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The Governance of Transformation in Utility Systems: Challenge and Practice

Jan-Peter Voß
Öko-Institut – Institute für Applied Ecology, Berlin, Germany

1. Introduction

How can the dynamic relationship between society, technology and nature be understood in order to derive operational concepts for sustainable development? How can long-term structural change in socio-ecological systems be intentionally shaped? These are central questions for industrial transformation research. They also form the background to this chapter which discusses some conceptual issues that have emerged from currently ongoing research on the transformation of utility systems in Germany.[1]

The conclusion of this chapter leads into an outlook to a set of new research questions. These questions focus on the process of governance transformation and strategies for governance innovation. The background is a concept of sustainability that is not focusing on questions about the *right state* of production and consumption but on *new ways to deal with uncertainty and complexity* in socio-ecological change. Sustainable development thus refers to the processes through which strategies are generated rather than to their specific content.

I argue that sustainable development requires specific capacities of societal problem treatment which are not supported by a modernist paradigm of problem-solving which is enshrined in the institutional arrangements for management and policy-making in contemporary industrial societies. Conceptual advances that propose ways to achieve policy integration, long-term orientation and learning strategies therefore find it hard to be taken up in practice. These kind of innovations don't seem to fit a dominant pattern of governance, a *governance regime* as it is, which is based on specialisation, short range orientation, prediction and control. The focus of sustainability thus shifts from system innovations in production and consumption systems towards system innovation in the realm of governance.

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[1] The research is conducted within the TIPS-Project (www.tips-project.de) and the MICROSYSTEMS-Project (www.mikrosysteme.org). Both are funded by the German Federal Ministry for Education and Research within its programme on "socio-ecological research" (www.sozial-oekologische-forschung.org).

The argument is developed by first having a closer look at the object of sustainable development: socio-ecological systems and their co-evolutionary dynamics (section 2). This leads me to formulate the problem of shaping sustainable transformation as specified by the complexity of system dynamics, ambiguity of goals and distribution of societal control capacities (section 3) and derive a set of process criteria for sustainable governance (section 4). In combination, these features pose a need to drop the fiction of prediction, clear goals and possibilities of control in problem-solving. Process requirements for sustainable development are contrasted with the rationalist paradigm of management and policy-making which is dominant in modern society (section 5). From this I conclude that processes and institutional arrangements which allow to actively deal with the pluralism of perspectives, interconnectedness of problems and the ubiquity of unintended effects are more important for sustainable development than blueprints of sustainable production and consumption pattern. The final section of the chapter (6) collects some points in sketching out further research on the *innovation of governance* as a prerequisite to introducing sustainable governance practices in the context of currently established governance regimes.[2]

2. Socio-ecological transformation

A first step of research on sustainable development is a conceptualization of the object that we are dealing with. What is it that is supposed to develop sustainably? I propose a few selected conceptual building blocks in this section in order to illustrate the nature of the problem that is at hand when we talk about sustainable development. A starting point for doing this is to have a closer look at the relation between society, technology and nature. How can reality be understood as a compound of elements from these heterogeneous dimensions? How do they hang together and how do they change in mutual interaction?

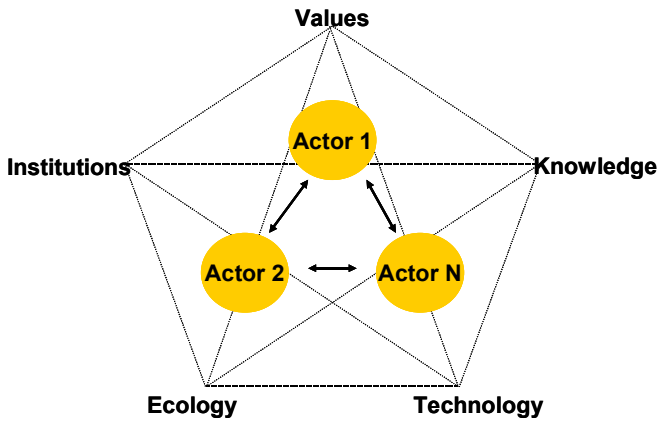
A concrete example is the transformation of utility systems in Germany. It is a process of fundamental structural change which is importantly influenced by a shift in the concept of "public service" and respective liberalisation and privatisation policies which have been implemented in the German telecommunications, electricity and natural gas system in the nineties of the last century and are currently under discussion in the system for water provision and sanitation as well. The transformation process entails far reaching changes in market shares, corporate structures, strategic orientations of consumers, production and consumption technologies, network architecture, institutional arrangements of governance and many other aspects. These ongoing developments are highly interdependent and collectively work towards "heating up" the socio-technical configuration of utility provision and opening possibilities for further change. This happens at a time when, in Germany, about 40% of generation capacity for electricity has to be replaced by 2010, demand for natural gas is forecasted to grow by about one fourth within the next 20 years, investment needs for maintenance of water infrastructure pile-up to 67-100 billion EUR and the volume of data transfers is expected to double within three years. The situation is one in which the regime of postwar utility provision is breaking up when at the same time functional requirements demand a massive build-up of capacity over the coming decades. It is largely unknown where this will lead up to, which structures of utility provision will emerge, which paths of future development will be taken. At the same time, the transformation has a strong impact for the sustainability of industrial society, because utility systems are closely entangled witch broader social, technological and ecological structures. They provide an important infrastructure for production patterns and lifestyles, account for a big portion of economic activity, channel important energy and

[2] These questions form starting points for a PhD project that I carry out at the University of Twente, NL. I appreciate inspiring discussion with Arie Rip and Maarten Arentsen in this context.

substance flows, entail considerable environmental and health risks and comprise some of the most powerful actors in the national governance system. There is a need to shape the course socio-ecological transformation and the resulting structures of utility provision. But how to do it?

For the purpose of having an integrated perspective on the variety of heterogeneous aspects that play a role for long-term structural change in the utility systems we developed a heuristic approach to socio-ecological transformation with elements from co-evolutionary theories of socio-technical change (Rip/ Kemp 1998; Geels 2002b), social ecology (Jahn/ Wehling 1998; Fischer-Kowalski/ Weisz 1998) and ecological economics (Norgaard 1994; Costanza et al. 1999). These theories are connected through a model of social interaction that explains social change in terms of a recursive relationship between agency and structure (cf. Giddens 1986; Mayntz/ Scharpf 1995; Hernes 1995; Ostrom 1999; Coleman 2000). In modification of the standard social science concept of "structuration" where the focus is on institutions (Giddens 1986), it is here assumed that structuration also takes place within the purely symbolic dimensions of societal values and cognitive frames and within the materially bound dimensions of technology and ecology. Thus, a basic framework is constituted for the analysis of socio-ecological transformation that is based on a specific set of actors who are situated within a specific socio-ecological context that is structured along the dimensions of societal values, knowledge frames, institutions, technology and ecology/nature (Figure 1).

Figure 1: Basis framework for the analysis of socio-ecological systems

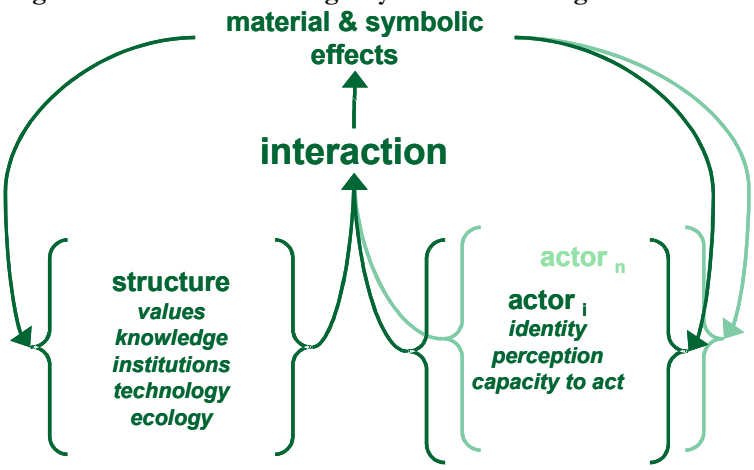


For the understanding of change it is important to note that the socio-ecological context structure enables and constraints human agency. There is a cause-effect relationship going from structure to agency. At the same time, however, the structure is being reproduced and transformed by as a result of human interaction. Through this there is a cause-effect relationship also from agency to structure. Observable interaction patterns can thus be thought of as being determined by constellations of interdependent actors (with individual identities, perceptions and action capacities), on the one hand, and socio-ecological structure (consisting of combinations of socially accepted values and knowledge, institutional and technical structures and bio-physical conditions), on the other hand. Within this basic framework socio-ecological change is understood to be caused by the aggregated symbolic and material effects of human interaction. These feed back on the actors themselves (e.g. make them learn) and on the socio-ecological structure. Effects that cause change are mostly unintended results of interaction, e.g. side effects of technology development, public interpretations of scientific findings, delegitimisation of institutions through individual misbehavior etc. Intended steering activities which are pursued by some actors with a view to shape so-

cio-ecological transformation are part of the interaction process and they influence its effects, but due to the complexity of influential factors they cannot control them (cf. Czada/ Schimank 2000). The time, speed and actual course of social-ecological transformation must therefore be understood as an emergent result, that comes "from behind the back of the actors" (see Figure 2 for illustration).

The circular causalities that are involved in the recursive relation between agency and structure constitute the systemic nature of socio-ecological entanglements. The ubiquity of positive feedback relations gives rise to the self-organisation of socio-ecological systems, momentum, inertia, path-dependency and other dynamic patterns which are known from the study of complex systems (Kauffman 1995; Holland 1998; Axelrod/ Cohen 2000).

Figure 2: Recursiveness of agency and socio-ecological structure



The outlined model can serve as a heuristic framework for the analysis of structural change in socio-ecological systems, no matter if they are defined functionally or regionally. For the purpose of our project on transformation in utility systems we focus on the provision of electricity, gas, water and telecommunications in Germany as functionally defined socio-ecological systems. In analysing change we concentrate on the sector level, or "regime level" (Rip/ Kemp 1998) of these systems. But we see that utility regimes are embedded in broader social, technical and ecological macro developments which exert influence on the regime level (e.g. European integration, discourse of Deregulation, spread of ICTs, climate change) and that regime change can also effectively be induced from developments on the micro level of functional niches and particular organisations (e.g. decentralised service provision in remote areas, procurement policies in the public sector).[3] On the regime level we further distinguish between three action fields which have primary relevance for transformation processes: production, consumption and regulation.[4] The fields are not sharply delimited but each comprises a specific network of actors that is aligned under a common func-

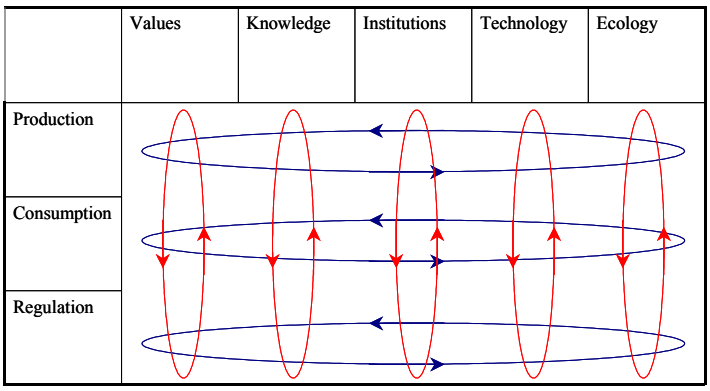
[3] That means we only "zoom in" for micro processes within organisations or local niches of provision, or "zoom out" for macro processes on the landscape level of global ideas, institutions, demography, technology or ecology when we find that these are relevant to explain processes of structural change that are going on at the sector level. We believe that a multi-level concept of structural change as presented by Rip/Kemp (1998) and elaborated by Geels (2002b) is useful for studying socio-ecological transformation. Here, we restrict our presentation of the conceptual framework to the regime level.

[4] We deliberately put other action fields like e.g. science and media "in the second row", because we believe that they only indirectly influence transformation in the utility systems (through e.g. changing mental frameworks of consumption) or actors from these fields directly take part in production, consumption or regulation.

tional orientation: producing utility services, making use of utility services or regulating the production and usage of utility services. Each field is structured by a specific sub-set of values, knowledge frames, institutions, technology and natural material conditions. As such, the action fields expose autonomous structural dynamics but they are embedded in and part of the socio-ecological structure of the sector as a whole. Their autonomous dynamics are coupled. The provision of utility services, technological innovation or the governance of sector performance comprise interactions between and across the differentiated action fields. The development of new production technologies, for instance, is linked to changing consumption patterns and both are linked to, say a stronger reflection of ecological risks in regulation. Novelty and variation in the established practices of one action field need to find complementary practices in the other action fields to be successfully established. Structural changes in production, consumption and regulation can therefore be observed to unfold in mutual adjustment. The transformation of regimes of utility service provision can be understood as a result of this co-evolutionary process.

Going back to the multidimensional structure of socio-ecological systems we find that co-evolution actually takes place in two different directions. In the first direction it is the various structural elements from the dimension of values, knowledge, institutions, technology and ecology that co-evolve as a result of the interaction processes within a specified action field. An example is the value change from "universal service provision" to "efficiency" in the regulation of utility services which co-evolves with a change in the cognitive framing of "natural monopoly", institutional changes towards the establishment of independent regulatory agencies and technological change towards a more decentralised network architecture. This co-evolutionary process constitutes structural dynamics within the action field of regulation. But co-evolution also and at the same time takes place in a second direction: Structural changes in one action field, e.g. regulation, are coupled with structural changes in other action fields, e.g. production. For the above example it can be stated that value change with respect to universal service is not confined to the field of regulation only, but that it is coupled to complementary value change in the field of production and consumption. In this direction co-evolution constitutes a specific dynamic of value changes that cuts across action fields. Taken together, it is this overlapping pattern of agency-structure dynamics within and across action fields that is behind the transformation of utility systems.[5] We attempt to capture this understanding by using the term "entwined co-evolution". Figure 3 visualizes the concept.

Figure 3: Entwined co-evolution in regimes of utility provision



[5] We have not explicitly looked at multi-level dynamics, yet. If we include the interaction of co-evolutionary processes across scale levels of socio-ecological systems we find that besides a horizontal overlap, there is a vertical coupling into nested processes of co-evolution.

I cannot go into more depth or detail with respect to the dynamics of socio-ecological transformation within the confines of this chapter. Here, the purpose is only to show that socio-ecological transformation is an object of study that easily escapes standard concepts and theories that exclude circular causality, multi-dimensionality, overlap and nested structures from reality in order to arrive at models that can be easily handled. The general characteristic of socio-ecological transformation is that it is a truly complex process that comprises abundant linkages between very heterogeneous elements. It could be said that science is about finding ways to tidy up this mess of real world entanglements in order to present models that allow for a clear definition of elements, cause-effect relationships and prognostic statements since, at last, it is to solve problems for what we do science. My point is, however, that this kind of problem-solving knowledge which tells us what to do in order to reach a given outcome is not available for the problem of shaping socio-ecological transformation. To ignore the complexity and uncertainty that is involved in long-term structural change across the boundaries of society, technology and nature would mean to produce knowledge that simply not adequate for getting the grips on the problem. Indeed, I suppose that overly simple models of reality, strategies that have been derived from them and their forceful implementation is one of the main roots of the problem of sustainable development. For illustration one can refer to examples such as the "green revolution" for solving food problems, nuclear power for solving energy problems, suburbial social housing to solve housing problems etc. (cf. section 3.2 of this chapter).

3. Shaping sustainable transformation

The above outlined concept of socio-ecological transformation provides a backdrop for elaborating the specific challenge of sustainable development as problem of shaping complex structural dynamics. This is taken further in the following section. In particular, three specific features will be highlighted as being constitutive for the problem of shaping sustainable transformation: complexity, ambiguity and distributed control. An unvarnished view on these characteristics reveals particular process requirements that are necessary for adequately dealing with the problem. These are summarised at the end of the section to build a set of process related criteria for the governance of sustainable development.

3.1. Complex system dynamics

3.1.1. Heterogeneous interactions

As briefly exemplified with respect to utility systems, the understanding of socio-ecological transformation implies knowledge about the heterogeneous dimensions of socio-ecological systems such as social values, knowledge, institutions, technology and ecology. It is further important to know how they are related to each other, how they change and how they interact while they change. Conventional disciplinary science does not deliver this kind of knowledge about the "interlinked and complex nature of reality" (Gallopín et al. 2001:228). Instead, it concentrates on analytically constructed "slices" of reality, such as molecular processes, problems of technical construction, social discourse etc. In reality, however, there is no clear borderline between these categories as part of the same world. Each of the specialised perspectives, consequently, defines away the systemic embedding of the analytical abstractions they are dealing with. In specific cases this may be methodologically justifiable because causal linkages are insignificantly weak so that parts of reality can be looked at in isolation without loosing important effects that determine processes in reality. In most cases, however, especially in the area of sustainability problems, linkages will reach well beyond the

scope of disciplinary defined problems and models to understand them (Funtowicz/ Ravetz/ O'Connor 1998).

But this does not only relate to the restrictions of disciplinary scientific perspectives, it also relates to the restrictions of science in general to grasp the full set of factors and interactions that are relevant for understanding any specific real world problem-setting. Knowledge production about problems of sustainable development can thus not rely on scientific knowledge that is produced within the institutions and along the methodological guardrails of the science systems. It needs to integrate the perspectives of societal actors outside of the science system. This includes practical knowledge which results from experiences made in daily interactions with reality. This kind of knowledge is often tacit and cannot be used by conventional methods of scientific enquiry. It can only be generated in interactive settings, in which knowledge is co-produced by scientists and actors from respective fields of societal practice.[6]

A first process element of effective problem treatment for sustainable development therefore is to pursue ways of integrated knowledge production which transcend the boundaries between disciplines and between science and society. Practical and methodological steps in this direction are taken under the heading of "transdisciplinarity" (Gibbons 1994; Nowotny/ Scott/ Gibbons 2001; Bechmann/ Frederichs 1996; Thompson Klein et al. 2001; Mogalle 2001; Bergmann 2003).

3.1.2. Uncertainty

If socio-ecological transformation is understood as a process of co-evolution of social, technological and ecological structures, which are constitutive elements for action fields such as production, consumption and regulation, and if these action fields are at the same understood to co-evolve with each other, we face a highly complex compound of interdependent processes. The overall process cannot be analysed by linear models of cause and effect anymore, because feedback is a common appearance. If the process of socio-ecological transformation is further understood as a process which takes place within a multi-level structure of nested subsystems (e.g. local, regional and global level) the interaction between dynamics on each level adds to the complexity of the overall dynamics of socio-ecological systems. The result is that socio-ecological transformation cannot be predicted. The occurrence of positive feedback loops which give rise self-organisation dynamics or destructive resonance is multiply conditioned and may pop up here and there without possibility for safe predictions (e.g. topics in public discourse, social movements, BSE, strategic action under regulation, stock market crashs). The thresholds for catastrophic changes cannot be defined by a single parameter but are determined by a confluence of many factors which cannot all be traced down in order to determine safe levels of activity (e.g. ecological pressure causing a breakdown of ecosystem resilience, social injustice causing upheaval, tax level rises leading into an economic depression). This is a fundamental constraint because of the impossibility to measure all incremental factors (especially the human factor) that play together and because of non-linear system dynamics which may give exactly those apparently minor factors a large say on where the system will go ("butterfly effect") (Gleick 1998).

At the same time this is also the reason why we cannot, for pragmatic reasons, rely on simpler models of the causes which are behind sustainability problems. If we do so, we externalise complexity in our cognitive models while the world stays as complex as it is (Dörner 1989). Inadequate problem constructions then come back in form of unexpected consequences when strategies are implemented in the real world (Böhret 1990). That means that, for processes of socio-ecological transformation, we

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[6] An important methodological questions that follows is about who is take part in such processes of interactive knowledge production, which disciplinary scientists and which societal actors.

face fundamental uncertainty about the effects of deliberate interventions by policy or management decisions (Dobuzinskis 1992; Stacey 1996; Walker/ Rahman/ Cave 2001).

The only way out of this dilemma is to stay in it, but do it reflectively: accept that there will always be a high degree of ignorance and uncertainty connected to societal action within socio-ecological systems. Unintended consequences will prevail, because no comprehensive and exact model for the prediction of socio-ecological dynamics can possibly exist. With growing impact linked to increasing scale and depth of human intervention a high probability of unintended consequences needs to be taken as a central condition of problem-solving strategies. This would mean that ignorance and uncertainty are actively dealt with and are not blocked off in order to pretend to have a practicable solution at hand (Stirling/ Zwanenberg 2002; Dobuzinskis 1992).

Because no secure knowledge can be acquired to predict socio-ecological system behaviour and the effects of human intervention, a second process requirement for the adequate treatment of sustainability problems is an adaptive design of strategies and institutional and technological structures. This would entail the capacity to respond to unexpected developments. Strategies should feature experimentation, monitoring and evaluation in order to systematically work with new experiences, altered interpretations and changed circumstances.

3.1.3. Path-dependency

While effects of human action are not entirely predictable they occur all the time and they feed into a continuous process of socio-ecological transformation. It is human action that shapes socio-ecological transformation, even if not intended. This happens through ongoing structuration processes which are not only linked to policies or other strategies that are explicitly aimed at inducing structural change but also to the daily conduct of production and consumption routines.

Changes in one element of socio-ecological systems are accompanied by changes in other elements. Within and across social, technological and ecological subsystems there is a constant generation of novelty and adaptation which induces further novelty and adaptation in response. This process may sometimes be so incremental to be non-conceivable, sometimes it may be very radical and rapid. A certain degree of stability is maintained as long as a specific configuration of elements play well together in bringing about systemic performances which meet the capacities and requirements of components within the system and outside of it. The System is then in dynamically stability because it produces outcomes which reproduce its structure (Geels 2002a).

An example are electricity systems. They comprise a specific configuration of culture, organisational rules, technology, geographical conditions and different types of actors. These elements play together in specific process patterns and deliver a certain performance with respect to service provision and side effects. The electricity system in Germany showed 40 years of relative stability after the second world war. Only towards the end of the last century turbulent changes occurred. An important source of this fundamental transformation are institutional changes which introduced competition to the market. This change has triggered other changes, e.g. in investment behaviour and technological innovation as well as the cultural meaning of electricity and consumer behaviour. Further changes in actor constellations, corporate organisation, technology, resource requirements and ecological impact are to be expected. Yet, it is highly uncertain how they will look like. These changes may again induce adaptations of regulatory institutions. At the end they may lead into another stable configuration which only changes gradually and very slowly over some decades - as it was the case for the phase after the second world war. But they may as well perpetually feed into new structural adaptations and not find a new dynamic equilibrium. The crucial point is that the future structure of electricity provision, be it relatively stable or fluent,

emerges from present processes which receive their dynamics from societal action. The future structure of electricity provision is being shaped by what we do today. Depending on how this structure will look like it will entail specific social and ecological impacts. And it will entail specific opportunities and restrictions for actions to deal with these impacts. What we now do about electricity - buying electricity, drafting regulations, investing in technology, discussing public concerns etc. – thus shapes the future performance of electricity provision and the conditions under which problems can be treated that appear later on. This is an example of the path-dependence of socio-ecological transformation. It puts large weight on decisions and actions that seem to be of minor importance today, because their aggregated and accumulated effect may be of major importance for what is possible tomorrow. The point is that, in the course of socio-ecological transformation, we are constantly shaping the future, consciously or not. Future developments which are induced by today's problem solving are not easily discernible, but they are largely irreversible.[7]

Sustainable development therefore requires a careful anticipation of the long-term effects of present actions. Due to the complex dynamics of socio-ecological transformation these effects cannot be predicted with certainty. Anticipation rather refers to an explorative evaluation of alternative development paths that may be spurred by the actions that are taken today. The general aim is to explore future opportunities and to avoid lock-in to trajectories which withstand the achievement of sustainable development. Such processes can, for example, be based on scenario construction, participatory modeling or policy exercises (Godet 1987; Ringland 1998; Asselt et al. 2001; Elzen et al. 2002).

3.2. Sustainability as a strategic goal

Sustainable development is often referred to as a normative orientation. Generically, however, it refers to a functional relation. Sustainability can be defined as a state in which something can be sustained, can be kept in existence. Sustainable development thus is a type of development that does not erode its own fundaments. In this perspective, sustainable development is a normative criterion only in so far as it implies a value decision to sustain societal development on earth rather than to annihilate it. Sustainability can hence be defined as "the long-term viability of socio-ecological systems".[8] On this level, not surprisingly, there is overwhelming social consensus. The crucial question then is: *How* can societal development be sustained? In order to know which practices can serve to sustain societal development it will be necessary to assess their *long-term systemic consequences*. This requires knowledge about social and ecological systems, the ways in which they are coupled, dynamics of their develop-

[7] For an example from the electricity system one could speculate that a forceful promotion of distributed generation could eventually lead into a gradual dismantling of the long-distance transmission grid. From today's perspective this may seem to be a sustainable path of transformation. It may be, however, that within a few decades solar power generation in North African deserts turns ot to be the most cost efficient and ecologically sound way to provide electricity to Western Europe. The social and technical infrastructure which would be needed to implement high voltage power import would not be at hand anymore so that this option for electricity provision would effectively be locked-out by then consolidated structures of decentralized electricity provision.

[8] Also the political operationalisation of the concept by the Brundtland Commission with its reference to inter- und intragenerational justice: "sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" can be interpreted in functional terms. The fulfilment of needs, self speakingly, is something that is needed for the continuation of society. If needs are only fulfilled for some, the resilience of social system is endangered by distress and conflict. Open questions, however, still are: What are the relevant needs, what will they be? How are they met? Which factors comprise the ability to meet them?

ment and the factors that influence it. As such, sustainability is clearly an analytical question, not a normative one.

In spite of the analytical content of the concept of sustainable development, however, specific practical problem features impede an "objective" scientific clarification:

(a) The fundamental limits to predict socio-ecological system behaviour mean that there can be no secure knowledge about the dynamics (and resilience) of societal systems and ecosystems. It may be possible to determine ranges of parameters within which system behaviour can be predicted with satisfying probability. These may be used to define "corridors of sustainability" within which dangerous system change can be avoided (for e.g. emissions, rate of inflation). In practice, however, sustainability assessment almost always deals with parameter changes at the fringe of so defined sustainability corridors. On these issues uncertainty is high and risk evaluations become decisive. The readiness to take risks, however, is a subjective disposition which differs between actors and different situations and cannot scientifically be decided.

(b) The dynamic stability of social systems depends on subjective evaluations of the actors who constitute the system. Societal systems, be it nation states, organisations or families are stabilised if the perceived situation of actors matches their identity and values. Values are thus an endogenous component of socio-ecological systems. Values changes, on the other hand, can shift requirements for sustainability.

(c) People hold different values and decide differently if they evaluate options. Even if everybody generally agrees on what is good and what is bad there will be differences in the weight that is given to certain values. This is particularly relevant for sustainability assessment since equally legitimate goals (such as social justice, reduction of environmental risk, economic viability) can only seldom be achieved at the same time and to the same degree. Value trade-offs are a common characteristic in the daily practice of sustainability assessment. The different ways to make these trade-offs effectively feed social dispute about what is sustainable and what is not. These disputes, however, can less be solved scientifically but rather through social discourse or political decision.

Taken together, sustainable development necessarily remains a contested concept. Its substantial content (i.e. definition of the parameters of socio-ecological systems that have to be met to sustain development) cannot scientifically be determined as "objective knowledge" but will always incorporate normative valuations which are ascertained in processes of social interaction. To a certain degree political institutions may have the legitimacy to decide on matters of values and risk. But when it comes to actions with potentially irreversible and large scale impacts, decisions which in fact have an existential meaning for human life on earth, the legitimizing function of democratic government may indeed be overstrained. When sustainability is taken as an orientation for societal action it will therefore not be lend itself to be resolved into a clearly defined goal but always deliver a variety of ambiguous goals. It may not be possible to eliminate the inherent discrepancies that exist between different goals or to define a clear ranking order by way of rational argumentation and empirical evidence. Social conflicts are inherent to the concept and need to be carried out with it.

Another aspect is that sustainability goals cannot be determined once and for all. Because substantial notions of sustainability are build on the basis of uncertain knowledge and social evaluation, they must be expected to change over time. Knowledge about socio-ecological system dynamics changes with scientific progress and new experiences being made. Values, on the other hand, are endogenous to the process of socio-ecological transformation. They may change, exactly because they are success-

fully being followed. And there is no way to know, what the needs of future generations will be.

Sustainability thus is a "moving target" which can only be followed through processes of iterative participatory goal formulation. Sustainability goals and assessments cannot be determined by principle once and for all, but only through iterative processes. The broad participation of affected societal actors in the process of goal formulation is necessary because their values are constitutive to the sustainability of social development.

3.3. Strategy implementation

A third feature of shaping sustainable transformation is related to the implementation of strategies. Even if certain predictions about socio-ecological system behavior and clearly defined goals were given, so that "best strategies" of intervention could be derived, there would still be specific difficulties with the implementation of strategies to shape transformation. These refer to the fact that capacities to influence the speed and direction of socio-ecological transformation are distributed among many different actors. In order to take effect their actions would need to be coordinated along the lines of a collective strategy. There is no one point from where processes of socio-ecological transformation can be steered.

The distribution of control capacities is surely not an exclusive feature of sustainability problems. It is a general characteristic of governance in modern societies. The shift from government to governance in talking about societal management reflects growing awareness for the fact that capacities to take influence are distributed between different governance levels (e.g. nation states and the EU) as well as between functional domains, such as production, consumption and political regulation, and between different actors within these domains (Kooiman 1993; Schneider/ Kenis 1996; Rhodes 1997; Mayntz 1998; Kohler-Koch/ Eising 1999). These conditions have to be taken as a starting point for strategy formulation and implementation. There are situational differences in how dispersed capacities of governance really are and in how far one actor (e.g. the head of government) or a small coalition of actors disposes over sufficient power to make other actors follow certain strategies. The situation is, however that the coordination of actors cannot be taken for granted, but that it needs to be established for any specific problem anew.

Problems of shaping sustainable transformation are a kind of problems for which a very high degree of distributed control capacities can be stated. The reason is that innovation and structural change are highly contingent upon a multitude of different factors. These are in the hands of many different actors. Overarching competencies and procedures for shaping structural change are not established. Public actors are but one type of actor among others, albeit equipped with democratic legitimacy as a special source of power. Moreover, the competencies of the state are fragmented into several agencies such as governmental departments, regulatory agencies, political parties etc.

The "de-factor" governance of transformation thus appears to emerge from the daily interactions between consumers, producers, policy-makers and various other actors such as researchers or journalists – without anyone controlling it (cf. Rip/ Groen 2002). The diverse actors involved in transformation follow their own vital interests, partly in cooperation and partly in conflict. And they each dispose over specific resources to enforce their strategies. Transformation, finally, is the result of the intended and unintended effects of these interactions. In contrast to "normal" policy or management arenas the governance of transformation is neither an instutionalised policy field nor are stabilised policy networks in place, yet, which comprise the relevant actors who have influence on transformation.

Due to the many roots of socio-ecological transformation distributed control capacities have to be taken into account in strategy development. For the shaping of transformation processes it is necessary to coordinate the action of a broad range of heterogeneous actors. Such coordination cannot rely on hierarchical modes of control but takes place in heterogeneous governance arrangements which comprise elements of negotiation, market and hierarchy. Problem perceptions, interests and practical knowledge of the various stakeholders need to be linked together in processes of interactive strategy development.

4. Criteria for sustainable governance

The above mentioned specifics of the problem of shaping sustainable transformation and derived strategy requirements can be compiled into a set of criteria for sustainable governance. Such criteria do not refer to specific targets that should realised or to the substantial content action strategies but to the very process and the institutional arrangements through which strategies to shape transformation are developed.Table 1 gives an overview on the criteria that have been derived in course of the above discussion.

Table 1: Process criteria for sustainable governance

Aspect of Problem treatment	System analysis			Goal formulation	Implementation
Specific problem features of sustainable transformati on	Co-evolution of social, technical, ecdological elements across multiple scales	Uncertainty about system dynamics and effects of intervention	Path-dependency of structural change, high societal impact	Sustainability goals involve value trade-offs, are endogenous to transformation	Capacities to influence transformation are distributed among actors
Strategy require-ment	**Integrated knowledge production**	**Experiments and adaptivity of strategies and institutions**	**Anticipation of long-term systemic effects of measures**	**Iterative, participatory goal formulation**	**Interactive strategy development**

If the complexity of socio-ecological systems, ambiguity of sustainability goals and distributed control capacities are taken as unavoidable starting points for the development and implementation of sustainability strategies, there occurs a shift in focus from questions directed at defining the right way of energy or water provision, agriculture or transport to questions about the design of processes which provide effective guidance in searching for sustainability (Minsch et al. 1998). This leads us to ask if we have the right institutions in place that create integrated and long-term problem perceptions, abilities to respond to unexpected dynamics, learning from experience and foster capabilities of self-adaptation. The set of criteria for sustainable governance can be used as orientation for the development of methods and institutions to shape transformation, and they can be used to assess current governance processes with respect to their adequacy for the problem of shaping sustainable transformation. They are briefly worked out in the following paragraphs.

4.1. Integrated knowledge production

Treatment of sustainability problems needs to be based on integrated concepts of the problem itself and the system context in which it is embedded. This refers to scientific knowledge production across disciplines and consideration of practical knowledge held by societal actors. It also refers to the development of integrated perspectives in defining policy problems, conceptualising its causes and effects and assessing possible intervention strategies.

4.2. Adaptivity of strategies and institutions

Because of the impossibility to predict socio-ecological transformation there can be no best solution defined ex ante. A strategy needs to be seen as a hypothesis about the problem and its solution. Policies should therefore be designed to test this hypothesis. This entails that the test is thoroughly monitored and that policies can easily be adapted according to test results. Responsiveness and adaptivity of strategies and institutions could serve as procedural criteria for sustainability assessment.

4.3. Anticipation of long-term systemic effects of action strategies

Within socio-ecological system dynamics effects may appear detached from their causes. Important repercussions often occur where they have not been expected and long after the triggering actions have been carried out. Narrow problem definitions and short time horizons are therefore likely to exclude important effects. A specific aspect with respect to socio-ecological systems are lock-in effects which may be the result of a neglect of the path-sensitivity of decisions at points where small interventions may cause large results. Sustainable governance systematically needs to anticipate the indirect and long-term effects of pursued action strategies, especially with respect to structural lock-in. Explorative scenario methods can be a method in case where complexity forbids analytical modeling.

4.4. Iterative participatory goal formulation

Sustainability goals can for generic and practical reasons not be defined "objectively". The ascertainment of the necessary conditions for long-term viability of socio-ecological systems involves subjective risk perceptions and value trade-offs that cannot be decided by scientific methods or political decision but only through social discourse. Moreover, values are themselves a constitutive element of the resilience of social systems because they determine social needs. As such they may change in course of transformation processes. Sustainability goals thus constitute ambiguous and moving targets. This needs to be taken into account by way of participatory processes for formulating sustainability goals. Goals need to be regularly revised in order to adapt to changing values and knowledge in course of transformation.

4.5. Interactive strategy development

Socio-ecological transformation is an outcome of dispersed social interactions. Interactions cut across institutionalised policy fields and action fields such as production, consumption, regulation, research or the media. A broad range of heterogeneous actors is involved who follow their own interests and dispose over specific resources of influence. Government and other public actors are but one type of actor among many, albeit equipped with political legitimacy as a special source of influence. In or-

der to shape transformation diverse actions have to be aligned for a collective strategic goal. Strategies therefore have to be developed in interaction with relevant stakeholders in order to integrate their know how and assure support for implementation.

5. Rationalist problem-solving and modern governance

The process features of sustainable governance that have been outlined pose specific requirements to institutional arrangements. When looking at institutional arrangements and the status quo of problem treatment in industrial societies it appears, however, that they follow quite different lines. The difference becomes clear when the criteria for sustainable governance which have been elaborated above are contrasted with currently established patterns of management and policy-making and their underlying paradigm of problem-solving.

The ideal of the modern approach to the world is to strive for rational coherence based on the assumption of a uniqueness of truth and universality of knowledge. If these assumptions are taken for granted it is a matter of clarification of goals, thorough analysis and choice of right instruments that makes problem solving successful. Great achievements are built on the cultural victory of the rational approach. It provides a common bottom-line and a stable reference framework for scientific and technological exploration, political discourse and even the handling of personal relationships. As such it helped to civilise society and gain control over large parts of nature.

But rationalisation also has a price. Rational order is not a generic feature of the world but it needs to be constructed by human cognition. The vast network of causes and effects which constitutes the real world beyond human perception must be shrunk and sliced in order to make it rationally accessible. Finally, this leads to the construction of problems in a way that they can actually be solved in a rationalist way. This orientation has obvious advantages in developing powerful levers to take effect on nature, motivating straight forward action and, not least, providing a common frame of reference for reasonable discourse. This modernist ideal proved to be appropriate for very many problems. However, it also has its specific limitations. Rationalist problem construction essentially works by externalisation: The order inside of a cognitive model is the result of leaving out the vast majority of factors that take effect in the real world. This holds true for physics as well as economics and psychology and it also holds true for more practical models such as those underlying the farmer's weather forecast or the politicians campaign strategy. The cognitive externalities only show effect when strategies which are derived from the model are actually implemented in the context of the real world. Then they appear in form of unintended or even unexpected effects. These may cause new problems or even turn against the original problem-solving intention. The paradox of rationality thus is that the motivation of getting the grips on the world may turn against its own ends: When the ambition to make things clear leads to ignorance and neglect of relevant aspects of reality, it may trigger actions which cause even more disorder. Such an approach is apt to produce new "second order" problems at the same time as it intends to solve problems (Jahn/ Wehling 1998). When these second order problems become more severe than the ones that are actually solved, it deems that there is something irrational about rationalist problem-solving. Global environmental change, soil degradation, poverty and adverse effects of globalisation and other issues of sustainable development are examples of second-order problems. They are caused by rationalist approaches to solve problems of energy and food provision and economic development. The ideal of rationalist problem-solving is starting to crumble in light of these experiences. But it is still deeply rooted in social expectations towards policy-makers and managers and in institutionalised procedures of societal problem treatment.

5.1. Functional differentiation

A general pattern of modern societies is functional differentiation (Luhmann 1990; Mayntz et al. 1988; Schimank 1996). From the early separation of the church and the state the momentum of differentiation takes effect. It leads through to the departmentalisation of policy-making, the disciplinary split of scientific knowledge and branching of ever more specialised professions. Differentiation is essentially a process of slicing up the world. Its main cognitive driver is that it allows for a reduction of complexity to be considered in carrying out professional communication and action. As such it allows to extend the application of rationalist problem-solving approaches.[9]

The patterns of differentiation are deeply rooted in the structures of society and they are difficult to transgress. Experiences with policy integration, inter- and transdisciplinary research and economic innovation networks exemplify the practical difficulties in crossing the boundaries. These are linked to differentiated theories, language and habitual styles, differentiated perceptions of relevance and feasibility of strategies, competition over resources and other factors. In many cases it is indeed two or many different social "worlds" that incompatibly stand beside each other.

5.2. Short-term orientation

Another structural aspect of modern society are loosened personal bondages and increased mobility compared to traditional forms of living which were prominently structured by clan membership and local residence. People move across space and social networks, live in different cities on different continents, change friendships and work with different organisations. This means a higher degree of personal freedom and a reduced obligation to stick with certain social relationships. But with it comes a general loss of liability and the need to introduce more sophisticated means of social control than communal norms and trust. For professional roles specific procedures of evaluation have been developed. Politicians are assessed through elections, managers through the shareholders of their company. This works to make them accountable and control their work to a certain degree. However, it also introduces a short-term perspective to their strategic behaviour. Against the background of the paradigm of rationalist problem-solving they are expected to deliver solutions within the timeframe of their assessment period, usually not more than 5 years. If they do not succeed, they are out.

Another aspect feeding the short term orientation in professional decision-making is that, in order to make rationalist problem solving possible, it is necessary to reduce uncertainty. The array of unexpected things happening, however, increases rapidly with the time horizon taken that is taken into account. This is a factor that systematically favours problem definitions and strategies that cover only short time periods. The more strategies are built on linear implementation plans without allowance for adaptation but only the possibility of failure, the stronger is this effect. Especially in the economic system, but also in the domain of politics and social relations, strategies thus tend to be concentrated on projects with short pay-back periods.[10]

Beyond both features, functional differentiation and short-term orientation, and their linkage to the paradigm of rationalist problem-solving many more structural specifics of the current governance regime in modern societies could be highlighted. These are, for example, competitive orientations in party politics or markets which work to impede the realisation of cooperation benefits, veto positions in informal

[9] The more aspects of the real world are excluded from theories about human behaviour, for instance, the more encompassing and sophisticated models of economic development become possible and instruments appear feasible to control it.

[10] Financial interest itself is another institutionalised form of the short-term as it systematically diminishes values when they occur in the future.

policy networks which are occupied by powerful actors who can dominate collective action, sovereignty of nation states contrasting the global scale of problems etc.

At first sight it appears that the dominant patterns within the configuration of governance in modern society contradict the criteria for sustainable governance in some important respects. Most clearly is the opposition of the modern paradigm of rationalist problem-solving with the uncertainties involved in complex socio-ecological transformation. Specifically, the momentum of functional differentiation contrast with the requirements for integrated knowledge production, participative goal formulation and interactive strategy development. The institutional embedding of short term perspective in political election cycles, management perspectives and interest rates hints at a mismatch with the anticipation of long-term effects in strategy development.

6. How to innovate governance?

Against the background of the rationalist paradigm of problem-solving and the structures of current governance regimes it deems important to have a closer look at the realistic prospect of sustainable governance. Which are the conditions for sustainable governance to gain ground and become implemented in the daily practice of societal problem treatment? How can new modes of governance be introduced within the context of existing regime structures? From this perspective sustainable development appears as a challenge to innovate governance.

Several approaches have been developed over the last years with the aim to improve societal problem treatment for sustainable development. Many of them follow similar lines of reasoning as contained in the criteria discussed above. Some of these approaches are not yet more than vague programmatic strategies like policy integration, transdisciplinary research, integrated assessment etc. Some of them, however, are already quite elaborate with respect to specific methods and procedures through which they can be applied. In some cases implementation experiences have been made. Examples of the latter are green cabinets and sustainability councils for integrated long-term strategies, participatory research methods like focus groups and scenario workshops, interactive technology assessment and new forms of prospective strategy processes such as foresighting and transition management.

Some of the experiments that have been carried out on the basis of these conceptual approaches can be observed to work quite well. In these cases it seems possible to implement sustainable modes of governance under the conditions of the prevailing governance regime, at least to a certain degree. The Dutch transition management programme, the British sustainable energy policy network, the German socio-ecological research initiative, European foresight exercises etc. could be cited as successful examples of introducing more integrated, learning oriented approaches – although all of them are pretty recent and only have a short record of experience. Many other attempts fail at different stages of the innovation process. Either the problems with established ways of dealing with sustainable development do not even become a topic of discourse or alternative approaches cannot gather sufficiently strong actor networks for further development or they become frazzled in the course of implementation. The success of governance innovations for sustainable development obviously depends an many factors from the cultural, institutional and technological context, the actor constellations and on the innovation strategies that are pursued by the actors in each case.

As a hypothesis from the briefly outlined characterisation of modern governance it can be expected that many unsuccessful attempts at innovating institutional arrangements of societal problem treatment suffer from a lack of fit with the dominant gov-

ernance regime. Yet, there is little knowledge on these aspects of innovating governance. Institutional and policy innovation for sustainable development is either simply referred to as something that ought to happen or it is merely being reported as a phenomenon that appears in comparative studies. Very few studies go into the details of the respective innovation processes, so that little is known about the evolution of innovation strategies for sustainable governance. Some work in the area policy studies dares a closer look at the birth and lifecycle of political reforms, but the analysis usually is restricted to a set of variables that is limited by the disciplinary perspective of political science which cannot sufficiently grasp the entanglement of governance in the context of socio-ecological transformation.

I therefore end the contemplations of this chapter with a brief outlook to further research on governance innovations for sustainable development. For this purpose I present possible directions that this kind of research could take.

- Research on governance innovations takes into account the embedding of processes of societal problem treatment in socio-ecological system contexts. An analytical framework that is restricted to actors and institutions, as is dominant in political science, may not be able to adequately consider the influence of cognitive frames, technology development and ecological conditions for changing governance patterns.
- For a dynamic understanding of governance, steering activities need to be seen to be endogenous to socio-ecological transformation. Governance is not somewhere outside or above the socio-ecological systems in which transformations take place (e.g. electricity systems, food production, geographical regions) but it is part of it. This is important for not to overlook how governance itself is conditioned by the social, technological and ecological structures of the area to where it applies. When governance induces changes in these structures it also induces changes in the conditions for its own working.
- Dynamic concepts of governance should not focus too much on the identification of general patterns or even universal theories of change. They should rather be open enough to give due recognition to the many contingencies that are involved in social and institutional change processes.
- The study of governance innovations may be able to make use of co-evolutionary concepts and theories from the field of innovations studies and socio-technical change. By drawing analogies between technological and institutional innovation some helpful concepts may be derived and interesting hypotheses may be generated.
- It could, for example, shed new light on the conditions under which institutional innovations occur, if they were, similar to technology, be conceptualised as "configurations that work" (Rip/ Kemp 1998). This would mean that they comprise a specific combination of values, knowledge, institutional rules, maybe also technology and elements from the natural environment. Innovations processes would then require complementary changes within these heterogeneous dimensions to be successful.
- Against this background "innovation journeys" of new governance arrangements can be traced by detailed case studies which could work with concepts that are known from technology studies such as "alignment", "momentum", "reverse salient", "hot phase and cool phase", or possibly a phase heuristic that comprises invention (idea), development (concept) and diffusion (implementation).
- It could be worthwhile to apply a multi-level framework of niches, regimes and landscape which has been developed for analysing socio-technical change (Rip/ Kemp 1998; Geels 2002b). An adapted concept of "governance regime" could be helpful in explaining institutional path-dependency and lock-in, but also patterns of governance transformation. This concept could be linked up with existing con-

cepts from political science such as policy style, political culture, political system etc. and add a dynamic component.

- Finally, various strategy recommendations which have been drawn from a multi-level, co-evolutionary analysis of socio-technical change, could be used to explore the ways in which societies could reflexively innovate their own governance.
  Among these are
  - A general orientation towards learning and modulation rather than achieving prediction and control
  - Active experimentation, management of niches in which a diverse portfolio of governance modes is tested and further developed
  - Contextualisation of governance innovation processes by establishing nexus arrangements for the integration of perspectives of various stakeholders. This would help to take socially robust paths of governance innovation.
  - Participatory formulation of performance criteria for sustainable governance and development of long-term visions, road maps of how to get there, including monitoring and a regular revision of criteria, visions and road maps.
  - Establishment of a "social innovation policy" including social science R&D, support for social innovation networks which comprise researchers and "institutional entrepreneurs", support for niche experiments and adaptation of framework conditions, institutional innovation impact assessment.

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