Approaching water stress in the Alps: transdisciplinary coproduction of systems, target and transformation knowledge

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Abstract

There is increasing recognition that transdisciplinary approaches are needed to create suitable knowledge for sustainable water management. However, there is no common understanding of what transdisciplinary research may be and there is very limited debate on potentials and challenges regarding its implementation. Against this background, this paper presents a conceptual framework for transdisciplinary coproduction of knowledge in water management projects oriented towards more sustainable use of water. Moreover, first experiences with its implementation are discussed. In so doing, the focus lies on potentials and challenges related to the coproduction of systems, target and transformation knowledge by researchers and local stakeholders.

Keywords: water management, transdisciplinary research, systems, target and transformation knowledge

1 Introduction

Both climate change and socio-economic development will significantly modify the supply and consumption of water in future, and consequently fuel existing conflicts or create new conflicts of interest. Dry valleys in the Alps will be particularly affected, as it must be assumed that in these regions the general water supply will become even scarcer and seasonal distribution may change significantly. Against this background, water management practices and strategies have to be fundamentally revisited.

Approaches to addressing questions of water management changed considerably over the last decades. Several years ago, the Global Water Partnership (GWP-TAC 2000) introduced the concept of Integrated Water Resource Management (IWRM). IWRM takes into account not only water supply, i. e. water availability and infrastructure, but also the demand side, and considers water in relation to other ecological, societal and economic factors that have to be balanced in order to achieve sustainable development. Moreover, a fundamental paradigm in the context of IWRM is the relevance of a participatory approach. Knowledge from various disciplines and stakeholders should be applied to devise and implement efficient, equitable and sustainable solutions to water and development problems (Medema et al. 2008).

Thus, IWRM implies a claim for a fundamentally different way of knowledge coproduction which resonates with the concept of socially robust mode 2 science developed by Nowotny et al. (2001), or with the concept of transdisciplinary knowledge creation proposed by Hirsch Hadorn et al. (2006). In these concepts, scientific knowledge is perceived as part of knowledge's wider societal, cultural, historical and 'natural' environments rather than as independent of it. Particularly in the cases of highly contested issues, there is a clear shift from facts to values: the more facts become uncertain, the more dialogues on values in dispute become important (Funtowicz & Ravetz 1993). In such cases, decisions cannot be based on factual knowledge, where scientists deliver objective facts and speak truth to power. Instead, scientists need to engage as active participants in a societal dialogue (Pahl-Wostl 2002). However, implementation of the mentioned principles of IWRM is very challenging, and IWRM projects often fail to fulfill the expectations (Molle 2009).

The aim of this paper is to contribute to this debate by presenting a conceptual framework for transdisciplinary coproduction of knowledge in water management projects oriented towards more sustainable use of water. First, we will introduce the concept of transdisciplinary research as developed in sustainability science, including the distinction of systems, target and transformation knowledge. Then we will present the transdisciplinary design of the research project MontanAqua and first experiences gained during its implementation.

2 Conceptualization of transdisciplinary coproduction of knowledge

There is increasing recognition among scholars in water management research that transdisciplinary approaches are needed to create suitable knowledge for sustainable water management (Dewulf et al. 2009; Mata-Lima 2009; Molle 2009). However, there are different conceptions of the term 'transdisciplinarity' and there is little scientific debate on issues of transdisciplinary coproduction of knowledge. For this reason, we introduce the concept of transdisciplinarity as developed by scholars of sustainability science (Hurni & Wiesmann 2004; Hirsch Hadorn et al. 2006; Pohl & Hirsch Hadorn 2007; Rist et al. 2007a). In doing so, we focus on the related notions of systems, target and transformation knowledge.

Rist et al. (2007a, 2007b) identified the following elements of transdisciplinary research:

- The aim of transdisciplinary research is to develop empirical and practice-oriented knowledge that can help to solve, mitigate or prevent life-world problems related to sustainable development (orientation to life-world issues). Societally relevant problems and potentials are jointly identified by practitioners and researchers.
- With respect to academic knowledge production, a transdisciplinary approach requires interdisciplinary bridging between different disciplines in the natural sciences, the social sciences and the humanities (interdisciplinarity).
- Non-academic knowledge is systematically integrated by continuously encouraging dialogue between different actors. The planning, execution, evaluation and interpretation of results are understood as an integral process of coproduction of knowledge with all relevant actor categories (stakeholder participation).

- Scientific work is understood as part of an overall societal process. Ideally, scientific work contributes to social learning processes which aim for a negotiated transformation of the norms, rules and power relationships that govern the use of natural resources, with a view to concretizing the principles of sustainable development (social learning).

A further relevant conceptualization of knowledge relevant to approach sustainability issues was introduced by several Swiss researchers (ProClim 1997; Hirsch Hadorn et al. 2006; Pohl & Hirsch Hadorn 2007): Systems knowledge, target knowledge and transformation knowledge.

- Systems knowledge is empirical knowledge about the current system or problem situation originating from all scientific disciplines and practice. Regarding water issues, this may be about the seasonal or spatial availability of water, its distribution and use, as well as about the governance system or the meanings stakeholders give to water.
- Target knowledge is about the desired future status and the values that indicate which direction to take. It recognizes the pluralism of norms and values that may be present, depending on actors' perceptions of the system, system relations and options for change. Regarding water issues this may be about different stakeholders' priorities for water use in the future (e. g. drinking water, irrigation of agricultural land, gardens and golf, snow production, industrial use), or about a common understanding of what sustainable water use may be.
- Transformation knowledge is about how to make the transition from the current to the target status. It embraces measures and tools conducive to changing the system in a certain direction. Regarding water issues, this may be more effective irrigation technologies or more efficient distribution systems, adapted water access regulations, and strategies for better water governance.

Based on the concepts presented above, we understand transdisciplinary coproduction of knowledge as a process where scientists, experts and other non-academic actors co-construct systems, target and transformation knowledge with a view to finding solutions to concrete life-world problems. How can the proposed concept of transdisciplinary coproduction of systems, target and transformation knowledge be transformed to a virtual research design and what are the challenges in its implementation? In the following we present the way this has been done by the transdisciplinary research project MontanAqua and share first experiences regarding challenges and potentials.

3 The case study: overview of the transdisciplinary project MontanAqua

3.1 Project outline

The main objective of the transdisciplinary project MontanAqua is to develop strategies for moving towards a more sustainable water resources management in the study region of Crans-Montana-Sierre (Valais, Switzerland), together with the actors involved. The project is divided into three disciplinary-oriented work packages (WPs) aiming to provide knowledge on the available water resources, the water use system, and the socio-economic structures. To facilitate successful inter- and transdisciplinary collaboration and data integration, the project contains a synthesis package (SP) which is responsible for enhancing data integration and learning between all actors involved.

The research process basically consists of the following steps: First, the current water situation in the study region is investigated. How much water is available? How much water is being used? How are decisions on water distribution and use taken? Second, participatory scenario workshops are conducted in order to identify the stakeholders' visions of regional development. Third, the water situation in 2050 is simulated by modeling the evolution of water resources and water use and by reflecting on the institutional aspects. Finally, options for more sustainable water management are identified. As we show below, during all of these steps researchers collaborate with stakeholders in the support group RegiEau. The RegiEau group consists of key representatives of owners, managers, users, and pressure groups related to water and landscape: representatives of the communes (mostly the presidents), the canton (administration and parliament), water management associations, agriculture, viticulture, hydropower, tourism, and landscape protection.

3.2 The study region

The study region is situated on a southern slope in the driest part of Switzerland and has been subject to dynamic economic, tourism and urban development during the last decades. It covers an altitudinal range between approx. 500 m and 3,000 m a. s. l.; annual precipitation increases with elevations from 500 mm/a to approx. 2,000 mm/a. The diversity in land use and land cover is another main characteristic: the lowest slopes are dominated by vineyards, above which lies an area with extensive farming and expanding forests. Settlement areas at this altitude mainly house local people. In the medium altitudes, tourist resorts and touristic activities such as golf and skiing are predominant. The highest part of the area is a typical alpine landscape. The Plaine Morte, a plateau glacier at the top of it, is partly drained through the karstic underground formations and linked to various springs in the region. The study area is delimited by the rivers Liène and Raspille and corresponds to the territory of 11 communes. Thus, it does not cover a classical hydrological basin. This is due to the fact that governance structures reach beyond catchment borders. The main anthropogenic influences on the hydrologic system are reservoirs

Figure 1: Map of the 11 communes of the Crans-Montana Sierre region.

(Tseuzier dam and various lakes) and a complex network of traditional water channels ('bisses') and water pipes for water supply. Water is mainly used for consumption, agriculture, hydropower and tourism (e.g. snow production, irrigation of the golf course).

4 Project design and first experiences with the transdisciplinary research process

4.1 Overview of the transdisciplinary process

The transdisciplinary process started as early as the proposal elaboration phase, before the project proposal was submitted for financing. Researchers in the social and natural sciences engaged in intense discussions regarding suitable concepts for bridging different perspectives. Furthermore, a stakeholder workshop was organized in order to identify and integrate the perspectives of the regional actors and to guarantee a proper focus and a sound life-world orientation of the research project. This

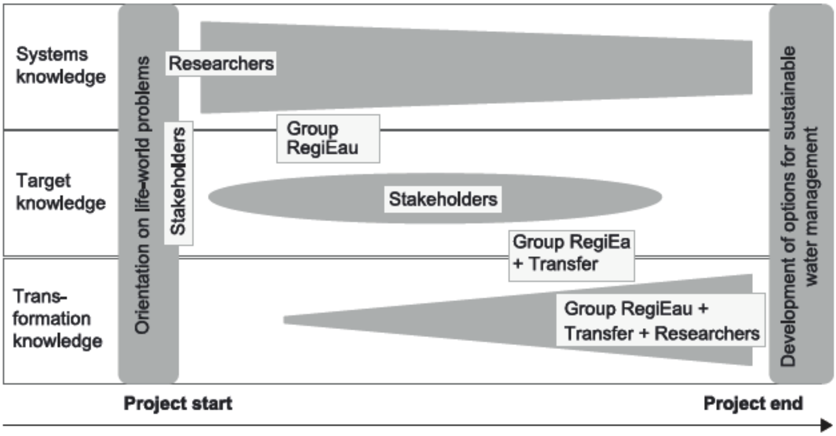

Figure 2: The transdisciplinary design of the MontanAqua project concerning the production of systems, target and transformation knowledge.

workshop was also important for establishing trust and commitment. The project was thus designed in a transdisciplinary manner.

During the first 1.5 years of MontanAqua, the research team emphasized the generation of systems knowledge in order to adequately understand the current water situation, the trends, and the basis for the planned modeling. Although the activities in this phase were clearly driven by the requirements of scientific work, communication with the stakeholders was already established in order to ensure optimal coherence between the systems knowledge to be generated and the target knowledge represented by the stakeholders. In the second year, production of target knowledge increased as visions of regional development were elaborated, and, consequently, interaction with stakeholders was intensified.

The future research process, finally, will give more priority to the production of transformation knowledge. In this phase, stakeholders and researchers will collaborate to identify possible policy, economic and technical measures to be taken into account in the search for adequate adaptation strategies. Figure 2 gives an overview on the transdisciplinary design concerning the production of systems, target and transformation knowledge.

In the following section we will discuss first experiences related to the process of transdisciplinary coproduction of systems and target knowledge in the MontanAqua project (production of transformation knowledge will be emphasized during the last year of the project (2012)). In so doing, we first present our approach to constructing each form of knowledge (actors concerned, issues addressed, methods used, forms of collaboration), and then outline some challenges encountered.

4.2 Production of systems knowledge

Production of systems knowledge is the traditional realm of empirical science. It is about knowledge on empirical processes and consists of data which can be structured with the help of mathematical and conceptual models. In addition, it is important to learn about the meaning that societal actors in the problem field give to the processes under investigation (Hirsch Hadorn et al. 2006). Thus, for the production of systems knowledge the research design and the related challenges are similar to those for classical research projects. In addition, however, transdisciplinary projects aiming for more sustainable resource use have to tackle further challenges related to their orientation to life-world problems and the interdisciplinary nature of these issues.

4.2.1 Approach

In the MontanAqua project, the production and integration of systems knowledge is organized along 3 disciplinary-oriented WPs and a synthesis package (SP) which facilitates interaction and learning between all actors involved.

WP1 aims at analyzing and simulating current and future available water resources. In this WP, an extensive hydrometeorological network has been established. Based on these measurements, a first PhD researcher is building a detailed hydrological model (PIHM) for the study region. A second PhD researcher is studying the relationship between the water resource and land use and the influence of different agricultural land management practices. Furthermore, there are two additional studies investigating the role of the Plaine Morte glacier (past, present and future mass balance) as well as the behavior of its karstic environment (underground water transfer system).

WP2 aims at analyzing and simulating current and future water use. In this WP, a PhD researcher is analyzing the main water uses (drinking water, energy production, agri- and viticulture, tourism) and their spatial print. A quantification of the current needs for each type of use is envisaged at the seasonal scale. The study is based on analysis of existing communal water use data, expert interviews, and run-off measurements in the traditional irrigation channels. Furthermore, an evaluation of the evolution of needs, based on both environmental (especially climatic) and social changes will allow simulation of water use for the future.

WP3 aims at investigating the socio-economic structures and decision-making processes. In this WP, a PhD researcher is studying how water management practices in the study area are working, from the decision-making processes down to concrete actions. For this purpose, the institutional and legislative frameworks are defined by comparing budgets, tariffs, cost recovery rates, and direct and indirect subsidies granted by the local authorities. Social relationships between the actors are analyzed, i.e. the alliances, antagonisms and conflicts. Finally, possible and reasonable territorial and political water management reforms will be identified.

Researchers of the synthesis package contribute to the interdisciplinary integration of systems knowledge produced in the work packages. In doing so, they focus on the development of bridging concepts (e.g. the concept of multifunctional landscape) and the enhancement of learning processes between all disciplines involved. Learning and communication is facilitated by organizing regular meetings of the whole project team, the steering group, and the group of PhDs (every 2–3 months each), joint field days, shared fieldwork and a website with a blog and data exchange functions.

4.2.2 Challenges

While the adopted design for producing systems knowledge appears to be very fruitful so far, there are also various challenges, namely its orientation to life-world problems.

One implication of the life-world orientation is the selection of the study area. The study area does not cover a classical hydrological basin, as the water flows (pipes and traditional irrigation channels) frequently cross natural hydrographic boundaries, and the water management is organized across catchment boundaries as well. This is a big challenge from a hydrological point of view, as a closed, measured water balance cannot easily be obtained. This situation, however, is common in real-world water management.

Another implication of the life-world orientation is the emerging tensions between project work and disciplinary research interests or current scientific debates. This can be exemplified with the case of the social science study. While the development of options for sustainable water management in a case study area requires detailed knowledge about the functioning of the current water management system, these findings are only partly interesting from a scientific point of view. An interesting scientific question is, for example, to what extent Bourdieu's concept of practice may help to surmount the weaknesses of the existing water governance approach, such as its notion of social engineering.

4.3 Production of target knowledge

Producing target knowledge requires participatory processes. On the one hand, the pluralism of stakeholders' values, norms and perspectives on the desired future status has to be considered; on the other hand, current systemic conditions and processes as well as existing practices of the actors have to be taken into account. The first issue represents a particular challenge, as the clarification of the various values and priority-setting has to be assured.

4.3.1 Approach

Production of target knowledge in the MontanAqua project is essentially organized along processes of participatory scenario development. In so doing, it is assumed that the stakeholders' visions of regional development represent their values, norms and perspectives on the desired sustainable future. Participatory scenario development takes place in the projects' support group 'RegiEau'.

The process is organized along the following steps: first, 3 visions of regional development for 2050 are identified representing the stakeholders' perspectives on their desired futures. Second, the 3 visions are translated to scenarios suitable for simulation, modeling and reflection according the needs of different scientific disciplines. Third, effects of different future development options on the availability, use and management of water as well as the related changes to the multifunctionality of the landscape are identified. Intermediary results are presented to and discussed with the RegiEau group in order to integrate their perspectives and knowledge in all steps of the knowledge production process. Finally, this allows all participants – researchers and local actors – to reflect on possible consequences, potentials and limitations of their desired futures, and possibly to adapt their target knowledge.

Thus, the production of target knowledge is more than the investigation of stakeholders' present perspectives on their desired futures. Stakeholders' visions of the future are interwoven with scientific modeling and reflection taking into account the systemic conditions and current practices as identified in the first phase of the project (see section on systems knowledge). This allows learning by all participants and new target knowledge to emerge.

4.3.2 Challenges

The process of producing target knowledge is ongoing. The RegiEau group was constituted and first meetings took place, including a workshop for developing visions for the future.

The first challenge to be tackled was to bring the different actors together. Success was anything but granted, as this seemed to be the first formal group where actors of the two main water management associations worked together. Furthermore, there are historic tensions among some of the communes and between a commune and the organization for landscape protection.

A second challenge concerns the plurality of the participants' values, norms and perspectives. While there is some agreement on a more general level (e.g. the wish to preserve the open space, to stop urban sprawl, and to increase collaboration with neighbor communes), there are many different visions regarding the concretization of these aims. Is it necessary to downgrade existing building zones? Are there alternatives to skiing and the increasing use of snow guns?

A third challenge consists in the process of linking the target knowledge developed by the RegiEau group to the systems knowledge produced by the researchers: The three visions of regional development have to be translated into the language required by (disciplinary) scientific models without losing too much of their character. During this process, it became evident that there are considerable gaps between the holistic character of the visions developed, on the one hand, and the possibilities and limitations of the models and the availability of necessary data, on the other. For example, different forms of urbanization were an important discussion point with regard to the visions for the future. Consequently, the researchers are required to identify the links between the different forms of urbanization and water needs (e.g. single family homes require substantially more water than apartment blocks do, for garden irrigation). However, it is very difficult to quantify these relationships because only limited empirical data is available.

5 Conclusions

The aim of this paper was to present first experiences from the transdisciplinary project MontanAqua regarding the envisaged process of co-producing systems, target, and transformation knowledge. Looking back on the first half of the project we can conclude that the project design based on disciplinary PhD studies, the stakeholder group RegiEau and a post-doc researcher responsible for transdisciplinary learning and synthesis is promising for successful coproduction of knowledge among and between researchers and local stakeholders. This setting has the advantage that the PhD researchers are not overloaded with transdisciplinary work. However, experiences have shown that transdisciplinary production and integration of knowledge can hardly be achieved by one researcher alone. It is a continuous (learning) process between all researchers involved that also requires continuous adaptation of concepts and methods. The synthesis process is a tightrope walk between allowing disciplinary results to flourish and setting clear guidelines, thereby risking to cement the hegemony of one perspective at the cost of the others. Furthermore, it is a tightrope walk between providing sufficient structure for efficient disciplinary research, and keeping sufficient openness in order to respond flexibly to new insights from other disciplines or to stakeholder needs.

We agree with Alroe & Noe (2010a), who argue that scientific intervention in a complex problem field should not strive for consensus on problems and goals, but the heterogeneity of stakeholder perspectives and their relation to different scientific perspectives should be exposed. From this view, the form of integration needed in transdisciplinary research is not only integration proper, as strived for with integrated modeling approaches, but also processes of social learning which, in turn, produce multidimensional spaces of understandings.

In other words, an important challenge in co-producing and integrating systems, target and transformation knowledge is to design and implement a research process adopting the suitable means for each issue. When does coming to terms require a quantification of the issue and joint modeling? When should emphasis be placed on making explicit distinct perspectives? When should the focus lie on building joint concepts and on learning and dialogue among and between disciplines and stakeholders?

An assessment of the contribution and value added that the research project MontanAqua offers for the case study region can only be made during the project's final phase, when concrete measures and options for sustainable water management will be elaborated (transformation knowledge). However, the experiences gained during the first 1.5 years allow the following preliminary conclusions:

- By producing systems knowledge, the MontanAqua project contributes to ameliorating the available data necessary for sustainable water management. So far, the local stakeholders especially appreciated new knowledge on the glacier development and the subterranean flow direction of the melting water. Furthermore, they expressed interest in regional overview information on land and water use as well as water rights.
- By bringing together key representatives of owners, managers, users, and pressure groups related to water and landscape, the MontanAqua project contributes to an intensified dialogue between the different actor groups. This dialogue is especially valued by the actors with little power related to water management decisions.

- By arguing for a demand-driven water management system, the MontanAqua project contributes an alternative perspective to the societal discourse. Main on-going water management initiatives are responding to the growing demand for water only by searching for new sources of water supply.

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