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How to support German cities in implementing the SDGs: learning from and about co-design

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Non-technical summary. Scientists often argue that today's efforts towards sustainability in cities call for a strong exchange on knowledge with non-scientific actors. But do urban practitioners think the same way? Do they see the need for scientific support in their work? In our research, we directly asked these questions to urban practitioners. This article evolves around their answers and describes the activities we conducted in order to start the necessary discussion with them.

Technical summary. Given the challenges cities are facing in their efforts towards sustainability, we scrutinize if urban practitioners believe that scientific knowledge can support them in implementing the Sustainable Development Goals (SDGs), and if, how. To find evidence, we conducted a 'co-design' approach in Future Earth in terms of knowledge production, targeting at German cities. In consequence, the aims of this article are twofold. First, we aim at describing the implementation of the co-design process itself as a potentially useful tool for the interaction with urban practitioners and the evaluation of their specific needs. Second, we present the main results of the co-design process and its contribution for SDG implementation in cities. Combining the two aims, we argue for novel research approaches that allow for more collaborative activities as well as for adequate funding opportunities in the light of urban sustainability transformations.

Media summary. Co-design to support SDG implementation in cities towards sustainability transformations.

1. Co-design in urban sustainability transformations

Co-design approaches in global change and sustainability research that are targeting at the collaboration between scientists and non-scientific actors range from jointly defined research questions and jointly developed projects (co-design), to 'co-production of knowledge' (Lang et al., 2012; Moser, 2016). It is particularly the aim to solve societal challenges that puts co-design and co-production more and more at the core of transdisciplinary research projects (Schuck-Zöller et al., 2017). Thereby, transdisciplinarity is understood as a joint effort of scientific and non-scientific actors for societal problem solving (Defila & Di Giulio, 2018). Knowledge co-production is considered a part of participatory and transdisciplinary research approaches, and is expected to result in greater sustainability outcomes (Norström et al., 2020). Thus, a clear distinction between the different terms, such as co-design, co-creation, and co-production, is not always made (Moser, 2016). But, overall, participatory activities and the exchange of knowledge are common elements that determine transdisciplinary research activities concerning actors' interaction in general.

One important initiative in research on sustainability transformations is the *Future Earth* program. Future Earth considers itself 'a global network of scientists, researchers, and innovators, collaborating for a more sustainable planet' and acts as an interdisciplinary umbrella network for research activities which investigate Global Environmental Change from different perspectives (Future Earth, 2020, para. 1). One main principle of Future Earth's 'research for global sustainability', which distinguishes it from other initiatives in global Change research, is the co-production of knowledge (van der Hel, 2016). In Future Earth, co-design of knowledge addresses primarily the development of research agendas through stakeholders and academia collaboration (Beck, 2019). Co-design is thereby considered as the initial step, followed by a co-production process (Mauser et al., 2013), with outcome to both research as well as policy and practice (Webb et al., 2018). To give one example: In Australia, a Future Earth co-design process and its findings were considered as the starting point to develop a collaborative research agenda in the field of sustainable urban development, with the aim of not only informing Australian cities but to also contributing to international communities such as the Future Earth Urbanisation Knowledge Action Network (Webb et al., 2018).

This urban focus from the Australian example links to the recognition of cities as places with both a high need and the potential for sustainability transformations (Mc Cormick

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et al., 2013; Rink et al., 2018; WBGU, 2011). In the light of transformational change as targeted by the UN Agenda 2030 and its seventeen Sustainable Development Goals (SDGs), co-production is an essential part of the transformation towards sustainability (Iwaniec et al., 2019), and requests 'rigorous collaborative process[es]' (ibid, p. 5). In this vain, transformative action at the local level is in demand (WBGU, 2011). Hence, obstacles occur when solutions of global issues are to be transferred to the local level (e.g. Nevens et al., 2013); with complexity and context-specificity among the main obstacles. In order to unravel this complexity and to shed light on the context specificities of cities, we claim that co-design processes with co-production activities bear strong potential for actively shaving urban sustainability transformations. Given the complexity of cities, other scholars also argue that decision-making can benefit from relevant scientific knowledge (McPhearson et al., 2016; Webb et al., 2018).

Different pathways on how science can contribute to sustainable development in cities exist: for example, sharing knowledge practices, implementing transformative research projects, contributing to local capacity building or self-governing of research institutions towards sustainability (Bansard et al., 2019). All of these pathways require a close cooperation with actors outside of the academic world. Lessons from previous co-design activities emphasize the need to consider the differences between science and practice with regards to motivations, timelines as well as language (Binder et al., 2015), all of which underpins the 'potentially bumpy road of transdisciplinarity' (Scholz & Steiner, 2015). This might be a reason why the proportion of transdisciplinary research that builds upon the joint work of science and society stakeholders has been described as 'surprisingly low' in comparison to more traditional forms of urban sustainability research (Wolfram & Frantzeskaki, 2016). Nowadays, there is evidence that transdisciplinary research approaches in urban sustainability research are increasing. 'Urban Living Labs' (Burch et al., 2018; Voytenko et al., 2016) or 'Real-World Laboratories' (Wanner et al., 2018) are attracting considerable attention in sustainability science. Generally, those labs highlight the need for joint action of research and practice in a specific urban area and apply an experimental approach for a specific urban problem. The idea is foremost to first test possible activities that show the potential to foster sustainable development on a local level in a lab environment, and second, to upscale successful activities in a broader or different context. Some Urban Living Labs and Real-World Laboratories have already demonstrated that collaborative action of research and practices can lead to more sustainable practice on a local scale (Marvin et al., 2018; Menny et al., 2018).

While transdisciplinarity and co-design are increasingly accepted as a way of doing research on urban sustainability and lead to innovative contributions to science (Schneidewind et al., 2018; von Wirth et al., 2019), there is still a lack of evidence concerning the 'real' needs of cities for processing towards urban sustainability transformations. On the one hand, there is only little evidence what city administrations and practitioners are struggling with and if and how science can support. Scientists, on the other hand, argue that the challenges of administrations and practitioners in terms of urban sustainability transformations range from a lack of political will and/or instruments, over obstacles to change existing behavioural patterns to economic forces (Naumann et al., 2018; Romero-Lankao et al., 2018b). Consequently, scientific work is often focusing on providing theoretical and conceptual knowledge, which reveals a particular discrepancy between theory and practice of urban transformations to sustainability (Koch et al., 2017).

Co-design approaches seem to be a promising tool to address this discrepancy. Given that urban transformations and the implementation of the SDGs require a holistic, cross-sector perspective, we argue that the focus of such a co-design approach needs to be broader than often pursued in Urban Living Labs and Real-World Laboratories: It is not a *specific* clearly identifiable urban problem but the process of urban transformations to sustainability *as a whole* which needs to be addressed in the co-design process.

Within this article, we aim to describe exemplarily how to realize such a process, reflecting our own experiences in that endeavour. Our established co-design process builds on the joint work of two activities, implemented within the German Future Earth network, and addressing both co-design as well as co-production activities. Insights on this process are given in Section 2. The urban practitioners who participated in the activities were informed beforehand about the scope of the process: Rather than developing solutions for the implementation of specific sustainability measures, the aim of the process was to identify co-productively research areas and methods, which support German cities in implementing the SDGs. The approach followed a pre-defined time table which was communicated to the participants. The main outcomes and results of this process are presented and discussed in Section 3. Section 4 highlights our findings concerning what city administration and urban practitioners actually require for SDG implementation from science. Finally, in Section 5, we take a step back and critically assess the potential and pitfalls of the co-design approach we designed in order to identify common principles which facilitate co-design processes on urban SDG implementation.

2. Organization and implementation of the co-design process

In order to identify what city administration and urban practitioners actually need from science in order to implement the SDGs in their respective cities, we were running two German Future Earth activities between the years 2017 and 2019: (a) the so-called Working Group on 'Urban Sustainability Transformations' and (b) the Co-design Group 'SDGs and cities'. The German Future Earth Network (*Deutsches Komittee für Nachhaltigkeitsforschung* in Future Earth (DKN)) receives funding from the German Research Foundation (DFG), for activities such as conferences and lobbying for sustainability research within the wider German research landscape as well as for establishing Working and Co-design Groups. Between the years 2014 and 2019, the DKN network funded in total ten Working Groups on topics such as Sustainable Work or Social Innovations in energy policymaking, as well as two Co-design groups. Working Groups in the German Future Earth network are research community-driven, temporary, consist of nine members and aim at promoting research in the context of Future Earth topics. Co-design Groups in the German Future Earth Network are established to initiate dialogue between academia and non-academic actors, with the objective to identify the contributions of different actors to a specific sustainability topic in terms of a joint research agenda. This means that the co-design activities have a broader approach and can include different kinds of formats and structures, leading also to co-production activities.

Both groups were concerned with the challenges central for SDG implementation in cities. The Working Group 'Urban

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Sustainability Transformations' as well as the Co-design Group 'SDGs and cities' received funding for travelling, catering costs for all participants and the rent for rooms, limited in total to four meetings. In our case, the Co-design Group had only two organising members but the support of the German Future Earth community coordinator. Overall, around 60 participants from academia, municipal authorities, companies and ministries actively took part in the groups. Most of the participants work in Germany and represent therefore the specific German context of urban sustainability transformations.

When first established, the main aim of the Working Group 'Urban Sustainability Transformations' was to discuss how science can support the implementation of the SDGs by a new coalition of urban research expertise, bringing together the German urban research community. The work of the group was framed by two questions:

- How can the SDGs be implemented in German cities, and thus contribute to successful transformations towards sustainability?
- What obstacles have to be overcome on the way of German cities towards urban sustainability transformations?

The Co-design Group 'SDGs and Cities', on the other hand, first of all aimed at analysing challenges, experiences, success factors and obstacles of previous efforts of sustainable urban development in German cities by bringing voice to the urban actors, and considering science as 'one voice among others' (cf. Scholz, 2017, p. 11). This was followed up in order to reveal the current needs of SDG implementation in cities, by learning from the past. The research questions guiding the work of the co-design process are:

- What is the role of science in urban sustainability transformation processes?
- What are possible constraints, but also the potentials of transformative urban research?

The questions of both groups are highly interlinked. This way, the conducted activities and answers to the questions are informing each other and both need an academic and a non-academic perspective. We therefore decided to see the work of both DKN Future Earth groups as a joint effort in pooling resources, capacities, and most of all, co-producing knowledge.

The co-design process we organized hence consisted of different activities, interlinking the findings of the DKN Working and Co-design Group (see Figure 1). Temporally speaking, the DKN Future Earth Working Group started half a year before the Co-design Group, in summer 2017. During the first meeting of the Working Group and based on a survey that was sent to the group members beforehand, an overview of ongoing research activities with relation to urban research on SDGs in Germany was elaborated. What came apparent is that investigations on SDG implementation in cities and the challenges cities are facing in this context are still scarce in Germany. Therefore, during the first meeting, it was decided to focus the work of the group on the challenges of SDG implementation in German cities.

It was consensus that a merit would be to identify the gaps between the practical needs in cities, existing and usually applied research modes, and research funding options. The necessity to intensively exchange with non-academic actors from urban development practice and planning was highlighted. In accordance, the decision was made that the main work of the group should consist in developing a position paper on the challenges related to SDG implementation in cities and that the hypotheses of this position paper should be validated and further developed by urban practitioners.

This envisaged approach was positively enhanced by the successful application at the German Future Earth Network for a Co-design Group. This opened the possibility to start the foreseen exchange on SDG implementation with non-academic actors and to validate the so far elaborated hypotheses with those actors. Until this moment, a first version of the position paper was already developed, but the hypotheses mainly reflected a scientific view on the challenges, although one of the nine working group members represented the practice-side.

As the first action of the Co-design Group, a stakeholder mapping was conducted to identify relevant actors from multiple levels that have a role to play for SDG implementation in German cities. One of the results of this mapping was that a lot of research as well as work in administration and politics deals with sustainable urban development in general, but only few actors and networks explicitly use an SDG-oriented perspective. We contacted some practitioners working with the SDGs in cities and invited them to join the process, which marked the starting point of the co-design activity.

At the same time, intensive exchange with the city of Bonn took part in order to organize two activities as side events of the 23rd Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC), the COP 23, in Bonn in 2017. We considered this a good opportunity to bring different actors together and to reach a wider audience. The activities we organized were (1) a panel discussion on the challenges of SDG implementation in German cities, and (2) a workshop along experiences of SDG implementation and the kind of urban research needed to support the implementation. This happened in collaboration with the Future Earth Secretariat in Paris, in particular the Urban Knowledge-Action Network (KAN), and opened an international perspective on the topic.

The panel session discussion at the COP 23 was organized with mayors and deputy mayors from the Cities of Bonn, Stuttgart and Augsburg, as well as a representative from the German Institute of Urban Affairs (DIFU). Input was given by a member of the *Cities Alliance*. All panellists already dealt in different ways with the SDGs and had a broad experience in urban sustainable development in general. The public event was filmed, the presentations translated to English and uploaded on the *Youtube* Channel of the Future Earth Secretariat[1].

The position paper with the hypotheses developed by the Working Group was central to the discussion of the workshop, which took place after the panel discussion. Representatives from German cities and municipalities, planning authorities, ministries, research and planning companies participated. As the workshop's topic was thematically open to all fields of urban transformations, the invited participants represented different areas of expertise including urban and regional water management, community organization, project development, climate adaptation and spatial planning. The participants were mostly working as head of departments or team leaders in their respective work environment. This way, we could ensure that different perspectives were included and the participants had the necessary knowledge of specific processes but at the same time also a strategic perspective. The overall aim of the workshop was to develop jointly ideas on future collaboration foci to support the implementation of the SDGs as part of overall urban sustainability transformations (start of the co-production activity).

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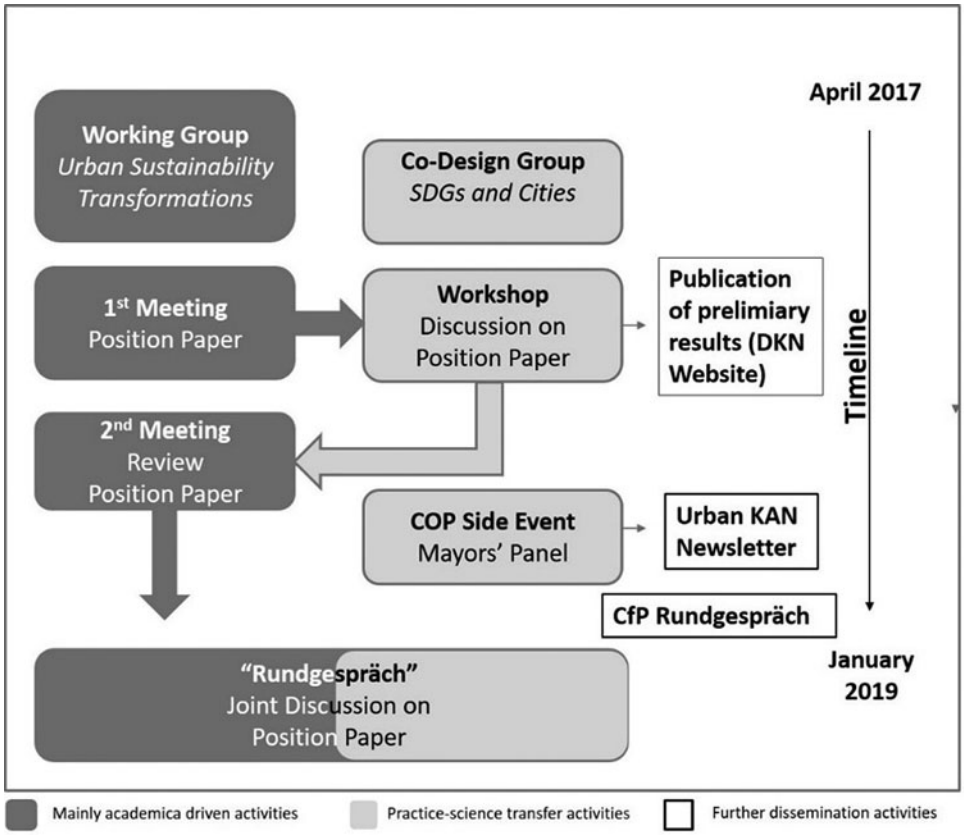


Figure 1. Co-design process.

The final activity of both DKN Future Earth groups was the so-called *Rundgespräch*. This *Rundgespräch* marked the official completion of the two-year work of both groups, and was designed as an open dialogue between academia and different actors concerned with the implementation of SDGs in cities: representatives of municipal administrations and politics, associations, civil society, intermediaries and funding agencies. We invited the latter to the two-half-day meeting of the *Rundgespräch*, as to discuss funding opportunities and formats to support SDG implementation in cities in a joint effort of academic and non-academic actors. In contrast to the previous activities, the aim of the *Rundgespräch* was broader: Besides presenting examples of how cities together with academia work in SDG implementation, also issues of funding for urban sustainability transformations research were discussed. During the *Rundgespräch*, presentations, panel discussions and a world café were organized, bringing in total about 40 people with different backgrounds together (co-production activity). The position paper in its revised state served as the main basis for the discussions. In addition, and in response to a beforehand spread open call for running urban collaboration projects between scientific and non-scientific actors on SDGs in cities, selected representatives from science and practice presented on the strengths and challenges of those projects. The overall limited response rate to the open call for contributions, although intensively advertised through different channels, underpins that concrete projects targeting explicitly on SDG implementation in German cities are still only partial.

At the German Future Earth Conference in 2018, the hypotheses as an important result of the entire process of both DKN Groups were finally presented in order to connect with the broader German and International science community (Schmalzbauer & Visbeck, 2018). In addition, we authored a report of the COP23 co-design event and published a summary for the newsletter of the KAN Urban in order to inform the international audience on the process and connect with other initiatives from outside Germany.

3. Outcomes of the different activities of the co-design process

As all activities conducted during the co-design process informed each other and led to a step-wise improvement of the hypotheses and the position paper, the outcomes are also step-wise described in the following.

The panel discussion at the COP 23 that was organized with mayors and deputy mayors on the challenges of SDG implementation in German cities revealed that, although considerable progress has been made in the respective cities towards sustainable development (e.g. the transformation of municipalities' public transport system on e-mobility), obstacles still exist. Those obstacles often relate to behavioural inertia of administrations and citizens. One of the issues mentioned is that many citizens oppose measures to reduce individual car traffic especially in a city where car industry companies are major employers. This makes it difficult for politicians to implement such measures. As missing support for transformative political measures is not a new problem at all, the participants of the discussion also drew parallels between the SDGs and the Local Agenda 21. In this context, lessons learned from the challenges and processes of implementing the Local Agenda 21 were considered as helpful: for example, the

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involvement and engagement of civil society actors and the possibility to deliberate also the economic potential of sustainability measures.

Overall, there was consensus that small-scale measures, with only limited immediate effect, may trigger a broader shift towards more profound sustainability in cities (e.g. in the mobility sector or the increasing use of renewable energy in the housing sector). The panel participants further agreed that the SDGs and the Paris Agreement can help to attract political attention to sustainability. However, SDGs are perceived more as a general framework or guideline than as a concrete action program for cities. Nevertheless, they bear the potential to foster urban sustainability transformations as they address several dimensions of sustainability at the same time. This allows concerted action and simultaneous transformations which can potentially lead to synergy effects. In addition, the participants of the discussion emphasized the importance of city networks. Those networks can play a crucial role in sustainability transformations, because they facilitate the knowledge transfer between cities and help to strengthen cities' roles within the global sustainability discourse.

In the subsequent workshop with eleven representatives from German cities and municipalities, planning authorities, ministries, research and planning companies, the participants were asked to highlight factors driving SDG implementation in cities based on their practical experiences. They mentioned an array of different, partly interrelated factors from which the following three stand out:

(1) political will,
(2) adequate municipal administration structure which allows integration or action across departments, and
(3) engagement of local communities in concrete sustainability projects.

The participants expressed different opinions about the need for changes when it comes to organizational structures of city administration. Some argued that the sectoral structure of German city administrations handicap SDG implementation because integrated actions towards sustainability are hardly possible within these silos. This implies a transformation of the administrative structure in order to achieve local SDG implementation. Other participants were less pessimistic and highlighted the progress made in SDG implementation and sustainability action, which was already realized within and through the existing administrative bodies of the respective cities or communities. In addition, the participants also emphasized the need to differentiate between SDG implementation in smaller and bigger cities. The organizational structure of bigger cities often consists of administrative units specifically dedicated to and responsible for sustainability and environmental issues. In contrast, smaller cities often do not have comparable structures and much of the work on sustainability is done in part-time or in voluntary work. Therefore, especially smaller cities have difficulties to capture the complexity of the SDGs and to assign responsibility to administrative units for leading the process of SDG implementation.

Both the panel discussion and the workshop helped to 'practice check' the hypotheses developed by the DKN Working Group. This 'practice check' underpinned that the emerging challenges of SDG implementation at the local level can only be informed by and addressed through intensive discussion and insights from urban practice. Thus, the final decision is a political one. Based on the insights from the co-design activities, the Working Group revised the original hypotheses and discussed them during the next group meeting.

As a result of these discussions, the group adjusted the position paper and identified four main hypotheses, which are presented here in their final wording (whereas hypothesis 4, as presented here, includes some additional explanation) agreed on:

(1) Sustainability as a cross-cutting issue in cities and communities calls for additional resources in order to fulfil the necessary integration and coordination.
(2) The participation process of different actors is among the major challenges, and it is crucial to find the right level and mechanism of participation to steer decision processes effectively.
(3) Local and practical framings need to be accepted, which calls for continuous and binding collaboration with urban stakeholders, and the importance to define the merit of the collaboration clearly.
(4) If adequate research funding programs are in place, science can support cities in their efforts to implement the SDGs. Here, Urban Living Labs or Real-World Laboratories are offering the possibility for experimenting and testing. Nevertheless, those Labs can only serve to support co-design and co-production for implementing the SDGs towards urban sustainability transformations but do not presenting a goal themselves.

From the final *Rundgespräch*, it became again clear that public participation is very crucial for SDG implementation in cities, even though the simultaneous involvement of all population groups can complicate implementation processes. It was stressed in the discussions that to foster synergies and to facilitate the implementation of the SDGs, collaboration with existing sustainability activities at the urban level should be followed up, such as climate protection or the still ongoing Local Agenda 21 processes. Networks to exchange ideas and best practices on urban sustainability are crucial as well. Although sustainability as a topic and target was considered to be of high importance for all institutions involved in the workshop discussion, only a few represented cities yet directly refer to the SDGs. The majority of the participants indicated that they defined their own, independent sustainability targets.

Participants of the *Rundgespräch* differed in their opinion concerning the kind of knowledge needed to successfully implement the SDGs. While some participants flagged specific research gaps (e.g. the degree of sealed surfaces in cities), others felt that there is no longer any thematic research gap in terms of how to address sustainability issues, and which would call for scientific analyses. Thus, overall, the discussion revealed that more knowledge on the process of implementing the SDGs is required, as well as more specifically, knowledge on evaluation mechanisms, the interdependencies between different sustainability targets and associated to this, on the interlinked processes. Here, academics can play an important role in working on the issues. It was also pointed out that so far scientific research on the urban dimension of the SDGs predominantly focuses on bigger cities. However, the German settlement structure mainly consists of small to middle-sized towns, which means that the specifics of these smaller-scale urban areas should also be considered in urban SDG research.

This way, the various discussions of the *Rundgespräch* again validated the hypotheses developed so far and brought further insights to the challenges of SDG implementation in cities: the

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process itself, the intensity of participation, indicators and data. From city representatives' point of view, it is particularly the high requirement to deal with cross-cutting issues, such as sustainability, that challenges administrations; nevertheless, it is politics that is often lacking behind administration. Already strong cities are gaining currency, which leads to an increase of disparities between cities. Here, as discussed as part of the co-production activity, adequate funding opportunities might be of help, if developed in a way that they also support the exchange between cities, at national and international level. Overall, different stakeholders stressed that new governance structures already reveal around power, lobbyism and the role of economic enterprises in SDG implementation. Thus, SDGs are rather seen as an opportunity than a threat and there is consensus that the newly evolving dynamics for sustainability should be taken up.

4. Conclusions from the co-design process for SDG implementation

Sustainability transformations supported by SDG implementation cannot be achieved top-down (Sachs et al., 2019). In this light, the co-design process we conducted revealed some challenges related to very practical issues of bottom-up SDG implementation in cities, so far not mentioned in respective academic papers. Among those challenges, the significance of semantics in SDG implementation or the ambiguous opinions on the available financial resources of cities, as well as the reluctancy of parts of the population to engage in sustainability actions. This underpins the clear benefit of intensive discussions with experts from urban practice to identify 'real-world' challenges.

We can say yes, urban stakeholders believe that scientific knowledge can support them in implementing the SDGs, although it is not the 'traditional' scientific knowledge rather than the support stemming from exchange and the joint work between scientists and urban actors as an outcome from co-production. Based on the conducted co-design process, we argue that strategies for SDG implementation and future cooperation between science and urban practice need to consider the following principles:

Issue 1: Reduce SDG complexity

The 17 SDGs include a broad range of different sustainability targets and indicators, which due to cities' particularities, might not be in total and in the same way of interest for all cities, and it is in particular the operationalization challenge, which strikes urban stakeholders to respect the strong interdependencies across all SDGs (Sachs et al., 2019). As we found out from the discussions during the two-year process, urban stakeholders prefer a more 'reduced' form of urban sustainability goals in which some of the SDG key issues are highlighted and directly translated into urban policies. Here we argue, continuing the process we started, that research based on co-design principles and an equitable positioning of the involved practitioners (Alonso-Yanez et al., 2019) can help to identify urging 'real-world' sustainability problems. This coincides with what Sachs et al. (2019) proposed: to work on key transformations, with a modular action agenda and with a selection of stakeholders. On the other hand, cities require local authorities that have the necessary competencies and are sufficiently endowed to pursue integrated strategies and ensure participatory processes (FAO, 2017). Here, co-design can also play an important role in order to identify and work jointly on the challenges local authorities are facing.

Issue 2: Make urban sustainability research sustainable

Policy makers consider much of current urban research on sustainable development as 'un-sustainable'. As urban policy processes have a long-term perspective, research projects with a typical duration of maximum three years mostly do not have long-term effects (Krellenberg et al., 2019). Personal trust and working results are getting lost, if cooperation ends after the funding runs out. Accordingly, it is of high importance to develop 'tools and methods for multi-stakeholder engagement and co-design that help identify perceived trade-offs, ensure technical feasibility of long-term pathways and explain the urgency to act' (Sachs et al., 2019, p. 812). This is especially key if not one, clearly identifiable urban problem is addressed, but a complex set of interwoven measures such as the implementation of the SDGs requires. Here, again funding schemes that consider co-design can present a helpful tool.

Issue 3: Consider the political sphere of urban sustainability transformations

The debates on sustainability transformations in cities take place within a highly politicized environment. The acceptance of measures for more sustainable cities (e.g. the reduction of individual car use) affects economic issues as well as daily habits of a huge part of the urban population. Therefore, co-designed research on the SDGs needs to understand the political dimension of urban transformations (e.g. Romero-Lankao et al., 2018a, 2018b). On the one hand, co-design processes to support urban sustainability transformations should identify potential conflicts between politically feasible measures and, on the other hand, measures, which seem necessary from a scientific point of view. This requires not only science-policy transfer but also policy-science transfer methods, such as knowledge on agenda setting and the temporalities of local politics. Co-design seems to be an adequate method to guarantee those mutual learning processes and to produce the knowledge on how to implement the SDGs.

Issue 4: Include a global perspective on urban sustainability

The current discussion on local SDG implementation in German cities often lacks a global perspective. The effects of local action for sustainability on global scale require more attention, in order to honour local activities and to stress their contribution to the great challenges at hand (Elmqvist et al., 2019). Questions such as: What is the global effect of electrifying the public transport in a city? require a close cooperation between urban research and practice to be realized. For example, in co-design processes, as this calls for quantitative measures as well as comparative analysis as well as for scenario work and/or backcasting.

5. Lessons learnt? Potentials and pitfalls of co-design processes

Based on the experiences with the co-design process organized by the German Future Earth Working Group and the Co-design Group, we conclude by critically looking at the process as well as its outcomes and achievements. One of the specifics of our

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co-design approach was its wide scope. Instead of a clearly identifiable urban development problem, the topic of the co-design process was more fuzzy, asking about SDG implementation and the role of science, based on the needs and challenges identified by practitioners. With the following subsections, we aim at contributing to the evaluation of challenges and benefits of co-design processes, particularly looking at factors which facilitate a successful implementation of co-design processes with a wider scope. Organizational, structural as well as content- and impact-related issues of the conducted process are reflected.

5.1 Resources and organization

The co-design process was embedded in the German Future Earth Network. This helped us to reach a broad audience and to use the organizational capacities of the network, such as the publication of our call for participants for the *Rundgespräch*, the connection to the Future Earth Global Secretariat, and the support of the Future Earth community organizer. Without this institutional backing, the organization of the co-design process would have been considerably more difficult. Future Earth also facilitated the distribution of the results of the Working and Co-design Group through their websites and the connection to the international Future Earth community. Furthermore, DKN funded travel costs as well as catering costs for all participants and the rent for rooms. These financial resources are in our opinion necessary pre-conditions and the minimum required funding to realize co-design processes. In order to involve also representatives of private companies in the co-design processes, the possibility to pay daily allowances as reimbursement for participation might be helpful.

Besides the support of Future Earth, also other resources were necessary to realize the co-design activities: we brought in our networks, contacts and our long experiences in the topic of urban development as well as own experiences in organizing workshops, transdisciplinary projects, etc. Without this, the process would not have been successful with the rather limited resources provided by the DKN. However, as DKN did not fund directly costs for personal and workforce, our work as organizers for the two Working Groups was indirectly financed through our positions as research associates at a publicly funded research institute. As we changed our positions during the process, we encountered the challenge to include the tasks of organizing the process also within our new positions.

5.2 Structure and participants

The acquisition of the members of the Working Group was based on personal contact. The same holds true for a considerable number of people we invited to the workshop at the COP 23. Rather than a representative selection of urban research and development actors, the participants were a group of researchers and practitioners with whom we previously worked together or which someone recommended. This way, we pre-selected participants, from which we knew that they work on cities and SDGs or from which we assumed that they might be interested in the topic. This selection process had of course an influence on the outcomes of our co-design process as we gathered together participants with similar disciplinary backgrounds and/or understandings of urban sustainability. With the aim to avoid a too narrow perspective and with the attempt to leave our own 'bubble', we published the open call for participants for the *Rundgespräch*. This opened the door to other actors interested in the topic.

Overall, we consider this tension between creating a functional working environment with already proven work relationships on the one hand, and avoiding a closed-shop mentality on the other hand, as challenge for co-design processes. Thus, we have to admit that our situation was somehow 'specific' as we were from our previous work already well connected with non-scientific actors. This might also have its roots in the topic itself, whereas other co-design processes might have to start from the very beginning, making first contacts to other communities and therefore would directly be considered as 'open processes'.

5.3 Outcomes of the process

Due to the simultaneous work of the academia-shaped Working Group and the more practice-related Co-design Group, a mutual fertilization took place and allowed us to practice-check the hypotheses of the working group. Therefore, through co-production we achieved to gain new results on the challenges of SDG implementation directly from the practitioners in charge.

Besides the above-mentioned concrete results of our working group, more general outcomes also exist. The participants of the Co-design Group were asked about their impression of the process and whether they would participate in other activities of Future Earth (Link: http://www.dkn-future-earth.org/data/media-pool/180215_workshop_evaluation.pdf). The statements were generally positive with most of the participants willing to participate in further activities. Even though most participants already worked on science-policy/science-practice interfaces, the co-design process was evaluated positively because of the possibility to gather new knowledge in a co-productive way. Participants also appreciated the possibility to exchange with other practitioners during the co-design process, an important aspect that was already found in former transdisciplinary processes of, for example, adaptation to climate change (Krellenberg & Barth, 2014). However, some practitioners also mentioned that they found it hard to get permission from their supervisors to participate in the activities. This reveals again that incentives or at least clearly communicated take-home massages need to be defined, particularly in co-design processes. This relates to the final issue we would like to highlight: the impact of co-design activities.

One of the open and most pressing issues of our co-design process was the question of how to make efficiently use of the results achieved in order to bring the implementation of the SGDs forward. With the limited resources available mainly two different formats have been followed up: (1) to publish the results in scientific articles, and (2) to document the different events on the website of the German Future Earth network. The question on how to achieve the attention of policy makers, which is seen as a crucial and most relevant outcome of the co-design process, was controversy discussed within the two DKN groups. We developed a concrete proposal on how to restructure urban research funding to facilitate the implementation of the SDGs, which was published as a discussion paper (Krellenberg et al., 2019). But, yet, it is not clear which impact the results will actually have, which indicates the limitations of the practical outcomes of the co-production activity. Nevertheless, most of the participants of the process expressed their interest in becoming involved in joint projects in the future, in order to support the implementation of SDGs in cities by co-designed/interdisciplinary work – which itself is a very important outcome.

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Research transparency and reproducibility. The manuscript is our own original work, and does not duplicate any other previously published work. The manuscript has been submitted only to the journal – it is not under consideration, accepted for publication or in press elsewhere. All listed authors know of and agree to the manuscript being submitted to the journal; and the manuscript contains nothing that is abusive, defamatory, fraudulent, illegal, libellous or obscene. We assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008. We assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional guides on the care and use of laboratory animals

Note

[1] https://www.youtube.com/watch?v=Cwj1pLnl66g&t=88s

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