# PROBLEM TRANSFORMATIONS IN TRANSDISCIPLINARY RESEARCH

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## Contents





## Summary

The possibility of redirecting life support systems towards sustainable development is analyzed from a methodological point of view. Socio-ecological transformations at global, regional, and local level are defined as general object of this new type of research. The scientific and technological knowledge needed for an understanding of these transformations is distributed over a broad spectrum of disciplines and professions committed to incommensurable values, different theoretical concepts and conflicting methodological orientations. Therefore, a strong demand for integrated knowledge has arisen with the aim of improving both explanatory power and usefulness for problem solving. Employing a distinction between three structural levels of discourse a methodological framework for sustainability oriented research is sketched. The levels of discourse are: a normative discourse on definitions, criteria, indicators and goals; an operative discourse on strategies and actions; a descriptive discourse on states and processes of socio-ecological transformations and crisis. At each level a complex web of problems, methods and knowledge is identified. With help of a formal concept of problem a process model for the transformation of agency problems of everyday life

into scientific problems is elaborated. The conditions for a cognitive integration of problem solutions are investigated.

## 1. The emergence of transdisciplinary research for sustainability

Human life and societal development depend strongly on the functioning of a highly complex set of interactive natural and social systems. *Life support systems* for water, energy and food are embedded in a fragile natural environment that require intelligent regulation in order to satisfy the needs of a growing population now and in the future. Life support systems establish ecological, economic, and social minimum conditions for the continuation of societal life. These systems are threatened worldwide by human agency. Alarming problems arise and then develop into crises: Shortages, and the uneven distribution of resources, pollution of air and water, degradation of soils, deforestation and loss of biodiversity, global warming and ozone depletion are global symptoms of an unsustainable world. An emerging world society interacts strongly with a global ecology. Since the 1992 Earth Summit in Rio, *sustainability* has become the slogan for a discourse and a political program committed to the conservation of natural resources, the quality of life and a sense of obligation toward future generations, a discourse that is also steeped in controversy (*see, Methods for Sustainability Assessment: Sustainability Indicators*; and *Unity of Knowledge in Transdisciplinary Research for Sustainability*).

To ensure as far as possible that current generations do not diminish the availability of resources for future generations, political and economic strategies have been developed for coping with the tightly linked challenges of an unsustainable world. New knowledge constructing practices and new technologies for an intelligent regulation of life support systems have been worked out. Yet this momentous global challenge has still not been sufficiently met. This challenge also defines the key problem of sustainability research in general: How is it possible to redirect an unsustainable world towards sustainable development? We can call this challenge the *problematic of socio-ecological transformations* at global, regional and local levels.

Until recently social science approaches have been incorporated particularly into the mainstream of environmental research. Environmentally oriented specialty fields have arisen within economy, law, sociology, psychology or education. In many cases the social sciences have been put to use for purposes of communication and management. Therefore, as far as sustainable development is concerned, we still depend on a strongly fragmented knowledge base. Scientific and technological knowledge is distributed over a broad spectrum of disciplines and useful applications committed to incommensurable values, different theoretical concepts and conflicting methodological orientations.

Together with the attempt to transcend the inadequate system of discipline-ordered knowledge within sustainability oriented research a strong demand for *integrated knowledge* has arisen with the aim of improving both explanatory power and usefulness for problem solving. There is also a broad spectrum of transdisciplinary knowledge outside the academic world that has been created within industrial production (see, *Integrating Knowledge in Technology Development*). This knowledge is, in part, classified to insure competitive advantage.

### 1.1 The constitution of discursive objects

Sustainability oriented sciences merge with various forms of problem-focused cross-disciplinary research by combining perspectives, knowledge and methods from different disciplines (multidisciplinarity) or by referring to shared problems at the interface of different disciplines, coupled with an exchange of knowledge aimed at common solutions (interdisciplinarity). But the main change has been that the *problems* dealt with can no longer be related easily to the traditional subject matter of one or several established disciplines. This means they demand definition and solution beyond the boundaries of the system of disciplines (transdisciplinarity) (see, *Unity of Knowledge and Transdisciplinarity: Contexts of Definition, Theory and the New Discourse of Problem Solving*).

This type of research is not defined by a distinct material field in the sense of a set of actual objects, as, for example, zoology is concerned with animals. Instead, it selects from a broad spectrum of phenomena those qualified as obstacles to sustainable development. But these phenomena do not form a homogeneous field of subject matters, as the physical and chemical properties of bodies do in physiology. Quite the contrary, a heterogeneity of subject matters characterizes the field.

From a methodological point of view a clarification of the concept of *problem* and an understanding of problem solving processes is crucial. Sustainability oriented research constitutes its objects by referring to socio-ecological transformations within the normative framework of sustainability. This normative option functions as a problem generator. Within the framework of sustainability, natural and social phenomena convert into discursive objects that exist as problems only within the discourse so constituted. They are neither immediately perceptible by the human senses nor given by empirical observation, but are instead contested and frequently ill-defined tangles of data and interpretation. Such discursive objects may appear as conspicuous phenomena, such as stinking waste, or as an issue of public irritation and protest, such as BSE. But this occurs only if we seek to reconstruct their genesis in the past and forecast their possible development in the future, while at the same distinguishing between their physical and cultural aspects; waste, for instance, is constituted as a problematic socio-ecological object for research on sustainability.

The aim, moreover, is not merely to explain the unsustainable world but to intervene in its problems directly for instance, with an economic strategy for the reduction of industrial waste. For the system of science such problems are exogenous, yet they remain pressing and call for political action or, perhaps, a technological quick-fix. To define and solve these problems in a methodological way we have to cross the boundaries separating disciplines, leaving their cognitive constraints and their traditional subject matters behind. Both the process by which exogenous problems are reconstructed as susceptible to scientific intervention and the ways in which science based solutions are introduced into the various arenas of agency need careful investigation. During the last decade, especially in Germany, Switzerland and Austria, the term of choice for this type of research and problem solving has been *transdisciplinarity.* In environmental science, research on global change, social-ecological research, technology and risk assessment, transdisciplinarity indicates a

transformation in the relationship of science and society. It has also been described as a "new mode of knowledge production," one that takes place primarily in the context of application, within heterogeneous and highly diverse organizational settings, and which involves socially accountable and reflexively performed activity.

Thus, the issues involved in socio-ecological transformation require a transdisciplinary approach. A new and contested discursive field of *transdisciplinary research for sustainability* has emerged in the last decade. Within this field a variety of projects and programs with innovative concepts and research designs have been initiated worldwide and to some extent evaluated (see, *Evaluation of Transdisciplinary Research*). But at the same time highly complex theoretical and methodological questions have emerged requiring epistemological reflection and conceptual clarification.

### 1.2 The order of discourse

The field of a transdisciplinary research for sustainability functions as an attractive focal point for different trends in research on environment and development. The general aim is to treat problems of social, economic and technical development, viewed as non-sustainable, in a scientific manner. Non-sustainability of life support systems defines the general problem focus of research. Science is directed towards challenging extra-scientific problems. Solutions for these problems are investigated using scientific means and methods; while, in turn, the solutions proposed or put to use become the subjects of new research.

Controversy, a terminological jungle, conceptual confusion and heterogeneous interests characterize this emerging field. In response many scholars have explored the meaning and use of the two rather murky concepts, sustainability and transdisciplinarity, and have proposed definitions to clear them up, thus making them useful for evaluating projects and programs. Yet a recognized conceptual framework for research is still missing.

One reason for this deficit is the hybrid character of the *sustainability* concept. It is simultaneously a political model used to argue for global change with a strong normative content and a concept used for scholarly investigation. As a result, academic and non-academic actors with heterogeneous interests and knowledge interact with one another in sustainability research regularly. Each definition and each proposed conceptual framework functions, therefore, as a kind of intellectual intervention in a field of symbolic struggle, strengthening one interest position and weakening another (see, *Methods for Sustainability Assessment: Sustainability Indicators*). Sustainability research, in other words, always operates as a discursive activity in a network of knowledge and power.

Another source of conceptual confusion is the undifferentiated use of the term *transdisciplinarity* for the identification of whole modes of knowledge production, research types, programs and individual approaches (see, *Unity of Knowledge and Transdisciplinarity: Contexts of Definition, Theory and the New Discourse of Problem Solving*). Transdisciplinary research, however, is always a highly interactive process among different researchers and social actors, organized in different phases with

changing relationships among social and cognitive components. Social components (actors, situations, interests) are woven together with cognitive components (problems, methods, knowledge) within the discourse and transformed by research and action. Slowly, a consensus has grown over the last few years that research for sustainability can only be conducted in a transdisciplinary form. What remains controversial, however, is how transdisciplinarity is to be understood. Generally speaking, the viewpoint has established itself that the most decisive criterion is relevance for agency problems of everyday life (see, *Methods of Transdisciplinary Research*). Which issues, however, are to count as important societal problems depends on given values, shifting political and economic interests and the manner in which the media portray the issue. Such issues normally are controversial, and knowledge and judgments about them uncertain.

Taking this point of view means that transdisciplinary research must continually reorient itself in response to ever changing societal demands and tasks. At the same time, however, it creates a public awareness of threats such as anthropogenic climate change, as something known only by means of scientific investigation. Transdisciplinary research achieves in this way a certain dynamic but at the cost of making it difficult to maintain its scientific autonomy. Consequently, the relationship between science and society changes decisively within the field of transdisciplinarity (see, *Actor Participation and Knowledge Dissemination in Transdisciplinary Research*, and *Unity of Knowledge in Transdisciplinary Research for Sustainability*). Science becomes involved directly in extra-scientific political, economic or technical practices, becoming, as a result, either politicized or transformed into an economic or technical activity. Criteria, procedure and review institutions for quality control became crucial for this type of research (see, *Evaluation of Transdisciplinary Research*).

There are, however, numerous definitions found in the literature where reference to extra-scientific societal problems is not decisive and, instead, emphasis is laid on the level of theoretical integration of the knowledge produced in the research process. Particularly influential in this respect was the OECD-seminar held in Paris in 1970. There, the Austrian physicist Erich Jantsch suggested an "overarching synthesis" of knowledge and action. Transdisciplinarity is characterized by Jantsch as a "higher, and more comprehensive level" of integration of scientific knowledge and human action oriented towards problems transcending scientific disciplines. The German psychologist Heinz Heckhausen, on the other hand, reserves the concept of transdisciplinarity for a form of theoretical integration of scientific concepts and methods deriving from different disciplines, functioning, as it were, as a meta-paradigm such as general systems theory and covering several disciplines.

Differences among conceptions of transdisciplinarity have often been exaggerated in an unproductive manner. These differences are used in particular to draw a sharp dividing line between theory oriented and agency oriented transdisciplinary research. Both forms of defining transdisciplinarity are found within the field of research for sustainability. Opposition between the two quickly dissolves, however, as soon as one views this kind of research as a whole as a cooperative enterprise with a division of labor, an enterprise realized in *projects*, each of which is organized into different *phases*. Disciplinary, multidisciplinary and interdisciplinary forms of working can take place simultaneously

or successively within individual projects and phases, with either the practical or the theoretical orientation dominating a project or phase. However, if one accepts that transdisciplinary research is a matter of scientific activity, then *knowledge* must play a central role in every project and in every phase. Revision and improvement of knowledge remains always the goal of research. And if the research field is not to disintegrate into a collection of heterogeneous and disjointed activities then an *ordering of knowledge* is also required, a theoretical integration.

Certainly, the debate over the definition of transdisciplinarity can be written off as a mere academic game; things become serious, however, once powerful scientific organizations become involved. The set of criteria chosen for defining transdisciplinarity bears critical implications for research policy because it defines which research approaches are to be included within the field and which are to be excluded (see, *Science Policy for Transdisciplinary Research*). To the extent that such definitional inclusion or exclusion has organizational, financial or personal consequences it must be characterized, just as corresponding attempts at defining sustainability, as an intervention in a discursive field fraught with effects. If, for example, direct cooperation with stakeholders from business and politics, or the implementation of research results as technical products or organizational innovations, are the defining criteria of transdisciplinarity then research projects with a strong focus on theoretical or methodological inegration will be marginalized or excluded altogether.

### 1.3 Structural levels of discourse

Discourse on sustainability does not form a homogeneous field; on the contrary, it is dispersed over structurally separated levels. In 1972, Erich Jantsch, in his influential concept of a system for transdisciplinary science and education, distinguished among four levels of activity: a purposive, a normative, a pragmatic and an empirical. At each level he localized specific activities. The whole system is directed from the purpose level at the top, where policy making is located; planned from the normative level; technologically designed from the pragmatic; and informed by scientific research at the empirical level at the bottom.

| | | Discursive activities |
|---|---|---|
| Structural levels of discourse | **Normative level** | valuation: discourse on definition, criteria, indicators and goals of sustainability |
| | **Operative level** | action: discourse on strategies and actions for sustainability with respect to problem situations |
| | **Descriptive level** | description: discourse on states and processes of socio-ecological transformations and crises |

Figure 1: Activities within the discourse on sustainability on different levels

Jantschs model is a thoroughly top-down technocratic vision of the scientific world. For an appropriate understanding of the discourse on sustainability we have to give up this vision and we need to modify this model. In doing so we can distinguish analytically among three levels: a normative, an operational, and a descriptive level. In our scheme the normative level includes purposive activities, while the operational level is not restricted to technical solutions, and the descriptive level includes empirical, causal-analytical and conceptual inquiry and reasoning. The main difference between our scheme and Jantschs is that scientific and non-scientific activities are not ordered in a hierarchy but, instead, distributed unevenly over the various levels, depending on the purpose and the design of research. There is no center of control. The following topological model of the levels may be used either as a framework for observation or as a conceptual tool for the construction or reconstruction of research designs.

a) *Normative level:* The idea of sustainability includes a normative vision of how to govern future-oriented action. It introduces a set of normative commitments into the discussion of the question of development or modernization that has been going on for some time and into the environmental debate as well. A call for equity is made on behalf of future generations, as well as a demand for the preservation of the natural conditions of life and the intelligent regulation of life support systems. In addition, international justice between North and South, social justice within societies, equity in gender relations and democratic participation in decision-making processes are all normative aspects of sustainability that have been frequently voiced and just as frequently contested.

b) *Operative level:* At the same time, sustainability implies a strong commitment to action aimed at reshaping the relationships between human beings and their environment. This occurs along several dimensions, ranging from cleaner technologies, the patterns of production and consumption to reproductive behavior relevant for demographic transitions. At the operative level different strategies and action frameworks for the fields of environment, economy, technology, politics and culture must be developed on the basis of general criteria of sustainability.

c) *Descriptive level:* A commitment to sustainability means that societal development can no longer be viewed without considering its natural prerequisites. The former is inseparably coupled with the latters reproduction and evolution. The focus of research questions, therefore, will be on the socio-ecological transformations that change the patterns of interactions between societies and their natural environment. Discursive activities such as Rachel Carsons *Silent Spring* function as early warning systems, identifying crisis still outside public awareness.

A highly interactive process among researchers and other actors, with different relationships among social and cognitive components, always takes place at each structural level of discourse. Social components (such as actors, situations, interests) are together woven with cognitive components (such as problems, methods, knowledge) at each level. One can use the structural levels schema (figure 1) either to analyze individual projects and programs within sustainability research more exactly or to organize the research field. For example, there are projects whose main emphasis is at the *normative level*. Examples of this kind of project are those where sustainability

goals and indicators are negotiated and legitimated, and criteria and indicators are established at the national or international level. Here knowledge of principles and procedures for justifying targets and norms is needed. Other projects concentrate on strategies for action, and on the institutionally and behaviorally caused difficulties in implementing them. Thus at the *operative level* procedures, tools, or planned forms of goal oriented action are of particular significance. Examples here can be found in traffic or consumption research: Here we can see how empirical research about social structure, life-styles, individual and group behavior and ecological impacts have been integrated, while attempts are made to implement sustainability goals in concert with social actors. Finally, other projects concentrate their activities on the *descriptive level* and analysis of states and processes. Here the attempt is made to understand the dynamic relationships arising from the complex interaction of natural and social systems in order to identify corridors of sustainability. Earth system analysis as conceptualized recently by Schellnhuber is an advanced example of this kind of project.

Each project that is allocated in this way to a level according to its main focus also operates at the other levels, only not as robustly. The activities are focused according to research type, either on valuation and legitimization (normative level), social action, organizational and technological innovation (operative level) or description and analysis of socio-ecological transformations (descriptive level) The other levels possess chiefly an instrumental significance for the one in focus they are simply assumed and viewed as more or less constant. Within the discourse on sustainability we can therefore ideal-typically distinguish three basic types of activities:
1. A goal-setting and valuating discourse,
2. an action-oriented discourse,
3. a process-oriented discourse.

For the most part, projects in the field of research on sustainability locate themselves within action-oriented discourse. At this level the research process may be oriented towards the development of new technologies or the management of successful cooperation between scientific and non-scientific actors. In the course of actual research a different design must be developed for each of these.

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**Biographical Sketch**

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