Integration of knowledge in inter- and transdisciplinary research projects: Use of Constellation Analysis in a project of sustainable land use management

Martina Schäfer, Melanie Kröger and Jana Rückert-John

Technische Universität Berlin, Center for Technology and Society, Hardenbergstraße 16-18, 10623 Berlin, Germany. Email: schaefer@ztg.tu-berlin.de; kroeger@ztg.tu-berlin.de; rueckert-john@ztg.tu-berlin.de.

Abstract: Inter- and transdisciplinary research projects can serve as learning networks for sustainable land use transitions since they enable processes of joint knowledge production and mutual understanding. However, this can only be achieved if the challenge of integrating heterogeneous forms of knowledge is taken seriously and supported by applying appropriate methods of knowledge integration.

In this paper we refer to experiences of the ELaN project, which is being carried out in Northeastern Germany. ELaN aims at linking technological innovations for water, nutrient and carbon management with organisational innovations for an adapted land use management. Governance innovations are supporting the implementation and economic valorisation of these integrated model solutions. This solution-oriented project is being carried out in close interaction between a number of disciplines as well as with different stakeholders.

For inter- and transdisciplinary research projects a common understanding of the existing problem(s) is an important starting point. A joint problem description provides a basis for the integration of knowledge from different disciplines as well as from scientific and practical actors. For the ELaN project, Constellation Analysis (CA) was used to facilitate joint problem description. Constellation Analysis is a visualization tool which aims at the creation of a focused image of the dominant elements of a problem and their relations. Scientists from different disciplinary backgrounds and stakeholders are requested to agree on a constellation resulting from the relations between the central elements, which allows identification of major conflicts and open questions. This paper presents the use of Constellation Analysis for describing problems of land use and water management for fenlands in Northeastern Germany. It is based on expert interviews and discussions between scientists and stakeholders.

Application of CA in the ELaN project has shown that it is a suitable tool for organising processes of mutual understanding which are challenged by different disciplinary languages, norms, cultures and methods. It is also a good basis for the analysis of the different logics of action which form the background for different views and rationalities. Even if these logics cannot be overcome by such methods, their recognition helps to identify systemic constraints on sustainable pathways.

Keywords: knowledge integration, interdisciplinarity, transdisciplinarity, sustainable land use, land use management, fenlands, Constellation Analysis

Introduction

Sustainability research highlights that, in most cases, mono disciplinary research is not able to deal with complex real world problems adequately. Socio-ecological problems like climate change, loss of biodiversity, deterioration of soils or pollution of the oceans do not conform to the traditional division of disciplines but rather need a re-orientation of knowledge adapted to these problems (Mittelstraß, 2005). If a research project focuses on developing solutions for such socially caused problems, the participation of different disciplines is necessary. This goes along with the challenge of achieving understanding between different academic languages, logics and methods. Furthermore, the integration of practical knowledge is seen as a fundamental principle of solution- and implementation-oriented projects (Ropohl, 2005; Hirsch Hadorn et al., 2002; Bergmann et al., 2010). For this reason many sustainability research projects are carried out in close interaction with stakeholders who are in some kind affected by the problem concerned (transdisciplinary research projects).

Knowledge integration often occurs more or less implicitly in the process of inter- and transdisciplinary research projects, on the basis of common sense. It is taken for granted by funding agencies as well as the researchers involved in such projects. In contrast, Truffer (2007) and Hunecke (2011) propose that knowledge integration is more than a technical or organisational problem but is also an active social process of negotiation and construction which has to be organized. If taken seriously, integration of heterogeneous knowledge claims to be more than merely adding up the research results of different disciplines. Knowledge integration is a process that needs to be planned, designed and organized in an active manner. Thus, the product of knowledge integration is a synthesis of existing and newly generated knowledge. Experience with this relatively new type of research indicates that the integration of distinct types of knowledge is by no means an automatic process. There is thus a need for appropriate and adequate methods supporting and managing this ambitious task (Defila et al., 2006; Truffer, 2007; Hunecke 2011).

Ideally, inter- and transdisciplinary research projects should run through the following steps, aiming at knowledge integration throughout the research process: joint description of problems and aims; formulation of a common theoretical frame; deduction of relevant sub-issues that can be dealt with by single disciplines; agreement on methods to be used; synthesis of results; transfer into practice (Bergmann et al. 2010).

This paper focuses on the first step of describing the life world problem which is to be dealt with by an interdisciplinary research team. A common problem description plays a key role for the subsequent steps and phases of a research project. It facilitates becoming aware of differences in the disciplinary use of terms which are of central significance for a project and promotes initial insight into the logic of action of different stakeholders (Kröger, et al. 2012). For the ELaN[58] project we applied Constellation Analysis (CA), a bridging concept of sustainability studies, to integrate knowledge from different disciplines and practical actors to obtain a joint problem description. CA is a visualisation tool which facilitates dialogue between actors with different background.

After a short introduction of the ELaN project (section 2) and the CA method (section 3), the process of conducting a CA is presented using the example of the ELaN project (section 4). Section 5 briefly presents the results of applying CA to problems of land use and water management in fenlands. The paper closes with a discussion of the advantages and limits of applying CA in complex project settings (section 6).

The ELaN project: Integrated land management in Northeastern Germany

[58] ELaN: **E**ntwicklung eines integrierten **La**ndmanagements durch nachhaltige Wasser- und Stoffnutzung in **N**ordostdeutschland (Developing an integrated land management scheme for sustainable water and nutrients use in North-East Germany), for further information see: <www.elan-bb.de>.

ELaN deals with the potentials and risks of using treated waste water. Currently, treated waste water is discharged into rivers and streams in Germany, bypassing soils and wetland ecosystems. In this research project, scientists from different disciplines (e.g. hydrology, soil science, limnology, agriculture, regional planning, sociology, political science) have been investigating whether the use of purified waste water has the potential to serve as one element of sustainable water and land use management. It is analysed whether the use of treated wastewater is an option to stabilize the regional water budget and whether it may contribute to the preservation of valuable wetlands. In addition, it is evaluated how remaining nutrients in treated waste water can be recycled and used as fertilizer for regional agriculture.

The potential of re-using treated waste water is investigated at two sites in Northeastern Germany: areas which were formerly used as sewage farms in the outskirts of Berlin and (degenerated) fenlands in rural areas of Brandenburg. Political and legal aspects of using purified waste water need to be considered and addressed. Aspects like wetlands ecology, river eutrophication, energy-crop cultivation, nutrient and carbon recycling and in particular the effects on regional supply chains are being evaluated.

ELaN comprises 12 network partners, with a total of 14 sub-projects. Over a period of five years (2011-2015) natural scientists, civil engineers and social scientists cooperate with regional stakeholders from different background. Stakeholders are involved in the project in different ways and intensities: One of the practical actors is part of the research team and autonomously conducts a sub-project. An advisory board with eleven stakeholders from different background (e.g. agriculture, regional planning, environmental protection, administration, energy consulting) is regularly consulted to discuss intermediate results and integrate the specific knowledge and experiences of these actors. At certain points of the project a wider range of stakeholders is integrated via stakeholder workshops in order to present elements of regional strategies for sustainable water and land management and get feedback to the suggestions.

Using different methods of knowledge integration, the consolidated findings will be transformed into practical local and regional solutions and their validity will be tested on the two ELaN study sites.

Constellation Analysis as a method for knowledge integration

What is Constellation Analysis?

CA is an interdisciplinary bridging concept designed for sustainability, technology and innovation studies. The method is based on the assumption that technical, social, and natural developments are closely intertwined in complex constellations. Thus, they can only be analysed and modified when these interlinkages are taken into account.

The nucleus of each CA is visualisation of a specific constellation. Constellations feature a certain degree of regularity and structure. They are constituted by various interrelated elements. The tool used for this project provides four types of elements:

- social actors (e.g. persons, groups, stakeholders, organisations),
- natural elements (e.g. landscape, livestock, soil, ground water),
- technical elements (e.g. energy, factories, infrastructure) and
- signs (e.g. rules, laws, concepts and principles).

Each CA follows a number of principles and rules, such as equal ranking of the distinct elements and a focus on the relations between them. As potentially all relevant disciplines and stakeholders participate in the creation of a CA, domination of the process by one disciplinary language – or stakeholder interest – can be avoided. Its basic idea is to bring together different approaches, data sources and forms of knowledge to create a picture of a constellation that can be accepted or even shared by all stakeholders and researchers involved (Schön et al., 2007).

CA constitutes an instrument for the presentation and analysis of complex problems at the interface of society and nature. It helps to identify different problem perceptions, knowledge and solutions. This tool can help to integrate different positions and take into account opposing concerns. In the process of identifying such differences, CA serves as a means for mutual understanding (Schön et al., 2007; Kröger et al., 2012). An additional effect is, that the participants get aware of ontological and epistemological differences at an early stage of the project and are challenged to find ways of dealing with them in the course of the project.

Constellation Analysis in ELaN

The topic of ELaN – (un)sustainable water and land management – is a typical example of a complex and not yet well-defined and understood problem. In order to develop applicable solutions, it has to be acknowledged that stakeholders have different problem perspectives together with divergent perceptions regarding how to solve them.

CA has been used in ELaN as a method to integrate diverse disciplinary and practical knowledge. As a first step, a comprehensive joint problem description was generated. It complemented and more precisely defined the brief problem description which was formulated in the project proposal. All participating researchers were systematically involved in the creation of the updated problem description, not only those who took part in writing the project proposal. Thus, the updated problem description was built on a wide basis of expertise. Problem descriptions were done separately for the two types of land use management ELaN is dealing with: former sewage-irrigated fields, on the one hand, and (degenerated) fenlands, on the other. This paper refers only to the use of CA regarding problems of sustainable land use and water management of fenlands.

As a first step, a review of the relevant literature and a number of structured interviews with experts from research and practice were carried out in order to identify and correlate the relevant elements of the specific ELaN constellation. A central question led the process of structuring the elements and the description and analysis of the constellation. CA visualises the elements and their relations in a graphic form. The translation of a complex problem into a structured figure makes it necessary to focus and to reduce the complexity, which necessarily entails simplifications and abbreviations. However, this process of focusing serves as a catalyst for interdisciplinary exchange. The graphical presentation of the constellation is always accompanied by a written description and analysis; it cannot be understood completely on its own. A CA constitutes a snapshot; it cannot represent dynamics or developments over time.

The updated joint problem analysis via CA was obtained following a number of iterative steps in the period between April 2011 and May 2012:

- review of the relevant literature about regional water- and land use management and with regard to the two different sites (fenlands and former sewage irrigated fields);
- conduct and analysis of 17 structured interviews with members of the advisory board and other external experts (water management, agriculture, nature protection, government and administration) as well as researchers of the project team; the guidelines of the interviews included questions about problems of landscape water balance, the current use of treated waste water as well as potentials and risks of an alternative use of waste water; the interviews were the basis for developing a draft of the CA;

- discussion of the CA draft within the ELaN coordination team and feedback interviews with eight researchers with different disciplinary backgrounds, leading to CA revision;
- discussion of revised CA at the annual consortiums plenum with 35 researchers, documentation of discussion, assessment of comments and revision of CA. Forwarding the revised CA to consortium, requesting written comments;
- analysis and consideration of written comments and finalisation of interdisciplinary agreement on problem description.

After the interdisciplinary discussion process, the preliminary CA was presented and discussed at a transdisciplinary stakeholder workshop, conducted in March 2012 in Berlin. The aim of the workshop was to discuss our findings with a larger number of regional actors, which were only loosely or not yet associated with ELaN. The participants were asked to comment the constellation analyses and, more generally, to discuss the following questions: What could be the benefits for the region using treated waste water? Which questions should be answered before considering the use of treated waste water?

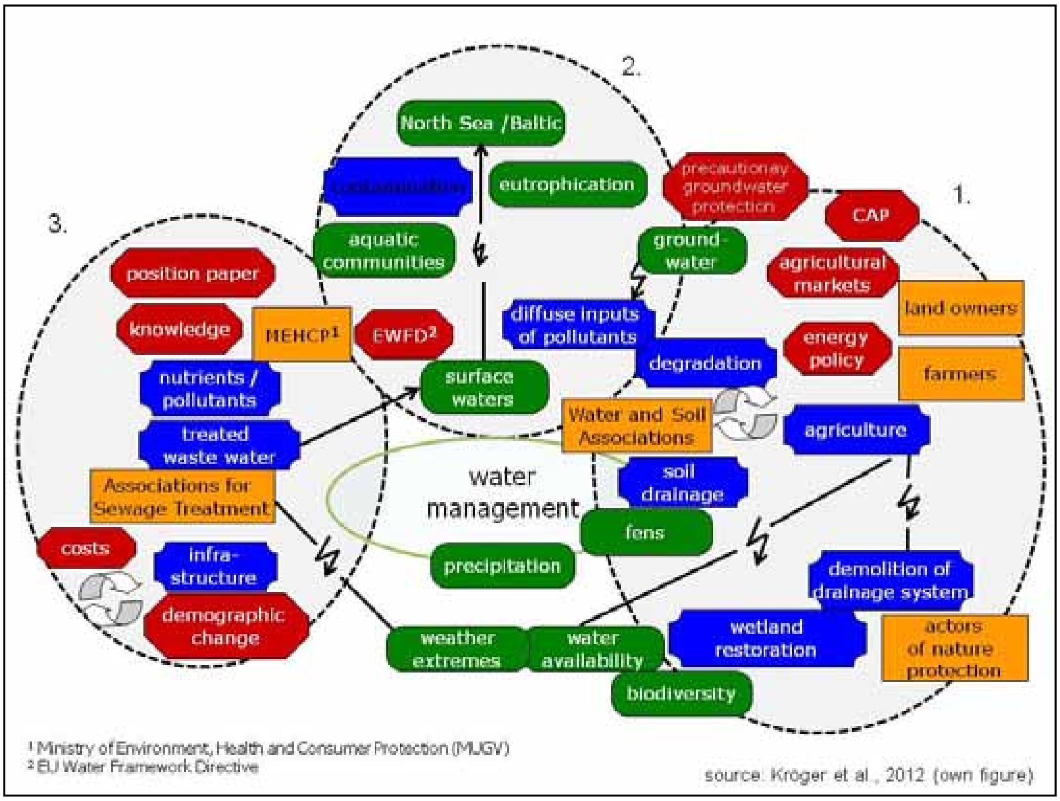
The comments of approximately 40 participants were documented and taken into account for a last revision of the CA.

The ELaN problem description for degenerated fenlands

During its first phase, the analyses of ELaN concentrated on two contrasting land use types: (degenerated) fenlands in remote rural areas of Brandenburg and sewage irrigation fields in the outskirts of Berlin. For both land use types, we developed a status quo CA and a projection into the future. In the following, the status quo constellation dealing with fenlands is presented in order to illustrate the use of the method within the project (see figure 1).

We developed the CA based on the following central question: *Which problems and risks does the current water management in rural areas of Brandenburg face, particularly regarding fenlands?*

Figure 1: Constellation Analysis for water and land management of rural fenlands.



The figure shows that the status quo constellation consists of three clusters: (1) land use and nature protection, (2) surface water and (3) waste water.

- Cluster 1 highlights the implications of the current agricultural use of fenlands. Due to conditions of agricultural markets, energy policy and the Common Agricultural Policy (CAP), farmers continue to intensify agrarian production, especially by improving conditions for cultivating their land via drainage. This dynamic is symbolized by a self-reinforcing feed back loop. Protagonists of nature protection blame this practice for degeneration of wetlands and consequent loss of biodiversity. They therefore support demolition of drainage systems or adapted water management which considers the preservation or regeneration of fenlands. Since fenlands have an important function for the storage of carbon dioxide, this debate has intensified with regard to measures for climate protection.
- Cluster 2 illustrates the current practice of disposing treated waste water. Usually this water is discharged into surface waters, mostly rivers. Since this treated waste water still contains nutrients and pollutants, the groundwater as well as the North and the Baltic seas have become polluted over time, resulting in problems of eutrophication. To avoid further contamination, the EU Water Framework Directive demands that all EU countries improve surface water quality towards a higher standard. It is, consequently, expected that standards for treated waste water quality will also rise during the coming years.
- Cluster 3 shows the relevant elements regarding the current treatment of waste water in Northeastern Germany. Due to migration into cities and demographic changes, associations for sewage treatment in rural areas are faced with increasing costs for an oversized waste water treatment infrastructure. They are also irregularly confronted with huge amounts of waste water caused by weather extremes, which cannot be dealt with adequately by current waste water treatment plants.

After the mapping process, the constellation was analysed. The figure makes clear that there are competing interests or problems that have to be dealt with in the future. The quality of treated wastewater has to improve to be able to fulfill the standards of the EU Water Framework Directive. However, in rural areas waste water treatment plants are already confronted with the problem of maintaining existing infrastructure in the face of decreasing population and lack the financial leeway for new investments. Regarding water management, there is a clear conflict between the interests of agriculture and environmental protection. A high percentage of fenland is already severely degenerated due to water management practices which allow intensive agricultural production. On the one hand, there is a growing recognition that the existence of fenlands is important for climate protection and for maintaining a sound regional water balance as well as biodiversity. Yet, on the other hand, the pressure on the agricultural sector to use land as efficiently as possible has risen due to economic and political trends. However, in the long run, the melioration of soils and intensive forms of production will result in a gradual deterioration of soils, which is also economically unattractive.

The ELaN project has been analysing whether the use of treated waste water for irrigating fenlands could be a feasible component of a possible solution for the sketched problems of water and land use management. So far, the use of treated waste water is forbidden due to precautionary groundwater protection and can only be tested in the context of a research project. By using treated waste water for irrigating land, it would be possible to solve the problem of polluting surface water. It is assumed that remaining nutrients and pollutants will be removed by microorganisms and plants when the water passes through fenland soil. However, the effects of long-term irrigation of sensitive soils with treated waste water have so far not been analysed. Potential groundwater risks must, therefore, be monitored carefully.

In any case the question of polluted surface water is only one part of the picture. Our analyses of the current constellation have made clear that the main barrier for changing water and land management of fenlands are the different logics of action of farmers, on the one side, and protagonists of nature protection, on the other. If considered alone, each of the two logics is plausible and rational, but they are not compatible. The main challenge is to provide economically viable options for farmers to cultivate land with higher groundwater levels. So far there has been a lack of attractive product and crop options that fit well with adequate cultivation of fenlands. The establishment of regional value-added chains for crops that are produced on fenlands as well as public compensation schemes for less intensive production will be key elements for finding acceptable solutions for all actors involved (Kröger et al., 2012).

Reflection on the process of knowledge integration with Constellation Analysis

The application of CA in the context of the ELaN project shows that the method is suitable for promoting dialogue between scientists of different disciplines and between researchers and practitioners. Discussing central elements of a problem and their relations helps to integrate different perspectives and heterogeneous forms of knowledge. Dealing with technical and natural elements, actors and signs as being equally important encourages different disciplines to relate to the method and helps to avoid dominance of one discipline or a certain group of stakeholders (Schön et al., 2007; Ohlhorst & Kröger, 2014).

The interventions and comments from the scientists and the practitioners during the processes of conducting CA can be differentiated according to different qualities:

- ***Comments which aimed at enriching or completing the problem description by adding more details:*** Scientists from different disciplines or actors from certain sectors have a highly differentiated knowledge in their specific field which they wanted to be included in the problem description. The dialogue made clear that CA serves the purpose to "draw the whole picture" but that it is not able to integrate the whole range of specific details. The joint discussion helped to come to conclusions which elements are of central significance for the overall problem and which should be dealt with on the level of disciplinary sub-projects. To give an example: Some practitioners suggested to differentiate "citizens" in residents, tourists and hunters since these groups might have different perspectives on the problem. This contribution was acknowledged to be important for the development of strategies further on in the project but it was regarded as being too detailed on the level of the problem description.

- ***Comments which aimed at correcting the use of certain technical terms or the presentation of certain facts.*** If there was consensus on these corrections, they were integrated in the figure as well as in the descriptive text. For example one of the representatives of the regional administration corrected the description of legislative competences regarding the possible use of treated waste water.

- ***Comments which represented a single perspective which was in conflict to other perspectives.*** It was especially this type of comments which made clear that there are ontological and epistemological differences in the group of researchers and that the practitioners from different sectors are acting with different logics of actions. In the range of this paper this can only be illustrated with some examples. Within the group of researchers – but also between science and practioners – there were, for example, different perceptions regarding the riks which are linked to current practices of disposing treated waste water and the risks which are connected to a possible use of waste water for irrigation. While some of the scientists had a stronger focus on the quality of the surface water, others stressed the potential risk for the quality of the ground water. There were also different opinions on how modern societies should – or are able to – deal with existing risks. The discussion made clear that it will not be possible to avoid risks completely but that politics – and society as a whole – have to find ways of assessing risks and weighing them against each other to be able to take justifiable decisions. As ELaN shows, science can play an important role in providing reliable information for risk assessment.

Another discussion which represented different logics of action was the debate about future possibilities of dealing with sensitive and valuable fenland. While practitioners from the agricultural sector stressed the necessity for adequate framework conditions – e.g. subsidies for extensive production, markets for alternative products – actors from nature protection put a stronger focus on the responsibility of the agricultural sector itself to preserve soils and contribute towards climate protection. Both groups were however able to agree on the necessity that farmers have to be able to earn their living with an agriculture which is adapted to characteristics of different soils and biotopes.

Due to the experiences we made, we conclude that CA is suitable for a) organising processes of mutual understanding which are challenged by different disciplinary languages, norms, cultures and methods and b) making different perspectives and conflicting views transparent. It is also c) a good basis for the analysis of the differing logics of action which form the background for various views and rationalities.

CA is done in recursive loops. Throughout the different methodological steps, the constellation was continuously enriched till it was possible to achieve an agreement.The method allows researchers from different disciplines to position their specific research questions within the context of the overarching questions of a whole project. However, the necessity of reducing complexity entails a certain superficiality. Thus, the different parts of the constellation have to be described and anaylysed in detail by the disciplinary sub-projects as it was defined in the project proposal.

An evaluation of the annual meeting of the entire project team in which the CA was introduced and intensively discussed came to rather positive results. A questionnaire survey was handed out and the participants were asked to give us feedback on the benefits of the common problem description.The analysis showed that two thirds of the participants (altogether 38 persons) found the visualization via CA helpful to position their research questions in the overall context of the research project. To assure that the individual sub-projects contextualize their specific research question in the context of the whole inter- and transdisciplinary project is an important aim of integrative methods. The same percentage stated that the process helped them to obtain a better understanding of the perspectives of the other sub-projects. However, the visualisation can be still improved: almost one third of the participants stated that they found the way of presenting CA confusing.

As our example shows, the process of developing a joint understanding of a problem can be rather time-consuming, at least for projects with many project partners. Consequently, appropriate resources have to be calculated for the moderation of such a process. Although a joint problem description is recommended as a starting point for every inter- and transdisciplinary project, it will rarely be possible to formulate one before the project partners start to work on their disciplinary research questions. Nevertheless, it has an important function even after some months into a project, because it allows for reflection on the problem description which was formulated for the proposal and readjusting to the current situation. This is especially important for members of the team who did not participate in the development of the proposal.

The CA method facilitates the discussion and negotiation process about forming an adequate reproduction of reality. However, the figures cannot be understood on their own, they have to be complemented by an explanatory and analytical text. A CA reflects risks and problems as they are described by participants. Therefore, it doesn’t present objective facts but rather represents the result of a socially constructed process. CA can help to structure problems, but for a more thorough analysis, a theoretical perspective is necessary. For the ELaN project, reference to different logics of action has been a helpful approach for interpreting conflicting interests in further detail (Ohlhorst & Kröger, 2014).

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