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Linking
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Instruments to
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Expertise

Innovation Report

Transdisciplinarity

SEVENTH FRAMEWORK PROGRAMME

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EDITORIAL

Dear Reader,

The 5th issue of the LIAISE Innovation Report deals with transdisciplinarity. It reflects the fact that knowledge production is increasingly transgressing the (disciplinary) boundaries of science and is becoming more inter- and transdisciplinary. Researchers are engaging in forms of research characterised by the integration of different bodies of knowledge for complex problem solving. This is largely driven by a demand from society for re-thinking research strategies and coping with the current problems of unsustainability in our societies.

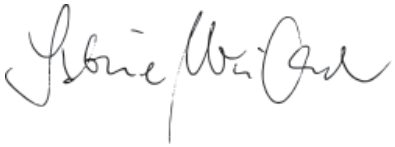
The result is a reshaping of the conception of science. The distinction between science and society, and between scientific and practical knowledge, is becoming obsolete. Conventionally, scientific knowledge, as an ideal, is upheld as universal and true as it is derived from standard scientific methods. It is free from extra-scientific societal values and in this respect distinct from societal knowledge. The latter is prevalent in the life-world ('*Lebenswelt*'), the notion going back to Edmund Husserl and Alfred Schütz. Life-world refers to the societal realities of people, the experiences, activities and contacts that make up their lives. It describes the structural properties of reality as perceived from an actor's perspective. In this vein, transdisciplinarity can be described as a form of science that transcends disciplinary boundaries to address and solve problems related to the life-world, so called 'real-world problems'.

The concept of transdisciplinary research has recently also become aligned with the discourse of sustainable development. In the face of increasingly complex societal problems, all sectors of society must collaborate in problem solving. This is achieved by integrative practices that recognize the multidimensionality of reality, and problem-oriented research including stakeholders and society at large. Transdisciplinarity hence goes beyond a science that merely informs public agencies and society of its research results. It is an interactive way of knowledge production and of managing societal problems. In the LIAISE context, this can be regarded as another angle from which to reflect on issues of science-policy/society relations.

The review article entitled “Transdisciplinarity – a way of bridging the science-society gap?” summarises a number of recent publications in the field of transdisciplinarity and transdisciplinary research. It aims at providing a good overview and summary of the main features of the transdisciplinary discourse as well as some practical hints on how to conduct transdisciplinary research. In the second part, the innovation report as usual contains a number of short reviews of recent publications from the field of impact assessment.

We wish you an interesting read!

Best regards,



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REVIEW ARTICLE

Transdisciplinarity – A way of bridging the science-society gap?

Reviewed articles:

Hirsch Hadorn, G, Biber-Klemm, S, Gossenbacher-Mansuy, W, Hoffman-Riem, H, Joye, D, Pohl, C, Wiesmann, U, Zemp, E, (2008) The emergence of transdisciplinarity as a form of research. In: *Handbook of Transdisciplinary Research*, Hirsch Hadorn *et al.* (eds.), pp. 19-39.

Jahn, T, Bergmann, M, and Keil, F, (2012) Transdisciplinarity: Between mainstreaming and marginalisation. *Ecological Economics* 79, pp. 1-10.

Lang, D, Wiek, A, Bermann, M, Stauffacher, M, Martens, P, Moll, P, Swilling, M, and Thomas, C J, (2012) Transdisciplinary research in sustainability science: Practice, principles, and challenges. *Sustainability Science* 7, pp. 25-43.

Mobjörk, M, (2010) Consulting versus participatory transdisciplinarity: A refined classification of transdisciplinary research. *Futures* 42, pp. 866-873.

Transdisciplinarity is a rather fuzzy concept displaying different features and notions of scientific practice. It can broadly speaking be defined as an extension of disciplinary and interdisciplinary forms of knowledge production and integration to address societal problems. Like this, transdisciplinarity refers not only to the integration of scientific questions at the interfaces of different disciplines, as in interdisciplinarity – it is also about integration at the interface of scientific questions and societal problems (Jahn *et al.* 2012).

The notion of transdisciplinarity has entered the scientific realm during the past four decades when questions were raised concerning the orientation of knowledge production in research, education and society at large. Discourse on transdisciplinarity started back in 1970 at a conference organized by the OECD on “Interdisciplinarity. Problems of teaching and research in universities”. At this event, Erich Jantsch, inspired by systems theory, introduced transdisciplinarity as the highest form of collaboration between scientific disciplines[1].

This paved the way for a deeper discourse on inter- and transdisciplinarity which included diagnoses of a fundamental change of scientific practice and the scientific system (Hirsch Hadorn *et al.* 2008, pp. 20-27). The most prominent catch phrases in this context are “post-normal science”[2] and a “Mode 1” and “Mode 2” science[3]. These concepts are dealing with an altered perception of science, e.g. in the public, which is no longer seen to be responsible for delivering general, universal and impartial outcomes fulfilling the Newtonian

[1] Jantsch, E, (1972) Towards interdisciplinarity and transdisciplinarity in education and innovation. In: Apostel, L, Berger, G, et al (eds.), *Problems of Teaching and Research in Universities*. Paris: Organisation for Economic Cooperation and Development (OECD) and Centre for Educational Research and Innovation (CERI), pp. 97-121.

[2] Funtowicz, S O, Ravetz, J, (1993) Science for the post-normal age. *Futures* 25(7), pp. 739-755.

[3] Gibbons, M, Limoges, C, Nowotny, H, Schwartzman, S, Scott, P, Trow, M, (1994) *The New Production of Knowledge*. London: Sage.

paradigm (Hirsch Hadorn *et al.* 2008, pp. 20-21)[4]. Rather science is increasingly seen as inadequate to ensure validity of knowledge about questions of high uncertainty, large stakes and real-world problems. This opens up debate on new and innovative modes of knowledge production, transdisciplinarity being one of them.

At present, we can distinguish different approaches to transdisciplinarity: On the one hand, transdisciplinarity is seen as an attempt to establish a scientific meta-discipline going beyond the boundaries of single disciplines. This notion goes along with the claim of a unity of knowledge and, therefore, of all scientific (disciplinary) as well as societal knowledge (Hirsch Hadorn *et al.* 2008, p. 29). Another conception, which is widespread in the German-speaking community on science studies and the discourse on scientific praxis, emphasises transdisciplinarity as a form of research organisation. This more pragmatic notion sees certain features as typical for this form of knowledge production. It deals with research organisation and, therefore, issues such as management of joint research projects, integration of different sets of knowledge, participation of non-scientific stakeholders as well as the quality of transdisciplinary and its evaluation are relevant and often mentioned in scientific literature[5].

In spite of four decades of academic discourse, a commonly accepted definition of transdisciplinarity is however not available, yet. Therefore, a number of authors recently started to identify common ground in the transdisciplinary discourse. These include the articles by Jahn *et al.* (2012) and Lang *et al.* (2012), which this review article is based on, among others. Furthermore, the first Handbook of Transdisciplinary Research edited by Gertrude Hirsch Hadorn *et al.* in 2008[6] provides an excellent overall picture of the subject[7].

This issue of the LIAISE Innovation report strives to present the main characteristics of the transdisciplinarity approach as well as current developments in transdisciplinary research. The report reviews a number of recent publications. Some of them rely on seminal publications and provide a good overview and summary of the main features of the transdisciplinary discourse. Most importantly in the LIAISE context, transdisciplinarity can be seen as an attempt to bridge the gap between science and policy/society – a topic which has been on the minds of the LIAISE partners and researchers right from the beginning of the project. For that reason, a special focus will be on practical issues, such as the process and design principles of transdisciplinary research.

4 See also Gibbons *et al.* (1994).

5 Pohl, C, Hirsch Hadorn, G, (2007) *Principles for Designing Transdisciplinary Research*. Munich: oekom.

6 Hirsch Hadorn, G, Hoffmann-Riem, H, Biber-Klemm, S, Grossenbacher-Mansuy, W, Joye, D, Pohl, C, Wiesmann, U, Zemp, E, (eds.) (2008) *Handbook of Transdisciplinary Research*. Dordrecht: Springer.

7 The Handbook starts off with an introduction on what transdisciplinary research is and how it has evolved over time. This is followed by a rich overview on transdisciplinary research issues, such as problem identification and problem structuring, problem analysis, and bringing results to fruition – all illustrated and discussed on the basis of case studies from a wide range of topical areas. The second part of the handbook is dedicated to more cross-cutting issues decisive for transdisciplinary research, such as participation, learning from case studies, integration, and research management.

Characteristics of transdisciplinarity

Several attributes are mentioned when talking about transdisciplinary research. In the following, the most important will be briefly summarised:

1) Transdisciplinarity is problem-oriented

The starting point for every transdisciplinary research is a societal 'real-world' problem. At present, many complex and persistent problems – from climate change to stock market crashes – exist that threaten the viability and integrity of our societies. Transdisciplinary research aims at addressing these societally relevant problems. Notably, this is not only meant as applied research; rather the normative goal, and the epistemic end, of transdisciplinary research is the "solution of real-world problems"[8]. Problem orientation in turn means that research problems cannot be solely defined by scientific scholars but has to take into account the views of the life-world in order to define problems and priorities (Jahn *et al.* 2012, p. 2).

2) Transdisciplinarity involves collaboration between disciplines and between science and society

Transdisciplinary research strives to cope with societal problems by integrating a variety of disciplines – in this sense, it is interdisciplinary. It also strives to transgress the boundaries of science and engage practitioners. The motive behind this is the focus on multidimensional and complex problems which can only be grasped when including a variety of perspectives. An additional motive is that science-society collaboration emanates from the goal to transfer research results to society, thereby contributing to the solution of societal problems (Mobjörk 2010, p. 869; Hirsch Hadorn *et al.* 2008, p. 28).

3) Transdisciplinarity is participatory research

Transdisciplinary research crosses scientific boundaries and engages non-scientific actors from public agencies, civil society and the private sector. In principle, practitioners are involved in all phases of the research process from problem identification and structuring, problem analysis to the implementation phase. In practice, however, participation is more prominent at the first and the last phase of the process while the analytical phase is often confined to the scientific actors (Mobjörk 2010, p. 869).

4) Transdisciplinarity enables learning processes

The motives for participation and collaboration are closely related to the notion of 'mutual learning' between scientists and societal actors. Learning can be understood as the exchange, generation

8 Klein, J, Gossenbacher-Mansuy, W, Häberli, R, Bill, A, Scholz, R, Welti, M (eds) (2001) Transdisciplinarity: Joint Problem Solving among Science, Technology and Society: An Effective Way for Managing Complexity. Basel: Birkhäuser, p. 4.

and integration of different bodies of knowledge the actors hold. The ultimate goal in these processes is joint problem solving. The idea of mutual learning often comes with an egalitarian impetus whereas in practice learning is often impeded by uneven power relations between the participating actors (Jahn *et al*. 2012, p. 3).

5) Sustainability research requires a transdisciplinary approach

Since the introduction of the concept of sustainable development scholars have across the board called for new forms of knowledge production to foster and support sustainable policies. A new research field emerged from this: sustainability science (Jahn *et al.*2012, p. 4). It employs research practices such as transdisciplinarity as well as interactive and participatory approaches. The arguments for sustainability science were similar to those in favour of transdisciplinarity, namely that research on complex sustainability problems requires the input from various knowledge communities to create socially robust knowledge; research should go beyond problem analysis and contribute to the solution of problems; and collaboration between disciplines and across scientific borders increases legitimacy and accountability of research results and solution options (Lang *et al.* 2012, p. 26).

The challenge of transdisciplinarity: Integration

Transdisciplinarity is often used synonymously with 'integrated research' or 'integration sciences'[9]. Integration can in this context be seen as the "cognitive operation" to establish novel, so far non-existent links between different entities in a given context, namely between different scientific disciplines, or stocks of scientific and extra-scientific knowledge (Jahn *et al*. 2012, p. 3).

It is important though to relate integration not only to different bodies of knowledge but to other levels or entities as well. These entities can be, as Jahn *et al.* (2012, p. 7) note, "specific knowledge structures, data or mind sets, theories, models, paradigms, norms, values, interests, linguistic forms, and the roles of actors and institutions". Integration then refers to a process that allows transforming the given problem by placing it in an extended context that links the above entities. This can be done on different levels (ibid):

First, on the *epistemic level*, different stocks of knowledge (scientific and extra-scientific) have to be interlinked. This refers to "cognitive integration" in a narrow sense. In practical terms, epistemic integration requires to recognise and understand the concepts and methods of other disciplines and knowledge repertoires.

Second, on the *social-organisational level*, actors and (sub-)entities, e.g. organisational units or sub-projects have to be connected. This level of integration suggests that transdisciplinarity also needs to address the fact that various societal actors get involved that all bring in their

9 See for example: Dovers, S, (2005) Clarifying the imperative of integration research for sustainable environmental management. *Journal of Research Practice* 1(2), Article M1.

specific views, values and interests. Thus, transdisciplinary research is essentially about mediating between different perspectives.

Third, on the *communicative level*, different practices exist among different groups of actors, which need to be integrated. The aim is "to establish a common language that advances mutual understanding and agreement" (Jahn *et al.* 2012, 7).

A conceptual model of transdisciplinary research

The above characteristics reflect a broad framework on what transdisciplinarity is. This does however not immediately provide practical guidance to researchers on how to conduct transdisciplinary research. Therefore, a number of scholars have worked on a conceptual model of the research process that includes the identified core characteristics and puts them into procedural perspective. The here presented model stems from Thomas Jahn who first developed it in 2005 and later refined it (Jahn *et al.* 2012, p. 4)[10].

This model is based on the assumption that addressing societal problems in transdisciplinary research means and requires linking these problems to gaps in the existing body of knowledge and, hence, to scientific problems. Consequently, the conceptual model can be built upon the respective contributions to societal and scientific progress which represent "two epistemic ends of a single research dynamic" (Jahn *et al*. 2012, p. 4). In this perspective, transdisciplinary research is an "interface practice" (Lang *et al.* 2012, p. 27). The research process proceeds in three phases:

The first phase contains a collaborative framing of the problem. Societal and scientific problems need to be linked to form a common research object. This process of *problem transformation* consists of two steps: First, the 'real-world' problem needs to be transferred into a boundary object. The latter is a product that belongs to both the societal and the scientific sphere, thereby enabling cooperation of actors from both spheres[11]. Second, the boundary object is transferred into an epistemic object which forms the basis from where research questions can be derived. Jahn *et al.* (2012, p. 5) emphasise that the first phase (including the above two steps) of the transdisciplinary research process involves a transformation of the given societal problem, not just a reframing or restructuring. In fact, what happens in this process goes in most cases beyond a conversion of the societal problem into a scientific one; instead the problem itself changes when it is transferred from the realm of interests and values to the realm of scientific rigor and objectiveness. What is decisive, the authors argue, is that this transformation is made consciously (ibid).

The second phase of the research process is dedicated to the *production of new knowledge*. This is done through the interplay of different (disciplinary) research teams – including scientific and extra-

10 There is however also many other models presented in the literature with slightly different foci (for references, see Lang *et al*. 2012, p. 27).

11 For further details on the concepts of 'boundary objects' and 'boundary work', see LIAISE Innovation Report No. 3 on "The Science-policy Interface", pp. 9-13.

scientific actors – that focus special questions or aspects of the research problem. The findings of these sub-teams then will be integrated into new knowledge. Hence, it is important to note that transdisciplinarity is a) based on disciplinary practice, and b) is fuelled by interdisciplinary integration as the science part of the transdisciplinary research process (Jahn *et al.* 2012, pp. 5-7).

In the third phase, the integrated research results will be assessed from two perspectives: regarding their scientific added value (Do the results provide new insights within and/or beyond disciplines?), and regarding their potential contribution to societal problems (Are the results valid and relevant for the 'real-world' problem at hand?). Hence, the results are scrutinised from various epistemological perspectives. This may at first result in their disintegration but only to the end of re-integrating the results again to make them better suitable to the needs of both scientific and societal actors. The second-order integration is at the core of the third phase, so called *transdisciplinary integration* – it is a prerequisite for fleshing out the added value of transdisciplinarity (Jahn *et al.* 2012, p.7). Ultimately, the aim is to intervene in the scientific and societal discourses by disseminating the transdisciplinary research results relevant for scientific and societal praxis, respectively.

In practice, transdisciplinary research does not always proceed in a linear way as suggested in the conceptual model. Rather the assessment in the third phase might make it necessary to revisit the second phase of knowledge production or even the first phase of problem framing. Thus, the model can be run through iteratively. It might also be that emphasis is more on the contribution to either societal or scientific progress. As a result, the integration needs and tasks of research projects will differ (Jahn *et al.* 2012, 7; Lang *et al.* 2012, 27).

Design principles for transdisciplinary research

Following from the conceptual model of transdisciplinarity a number of design principles can be derived on how to organise the research process. Lang and colleagues (2012) synthesised insights from various experiences with transdisciplinary research projects into a set of eleven principles[12], which are presented in the following. The principles are structured along the three ideal-typical phases of the transdisciplinary research model, complemented by principles that cut across all phases.

First phase: Problem transformation

- Build a collaborative research team
- Create joint understanding and definition of the sustainability problem to be addressed
- Collaboratively define the boundary/research object, research objectives as well as specific research questions

12 See also Pohl, C, Hirsch Hadorn, G, (2007), *Principles for Designing Transdisciplinary Research*. Munich: oekom.

Second phase: Knowledge production

- Assign and support appropriate roles for practitioners and researchers
- Apply and adjust integrative research methods and transdisciplinary settings for knowledge generation and integration

Third phase: Transdisciplinary integration

- Realise two-dimensional integration
- Generate targeted products for both parties
- Evaluate scientific and societal impact

General design principles (for all phases)

- Facilitate continuous formative evaluation
- Mitigate conflict constellations
- Enhance capabilities for and interest in participation

The principles are largely self-explanatory (for further details and examples, see Lang *et al.* 2012, p. 29-35). They aim at guiding transdisciplinary research practice and at making the process effective for all actors involved. In a concrete research project, these principles might be adapted to the specificities of the project, the given societal problem and the scientific and extra-scientific actors involved.

Participation in transdisciplinary research

In this final section of this report, a main characteristic of, and a challenge to, transdisciplinary research will be discussed: participation. We already looked at 'integration' as the major principle of transdisciplinary research. Participation is one aspect thereof, related to the social-organisational level. It is however a key means of achieving integration and of bridging the science-policy/society gap, and hence of particular interest in the LIAISE context.

Transdisciplinarity is a way of extended knowledge production that includes a variety of stakeholders and societal actors. The decisive question however is who is included in the process and who is not, and in which ways. In an instructive paper, Mobjörk (2010) analyses different forms of participatory knowledge production. She suggests differentiating between consulting and participatory transdisciplinarity. This distinction draws upon the qualitative difference between research including societal actors on equal terms in the process of knowledge production (participatory transdisciplinarity) or having actors from outside science responding and reacting to the research conducted (consulting transdisciplinarity). In the former case, societal actors are conceived as partners in a joint research process whereas in the latter, actors only have the role of responding and reacting to the research, e.g. problem definition, choice of approaches, etc. (ibid., p. 870).

Both are forms of transdisciplinary research. The participatory approach fully includes societal actors in research process, and their knowledge is seen equally valuable to scientific knowledge. The consulting approach does also fulfil the basic requirements of transdisciplinarity – their contributions to the problem focus of the research, methods chosen and developed etc. are taken into account. Here, the societal actors are however not actively incorporated in the knowledge production process (Mobjörk 2010, 870-71). This has implications for the integration aims and the success of the transdisciplinary endeavour.

One issue is ownership of the research process and its results. Often transdisciplinary research projects are initiated by scientists with an interest in a topic (often in reaction to a research call); they then approach praxis partners to join the project. This may result in unbalanced problem ownership (Lang *et al.* 2012, 36). Legitimacy of the actors involved in the research might also be an issue. The selection of a range of stakeholders with diverse stakes in the research subject is therefore crucial (ibid.). Participation of societal actors might vary in the course of the research process. As mentioned earlier, participation is often more prominent at the first and the last phase of the process while the analytical phase is often confined to the scientific actors – which in fact confines the influence that the stakeholders can have on knowledge production (Mobjörk 2010, p. 869).

Yet participation of actors in transdisciplinary research involves also trade-offs. If a broad spectrum of actors is involved, it makes the integrative work much more challenging. Moreover, participation is also a question of time and resources, hence of practical means of achieving research goals. On the whole, however, the questions of participation and integration are not simply of practical character. They are fundamental to the concept of transdisciplinary research as it strives to establish a novel approach that goes way beyond interdisciplinary research, on the one hand, and applied research, on the other.

IN BRIEF

Torriti, J, Löfstedt, R, (2012) The first five years of the EU Impact Assessment system: a risk economics perspective on gaps between rationale and practice. *Journal of Risk Research* 15, pp 169-186.

In order to better evaluate *ex ante* the economic, social and environmental consequences of its policy proposals, the European Commission has introduced its Impact Assessment (IA) system in 2003. In the subsequent years, a large number of IAs has been carried out. The authors identify two types of scientific literatures dealing with this subject: The first type consists in rather theoretical, conceptual contributions that made assumptions about the rationale of IAs, whereas the second type consists in empirical evaluations on their performance, conducted during the first five years after the introduction of IA.

The authors contrast the findings of these two types of literatures in order to assess in how far the expectations raised in the conceptual contributions could be confirmed by the empirical studies. The first part of the article provides an overview and short evaluation of the rationales for IA found in the conceptual literature. These rationales mostly followed concepts of accountability, organisational structures, regulatory philosophies and policy learning.

In contrast to the conceptual literature, the examined empirical studies were fairly critical of the IA system. These analysed for example the procedural correctness of the IAs, the inclusion of sustainable development issues, their technical correctness and consideration of risk economics. The authors diagnosed a large gap between rationale and empirical studies, only very few of the expectations from the theoretical literature could be partly confirmed by the empirical studies.

While the authors emphasise the importance of theories and concepts, they stress that more empirical research ought to be carried out, considering that the number of empirical studies was relatively limited. They especially deem necessary further research efforts in the areas of regulatory quality, competition and cooperation and risk-economics perspectives.

Lindenfeld, L, Hall, D, McGreavy, B, Silka, L, Hart, D, (2012) Creating a place for environmental communication research in sustainability science. *Environmental Communication: A Journal of Nature and Culture* 6, pp. 23-43.

In sustainability science the importance of coproducing knowledge with stakeholders and communities including practitioners, business and the public is stressed to be able to produce “useable knowledge” aimed at enhancing sustainable development.

In this context, the authors of this article regard environmental communication research as crucial for the success of Sustainability Science. The Maine's Sustainability Solutions Initiative is a project that integrated environmental communication into sustainability science. The article draws on experiences from this project to illustrate the key outcomes of this approach.

The authors identify three dimensions of intersection between sustainability science and environmental communication: First, findings from environmental communication research on public participation processes are relevant for sustainability science to improve efforts of linking knowledge with action. Second, as sustainability science is organized in a trans- or interdisciplinary way, it needs to integrate approaches and concepts from different institutions and disciplines.
The article argues that environmental communication can support the reorganization of knowledge production and application across disciplinary boundaries. Third, science communication should play a more important role in sustainability science as it has the potential to bridge sustainability science and environmental communication. In this way, the integration of science communication in interdisciplinary projects may help to develop concepts for the relationship between discourses that can be found in the media and daily practices in research.

Scholz, M, Hedmark, A, and Hartley, W, (2012) Recent advances in sustainable multifunctional land and urban management in Europe: A review. *Journal of Environmental Planning and Management* 55, pp. 833–854.

The paper focuses on sustainable management of urban, rural and coastal areas and discusses high impact research in this area on European level. It is a review on an original work that examined recent international trends in sustainable multifunctional land management. The focus thereby was on large European projects with potential to make a significant impact in environmental policy making. In order to limit the vast range of options concerning the selection of such projects, the authors applied a list of criteria. For example, the selected studies must have a wide geographical focus, must be undertaken at an overall systemic level and also show a high innovation potential. In sum, projects were selected, which represent a holistic and multi-disciplinary assessment approach towards the total environment.

The selected 14 projects and studies can be subordinated to five different focus areas: Urban management promoting sustainable cities, urban and rural interface management, rural management supporting sustainable agriculture and rural livelihoods, sustainable water management, and sustainable coastal development and management.

Each selected project is shortly presented with regard to their key objectives, proceedings and outcomes. The studies are being assessed with respect to their potential for presenting good decision-making planning tools that are of practical value for policy makers and other stakeholders.

The paper concludes that while most of the projects' output is intended to be practical regarding the sustainable management of urban, semi-urban and rural areas, the real value of the studies' output is very difficult to assess academically in a quantitative way, as they present mainly soft research. The evidence-based project output, in terms of practical and original solutions to real issues, should be much higher for most of the presented projects, especially taking into consideration the significant amount of funding.

Edelenbos, J, van Buuren, A, van Schie, N, (2011) Co-producing knowledge: joint knowledge production between experts, bureaucrats and stakeholders in Dutch water management projects. *Environmental Science & Policy* 14, pp. 675-684.

Based on the finding that knowledge plays a crucial role in complex decision-making, the article deals with the co-production of knowledge by bureaucrats, experts and stakeholders in order to establish a common knowledge ground and guide subsequent decision-making. Knowledge in the three "worlds" of bureaucrats, experts and stakeholders differs with regard to perspectives, values and motivations. Therefore, the interaction between these groups is characterised by discussion and negotiation that is supposed to lead to co-produced knowledge that is not only relevant for policy-making and scientifically valid, but also socially robust.

By conducting a comparative case study research on two water management projects in the Netherlands, the authors aim to describe and analyze the process of co-producing knowledge among civil servants, experts, i.e. scientists, and "non-professional" stakeholders. Their research focuses on the organization of knowledge co-production as well as its final impact on decision-making. While experts have been traditionally involved in Dutch water management projects, the inclusion of stakeholders is a rather new phenomenon challenging established cooperation patterns. This explains why the co-production of knowledge between civil servants and experts, on the one hand, and stakeholders on the other turned out to be difficult. While the former were reluctant to acknowledge stakeholders' potential contribution to identifying and resolving problems, the latter frequently questioned scientific results and neglected political imperatives. Interaction between experts and bureaucrats, on the other hand, functioned more smoothly due to interconnected interests and similar disciplinary backgrounds.

The case studies show that co-produced knowledge is difficult to establish in the light of differing perspectives and values between bureaucrats, experts and stakeholders. In their conclusion, the authors discuss the impact of their findings for political decision-making. They stress the importance of taking into account all three types of knowledge because the legitimacy of a decision might otherwise be at stake.

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