The DGH Symposium 2008
Human/Nature Interactions in the Anthropocene: Potentials of Social-Ecological Systems Analysis

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Overview and outcome

The 2008 Annual Conference of the German Society for Human Ecology (DGH) in the beautiful viticultural town of Sommerhausen, Germany, was supported by LOICZ (Land-Ocean Interactions in the Coastal Zone). Sommerhausen hosted the fourth symposium on social-ecological systems analysis, LOICZ priority topic 1. The international conference, organized by researchers from Bremen (Marion Glaser & Gesche Krause), Hamburg (Beate Ratter) and Berlin (Martin Welp) brought together representatives from different academic fields, including physics, medicine, psychology, ecology, mathematics, geography, various social sciences and philososophy for an exploration of systems thinking and systems analysis in order to address pressing global issues.

Detailed report

The symposium was opened by Bernhard Glaeser (DGH president and LOICZ SSC member) and Marion Glaser (organiser and LOICZ SSC member). It was stressed that there are several priority topics under the big theme of understanding the transformation, transition, and change determined by interactions between humans and nature through the consideration of the natural and societal dynamics in conjunction. The conference, co-funded by LOICZ, was one of the LOICZ Symposia on Social-ecological Systems Analysis. These symposia aim to assess and compare possible future transformations of coastal social-ecological systems and their key drivers. The Sommerhausen conference particularly intended to explore innovative methodological approaches to SES analysis, including participatory modeling and scenario construction in order to provide the basis to better systematize SES analysis in the coastal zone.

It was emphasized that a main method for social-ecological analysis is to compare and develop modeling methods for better understanding the social-ecological dynamics at different scales which have to be accessible to stakeholders and to provide system understanding and decision support. For this, a reality check between the model and SES reality is needed.

There are three planned publications from the LOICZ SES symposia to contribute in the ongoing discourse of the SES, first is “Social-ecological systems in coastal and marine areas. A Path towards Interdisciplinary Knowledge Integration”, an article by B. Glaeser, K. Bruckmeier, M. Glaser and G. Krause submitted to Cambridge Publishing Scholars. The second one is a Regional Environmental Change (REC) special issue on Social-Ecological Systems Analysis, edited by B. Glaeser and M. Glaser, and the third one is the proceedings book of the Sommerhausen conference, edited by Glaser, Krause, Ratter and Welp as a joint DGH and LOICZ publication.

Session 1: Social Ecological System and Complexity

The first keynote speaker was Felix Tretter, sociologist and psychiatrist, Munich, on “Systems Thinking in Human / Social Ecology, System Science meets Social Ecology”. Professor Tretter first described the scientific knowledge cycle, the transformation from quality to quantity, from empirics to theory and back again. He proposed the multi-, inter- and transdisciplinary approach to understand the socio-ecological system. He then explained the system modeling process as an iterative approach passing

from verbalization via graphical model towards formalization. He also interpreted human ecological models as network models with multiple components and relations and argued that further exploration of the concepts of "network" and "relation" is needed. He introduced system science as a set of concepts, propositions, methods, models/theories, paradigmatic data that are related to the study of networks. He supported his explanation with the multilevel perspective of general systems theory, known as panarchy and supported this with the resilience concept defined as "the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks". In conclusion, he proposed the notion of ecosystems as "mobiles" as a visual analogy of a complex dynamic system.

The second speaker of this session was Egon Becker, founder of the Institute of Social-Ecological Research in Frankfurt / Main. His presentation "Social-Ecological Systems, A View from the Critical Theory of Social Relations to Nature" started off with the Symposium´s point of departure, namely with the need for a new worldview in the anthropocene. Becker´s view of the world as a "crisis ridden self-organizing complex system" includes mankind as an integrated part and a powerful driver of system dynamics so that observation is only possible for us from the inside: the observer is part of the system. Science, however, should be able to conceptualize the system with complexity theory, second-order cybernetics and network topology. Becker emphasized the need to understand the boundary objects to define the system arguing that the social-ecological systems are situated between social and natural science in the realm of inter- and transdisciplinary research. Examples are the world system in social science, the earth system in natural science, the managed ecosystem in inter- and transdisciplinary research and the human/environmental system of composite "multidisciplinary" disciplines. Becker called for the transformation of such boundary objects into epistemic objects and proposed the Frankfurt ISOE approach of conceptualizing nature-dependent supply systems. He then addressed the ongoing debate between 'realism' and 'constructivism' suggesting that, from the "constructivist realism" point of view ecological systems are models of knowledge about real world phenomena. Thus systems remain abstract objects in an ideal symbolic world. Professor Becker also emphasized how the SES mind map might guide us in transforming SES boundary objects into the epistemic object, that is into objects for which ground truthing is possible.

The third speaker was Beate Ratter, Institute of Geography, University of Hamburg and GKSS. The title of her presentation was "Complexity and Emergence: key concepts in non-linear dynamic systems". Ratter started off by giving an example of emergence happening in the traffic jam. The model simulates the movement of cars on a highway to exemplify how traffic congestion emerges without any "central cause" such as a car accident or broken bridges. but merely by cars following **simple rules**: **slowing down if seeing a car close ahead**, **speeding up if not**. "Traffic jams can start from small "seeds." These cars start with random positions and random speeds. If some cars are clustered together, they will move slowly, causing cars behind them to slow down, and a traffic jam forms. **Even though all of the cars are moving forward, the traffic jams tend to move backwards**. This behavior is common in wave phenomena: the behaviour of the group is often very different from the behavior of the individuals that make up the group. This is the model of Wilensky, 1997. Professor Ratter then explained the theory of complexity which deals with non-linear dynamic systems. She emphasized on how elements interact in a non-linear way. She also described the notion of *complex* as relating to the behavior of a system rather than to its structure which may be simple or complicated. In the complexity theory, complex means becoming, emerging or changing. Complex behaviour is thus characterized by evolution, path dependency, non-linearity, agents and emergence. She explained emergence as a phenomenon evolving from the interaction of the constituent elements of a system which is characterized by irreducible, counterintuitive, and unpredictable features. Non-linearity and emergence is what dynamic natural and social systems have in common and have to be taken into consideration in any systems trajectory.

A discussion on SES and complexity followed. It was argued that we cannot predict but we can explore and assume in order to develop scenarios. Questions were debated such as how to

understand the embeddedness of human in nature? What is emergence and self-organization? The importance of clearly defining the notion of "relation" in SES analysis was reiterated.

Session 2: Resilience, Adaptability and Transformability

The first speaker of this session was Per Olsson, Stockholm Resilience Centre. His presentation on "Social-ecological system's dynamics and change: Key concepts and their application" started with the definition of "relations between humans and nature" as the environmental functions that benefit humans. Water and air purification, flood and erosion control, generation of fertile soils, detoxification of wastes, regulation of climate, and pollination but also the provision of aesthetic and cultural benefits were given as examples. Dr. Olsson characterized SES dynamics as multilevel change, catastrophic shifts and ecological surprise and identified a mismatch between ecosystem and governance as a key problem. Arguing that the institutional capacities to manage the earth's ecosystem are evolving more slowly than human overuse of the same systems. For Olsson, this raises two main questions: firstly how to avoid or steer away from cascading ecological crises, unsustainable trajectories, and traps. And secondly, how to build an understanding about ecosystem dynamics into governance systems. To address these, Olsson proposed adaptive governance with the following framework of analysis: 1. Social dimensions of ecosystem management, 2. Interactions between individuals, organizations, and institutions at multiple levels, 3. Detecting and responding to crisis, shaping change and building resilience, 4. Mechanisms to match governance and ecosystems. Olsson sees windows of opportunity as important ingredients of SES transformations and emphasized the need to increase human capacity to learn from, respond to, and manage environmental feedbacks from dynamic ecosystem.

Klaus Eisenack, Potsdam Institute for Climate Impact Research and University of Oldenburg, talked about "Archetypes of Adaptation" proposing that complexity and adaptation at the social-ecological interface are more difficult to address. Describing the collection of different experiences of adaptation as "seeing trees but missing the forest", Eisenack argued that adaptations fall in multiple categories, are often linked, nested, and difficult to disentangle and can be observed at different institutional and abstraction levels. In order to approach the issue more systematically, Eisenack proposed the archetype approach to of Social Ecological Systems Analysis. This starts with detailed local and regional case studies which are clustered according to major functional patterns. He concludes that archetype analysis is now an established approach with extensive, currently mainly diagnostic experience and suggests that in future the "action component" will need to be strengthened in order to structure the analysis of adaptation to climate change. One possibility here is the construction of adaptation indicators.

The third presentation by Diana Hummel, Institute for Social-Ecological Research (ISOE) at Frankfurt/Main on "Adaptive capacity of supply systems" addressed the interactions of demographic processes and ecological problems, conceptualizing population dynamics in relation to supply systems. Hummel defined supply systems as "structures to provide the population with basic goods and services which constitute specific societal relations to nature", the adaptive capacity of supply systems for coping with demographic changes being the issue. Supply systems as social-ecological systems consist of interactions between resources and users and revolve around knowledge, practice, institutions and technology. Hummel argued that the challenges for adaptive capacity are migration, the need for temporal and spatial scales, path dependencies, non-linear relations between resource use and the demand for goods and services provided by supply systems, and uncertainty. She argued that adaptivity, transformation openness and integration of society and nature are important preconditions for adaptive capacity.

Session 3: Multi-agent modeling and simulation

The first speaker in this session was Peter Mandl, University of Klagenfurt, Austria, on "Multi-agent simulation for representing human/nature interaction: an appropriate basic approach". After an overview on the principles of multi-agent systems (MAS) and agent-based models (ABM) as a space-

time integrated approach, Mandel gave several examples of agent-based models in different settings. It was shown how ABM can be used in ecology and biology (artificial life), genetics medicine, social sciences (artificial societies), economy, traffic, mathematics, physics, chemistry and art. The specific aspects of human/nature interaction modeling, Mandl examined were: the language of ABM, spatial representation and social (network) aspects, scale aspects and the need to clearly determine the objective of modeling. As most important objectives of ABM, Mandl named sensitivity analysis, scenario building, state calculation, optimization, learning, and creation. As advantages of ABM for the modeling of human-nature interactions he listed: the possibility of space-time integration, of simulation and of the bottom up approach to understanding emergent structures. The option, to combine deductive and inductive research strategies in the (re)construction of complex relations through ABM, was emphasized. As a disadvantage of ABM in the analysis of human nature interaction Mandl found that the method does not produce empirically-based predictions but simply creates possible structures and dynamics so that emergent structures have to be evaluated and interpreted. Mandl argued that this experimental approach, generative of "virtual SES worlds" is only possible with computers and is at the moment not sufficiently user friendly. He also mentioned the open ABM working group to promote a protocol for ABM description and communication, a model archive, and a library of model components for ABMs, platform for ABM, GIS-ABM integration, as well as education in ABM. As possible extensions of ABM, he mentioned: participatory modeling, multi-method simulation, interfacing of ABM with GIS and with equation-based dynamic models.

The second presentation on "Agent-based models of coastal and marine social-ecological dynamics" by Marion Glaser, featuring her work with Gesche Krause and others at the Center for Tropical Marine Ecology (ZMT) Bremen, Germany, started with a working definition of coastal and marine social-ecological systems (CM-SES). Glaser pointed out a number of specific features of CM-SES in comparison with terrestrial social-ecological systems. The observation that coastal and marine governance is weaker and less structured then led her to present some pieces of field research on CM-SES in Brazil, Indonesia and several other areas. These illustrated that the ABM approach is capable of explicitly linking natural and social dynamics as part of an integrated complex system with an emphasis on the co-evolution of humans and nature. Social-ecological systems analysis operates at multiple spatial and institutional scales from the local to the global. The social-ecological system is defined as an ecological unit with the social actors connected to it. The analytical focus is on the linkages or drivers of complex social-ecological systems and how these co-evolve over time. The study and simulation of agent-based models of coastal and marine social-ecological dynamics will be conducted in the Spermonde Archipelago in South Sulawesi province, Indonesia. One aspect that will be incorporated in the study is the participatory approach of the agent-based model. From the very beginning the agents will be involved in the modeling and simulation processes.

The third presentation by Martin Wildenberg, Ph.D candidate at Klagenfurt University and researcher at Institute of Social Ecology, Vienna, was on "Research on Coping with Vulnerability to Environmental Risk". The project aims at generating scientific support for the planning, implementation and evaluation of aid after the 2004 tsunami in Central Nicobar, at better understanding the interplay of natural, cultural, and institutional features in determining the resilience of local social-ecological systems and to explore the potential of different modeling techniques to link functional tools and tools dealing with meaning, human preferences, and choice. Wildenberg first describes the Nicobar Island and the effect of 2004 tsunami to the islands and to the people. Then he explains about the "second wave" which is the foreign aid and the effect of foreign aid on local change (social coherence, family structure, consumption pattern, production pattern, excessive alcohol use). The challenges for the modeling are: the changing situation of the island over time, data availability, restriction to enter the island, the emerging of a completely new situation (new types of resources use). Wildenberg explains the integrated model at the island level with the following purposes: compile information of all levels, policy guidance, knowledge transfer, usability for adaptive management processes.

Sesson 4: World Systems Café

The world systems café **Application of systems thinking in social learning for sustainability** brought symposium participants together in a relaxed atmosphere of coffee, cookies and music. Each discussion group had a “host” or “hostess” who remained at certain tables while other participants regularly changed their location. Four questions were discussed:

1. Who needs systems thinking?
2. Which are the arenas where people can learn systems thinking and put knowledge in action?
3. What tools, methods, approaches can scientist use to bring the systems thinking to the society?
4. What do you not perceive of the world when you apply systems thinking?

Some of the results and answers from the groups:

As to the first question, most of the groups argued that everybody needs systems thinking. Several groups argued that systems thinking exist in any individual. It may not be recognized by others. But the type of the system needed depends on the context, the social and political landscape. Several critical questions arose, such as: Does systems thinking really exist? Is systems thinking material or non-material? What was before system thinking?

Several answers to the second question were offered. Some participants believed that the family was the arena where people could learn systems thinking and put knowledge in action. Other participants suggested that school was also an arena. One group focused on the media. Another group argued: *arena* is where there are actions and inter-actions.

With respect to the third question, different answers came up. It was argued that models can be used as tools. Also the internet and computer games can be used as tools, the important thing is fun and play. Another group argued that meeting and gathering is important (and this doesn´t have to be formalized). Just bring the brains together (like this world system café). Several critical questions also arose, such as: Who actually represents society? Do scientists really need to bring systems thinking to the society, or is it also the other way around?

Some of the major areas of consensus in Sommerhausen were:

- Systems are abstract objects in an ideal, symbolic world, models of knowledge to advance our understanding, rather than images of reality. Systems thinking is a subcategory of relational thinking, and social-ecological systems represent one type of system, characterized by an open, dynamic and non-linear character.
- Methods for social ecological systems analysis need to be developed further. In particular, inter- and transdisciplinary agent/individual-based modeling (simulation-supported science) offers good potentials to explain emergent phenomena.
- Our understanding of social-ecological transformations is fragmented at best.
- We need to develop a knowledge-action system, to further the incorporation of knowledge into practice.

A book publication on this conference is in preparation.