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Article

Building Bridges across Sectors and Scales: Exploring Systemic Solutions towards A Sustainable Management of Land

—Experiences from 4th Year Status Conference on Research for Sustainable Land Management

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Abstract: Interacting land use demands and competing interests originating from fields such as agriculture, housing, mobility and nature conservation call for integrated governance approaches that incorporate disciplinary perspectives and arbitrate between them. The German research program "Sustainable Land Management" targets this challenge and provides an umbrella for a number of regional projects involving transdisciplinary system-oriented approaches to sustainable land use, connecting researchers and practitioners. This research note gives an insight into the experiences presented at the program's fourth year status conference, held in October 2014 in Berlin. It focuses on cross-scalar and cross-sectoral approaches to governing urban-rural interdependencies of land use and scrutinizes debates on how to implement and disseminate project results.

Keywords: land use governance; land management; urban-rural linkages; transdisciplinarity; implementation

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1. Background for Research on Sustainable Land Management: Changing Land Use Drivers and Demands

The diversity of human demands for land resources goes hand in hand with intensive pressure being placed on land and related services, involving complex human-environment interactions. Resulting changes in land cover and distribution of land use types, however, evoke regional land use conflicts that occur both within a certain type of land use (e.g., agricultural production for food or energy supply) and between different types of land use (e.g., between agriculture and housing). Reasons for an intensification of these conflict constellations consist in a variety of drivers that provoke land use change and interact with each other: Climate change with changing cultivation conditions likewise contributes to this development, as do land use demands for housing and mobility purposes in the wake of urbanization processes. Further major influence factors include migration movements due to demographic change and an increased demand for food and energy by the world's growing population. Simultaneously, these development processes prompt more intensive and increasingly complex interactions between urban and rural areas. Land use science, as also represented by the Global Land Project academic network and the endorsed research program "Sustainable Land Management", seeks to address this phenomenon by adopting an interdisciplinary perspective, spanning different spatial and temporal scales [1,2].

Challenges related to land use regularly transcend sectoral competences and disciplinary boundaries. For example, current developments and research strands such as teleconnections—distant causes and consequences of land use change—, functional linkages and flows causing land use changes, urbanization and urban-rural interactions as well as land use competition and conflicts [1,3,4] emphasize the complexity and interconnectedness of the issues at stake. At the same time, approaches to land are subject to changing political and societal frame conditions rooted in the role of sustainability on the political agenda, an associated change in societal values and political priority setting. Examples include various sectoral lines of discourse at both national and European level, especially the paradigm shift towards renewable energy, agricultural policy with "greening" as a core element as well as biodiversity and water policies. Governance approaches that remain restricted to sectoral and scalar boundaries, however, fall short of understanding and addressing this nexus of interconnected processes. In their outlook on the second GLP Open Science Meeting in Berlin 2014, Verburg *et al.* [2] therefore explicitly mention the fact that furthering the understanding of land change transitions and developing responses and governance on that base constitutes a major challenge for the land use science community.

This is where research on Sustainable Land Management, launched by the German Federal Ministry of Education and Research in 2010, comes in: Building on an array of experiences with research foci dealing with partial aspects of governing land, module B of the research program comprises 13 joint projects that work on "Innovative System Solutions for Sustainable Land Management" in different regions of Germany [5,6]. These joint projects are cooperative arrangements between several partners from the realms of research and practice (e.g., municipalities, regional planning departments, water and energy companies) and encompass, for instance, urban land management (also brownfield regeneration), water governance or sustainable forestry. However, whilst tackling these issues, it became apparent that sectoral boundaries go hand in hand with "functional gaps" [7,8]: While spatial development processes, resulting from changing land use drivers and demands due to climate change, demographic developments, changes in agricultural production processes, *etc.*, affect land use patterns in different and

yet interconnected ways, governance approaches remain largely defined by their respective institutional embeddedness and disciplinary foci. This is particularly evident in regions characterized by complex spatial linkages, such as urban-rural interdependencies. These linkages refer to, and are evoked by, various aspects of land management, including agriculture, nature conservation, energy supply, housing and mobility, and typically span territorial boundaries as well as sectorally defined governance areas and disciplinary domains.

Interacting land use demands and challenges arising from urban-rural linkages refer to the problem of fit, scale and interplay identified by Young [9] with regard to human-environment interactions. He differentiates between the dimension of fit, referring to (in) congruencies between ecosystems and institutional arrangements, the dimension of interplay, referring to cooperation between institutions, and the dimension of scale in spatial and temporal terms. Young provides a general conceptual framework for identifying mismatches as drivers for land use conflicts. "Functional gaps" identified by an assessment of the German governance setting detail the approach of fit, scale and interplay for urban-rural interdependencies, *i.e.*, horizontal interactions through sectoral interests, on the one hand, and vertical interactions, *i.e.*, between spatial scales, on the other hand [7,10]. This analysis shows that major gaps prevent the interlocking of existing governance modes for land management: First, there is a lack of interplay, where competences for governing land are fragmented and organized mainly along disciplinary boundaries. This implies that comprehensive planning and sectoral planning, e.g., for transport, waste disposal, nature protection sites, operate largely independently from one another at the policy design stage, whilst being obliged to ensure a reciprocal information process. Second, the dependence of governance competences on administrative entities hinders trans-boundary processes, referring to both the dimensions of fit and interplay. This is particularly relevant for urban-rural linkages that, by definition, extend beyond these entities. It has also evoked quests for more targeted governance modes by policy makers, at both EU and national level (e.g., [11–13]). Third, competences that are not only tied to administrative entities, but also to different—often hierarchical—spatial scales, address the dimension of scale.

This analytical perspective, comprising the three dimensions of fit, interplay and scale, thus constitutes a central point of departure for system-oriented, cross-sectoral and cross-scalar approaches to land management. In the following sections, we will provide insights into the results of the research program's fourth year status conference in 2014, reviewing the strands of discussion according to this rationale and focusing on ways in which systemic solutions can be developed for land management by bridging scalar and sectoral divides. These approaches will be exemplified by concrete examples from selected projects and concluded by a section on how to implement and transfer research results into practical use *in situ*.

Against this backdrop, the land management approach refers to and takes up on research strands surrounding the governance of natural resources. Governance in this context is understood as a "*generic term for all modes of coordinating collective action*" [14,15], constituting a multi-stakeholder process "*in which state actors are not necessarily the only or most significant participants*" [16,17]. The concept thus looks beyond the various understandings of governance that mostly focus on particular scalar and thematic issues, offering a way to connect disparate strands of governance research from a systemic perspective [18].

The understanding of governance that we apply here is also built upon the two main strands discussed in the literature, *i.e.*, multi-level governance, focusing on vertical interactions between spatial scales [19] and governance for functional spaces such as river basins [20], scrutinizing horizontal, cross-sectoral

linkages [21,22]. Seizing both dimensions by fostering cross-scale and cross-sectoral approaches, the concept of land management also acknowledges the need for flexible, adaptive modes of governance, given the existence of different and overlapping functional or action spaces, as recently emphasized by Moss [14].

"Land" management as a governance approach, however, goes beyond notions of environmental governance or landscape governance—although the latter indeed tackles interactions between physical and social processes [23]—and adopts a wider-reaching understanding of land. Following Davy [24], land use as understood in this case explicitly includes non-use options, protecting ecosystems, natural resources and services, and incorporates interactions between spatial and temporal scales. The term also acknowledges the existence of different rationalities in using land and the need for governance to deal with this polyrationality.

The concept thus builds on major strands of debate on environmental governance, extending them to a more encompassing notion of "land" and to a transdisciplinary mode of generating systemic solutions regarding regional land use conflicts. Besides Young's analytical dimensions of fit, scale and interplay, as explained above, this perspective explicitly tackles cross-scale dynamics, acknowledging Bulkeley's [17] geographies of environmental governance. These need to address scalar and network interactions as opposed to the assumption of "nested territorial containers" such as nation states. Hence, the land management approach refers to debates on co-management structures by adaptive processes of learning. It also refers to the integration of different kinds of problem perspectives and knowledge for developing management approaches as well as boundary management, which addresses these dynamics and linkages [25–27].

2. Challenging a Plethora of Perspectives on, Approaches to and Understandings of Land

Research on Sustainable Land Management is located within a wide spectrum of disciplinary backgrounds, scientific and methodological approaches, and policy sectors that all deal with "land" in one way or the other. Since this fragmented institutional landscape evokes parallel decision making and subsequent impacts on actual land use, the joint research projects attempt to provide innovative approaches and model solutions for tackling these incongruences.

For example, negotiation processes are determined by behavioral patterns and disciplinary logics that are distinctive of different research communities as well as communities of practice. Joint research on land management thus has to deal with the challenge of finding a common understanding of how to approach a land-related problem and ways to deal with these different backgrounds and problem-solving strategies. This is in line with what the Global Land Project also postulated as a major challenge for upcoming research on land, land use processes, conflicts and management approaches, *i.e.*, the plea for a cross-sectoral perspective on land [2].

The land management approach, as outlined in Box 1, tackles this challenge not only by integrating disciplinary perspectives, but by applying an explicitly transdisciplinary mode of project design: By connecting researchers and practitioners throughout the project cycle, practical interests and needs are fed into the research process from the very beginning, simultaneously guiding the development of practice-oriented products. The characteristics and challenges involved in this transdisciplinary approach

have been scrutinized by Zscheischler and Rogga [28], who particularly emphasize the multiple interests involved, power inequalities and different disciplinary "languages".

Box 1. "What is Sustainable Land Management"? [8,29].

The concept of "Sustainable Land Management" in the context of FONA (German research program for sustainable development). Sustainable land management can be viewed as an emerging framework that includes different perspectives on land with regard to future global challenges (climate change, demographic change, changes in values and economic trends, loss of biodiversity, *etc*.). By that, it transcends the conventional conception as a normative goal used by international development collaborations. Sustainable land management spans a highly complex sphere of activities, including water, soil, biodiversity, housing, commercial and infrastructural aspects. Sustainable land management is therefore of a regional, integrative, and transdisciplinary nature.

The aim of the research program, funded by the German Federal Ministry of Education and Research (BMBF), is to generate new knowledge for effective decision making in land and natural resource management. The program integrates science and practice in order to develop new strategies, technologies and system solutions based on examples from selected regional case studies. It is split into two modules that focus on different core activities and research approaches. Module A focuses on interactions between land management, climate change and ecosystem services. Projects in Module B particularly aim to integrate the development of urban, suburban and rural areas.

The research program generally focuses on regions that are severely affected by climate and structural-demographic changes. Using these representative regions as examples, applicable solutions are developed that can be implemented as policies and transferred to comparable regions. All research projects are tackled in an interdisciplinary and transdisciplinary manner to overcome barriers between disciplines, to include regional and local stakeholders, and to elaborate action-oriented concepts and strategies.

Adopting a perspective on land use and land management that looks beyond and across these gaps thus requires ways to deal with these incongruences. This article reviews experiences presented and discussed at the fourth year status conference of the joint research projects (module B), held on 14–15 October 2014 in Berlin. The conference involved exploring how research on Sustainable Land Management builds bridges across these gaps. The conference kicked off with a welcome speech by Dr. Ingo Fitting from Project Management Jülich (PtJ), representing the Federal Ministry of Education and Research (BMBF), and an introductory presentation of the preliminary results of the joint research program given by Prof. Dr. Klaus Müller and PD Dr.-Ing. Thomas Weith, head of the Institute of Socio-Economics and of the scientific coordination project for the joint research projects, located at Leibniz Centre for Agricultural Landscape Research (ZALF), respectively. Thematic slots then focused on system-oriented approaches to land management problems, in addition to an integrated view on urban-rural development, mainly encompassing resource management and climate protection as well as elements for energy transition processes.

Each thematic slot was designed according to the transdisciplinary nature of the research program, featuring "tandem" presentations by researchers and practice partners from the respective projects. Central insights into how these processes are managed and how project results are implemented were also provided by a panel discussion between project partners, external representatives of federal and state ministries and associations such as the chamber of agriculture or municipal umbrella organizations. Discussions were also held at a roundtable, connecting practical perspectives and experiences within the research program.

Against this backdrop, we specifically take into account approaches to urban-rural interdependencies of land use as a major challenge of land management, and reflect on concrete case studies that illustrate methods and strategies for implementing and further disseminating the results of transdisciplinary projects. Special emphasis is placed on discussions centered around research-practice interactions and the role of process managers. In that regard, methodological approaches—and intermediate lessons learnt—will be scrutinized and illustrated by concrete experiences from organizing negotiation processes. To this end and from the perspective of the authors' role as members of the scientific coordination project for the research program, the presentations and discussions held over the two-day status conference were documented, analyzed and clustered with regard to these core aspects.

3. Bridging Scalar and Sectoral Divides: Exploring "System Solutions" for Urban-Rural Interdependencies

In order to develop governance approaches that address processes of land use change as outlined above, all of the joint research projects follow a transdisciplinary logic, *i.e.*, connect researchers and practitioners for working together on an issue of mutual interest. These projects are complemented by the scientific coordination project, which focuses on this cross-sectoral perspective and on a meta level, scrutinizing questions of mutual interest for all projects. The following examples illustrate these project constellations by depicting exemplary compositions of project partners and their debates on how to develop governance approaches in the sense of systemic solutions that bundle sectoral instruments and governance logics with regard to "real-world" problem constellations. One of these meta-level subject areas are land use demands and (changing) urban-rural interdependencies. These subject areas are tackled in a number of projects, three of which are referred to below.

3.1. Project Example KuLaRuhr

In the densely populated Ruhr region in Western Germany, the Emscher Landscape Park was a forerunner of planning across administrative boundaries and accompanying a restructuring process in the wake of the declining mining industry. With the need to further develop usage strategies in and for the park area and the linkages that have been enforced by it since the start of the International Building Exhibition in 1989, the guiding principle of the "productive park" emerged.

In order to combine forestry and agricultural use with waste management and maintenance of green and recreational space in a densely populated cultural landscape, a complex and multi-faceted approach was pursued by the *KuLaRuhr* project [30], scrutinizing land use development in the highly urbanized Ruhr region. In that context a regional biomass strategy was developed, also targeting the expansion and professionalization of urban agriculture and multifunctional land use in the region. The main feature

of the project is to achieve a more sustainable use of land, energy and water, as well as linking them. This aspect is considered from the perspective of economics, ecology and transport infrastructure. Exemplary elements of developing the cultural landscape and shaping its urban-rural connectivity in a system-oriented approach include the conversion and development of former mining sites, an assessment of brownfield sites for biomass production, the conversion of wastewater channels and the targeted use of rainwater by installing cisterns. These elements together shape the development process of the Emscher Landscape Park towards the "productive park" framing the urban-rural cultural landscape.

3.2. Project Example RegioProjektCheck

The continuing demand for housing and commercial development sites, especially in the context of inter-municipal competition for new inhabitants and tax revenues represents an important factor for land use demand and potential conflicts. Longer-term impacts of new site developments, however, usually remain opaque to individual municipalities. In particular, the follow-up costs of technical and social infrastructure are rarely considered when new housing or commercial sites are developed. Regional interdependencies and the consequences of land use decisions at the municipal level for the regional setting are also usually disregarded.

RegioProjektCheck tackles these gaps in the framework of land management by developing a method for assessing alternatives and making longer-term impacts of development options transparent at the early planning stage. In order to avoid demand-exceeding site development and inter-municipal competition for inhabitants and commercial investors, the aim is to provide tool-based information on the expected consequences of different development scenarios and their cross-sector evaluation. This tool is applied to two case study areas: south of Hamburg and east of Cologne [30].

During the status conference it was emphasized that, in spite of the experimental character of such a tool-based decision-making support process, a continuously growing consideration of the consequences and costs of developing new housing sites by municipal decision makers can be observed. Such an informative tool exhibits the greatest supporting effect in existing regional cooperation arrangements so far. However, it continues to be difficult in regions that do not have a culture of cooperation being already existent in the region. In this regard, and from the practitioners' perspective in particular, emphasis was placed on the importance and value of employing objective arguments for advising regional politics, e.g., in terms of ranking development sites.

3.3. Project Example €LAN

Regional interdependencies also constitute a land management issue when exploring the development of energy costs and mobility needs. While housing decisions, especially in urban agglomerations, have mostly been explained by costs of land, rising mobility and commuting costs as a result of increasing energy prices might potentially alter residential patterns in regional contexts.

The €LAN project addresses potential interdependencies between energy prices and accessibility. It involves modeling the impacts of energy prices on housing and mobility patterns for the study area of the metropolitan region of Hamburg, encompassing the city of Hamburg as well as adjacent districts in the federal states of Schleswig-Holstein, Lower Saxony and Mecklenburg-Western Pomerania. By integrating data on infrastructure networks, land use, the job and real estate market as well as

demographic trends, the model simulates reactions and location decisions differentiated according to household types and spatial categories that range from rural areas to the metropolitan core. Along the lines of a feedback loop, simulation games are conducted with political representatives who are confronted with these outcomes and involved in a discussion process on policy responses and governance options [30].

The project results particularly reveal the performance of different spatial categories by identifying intermediate centers in rural areas as "winners" of a situation with rising energy prices and commuting costs. In the wake of discussing project results, emphasis was placed on the added value of project involvement: As pointed out from the viewpoint of a district in the Hamburg metropolitan region, the opportunity to address commuter linkages and to legitimize municipal involvement in establishing "bioenergy villages" by providing an objective data basis were specifically important. The role of communicating the results of projects to promote the active shaping of development processes instead of merely administrating the municipal status quo, highlighted by a municipal stakeholder, was also of interest for the role of transdisciplinary research.

4. Lessons Learnt

The project examples outlined here demonstrate various experimental ways of developing system-oriented approaches to land use demands in urban-rural contexts: They range from the explicitly cross-sectoral KuLaRuhr approach, spanning the fields of (agricultural) land, forestry, energy and water, via the development of tool-based information on regional impacts of new site developments by RegioProjektCheck to the identification of urban-rural interactions between energy prices, mobility and housing by €LAN. These approaches emphasize the variety of interdependencies at the urban-rural interface, which have so far been addressed inadequately by research on land use and governance.

Taken together, the examples represent the scope of the challenges addressed by joint research on Sustainable Land Management and the approaches developed so far. While these examples can only provide a brief glimpse of the program content, they help explain the inter- and transdisciplinary nature of the search for solutions to land management problems and of the challenges related to urban-rural interdependencies of land use patterns spanning sectors and spatial scales.

In addition, the subsequent discussion on experiences with transdisciplinary research on land management led to the identification of essential components of research-practice cooperation on systemic solutions for Sustainable Land Management: as a precondition for developing cross-sectoral land management approaches, emphasis was repeatedly placed on gathering the interests and stakeholders involved and addressing the learning process to adopt each other's perspectives on a "land issue". This includes continuous cross-disciplinary exchange between project partners, feedback on individual stages of the research process and an even weight integration of the stakeholders and interests involved in the development of systemic solutions. From the experiences of the conference participants and the subject areas of the involved projects, core challenges were attributed to the question of how to deal with superordinate frame conditions., e.g., EU regulations such as Greening or national and state level incentives (e.g., for electromobility) that exert a considerable yet usually sectorally defined influence on land management decisions. Emphasis was also placed on the significance of the processes carried out, the tools developed and the resulting knowledge base on cross-sectoral and cross-scalar interdependencies

with regard to land management. This was considered particularly important when conducting an early evaluation of potential decisions—before the "normative power of facts" occurs.

5. From Research to Implementation: How to Manage the Leap?

While these discussions reveal the contributions of the projects to cross-sectoral and cross-scalar systemic approaches to land management, the panel discussion that concluded the first day of the conference also tackled the challenge of bringing the results of model projects into practical use—within and beyond the case study regions.

Discussants focused on the question of "how to keep stakeholders and the interested public engaged", emphasizing continuous stakeholder participation as a core element for realizing and stabilizing policy-oriented guidelines. This leap between research results and their availability dependent on both project periods and their implementation may be taken by intermediaries such as regional coordinators as an interface between researchers and practical logics of action. In addition, experts highlighted the importance of not only providing results and guidelines, but also addressing politics directly, e.g., in committees at municipal level, making results available to those who may implement them on the ground. Regional "lighthouses" in the landscape can play a pivotal role in this regard, transferring the results to other regions and municipalities. For instance, the municipality of Uebigau-Wahrenbrück in Brandenburg, a practice partner in the RePro project, is an innovative "trial site" for installing a district heating network based on wood waste from the region. However, discussants also stressed that logics of research and logics of local politics may differ considerably, requiring explicit thematisation, e.g., a regular organized search for "new" knowledge in municipal administrations.

Special emphasis was placed on a stronger embedding of communication and public relations in transdisciplinary projects, and specifically on their professionalization and appropriate implementation. In this context, project participants need to define (and narrow down) targets and target groups, and ensure that the project language (acronyms, *etc.*) is translated into practitioners' terms. An essential role was attributed to the creation of markets for the approaches and products developed, e.g., construction material derived from dendromass or ICT-based planning tools for assessing the consequences of potential housing development sites.

Furthermore, adopting each other's disciplinary lenses and integrating feedback loops into further stages of the transdisciplinary research process were considered central to the implementation of joint project results that integrate different land use sectors and the logics of researchers and practitioners alike. The conference debates also highlighted the importance of identifying windows of opportunity as well as barriers that occur repeatedly and in different spatial and thematic contexts, and to feed these into the political debate. One way of pursuing this continuously was illustrated by establishing partnerships with political interest groups, associations and foundations.

Beyond these essential elements for implementing project results towards systemic solutions for land management, a number of urgent issues that require further debate were raised during the panel discussion: most notably, new instruments for land management, and thus also modified regulations were considered to play a central role in realizing systemic solutions and reducing barriers. One example of this claim is the need, voiced by various agroforestry systems experts to reach an acknowledgement of further energy plants at the European level as a precondition for a more profitable character of these

systems, for the establishment of regional value chains and the use of secondary resources. In addition, the role played by intermediaries such as municipal umbrella organizations that are linked to multiplier organizations and events was emphasized with regard to the sustained availability and use of project results for and by its target groups.

To conclude, and in view of the next phase of the research program "Sustainable Land Management", of similar programs and future transdisciplinary research strands in the field, we identify a number of aspects that should be broached further: first, a number of major theoretical strands of discussion that were mentioned briefly in this article require greater scrutiny and empirical foundation. In particular, the concept of functional governance has the potential to further systematize governance gaps and derive systemic solutions that cross the disciplines and scales involved in land use problems. The urban-rural interface as a core relational space and continuum of the territorial entities and administrative scales involved represents an important reference space for the concept of functional governance and prompts case studies that scrutinize its elements in more detail. The analytical dimensions of fit, interplay and scale as well as Governance Systems Analysis as a systematic framework for analyzing governance arrangements [18] may act as a point of origin for approaching these questions systematically. In this context, empirical studies that analyze transdisciplinary processes in research on land management in detail may offer important insights into these boundary challenges and bridging approaches.

Finally, future attention should focus on the practical challenges of land management, building on the experiences gained from the research program as outlined in this article: Knowledge Management is a key aspect in this regard, aiming at securing knowledge and experience developed by researchers and practitioners alike for future use, well beyond the time and funding horizon of individual projects. In this regard, emphasis should be placed on measures that help embed lessons learnt, linkages discovered and systemic solutions developed in the case study regions and transferring them to other regions that may benefit from these. Starting points for this consist in regional workshops that will be organized in a number of regions in 2015 and 2016, involving a wide range of stakeholders and multipliers, as well as intensified work on target group specific communication and editing of results, e.g., through leaflets focusing on illustrative systemic solutions or through contributions in public media.

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Author Contributions

The conference activities referred to here are part of the scientific coordination project which both authors have been working on. A.R. and T.W. designed the research process, documented and analyzed the results of the conference, A.R. is the main author of the paper. Both authors read and approved the final manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

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