AsiaFlux — sustaining ecosystems and people through resilience thinking

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There are very few people in this world who ever ask the right questions of science, but they are the ones who affect its future most profoundly. Great thinking precedes great achievement and the right question gives birth to a vision that is greater than the visionary. Vision is the key to unity, the magnet for commitment, and the determinant of our destiny.

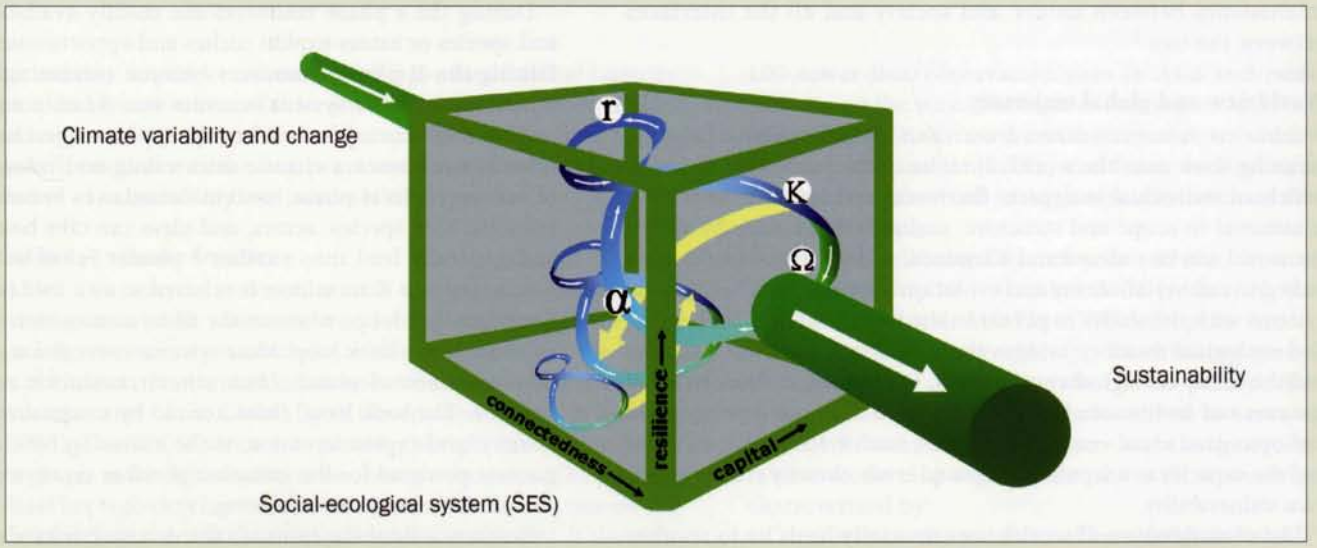
The vision of World Climate Conference-3 is a global framework for climate services that link climate predictions and information with risk management and adaptation, towards sustainability. What does it mean to be sustainable? What kind of management and adaptation do we need towards sustainability? Even more important questions would be sustainability of what and to what? Why are current approaches to sustainable natural resource management failing us despite a plethora of information? Are we properly acknowledging how the world actually works?

Defining and understanding the system

Some available definitions of sustainability are:

- The use of environment and resources to meet the needs of the present without compromising the ability of future generations to meet their own needs
- The likelihood an existing system of resource-use will persist indefinitely without a decline in the social welfare it delivers
- A cultural adaptation made by society as it becomes aware of the emerging necessity of non-growth.

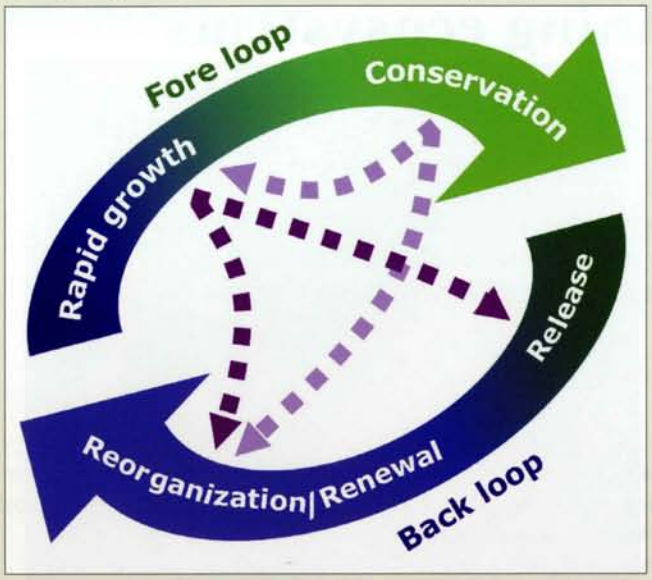
Social-ecological system with the focus on adaptive capacity for sustainability



At each scale, the social-ecological system moves through its own adaptive cycles. These recurring cycles consist of four phases: rapid growth (r), conservation (K), release (Ω), and reorganization/renewal (α). The adaptive cycles are pictured in three dimensions: (1) X axis – the degree of connectedness among controlling variables; (2) Y axis – the capital (or potential) that is inherent in the accumulated resources; and (3) Z axis – resilience, the capacity of a system to absorb disturbance and remain within the same regime, retaining the same function, structure, and feedbacks. The structure and dynamics of the system at each scale is driven by a small set of key processes and, in turn, these linked set of hierarchies govern the behaviour of the whole system

Source: Gunderson and Holling (2002) and Berkes et al. (2003)

A simple representation and variants of the adaptive cycle



Source: Adapted from Walker and Salt (2006)

These definitions make clear that sustainability is not an end product but a dynamic process that requires adaptive capacity for social and ecological systems to deal with change. Here, a dynamic process features the relationships between the motion (towards sustainability) and properties of a complex system, (social and ecological systems) and the forces (climate variability and change) acting on it. When considering the earth climate system, a complex social-ecological system, it is important to consider it as a whole. This 'human-in-ecosystems' (not human-and-ecosystems) perspective is a way to think about the relationship between nature and society and all the interfaces between the two.[1]

Worldview and global trajectory

Worldview is a term taken from the German weltanschauung, meaning 'look onto the world'. It refers to the framework through which an individual interprets the world and interacts in it. It is communal in scope and structure, and provides a view by which the world can be ordered and illumined. A diversity of worldviews linked to cultural diversity and evolution provides social-ecological systems with the ability to persist in the face of change. Such social and ecological memory bridges the values and truths of a society and the social-ecological environment. In opposition, modern belief systems and institutional frameworks seem to create homogenized and optimized social-ecological systems. Such systems lack diversity and the capacity to adapt to change and crisis, thereby creating their own vulnerability.

The consideration of worldviews naturally leads us to another important question of global trajectory, namely, whether humanity at the global scale is currently on a sustainable or unsustainable path. As was pointed out by the global think tank 'the Club of Rome' almost four decades ago, the current global trajectory is unsustainable for both ecological and social systems.[2] More recently, the Stern Review of the Economics of Climate Change provided rigorous analysis of the costs and risks of climate change, and of reducing greenhouse gas emissions.[3] While the details are still debatable, the main thrust of the report is clear and compelling — the expected benefits of tackling climate change surpass the expected costs. The question is no longer whether we can afford to act, but whether we can afford not to. And yet, with less than six months to go to Copenhagen and little communal action, most countries are hesitant to move forward.

Lance Gunderson and C.S. Holling condensed the major obstacles to sustainability into the lack of three basic categories: understanding of the dynamics of complex systems; willingness to implement; and capacity to perform the actions and changes needed.[4] The pursuit of services linking climate information with management and adaptation towards sustainability pose new challenges to the ways we define problems, identify solutions and implement actions.

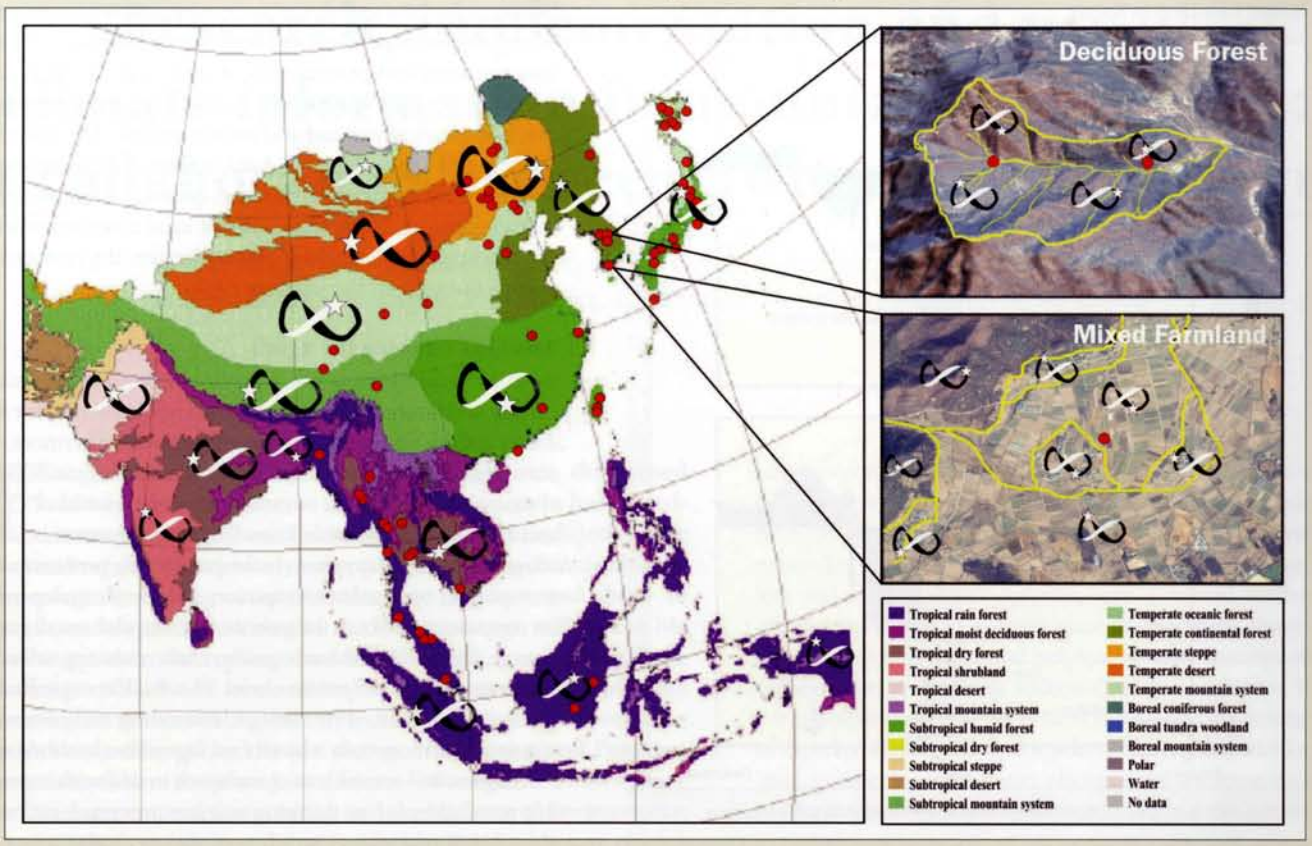
Resilience thinking

C. S. Holling and his colleagues offer a new paradigm, the idea of resilience as a potential organizing concept and scoping device for understanding and managing our social-ecological systems.[5] They define resilience as the amount of change a system can undergo before it crosses a threshold and flips to an alternate stability regime of that system. In resilience thinking, three main concepts need to be recognized. Firstly, complex adaptive systems are self-organizing. Secondly, these systems are non-linear in their trajectories of change, which leads to their potential for alternative stability regimes. Third, and finally, such systems go through adaptive cycles that describe a repeated process of four phases: rapid growth (r), conservation (K), release (Ω), and reorganization and renewal (α).[6]

During the r phase resources are readily available and species or actors exploit niches and opportunities. During the K phase, resources become increasingly locked up and the system becomes less flexible and responsive to disturbance. When the Ω phase is reached disturbance causes a chaotic unravelling and release of resources. In α phase, system boundaries become tenuous. New species, actors, and ideas can take hold, and generally lead into another r phase. Taken as a whole, the r to K transition is referred to as a fore (or development) loop, whereas the Ω to α transition is referred to as a back loop. Most systems move through this sequence of phases, but other transitions are possible. The back loop, characterized by uncertainty, novelty, and experimentation, is the transition time of greatest potential for the initiation of either creative or destructive change in the system.

Resilience thinking captures the dynamic nature of the world. It recognizes the dangers of optimizing for particular states or products of a system, and explains why current approaches to managing resources are failing. It focuses on how the system changes and copes with disturbances, not only anticipating and responding but also creating and shaping them. Successful management and adaptation for social-ecological

Tower flux observation sites in AsiaFlux in different plant functional types in different phases



The various adaptive cycles illustrate that ecological and social memory is maintained in the system through the presence of different functional groups in different phases. Two local sites, a deciduous forest (right top) and a mixed farmland (right middle), are shown to highlight the importance of integrating cross-scale ecosystem knowledge with social practices and the historical profile of disturbances (e.g., drought, fire, typhoon, and land use change)

Source: AsiaFlux (www.asiaflux.org) and Mizoguchi et al. (2009)[12]

sustainability requires resilience thinking — institutional capacity to respond to environmental feedback, to learn and store understanding, and be prepared and adaptive to allow for change. In a nutshell, resilience is the key property of sustainability and the measure of vulnerability and adaptability.[7]

AsiaFlux — science frontier

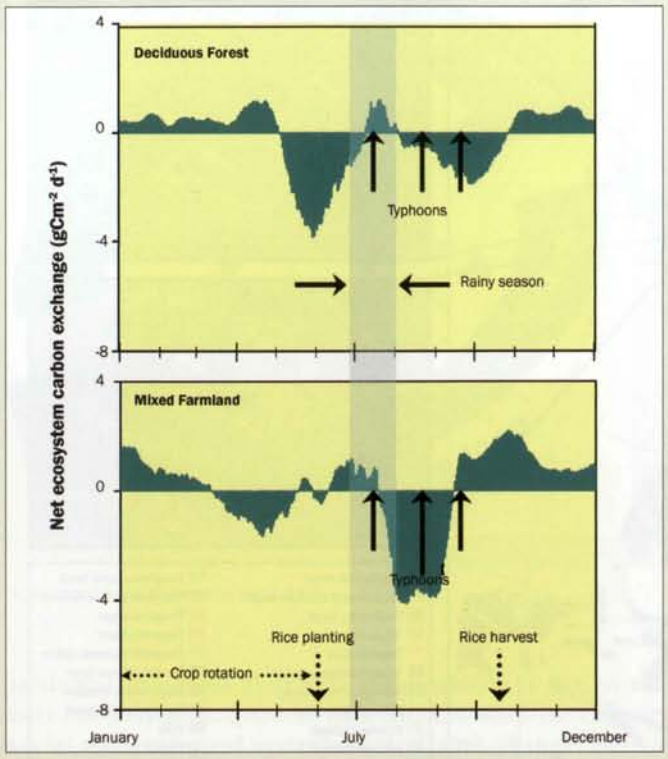
AsiaFlux is a science community with a mission to 'bring Asia's key ecosystems under observation to develop and transfer scientific knowledge to ensure sustainability of life on earth'. It is the Asian arm of Fluxnet, the worldwide flux research network, and one of the key components of the Global Earth Observation System of Systems (GEOSS). The GEOSS vision is to provide the right information to the right people at the right time to make the right decisions. The purpose of AsiaFlux is to develop collaborative research and data sets on the cycles of carbon, water, and energy in key Asian ecosystems. It also aims to provide workshops and training on current and related global climate change science and technology. Finally, AsiaFlux seeks to cultivate the next generation of scientists with skills and perspectives to address global climate change as informed leaders and stewards.

AsiaFlux has grown from a small network of independent flux monitoring groups in 1999 to a multi-national science community with 449 members from 28 countries. Currently, there are 109 tower flux observation sites in Asia and more sites are on the way. The biomes covered in AsiaFlux range from rainforest near the equator to tundra in the Arctic and Antarctic, and from wetland near sea level to grassland in high altitudes such as the Tibetan Plateau.

AsiaFlux celebrated its ten-year science, service, and stewardship in November 2008 by hosting the 7th International AsiaFlux Workshop in Seoul, Korea. During this workshop, 'Re-thinking global change science: from knowledge to policy', the refined vision of AsiaFlux was launched to serve as 'science frontier' in carbon, water and energy cycles. It aims to develop and transfer scientific knowledge characterized by:

- Consilience — the synthesis of knowledge in holistic, exploratory, pluralistic and perspectival ways
- Contextualization — the reformulation of scientific knowledge in social and pedagogical context by embracing its implications as well as the applications
- Cultural diversity — building resilience by welcoming diversity and conflict, tolerating ambiguity, and embracing paradox through teaching and learning.

Net ecosystem carbon exchange (NEE) in a deciduous forest and a mixed farmland in Korea



Positive NEE indicates carbon release and negative NEE indicates carbon uptake. Terrestrial ecosystems are strong sinks of atmospheric CO_2. Climatic disturbances such as monsoon, typhoons and management practices can, however, dramatically change the ecosystem processes and feedbacks

Source: KoFlux (www.koflux.org)

Embracing resilience thinking

The idea of resilience thinking is deceptively simple, but its application has proven profound and there is much to learn. Walker and Salt[9] suggest a resilient world would be characterized by:

- Diversity — promoting and sustaining all forms of diversity (biological, landscape, social and economic)
- Ecological variability — embracing and working with ecological variability rather than attempting to control and reduce it
- Modularity — consisting of modular components
- Acknowledging slow variables — having a policy focus on slow controlling variables associated with thresholds
- Tight feedbacks — possessing tight feedbacks, but not too tight
- Social capital — promoting trust, well developed social networks and leadership
- Innovation — emphasizing learning, experimentation, locally developed rules and embracing change
- Overlap in governance — having institutions that include redundancy
- Ecosystem services — including all the unpriced ecosystem services in development proposals and assessments.

Folke et al. proposed four principles for building resilience: learning to live with change and uncertainty; nurturing diversity for reorganization and renewal; combining different types of knowledge for learning; and creating opportunity for self-organization.[9]

Overall, building resilience will require dynamic interplay between diversity and disturbance, along with recognition of cross-scale dependencies. Resilience thinking encourages scientists and practitioners to work together with the public to produce trustworthy knowledge and judgment that is scientifically sound and socially robust. The science, service, and stewardship of AsiaFlux are complementary with resilience thinking. It provides qualitative monitoring, management, and long time series of local observation and ecological and social memory for understanding ecosystem change throughout the adaptive cycle.

AsiaFlux entering the agora

By 2011 AsiaFlux hopes to provide a report on the Asian carbon and water budget and develop infrastructure for an Asian carbon and water tracking system. Furthermore, it aims to develop a synthesized measurement and modelling system that keeps track of emissions and removal of CO_2 and H_2O in Asia. Reliable knowledge can become socially robust only if society perceives the production process to be transparent, open and participative. This, in turn, depends on reciprocity in which the public understands how climate change science works but, equally, climate change science understands how the public works. The AsiaFlux vision will guide such enhanced mutual understanding and communicate and demonstrate it by embracing resilience thinking.

AsiaFlux will continue to create space to deal with emerging paradigms for re-thinking science processes such as cultural boundaries and authority of climate change science, its co-evolution with risk society, context-sensitive science, and the challenge of nurturing diverse functional groups.[10] The latter may include: knowledge carriers and retainers; interpreters and sense makers; networkers and facilitators; stewards and leaders; visionaries and inspirers; innovators and experimenters; entrepreneurs and implementers; and followers and reinforcers.[11] Such efforts guide AsiaFlux to enter a new community space, the agora. The agora was an open place of assembly in ancient Greek city states, where citizens would gather for military duty, to hold markets or to hear statements of the ruling king or council.

This October in the beautiful city of Hokkaido in northern Japan, AsiaFlux will host the 8th AsiaFlux Workshop on 'Integrating cross-scale ecosystem knowledge: bridges and barriers'. The workshop consists of a regular science session and many special sessions such as 'CarboEastAsia', 'Global biogeochemical cycles', 'Bridges between ecosystem observation and remote sensing', 'Barriers in flux measurements', and 'Interfaces between carbon science and society'. These sessions consist of a diversity of individuals, workgroups, institutions, and organizations with different but overlapping roles within and between critical functional groups, thereby building resilience. The workshop will not only bring students, scientists, technologists, capitalists, entrepreneurs, diplomats, and policy-makers together, but also help us cross cultural, disciplinary, geographic, and hierarchical boundaries. Thus, we invite all to our new community space in which science meets and interacts with others and where interests, values, and decisions are discussed, fought over, and perhaps settled. Welcome to the AsiaFlux agora.