

Transdisciplinary Knowledge Integration within Large Research Programs

Research is increasingly organized as large programs. A growing number of such programs produce a synthesis that links and relates scientific results of individual projects and integrates them into an overarching context. The synthesis thus creates an added value that goes beyond individual project results. Which methods and procedures are used to generate that added value? This paper presents methods and procedures of transdisciplinary knowledge integration that were applied within four thematic syntheses of the Swiss National Research Programme on Sustainable Water Management (NRP 61).

Sabine Hoffmann

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Knowledge Integration – a Key Challenge

Knowledge integration is widely regarded as a key challenge of inter- and transdisciplinary research (Bammer 2005, Bergmann et al. 2005, Truffer 2007, Klein 2008, McDonald et al. 2009, Jahn et al. 2012). In a transdisciplinary context, it means the interrelation of different bodies of knowledge from science and practice (e.g., transcending disciplinary boundaries and bridging theory and practice) to create a more comprehensive understanding of a societal problem (Jahn 2008, Pohl and Hirsch Hadorn 2008). It also implies both the generation of practice-oriented solutions and their diffusion among the target audience (Bergmann et al. 2005, Defila et al. 2006). Transdisciplinary knowledge integration is thus expected to contribute to societal problem solving (Truffer 2007, Klein 2012).

This paper explores transdisciplinary knowledge integration within the *Swiss National Research Programme on Sustainable Water Management (NRP 61)*. Funded by the Swiss National Science Foundation (SNSF), the program aimed to develop scientific foundations, methods and strategies for the sustainable management of Switzerland's water resources (SNSF 2010). It involved 16 inter- and transdisciplinary research projects carried out between 2010 and 2013 and four thematic synthesis projects generating targeted synthesis reports (TS). Published at the end of the program, the reports addressed four topics: water resources in Switzerland (TS 1) (Björnsen Gurung and Stähli 2014), management of water resources under growing user demands (TS 2) (Lanz et al. 2014), sustainable water and wastewater management (TS 3) (Hoffmann et al. 2014), and sustainable water governance (TS 4) (Schmid et al. 2014). In addition, the program included an associated research on transdisciplinary knowledge integration within the four synthesis projects, which was conducted by the author.

The research aimed at exploring methods and procedures used by the four TS to link and relate scientific results of individual research projects and integrate them into an overarching context (SNSF 2012).

Summarizing the results of the associated research, the paper 1. illustrates transdisciplinary knowledge integration within *NRP 61*, using the example of TS 3, and 2. compares knowledge integration across the four TS, applying an analytical framework that connects two aspects of integration that have previously been studied, that is, procedures by which knowledge integration is organized within a team (Rossini and Porter 1979, Pohl and Hirsch Hadorn 2007) and methods by which knowledge is linked and related to each other (Bergmann et al. 2012; for details on the framework, see Hoffmann et al. forthcoming).

Knowledge Integration Exemplified

Transdisciplinary knowledge integration within TS 3 was led by a core team composed of three *NRP 61* researchers, including the author. It aimed at generating three different types of knowledge relevant for urban water management in Switzerland (figure 1, p. 202): 1. *systems knowledge* about current and future challenges of urban water management and the causal links that underlie

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Contact: Dr. Sabine Hoffmann | Swiss Federal Institute of Aquatic Science and Technology (Eawag) | Überlandstr. 133 | 8600 Dübendorf | Switzerland | Tel.: +41 58 7656818 | E-Mail: sabine.hoffmann@eawag.ch

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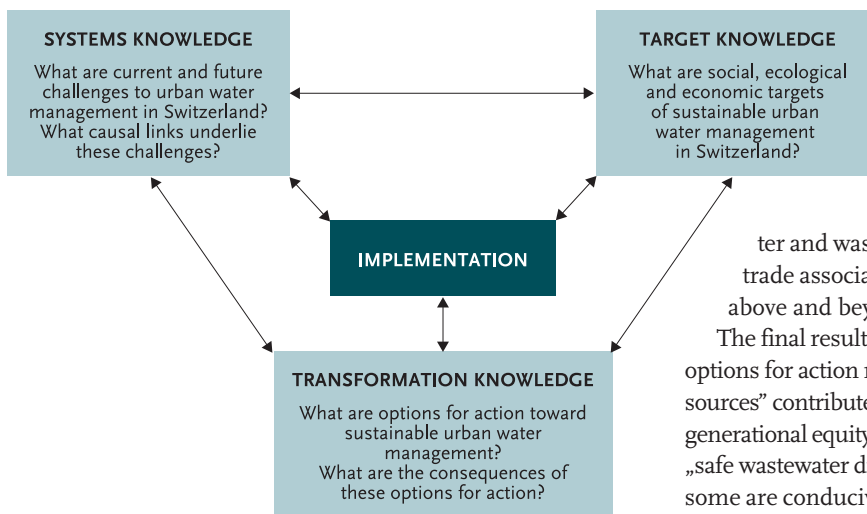


FIGURE 1: Transdisciplinary knowledge integration: research questions to systems, target and transformation knowledge addressed within the synthesis project on sustainable urban water management (Hoffmann et al. 2014, based on CASS and ProClim 1997).

these challenges, 2. *target knowledge* about social, ecological, and economic targets of sustainable urban water management, 3. *transformation knowledge* about options for action toward sustainable urban water management and their consequences with respect to target achievement. In general, these three types of knowledge are interdependent (Pohl and Hirsch Hadorn 2007): new integrated insights on one type of knowledge require reconsidering the other types of knowledge as parts of the assumptions underlying them might have changed (Wueller et al. 2012, p. 89).

To answer the research questions (figure 1) with respect to each type of knowledge, the core team combined scientific results of seven individual research projects and engaged in consultation and collaboration with *NRP 61* researchers and practitioners. It used key elements of system analysis including drivers, pressures, state, impact and responses (DPSIR) in order to identify, prioritize and analyze current and future challenges to urban water management, explore the underlying causal links, and devise options for action. It also applied key elements of multi-criteria decision analysis (MCDA) to define targets of sustainable urban water man-

agement and assess the potential consequences of different options with regard to target achievement. Combining key elements of DPSIR and MCDA enabled the core team to link systems and target knowledge provided by different individual projects in a coherent and consistent way. It also enabled the team to generate new transformation knowledge tailored to the specific needs of the target audience (e.g., federal, cantonal and municipal authorities, wa-

ter and wastewater companies, stakeholder networks and trade associations), thus creating an added value that went above and beyond the results of the individual projects. The final results of the knowledge integration show that many options for action related to “water infrastructures” and “water resources” contribute significantly to the sustainability targets “inter-generational equity”, “good water supply”, “good water protection”, „safe wastewater disposal” and “efficient resource use”, while only some are conducive to “high social acceptance” and “low costs”. Many options related to “knowledge” – for example, improving knowledge integration across different decision levels (municipal, cantonal, federal) and sectors (water supply, wastewater treatment), or fostering knowledge exchange between science and practice – are robust “no-regret” options (Hoffmann et al. 2014). The integrated results suggest that the agreement on overarching targets among all actors involved in urban water infrastructure planning processes is a critical first step toward the sustainable management of urban water infrastructure in Switzerland. The integrated results provided by TS 3 constitute an important basis for supporting these planning processes.

Comparing Ways of Knowledge Integration

The comparison of methods and procedures of transdisciplinary knowledge integration within the four TS is based on analyses of written documents (e.g., proposals, reports, articles, and presentations of all TS), semi-structured interviews with core team members of all TS, and participant observations in *NRP 61* program meetings (Hoffmann et al. forthcoming). All in all, the four TS

The ex-post self-evaluation of the overall synthesis process revealed the need for structuring transdisciplinary knowledge integration from the outset, by defining the object and purpose of knowledge integration, identifying common objectives and questions, and developing a joint vision.

applied a variety of integration methods, including the formulation of research questions and hypotheses (TS 1, 2, 3, 4), the definition of concepts and theoretical frameworks (TS 1), the design of assessment procedures (TS 3, 4), the development and application of models (TS 1, 2, 3), and the creation of boundary objects (TS 1,2) (cf. Bergmann et al. 2012). TS 3 was unique in developing an integrative method in order to relate different types of knowl-

edge. It relied more on procedures by which transdisciplinary knowledge integration was carried out by a group of experts from science and practice than on integration by a leader (cf. Rossini and Porter 1979) used predominantly by other TS.

The overlapping timeframes of the four TS and the associated research enabled a process of mutual learning among core team members of all TS by jointly reflecting on strengths and weaknesses of different methods and procedures of knowledge integration. The reflection triggered some adaptations in the ongoing synthesis processes and stimulated the ex-post self-evaluation of the overall synthesis process (Hoffmann et al. submitted). The self-evaluation revealed the need for structuring transdisciplinary knowledge integration from the outset, by 1. defining the object and purpose of knowledge integration, 2. identifying common objectives and questions, 3. developing a joint vision for knowledge integration (Defila et al. 2006, Wiek 2007, Lang et al. 2012). The latter serves as a basis for defining different integration steps and identifying for each step the methods and procedures to be applied and the actors to be involved in the process (Krütli et al. 2010, Lang et al. 2012, Hoffmann et al. forthcoming). It also emphasized the need for further research on roles and responsibilities of researchers (and practitioners) leading transdisciplinary knowledge integration within large research programs (Hoffmann et al. forthcoming).

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Sabine Hoffmann



Born 1971 in Kassel, Germany. 2010 PhD in development studies. 2010 to 2014 coordinator and researcher within the Swiss National Research Programme on Sustainable Water Management (NRP 61). Since 2015 group leader Transdisciplinary Research in the Environmental Social Sciences (ESS) Department at the Swiss Federal Institute of Aquatic Science and Technology (Eawag), Dübendorf. Research interests: management of transdisciplinary research, transdisciplinary knowledge integration.