls that come about short-term because of the disruption of the supply of natural or manufactured inputs, or long-term because there is not enough water, will probably not result in high-level starvation and misery for the human inhabitants of the North China Plain, in contrast to the Great Leap Forward period. One of two things can happen. A short-term disruption can be made up by imports of food and increased imports of agricultural inputs. A long term shortfall in the water supply, unreplenishable by further mining the aquifer or transferring more water from outside--as may happen with as yet poorly understood prospective changes in the East Asian summer monsoon brought about by global climate change--will probably mean a fundamental alteration in the agroecosystem of the North China Plain, moving away

from intensive grain farming to something else. This will be a true system flip, and the new basin of stability into which the system emerges may, if we are allowed to be optimistic, be a more stable and resilient one than the current system.

Historical periodization and cycle resonance across scales. What is interesting from the standpoint of Chinese historiography here is that the North China regional ecosystem history only partially reflects the periodization of China's recent historical trajectory as set out by the hegemonic narrative. Big changes in the direction of better system buffering were indeed probably made in the first five-year plan period, and there were certainly heroic attempts to transform the system by large waterworks during the Great Leap period, which were quickly unsustainable. But unlike the forested areas of the country, which were fundamentally transformed (toward greater instability) by the mistakes of the Great Leap, the North China ecosystem seems to have absorbed this shock with a great amount of suffering and then gone back to what it was previously, slowly increasing its productive capacity. The big changes came during the late 1960s and 1970s, when new, high-yielding, irrigation-dependent varieties were introduced, along with tube-well technology and the necessary fossil fuels to run the pumps and fossil fuel-derived fertilizers to restore soil nutrients taken out by the Green Revolution varieties. During the later years of the Cultural Revolution, the agricultural policy of 以粮为刚 certainly helped this process along, but it had started well before the Maoist radical politics enveloped the country, and its firm implementation crossed the divide from the Cultural Revolution into the Reform Period, and in fact the ecosystem is still proceeding down the same path that was set out for it in the early 1960s, in the case of groundwater irrigation and high yielding grain varieties, or even earlier, in the case of surface water conservancy and delivery programs--the South-North transfer will move about 60 times as much water as Henan's famous Red Flag Canal, but they derive from the same principle of modernistic developmentalism.

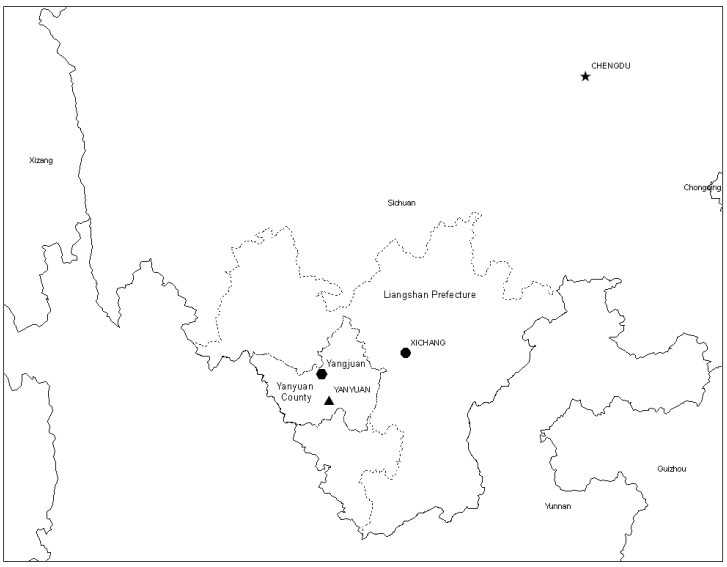
3. Deforestation and other disturbances in the Baiwu Valley.

For my final case study, I want to scale down to the level where an anthropologist is

most comfortable, and talk about the ecological history of a very small place on a very far periphery (Skinner's maps place it right on the border of the Upper Yangtze and Yun-Gui macroregions), the Baiwu Valley in Yanyuan County, Liangshan Yi Autonomous Prefecture, Sichuan. I know this place well from having conducted frequent short-term fieldwork and introduced many students and scholars to the area over the past 14 years. The local ecohistory of Baiwu bears a different relationship to national-scale ecological history than does the larger regional system of the North China Plain, but as a case study it illustrates on a local and detailed level the same principles about cross-scale interaction and historical change. In a nutshell, the Baiwu Valley developed slowly for the last 200 years and was still in a rather unproblematic exploitation phase of the ecosystem cycle for the greater part of the early 20th century, until 1957. It underwent a fundamental flip at the time of the Great Leap Forward, causing a premature and unnecessary move to a rapid backloop of release and reorganization, with widespread privation and starvation from 1959-61, as happened to most of the country including the great majority of places on the North China Plain. But in addition, the local ecosystem shifted after 1961 to a new basin of stability, based on a very different set of relations of species and resources in the ecosystem. The system in this new state has undergone minor shocks but has proved reasonably resilient until the present, perhaps because much of the local people's behavior is still built around the principles of resource conservation and ecosystem resilience that inform their traditional agricultural practice. Hence in this section I want to concentrate on the ways in which a local ecological ethic of resource conservation allowed the ecosystem to continue in a relatively stable mode for over 200 years, and how programs brought in by CCP developmentalist policies disrupted the continuity of the system and brought about the major changes described here.

The Area. The Upper Watershed of the Baiwu River in Yanyuan County, Liangshan Yi Autonomous Prefecture, in the southern part of Sichuan Province, has an area of about 38 km^2 and extends from an elevation of about 2550 meters on the valley floor, to over 3800 meters on the peaks of the Zala Mountain range. The present inhabitants of the upper watershed are concentrated in two administrative villages, Baiwu and Mianba. The part of Baiwu Administrative Village that lies within the Upper Watershed consists of the village settlement clusters of Yangjuan and Pianshui, with about 80 households and 450 inhabitants

each, and Zhuchang and Gangou, with 15 households and about 60 inhabitants each. All inhabitants of the valley belong to the Shynra dialect group of the Nuosu, an ethnic group of about 2 million members who are part of the larger, stated designated Yi *minzu*. The administrative village of Mianba lies entirely within the watershed, and consists of several natural villages with a population of several hundred people. Both Baiwu and Mianba Administrative Villages belong to Baiwu Township, Yanyuan County. Our research has been concentrated in the area belonging to Baiwu Administrative Village.



Map 1: Location of Yangjuan in the Baiwu Valley in Sichuan

The upper Baiwu watershed, because of its high-relief topography, contains several geological and ecological zones. The mountains, which rose originally as part of the overall Himalayan orogeny, are sedimentary in origin, and the valley lies astride a boundary between sandstone and limestone strata. Heavy rains, perhaps aided in recent years by anthropogenic erosion on the mountainsides, bring down large amounts of alluvium, which produces the *ladda*, or plains. The upper part of the *ladda,* extending from Gangou south to Yangjuan and thence southeast to Baiwu, is a narrow flood plain with a braided stream, used by humans mainly for pasture. When the River breaks out onto the wider plain around the villages of Yangjuan and Pianshui, the *ladda* becomes agricultural land*,* suitable for growing the staple crops of corn and potatoes, and also, increasingly in recent years, such commercial crops as apples and sunflowers.

The non-alluvial but relatively flat benchlands to the south of the villages are known as *jjoba*, and at present are cultivated on a two-year fallow cycle, planting potatoes and the other primary Nuosu staple, buckwheat, along with small amounts of oats and wheat. Parts of the *jjoba* have limestone outcrops and are unsuitable for farming; there are also a large number of caves and sinkholes in the karst portion of the landscape.

Above the *jjoba* are the *hxobbo*, or mountains proper, which in turn can be divided into at least four sub-zones according to natural vegetation and human use. The lowest zone, close to the villages at elevations from about 2550 to 2800 meters, was logged extensively in the 1950s and again in the 1970s, and has regrown naturally with a single predominant overstory species, *Pinus yunnanensis*, and a variety of understory species dominated by scrub oak, *Viburnum*, and especially rhododendron. Above this is a belt that was not extensively logged, and is dominated by a mix of larger deciduous trees, again with oak and rhododendron dominant. Human use of this zone is confined to a small number of upland farms and some cutting of wood. Above this, at elevations higher than 3100 or 3200 meters, are open grasslands studded with large, lichen-bedecked oak trees and a few stands of fir and spruce; these grasslands are used to pasture yaks and to grow fodder for the yaks to eat during the winter.

Several different ethnic groups have lived in this area for an undetermined length of time, but our story begins in the late 18th or early 19th century, when the first Nuosu

immigrants from east of the Anning River entered the area, where the *ladda* and parts of the *jjoba* were already cultivated by Prmi people; the Nuosu began practicing shifting cultivation on the lower and middle slopes; which they continued exclusively until the decade of the 1910s, when one family moved to the *jjoba* near the present village of Mianba, and cleared some patches of forest to begin to farm there. By 1957, when the large ecosystem changes began, Nuosu and Prmi were living and farming scattered throughout the *jjoba,* and also farming part of the prime alluvial land in the *ladda (*though many Nuosu remained in the lower mountain zones), while many other parts of the *jjoba* remained forested, and part of the *ladda* was still given over to braided streams and seasonal wetlands. Nuosu also pastured their animals on the upper *ladda*, and in seasonally fallowed and uncultivable parts of the *jjoba*, as well as in less dense parts of the forest. They also used the mountains as sources of wood for fuel and construction, gathering wild food and medicinal plants, and hunting what people now remember as abundant game including several species of small deer, wild pigs, and fur-bearing animals such as bears and red pandas.

Local Nuosu environmental beliefs. It is clear from folklore, sayings, and accounts of traditional agricultural methods that the Nuosu in this area see themselves as ideally exploiting several ecological zones at once, and that their environmental ethics stress resource conservation and using the ecosystem for human benefit as a series of interacting environments and species.[10] They conceive of the annual cycle as divided into two parts. The first begins when the environment wakes up from its winter slumber with the blooming of the rhododendrons and the calling of the cuckoo (called *gubu* according to the same logic as the European word), telling people that it is time to plant corn. From then until the fall harvest first of potatoes, then corn, then buckweat, and finally oats, is the season of growth, when no one is allowed to cut trees or hunt wild animals. After the last harvest in the fall begins the season of decay and killing, when wood needs to be cut to keep the larger winter fires burning, when wild animals can be hunted for food or furs, and when the major occasions for ritual slaughter of domestic animals take place (although domestic animals can be slaughtered for ritual occasions during the growth season as well). This environmental ideal recognizes

[10] It would be interesting to investigate Prmi ecological ideas, but that would have made this paper even longer.

the natural pattern of seasonal growth and decay, and prescribes adapting human activity to this pattern.

These seasonal prescriptions and proscriptions for human activity are part of a more general ethic of resource conservation. I refer to this attitude toward natural resources as Paleo-Pinchotism, after the early 20th-century conservationist and founder of the U.S. Forest Service Gifford Pinchot, who stressed conserving the supply of natural resources for sustainable human use. Nuosu *lurby*, or parallel sayings, illustrate this attitude toward resources in a metaphorical and poetic manner, stressing the parallels between the continuity of the patrilineal clan, which is assured by human reproduction, and the continuity of the resource base, which is assured by maintaining the resources necessary for production. For a couple of examples, *sy zzu i pa mu; yy zzu i pa mu* (trees are from your parents; water is from your parents) means that trees and water resources, necessary to the continuation of production, are closely connected with the continuation of the family and society from generation to generation. Even more to the point is the saying that *o nyi a bo mi; yy kit pu ji she* (the maternal uncle's household and the father's household are the source of human life; water and the trees by the water are the source of sustenance). In this saying, the close interdependency of a water source and the trees that keep the water from eroding the land and fouling itself in the process is compared to the close interdependency of a clan and the affinal clans that provide wives, and thus reproductive continuity.

Finally, this attitude toward resources is parallel to the attitude toward the ecosystem as a whole which, as in the human system of affinal ties between patrilineal clans consists of a web of interdependent parts: *te jjo see mie ndie; yy yy ne vu se; te jjo mu a hly,* (where pine seedlings grow straight, water runs clear; where there are pines wind does not blow the dust). Each piece of the ecosystem--forests, water, soil, has its function in maintaining the integrity and thus the sustainability of the system as a whole and of its resources. And central to this ethic of resource conservation is the recognition of the importance of what we would now call ecosystem services provided by forests. Although forests were exploited directly in the form of wood, medicine, and animals hunted, their value as preservers of ecosystem quality is just as important or more so.

What happened in the Great Leap Forward. We are not sure, of course, whether the

intensification of production and the shift of ecological zones represented by the Nuosu move from the mountains to the *jjoba* in the early 20th century would have produced a system that was sustainable for the next century or more if it had been left alone, because it was not. But this system, as one watershed and one economic and ethnic periphery within the nested system of larger systems, was severely disrupted by a series of shocks that came from larger scales starting a few years after the founding of the PRC. From late 1956 to about 1961, the first waves of Communist developmentalism swamped the Baiwu valley, causing a premature release and reorganization of the ecosystem, accompanied by great human suffering and by a fundamental shift of the ecosystem to a different basin of stability. Three things happened to start this process. First, the Democratic Reforms--which in many minority areas replaced the Land Reform as the CCP's primary campaign to eliminate traditional political-economic systems and substitute systems that they considered more just and more progressive--began in Nuosu areas 1956. This led, in some places, to a rebellion against Communist domination, which in turn led to a kind of "Strategic Hamlets" policy referred to as *jumin dian*, or places for aggregating the population. Most of the inhabitants of the local mountains and *jjoba* were aggregated into the two villages of Yangjuan and Pianshui. Second, agriculture was collectivized in the next two years, with inhabitants of the new villages grouped into the four production teams that have remained (as "villager small groups") to this day, and soon the village became part of the Baiwu people's commune. This involved a rationalization of land use and an increase in the intensity of agricultural production, particularly on the *jjoba*, where almost all the remaining forests were cut down at this time and put into agricultural production; collective mess-halls were also established at this time. In other words, even this remote minority area, where hardly anyone even spoke Chinese, underwent many of the same convulsions as did villages in the core Han areas of the country. Third and perhaps most important here, all the trees on the *jjoba* and on the lower mountains near the villages, all the way to Baiwu town and on both sides of the upper, uncultivated portion of the *jjoba* were cut down to build new houses and to feed the steel furnaces being built in areas nearer to the Yanyuan county seat, as part of the Great Leap Forward industrialization drive.

The immediate results were part and parcel of what happened nationwide; after a promising start in 1958, the communal system broke down, and between 1959 and 1961 eight

people starved to death in Yangjuan village. But eventually, as in other areas, the political-economic system found a kind of satisfactory level in the production-team based, work-point rewarded system, and there was no more starvation, though people still remember the 1960s as a poor and hungry time. The most important effects for the ecosystem were set in motion by the deforestation of this time, which continued with two more bursts in the early 1970s under the Cultural Revolution policy of 以粮为刚 and again under the development of markets for lumber at the beginning of the Reforms in the 1980s. The results have been a fundamentally transformed ecosystem, even if attempts to grow paddy rice in the mid-1960s failed miserably. Clearing the forests caused dramatic increases in erosion, meaning gullying of many parts of the *jjoba* and probably an increase in the sediment load during heavy summer storms, making the rivers run brown and altering the geomorphology of some of the *ladda* areas. It also meant dramatic decreases in biodiversity; older inhabitants can list over 20 species of trees that used to grow in the forests on the *jjoba* and the lower mountainsides now dominated by the single-species Yunnan pine. Many familiar bird-calls (which also have an ecological and cultural significance, as with the cuckoo telling people to plant corn) are seldom heard anymore, and forest animals, including bears, wolves, red pandas, and various kinds of wildcats, as well as a great variety of formerly common snakes, are rarely seen anymore. Women have to go much farther from home to gather firewood, and although our preliminary quantitative estimates seem to indicate a rough balance between biomass growth and wood use in the lower forest zones, this imposes an extra burden of labor on the community.

The years of agricultural rationalization, deforestation, and collectivization were, for the Baiwu Valley, as for so many other parts of the country, an ecological surprise, but with a difference in this area; under the previous system, with low population density; integrated regimes of agricultural, pastoral, and forestry activity; and crop insurance from growing a variety of staples, natural disasters had not been a clear and present danger, as they had for example in many parts of the North China plain. The system in the Baiwu Valley, and most probably in neighboring areas, was sustainable on the scale of many decades, at least, and displayed enough resilience so that a natural disaster (the most common was hail in the summertime, as happened in 2005), would neither cause much immediate human suffering

nor alter the ecosystem in any fundamental way. In other words, the Baiwu system before the Great Leap was not bouncing around on the asymptote of carrying capacity or in the far, brittle reaches of the consolidation phase of the adaptive cycle; it could have gone on as before. But what happened was a major alteration in the balance between agriculture, pastoralism, and forestry, or in the ecological exchanges between field, pasture, and mountains, which also set into motion at least minor positive feedbacks as erosion further diminished the resources available in the forest zone.

The new state of the ecosystem after 1961, however, was still reasonably workable, and there have been no further famines. But other shocks to the system have made it potentially less resilient. More trees were cut down, and shipped out of the watershed, in 1971, as areas toward the south end of the narrow alluvial valley were brought into cultivation, as were some terraces constructed on the now-deforested slopes, adding further to erosion. Import of high-yielding, Green Revolution hybrid varieties of corn in 2000-2001 began to alter soil chemistry, making plowing more difficult, as well as shifting many local farmers to a regime of market dependency, in which they replaced former staple crops (including landrace corn) with the hybrid varieties which, like those grown in North China (above) required inputs of irrigation water (hand carried from streams), purchased seeds (the farmers found out by experiment that the hybrids indeed did not reproduce true to variety), chemical fertilizers (two applications per crop of urea and one of phosphate), and plastic mulch to hold in warmth and moisture in the early spring season (also creating problems of "white pollution" when it hung undegraded on the thorn bushes after the fall harvest). Farmers sold the corn--considered inedible--and purchased rice, setting into motion nutritional changes, but they were also able to use profits from selling corn to pay school fees for their children and to purchase household goods such as satellite TV hookups.

Farmers in the Baiwu Valley are already experiencing nostalgia for the old days, when the trees grew thick amidst the braided streams and limestone cliffs, when the bird calls were like an orchestra on spring mornings, when all kinds of delicious and valuable things roamed the forest. In some ways, they are lucky compared to their counterparts in parts of North China where there have been no forests for millennia, where urban pollution fouls the air, and where water sources are muddied not just by the erosional discharges in high-water summer

storms, but by both eroded earth and industrial pollution from many different upstreams. But as they become part of China's rapid, market-based consumer revolution, as they see their lives come to depend more and more on industrial and commercial products, there is a danger that their Valley, still beautiful in many ways and still reminiscent of the ideal landscapes of their folklore and poetry, will at some point no longer be able to sustain them. They have already begun migrating to cities in near and distant provinces (even to Burma) to take up manual labor, and as an attempt to support their increasingly market-dependent lifestyles with some sort of local activity, some people in 2005-06 started going up to the middle-story oak forests to manufacture charcoal from the big oak trees, and they did it at the height of the summer season when the old wisdom prohibited cutting trees. Whether the thunder spirits will retaliate, as of old, by bringing hailstorms upon the community remains to be seen, but the loss of the old ecological ideas in the face of the desire for development and the goods that it brings may yet lead to another crisis for the ecosystem, this time, unlike in 1957-61, at a time when human consumption within the system really is approaching carrying capacity, but at the same time people can, of course, just leave and become part of the urban underclass.

Personal Thoughts in Conclusion

It seems that students of China, whether Western historians and political scientists or Chinese public intellectuals, or even cosmopolitan environmentalists worried about who emits the most CO_2 or creates the most air pollution, have discovered the question of China and the environment in the last decade and a half. It's late, of course, but better late than later. At the same time, my feeling is that they have discovered the environment as a series of serious problems that merit our attention and urgently need solutions, rather than as a new and systemic perspective on how China has gotten to its present state, and what that means. It is meritorious that both the Chinese government and environmental critics of various nationalities are now paying attention to these problems and their short-term solutions, and that Chinese officials, scholars, and even a few NGOs are becoming parts of their respective international communities. With the exception of a very few systematic thinkers like Mark Elvin and Václav Smil, they still need to supplement their analyses by putting all their facts

and figures into the framework of ecosystems theory, to show how everything really *is* connected to everything else. I have made a few preliminary attempts here at case studies that might be refined to become parts of a broader and more integrated analysis.

At the same time, however, as valuable as ecology for ecology's sake might be, I have a broader purpose here with respect to the China Studies community and specifically the people presenting papers at the Paradigms in Flux Conference. I'm guessing that few of the facts in my first two case studies here are new to any of the conference participants, and that even the third, while containing novel details, probably rings familiar to anyone who has paid attention to China in the last five years or so or spent time in a place that recently had forests. But I hope to have opened the window on a new conversation on how to understand China's recent history and present predicament. I think that the influence of ecological change has been understated in most scholarship. Even Dali Yang's *Calamity and Reform* in China, which shares my opinion that the Great Leap Forward is more important than usually considered, carries no entry in its index for "forests," "ecology," or "irrigation." It was clearly because of the ecosystem changes that it brought about, because it precipitated a back loop of the adaptive cycle, that 30,000,000 people died in the famine, that erosion and deforestation became a fact of life in so many places, that China began to have even more serious biodiversity losses than had happened previously. And it was because of these ecosystem changes and their secondary effects such as starvation and breakdown of local collective organization and bureaucratic structures, that China started on the road to reform and that even the Cultural Revolution did not try to make material changes of the scope of those that were tried in the Great Leap.

When it comes to the Cultural Revolution, I have played down its ecological importance here for purposes of argument, but it in fact also brought about a large number of ecosystem changes particularly through the grain policy of 以粮为刚, which occasioned the second of the three great cuttings or 三大砍伐, and led the way toward destructive erosion on steep slopes all through the southwest, as well as really idiotic projects such as the reclamation of Dian Chi described by Judith Shapiro (2001: 95-137). These were logical extensions of the policies that began with the large-scale environmental alterations of the Great Leap, and which continued beyond the end of the whole radical Maoist phase into the

period of the reforms.

Also, when we look at China or many of its parts, whether at the scale of the North China Plain or the much smaller scale of the Baiwu Valley, what we see after the release and reorganization of the ecosystem in the Great Leap is more continuity than discontinuity. Policies of maximizing a single output without regard for its systemic effects continued throughout the early 60s relaxation, the Cultural Revolution, and at least through about 1990. If there is a break, a place where at the policy level at least China turned from wanton exploitation and degradation of resources in the service of development to beginning to look at resource sustainability and ecosystem resilience, it came not with the beginning of the Reforms in the late 1970s and early 1980s, but rather very gradually through the decade of the 1990s and beyond. From 1957 until the mid-1990s, policy basically said "To hell with the ecology and sustainability, we need to get rich first." Concern at the policy level has grown gradually but steadily since then, although implementation has lagged, a phenomenon that has more to do with the socioeconomic system than with the ecosystem per se, but which illustrates the close intertwining of the two.

I don't think China is doomed to a post-apocalyptic, Blade Runner world of poison air and artificially manufactured foods. I think that a sensible combination of mitigation and adaptation, whether it be to the effects of climate change, which we haven't seen yet, or to the milder effects of continued industrialization and growth, can mean that China can slide gradually from its present system into a future basin of stability that retains a reasonable quality of life for its inhabitants. But to do so will take recognition not only of the importance of understanding the ecosystem for its own sake, but also of the importance of the ecosystem for the health of the social, political, and economic system. Whether China or any other country can accomplish this remains to be seen. But understanding the phenomena and the models we use to describe them is a first step.

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