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An integrated assessment framework for combining general systems and organizational levels

Roman Lenz

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Roman Lenz

Nürtingen University of Applied Sciences, Schelmenwasen 4-8, D-72622 Nürtingen, Germany,
Tel. +49 7022 404 177; Fax +49 7022 404 166, lenzr@fh-nuertingen.de

Abstract: It is stated, that ecological theories like the one of organizational levels in living systems, if combined with a general systems approach, can be useful also for understanding and manipulating social systems and its "hidden socio-cybernetic processes".
Especially in relation to trans-level phenomena affecting different organisational levels, different research approaches have to be introduced, showing that descriptive-observational (which also means more holistic) and quantitative-experimental (which also means more reductionistic) approaches are complementary. Therefore, to include all relevant information in delineation and description of systems at any integration level, a "staircase" or "scaling" of research steps appears to be the most useful approach. This combines comparative and quantitative research and is related to the various organisational levels and, also, takes into account that there are continuous transitions between observations and experiments, and between structures and processes.
Landscape management already traditionally deals with practical problems and concepts for solutions. Hence, specific efforts like translating the scientific models and indicators into models and indicators people can understand as well as evaluation procedures of the scientific outcome into a social and political context have to be provided. This approach is problem as well as data and knowledge driven, and similar to general systems approaches.
To conceptually overcome these gaps of interfaces for integration, translation, and communication between science and society we have worked out an Environmental Impact Assessment Multi-level Approach. It is a combination of the multi-level scaling and integration approach, and the environmental impact assessment concept.

Key words: Indicators, Sustainable Development, Environment, Assessment science, Systems approach

1. INTRODUCTION

An integrated assessment framework needs systems concepts to comply with new requirements and prescriptions. Learning from engineering concepts in traditional fields like mechanical engineering, the so-called "problem solving approach" arose during the last two to three decades also in ecology. This means in principal, that we have to solve a problem on the basis of analytical (hard) and observational (soft) knowledge, related to societal needs and/or risk perception (Figure 1).

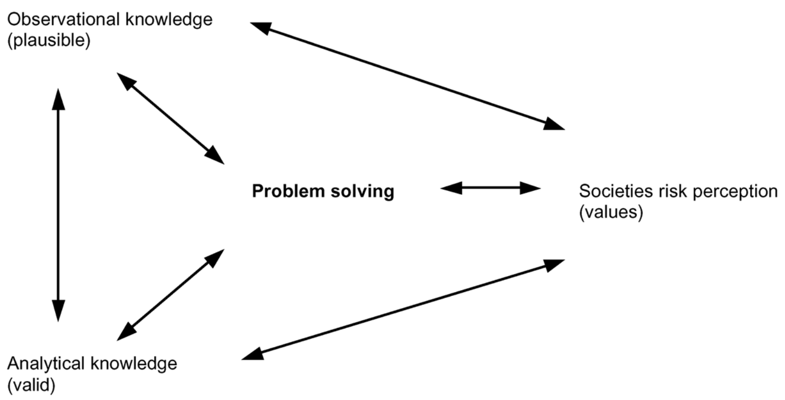

Figure 1 Problem solving as an optimisation process of compiling analytical and observational knowledge with societal perception and evaluation (Lenz 1991)

Looking at the hierarchy of organisational levels in ecology, much activity shifted from the ecosystem level upwards to the levels of landscape and society-environment system. Hence, the task e.g. of the Man and Biosphere (MAB) program to facilitate sustainable protection of natural resources required a systematic approach which combined scientific, economic, social, ethical and cultural perspectives (Erdmann and Nauber 1995). A very useful concept, originally developed by Messerli and Messerli (1979) for the Swiss MAB 6, is the regional ecologic-economic system (Figure 2). It is a threefold system with the components of natural ecosystems represented at the left side of the diagram and the socio-economic system on the right. The influence and impact of human society upon nature has produced the land use system shown in the centre of the figure, e.g., our cultural landscape. Additionally, there are external inputs and outputs, for example air pollutants or government subsidies entering the regional system and wastewaters or exports goods leaving it.

To transform information supporting the regional ecological and economic conceptualisation shown in Figure 2 into an environmental planning or management tool requires the implementation of additional linkages, which will allow landscape level predictions and simulations.

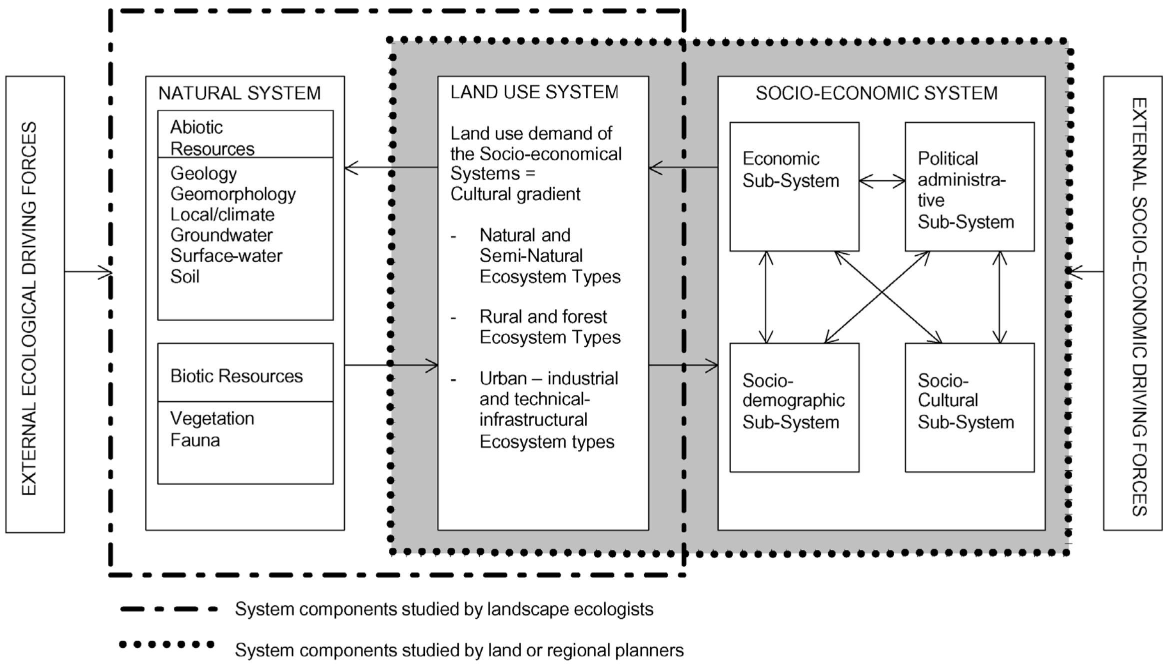

Figure 2 Simple model of a regional ecological-economic system (adapted from Messerli and Messerli, 1979)

2. A FRAMEWORK FOR COMBINING SYSTEMS AND LEVELS

Many environmental problems, however, can only be fully understood by analysing them at many different organisational levels, e.g. the problem of release of fluoro-carbohydrates by man into the atmosphere, reacting with the stratospheric ozone layer, and thus changing irradiation for all organisational levels. Hence, if there are trans- and cross-level phenomena, such as reaction chains due to chemicals or radiation, passing across several organisational levels and connecting them in such a way as to be considered a system of their own, then the hierarchy of organisational levels and the role of single levels may become merely background information. Such so-called trans-level systems (Lenz 1994, Lenz and Haber 1996) have to be thought of exceptions to systems according to organisational levels, and, therefore, they do not have a priori common characteristics with the systems of hierarchy of organisational levels. Even a new hierarchy of dominance created by cross-level matter flow can be recognised, resulting in specific structures like shoot-root ratio, root ramification pattern, or others (Ulrich 1994).

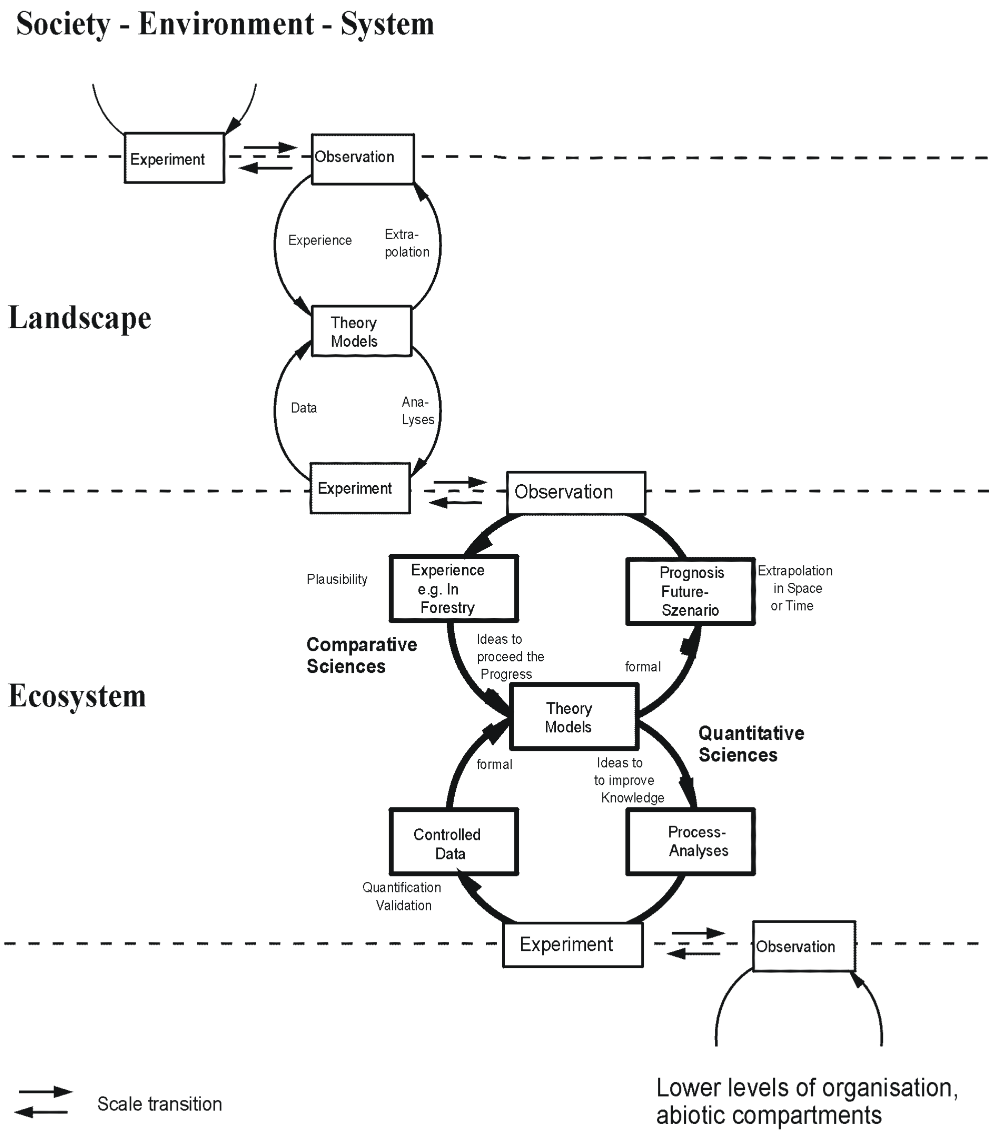

Figure 3 Experiments on higher integration levels can be related to observations of lower levels (scaling). The best description or model of a specific level can be derived from both, (comparative) observations and (quantifying) experiments. Because of the fact that systems may consist of several levels or are at least embedded in the two levels above and below, an up- and downwards "chaining of knowledge" along the arrows is suggested (adapted from Lenz 1994).

3. MULTI-LEVEL INTEGRATION AND SCALING APPROACH – COMING FROM SCIENCE

Especially in relation to trans-level phenomena affecting different organisational levels, different research approaches have to be introduced, showing that descriptive-observational (which also means more holistic) and quantitative-experimental (which also means more reductionistic) approaches are complementary. In Figure 3 the focal objects of consideration are the landscape and the ecosystem, embedded in frame-conditions of a society-environment-system and composed of biotic and abiotic compartments. Under steady-state conditions, they can be better (and easier) described by observations, i.e. holistic comparisons, in some cases, or by experimental work, i.e. reductionistic analyses, in others.
Therefore, to include all relevant information in delineation and description of systems at any integration level, a ”staircase” or ”scaling” of research steps appears to be the most useful approach. This combines comparative and quantitative research and is related to the various organisational levels and, also, takes into account that there are continuous transitions between observations and experiments, and between structures and processes. In this sense, structures are the result of processes, yet new or strongly modified structures are also modified processes, thus generating ”higher” structures and patterns (cf. Lenz 1994). Hence, it is necessary to scale up and down, as well as repeatedly – Root and Schneider (1995) call this strategic cyclic scaling – in order to parameterise the object under consideration in an optimised way. An example of following the framework suggested is the determination of critical loads; their eventual exceedances and the application of the concept in mapping and planning can be found in Lenz 1995.

4. ASSESSMENT APPROACH – COMING FROM PRACTICE

Landscape management already traditionally deals with practical problems and concepts for solutions. Often decisions under uncertainty are to be undertaken, not always based on the state of knowledge. E.g., during the period of acid rain and forest decline research, Streets (1989) identified the Integrated Assessment as a frequent missing link between Science and Society. Hence, specific efforts like translating the scientific models and indicators into models and indicators people can understand as well as evaluation procedures of the scientific outcome into a social and political context have to be provided. This approach is problem as well as data and knowledge driven.

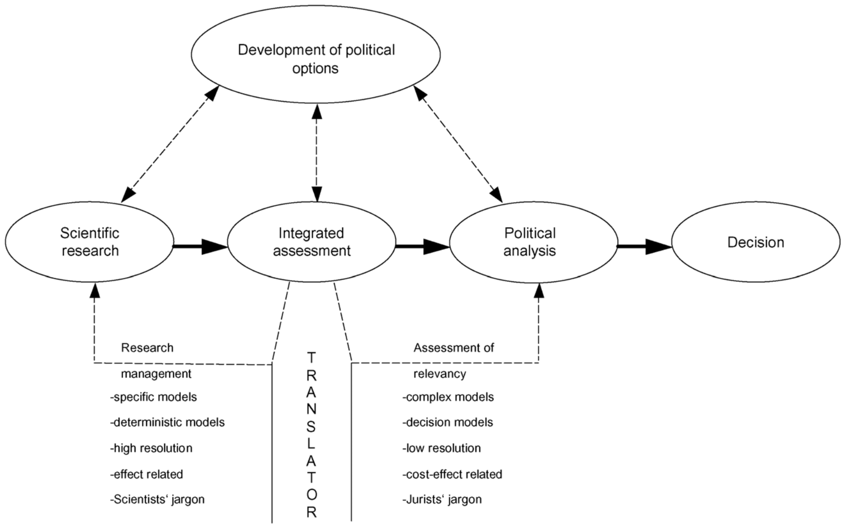

Figure 4 EIA concept for an Integrated Assessment (Streets 1989)

5. COMBINATION OF THE MULTI-LEVEL AND ASSESSMENT APPROACH: EIAMA

To conceptually overcome these gaps of interfaces for integration, translation, and communication we have worked out an Environmental Impact Assessment Multi-level Approach (”EIAMA”, or good planning practise approach) shown in Figure 5 (Lenz 1995, Lenz et al. 1996). It is a combination of the multi-level scaling and integration approach, and the environmental impact assessment concept. Be aware, that such graphs are simplifications, and at least some feedbacks and iterations between the various steps should be included.
In more recent publications we claim for more efforts in a so-called Assessment Science (see Lenz et al., 2000)

6. PROBLEMS LEFT

Besides a better scientific underpinning of SD indicators and harmonization efforts for indicators, frameworks and applications (cf. Lenz 1999, Lenz et al. 2000), there is also still an underestimation of environmental aspects of SD. E.g., Steiner (1998) points out, that the three dimensions of sustainability: Ecology, society,

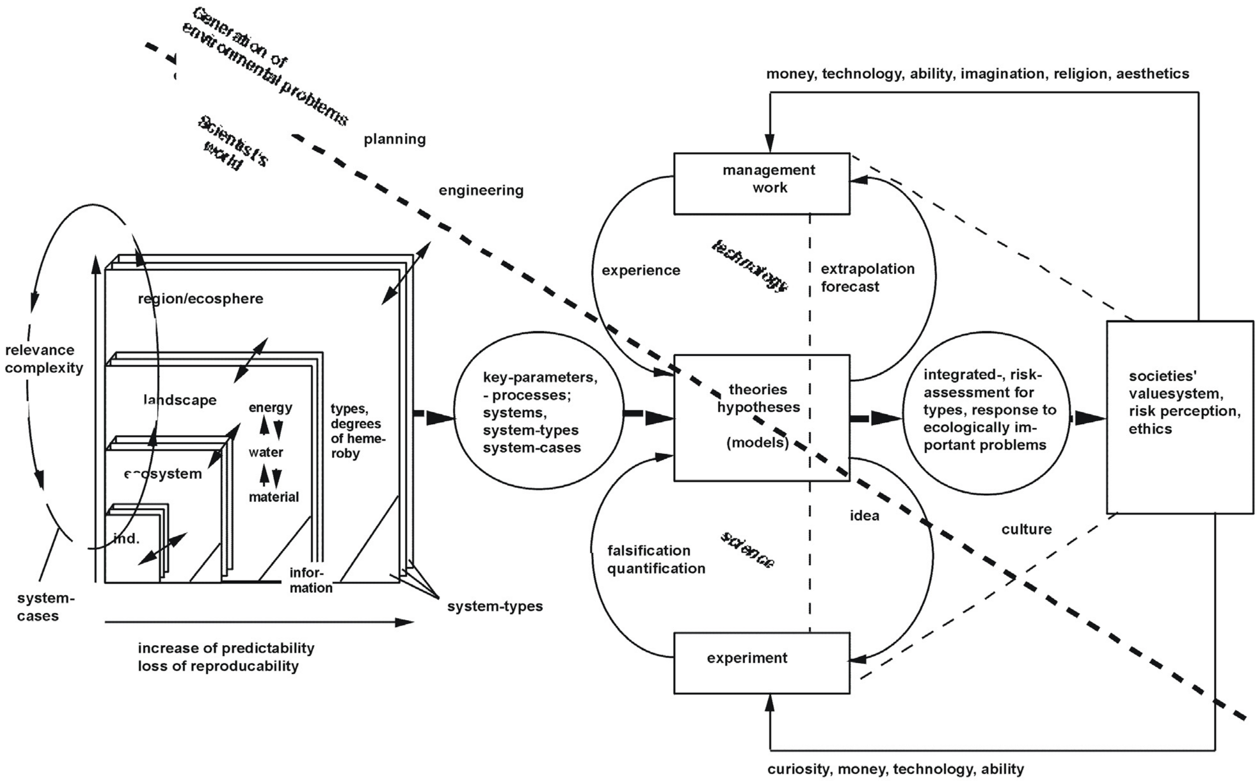

Figure 5 An Environmental Impact Assessment Multi-level Approach: Translating and using environmental knowledge for solving environmental problems in the transdisciplinary context of social and political evaluation (adapted from Lenz et al. 1996)

economy, are not equal should not be weighted equally and that there is a hierarchy to be considered. In looking on the line: Ecology – culture – policy – economy, an evolutionary background can be detected. In short, from living (and depending) from nature in the beginning of mankind, first culture, then policy and final economy developed one after the other. The dependencies follow the line the other way round: Economy must be framed by certain policy, otherwise it does not work sustainable, and policy has to rely on culture, which has to be oriented on ecology! Hence, what we need is an ecological culture, which provides space for a cultural policy, and therefore enables a political economy (Figure 6).

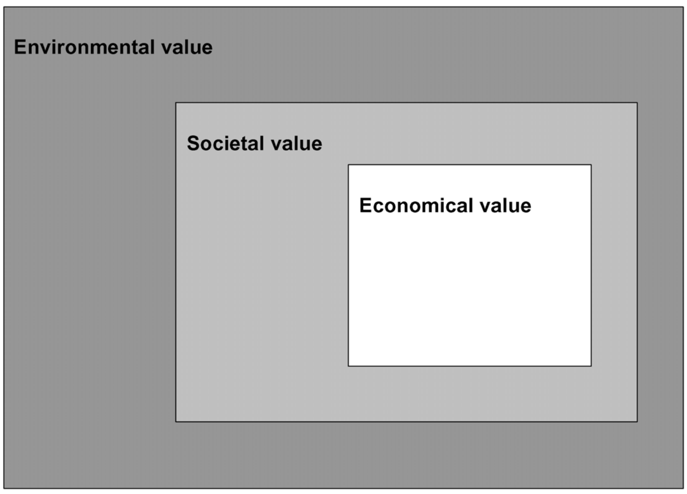

Figure 6 Value levels of sustainability (adapted from Seidl and Gowdy, 1999)

Another problem left is the continuous underestimation of communication needs. In short, Erz (1983) put it as follows:

”Spoken still does not mean heard. Heard still does not mean understood. Understood still does not mean agreed. Agreed still does not mean applied. Applied still does not mean maintained.”

A third major problem, which also needs continuous optimisation, is the simplification problem. Although there is a broad consensus about the need of indicators and indices because of many reasons, they are very much exposed to simplifications leading to wrong information. In the field of Landscape

Planning, the evaluation of Landscape Scenery is a good example: can we display it with an index? Or are we reducing something, which is highly complex and very much related to its perception by people, e.g. reducing to "ketchup" although it should be identified as a "tomato" (Figure 7)? On contrary, we also can fail with sophisticated models, if they do not reproduce the system under consideration. This inevitably leads to an inter- and transdisciplinary systems analysis approach – which is as complex as displayed in Figure 5.

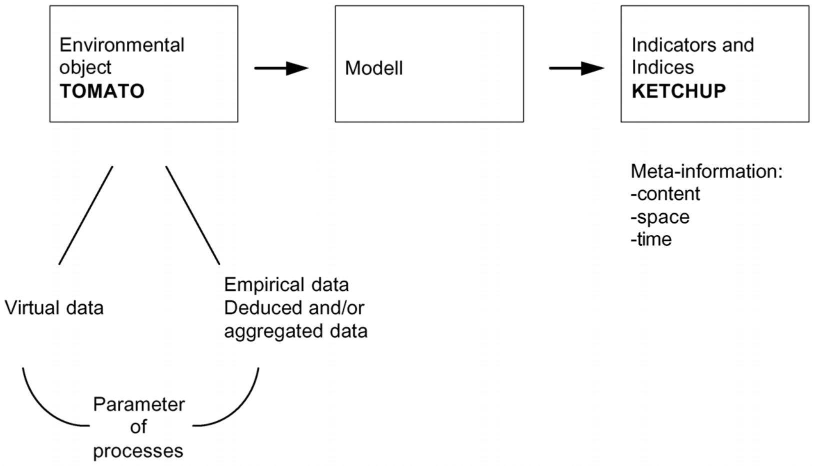

Figure 7 The tomato – ketchup problem: simplifications should not destroy identification properties

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