

# Insights into and Recommendations from Three Real-World Laboratories

## An Experience-Based Comparison

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*Real-world laboratories (RwLs) from an inside perspective: comparing interior design, sustainable development, transformation and learning in three RwLs, we present core issues for the future design of RwLs.*

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### Abstract

Real-world laboratories (RwLs) as a new format within transdisciplinary science aim at promoting learning for and transformation towards sustainability. However, what are essential aspects to take into account while initiating and stabilizing such processes within RwLs? Comparing lessons learned of three German RwLs (*BaWü Labs*), we show that for establishing RwLs as melting pots for transdisciplinary research and societal transformation, four properties are crucial: an interior design that enables transdisciplinary research and intervention (in particular real-world experiments) based on a stable infrastructure; sustainability as guiding and operationalized principle for differentiating the format “RwL” from other labs; overarching research programs for assessing transformative effects of RwLs and didactic concepts suitable for RwL circumstances. Since RwLs mainly address a long-term cultural change, a long-term funding and research structure are essential as well.

### Keywords

BaWü Labs, challenges, comparison, interior design, learning, real-world experiment, real-world laboratory, recommendations, sustainable development, transdisciplinarity, transformation

Real-world laboratories (RwLs) enhance existing transdisciplinary and sustainability science with a focus on an interventionist and experimental approach, especially real-world experiments (RwEs) (see Schöpke et al. 2017, Parodi et al. 2016a, pp. 77, 79 ff., Parodi et al. 2016b, Wagner and Grunwald 2015, different view Gross and Krohn 2005). RwLs function as labs providing infrastructure for, and a scientifically framing of, RwEs. Expectations and claims are promoting transformation processes in RwLs as well as the initiation and stabilization of scientific and societal learning processes (Singer-Brodowski et al. 2018, in this issue, Schneidewind and Singer-Brodowski 2015).

The present paper reflects the experiences of our three RwLs in Baden-Württemberg (*BaWü Labs*): *Urban Transition Lab 131 (R131)* (box 1), *The Future City Lab – a Real-World Laboratory for a Sustainable Mobility Culture (RNM)* (box 2), and *Knowledge Dialogue Northern Black Forest (WiNo)* (box 3). *R131* and *RNM* are located in urban areas, as many RwLs currently are (Schneidewind 2014). *WiNo* is located in a rural area and may function as a contrasting case to explore the breadth of potential applications of the RwL approach. The paper compares and highlights crucial aspects of the design and operation of the three RwLs that seem particularly important for the development of RwLs. The overall aim is to contribute to the conception and practice of future RwLs. To this end, preliminary recommendations for their design and operation are given.

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## BOX 1:

**Urban Transition Lab 131 (R131)**

The way we organize our lives in cities is a crucial determinant of sustainable development (SD) (WBGU 2011). Thus, the Karlsruhe Institute of Technology (KIT) established the R131<sup>a</sup> to integrate science, sustainability and urban development into a transdisciplinary process at district level. It aims to initiate a dense sustainability (see below) and cultural change in Karlsruhe Oststadt based on the three pillars of intervention, research and education. R131 runs transdisciplinary projects and experiments: four projects mainly driven by scientists (energy concept, mobility, social issues and urban space, sustainable consumption) and a series of four RwEs named *Your Sustainability Experiment* (Trenks et al. forthcoming), mainly driven by citizens pursuing their own ideas. The projects were defined and co-designed in a participatory process with 300 inhabitants. The RwEs were defined through a public ideas contest. In addition to these activities, surveys of buildings and actors in the Oststadt were conducted and a sustainability assessment tool for quarters was developed to provide baseline information. The lab, and in particular the R131 location *Zukunftsraum (Future Space for Sustainability and Science)*, serves as a networking platform and infrastructure, enabling sustainability experiments arising from the district's needs and interests.

<sup>a</sup> [www.itas.kit.edu/projekte\\_paro15\\_qzrealab.php](http://www.itas.kit.edu/projekte_paro15_qzrealab.php)

## BOX 2:

**The Future City Lab – a Real-World Laboratory for a Sustainable Mobility Culture (RNM)**

The RNM<sup>a</sup> investigates how the city of Stuttgart and its surroundings can move away from a car-dominated towards a more sustainable mobility. To achieve such change, the University of Stuttgart established an interdisciplinary team working closely together with institutional practice partners, such as the Municipality of Stuttgart. A special role is played by people in society who are actively developing and implementing socio-technical innovations and innovative sustainable projects (*transformation pioneers*). Apart from a few discipline-specific research activities (such as a meta-analysis of the main determinants of mobility behavior or the modelling of traffic measures), the main focus rests on the diverse RwEs, which were designed and monitored scientifically throughout implementation. To meet the requirements of the RNM's collaborative research approach, the *transformation pioneers* are not only involved in the implementation but also in the data analysis of the experiments. In total, six RwEs were considered by the RNM: stimulating the *Stäffele Gallery* (typical open staircases) as public space; developing sustainable mobility options for hospital employees of the Marienhospital; the people's rickshaw; free cargo bikes; parklets; and *Plusrad* (an app that rewards cycling).

<sup>a</sup> [www.r-n-m.net](http://www.r-n-m.net)

Three common key characteristics of RwLs (Schäpke et al. 2017, Beecroft and Parodi 2016a) serve as guiding criteria for the discursive comparison: 1. sustainability and 2. transformation, as core aims of RwLs, and 3. learning, as an overarching and ubiquitous process in RwLs. To understand how RwLs function and to try to achieve their core aims via RwEs (resp. transdisciplinary research and interventions) and organize learning, the interior design of RwLs is compared and discussed beforehand.

The experience-based discursive comparison of the three RwLs from an inside perspective refers back to: research data obtained by the labs;<sup>1</sup> internal analyses and self-reflection in/of the labs; two discussion workshops for comparison across the three RwLs. Statements below are offered as theses, are based on the authors' three years of practical experiences in coordinating or leading their RwLs and participatory observations, and are grounded in iterative discourse amongst co-researchers. We present a first (evaluative) step in empirical comparison of RwLs. Systematic empirical testing as a next step is a future research demand.

## BOX 3:

**Knowledge Dialogue Northern Black Forest (WiNo)**

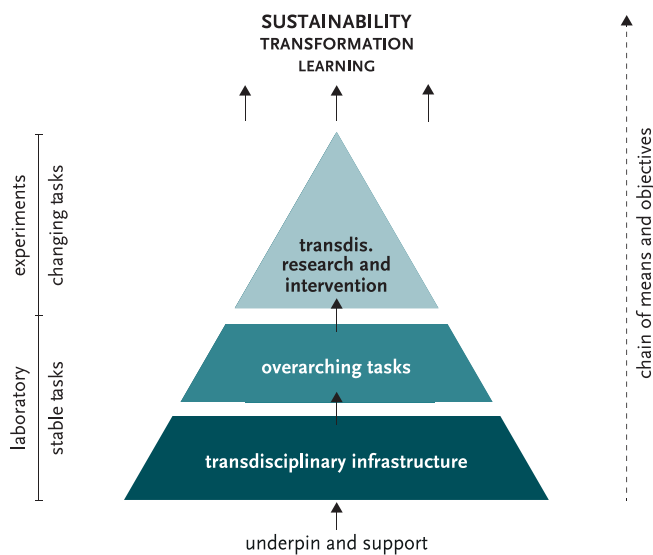
This RwL is closely connected to the question of how national parks might contribute to a sustainability transition in their surrounding regions. As an example case, *WiNo*<sup>a</sup> looks at the newly established National Park Black Forest in Baden-Württemberg, Germany. The project seeks to answer the following questions: what can be learned from ecological processes taking place in the park? How can opportunities generated by the park be used for a regional sustainability transformation? The topics addressed are organized within seven subprojects and range from silvicultural restoration, bark beetle management, health tourism and sustainable mobility to the identification of local knowledge. These subprojects have been defined and worked on in close interaction with a wide variety of societal groups. Throughout the project, various modes of participation were executed. The project benefited from intensive reflection processes. As regards the outcome, *WiNo* has generated diverse knowledge on how a national park may impact on the surrounding region in terms of its social, ecological and economic development. It has furthermore contributed to establishing new regional cooperation networks and to an ongoing dialogue between park administration and region.

<sup>a</sup> [www.wissensdialog-nordschwarzwald.de](http://www.wissensdialog-nordschwarzwald.de)

**Interior Design****Theoretical Background**

RwLs are clearly prescribed as transformative and transdisciplinary endeavors (Schäpke et al. 2017, Parodi et al. 2016a, Beecroft and Parodi 2016b, Schneidewind and Scheck 2013). Debates arise regarding the question of how RwLs can be conceptualized and developed as serving infrastructures for transdisciplinary and transformative research and innovation, thereby opening a frame for RwEs (Beecroft et al. forthcoming, Beecroft and Parodi 2016a, Parodi et al. forthcoming, Schneidewind et al. 2018, in this issue). Contributing to these debates, we compared the interior design >

<sup>1</sup> Analyses of the following sources contributed to the comparison: R131 – written questionnaires, individual and group interviews and various protocols of the R131 RwE series, visitors' book of the *Future Space*; RNM – fact sheets for each RwE, workshop protocols, observational protocols, media analysis, user surveys, logbooks, and mapping; *WiNo* – workshop and working-group minutes, guideline-based interviews.



**FIGURE 1:** Common interior design of our RwLs regarding the hierarchy of tasks – connected to RwLs’ societal aims of promoting transformation towards sustainability.

of the three RwLs with regard to the types and hierarchy of tasks structuring the work within them.

### Comparative Insights

We found that our RwLs have a common portfolio and hierarchy of tasks consisting of three levels described here as *transdisciplinary infrastructure* (TI), *overarching tasks* (OTs), and *transdisciplinary research and intervention* (TRI), including RWEs.<sup>2</sup> These levels build upon each other and are embedded in a chain of means and objectives (Ropohl 1999, p. 154): the RwL as a whole can be considered as a means for (societal) transformation.<sup>3</sup> Within RwLs, TRIs and OTs are (internal) means for performing RWEs or other forms of TRI successfully. The hierarchy of tasks is characteristic at least of our three RwLs.

### Transdisciplinary Infrastructure

The TI serves as a basis and enables scientific, transdisciplinary, transformative tasks and processes as steady working equipment. This infrastructure includes staff and working capacities to organize all kinds of processes and events, including sophisticated RwL-internal and transdisciplinary processes, meetings, communication, public relations and support for actors within the RwL. Taking a closer look, this appears different to regular (multi-/inter-)disciplinary research projects in quality, quantity and possibly also durability. For example, RwL communication is “multi-lingual”, thereby addressing scientists and practitioners from (city) administrations, companies as well as citizens. An appropriate and professional communication involving all different actors is crucial for the success of transdisciplinary and transformation processes. TI also includes suitable locations. To run the labs successfully, two RwLs established easily accessible locations within the project areas (e. g., the *Future Space* of R131), thereby making

the labs visible, addressable and tangible. Further components of the TI are an administrative management, multifunctional operative assistance, an (transdisciplinary) advisory board and competencies for facilitating, mediating or supervising the often politically sensitive and sometimes conflictual RwL activities. TI frames and maintains the labs’ work processes and offers working capacities. It does not depend on the research topics or RWEs but supports them. All compared RwLs have incorporated the abovementioned components sooner or later, and we consider that they are crucial for the labs’ work. Unfortunately, in all three labs the TI was understaffed, which often led to stress and struggle and also endangered the success and quality of TRI.

### Overarching Tasks

The OTs also have basic and supporting functions but are not as steady as TI, could end or be replaced by others over time or sometimes be stabilized and then implemented in TI. In all three RwLs, we find similar OTs. We distinguish “scientific” OTs from “general” OTs.

Scientific OTs, for example, in the form of (inter)disciplinary surveys, support or substantiate the TRI projects or RWEs. Moreover, they can produce transformative knowledge. In *RNM*, a meta-analysis of interdisciplinary studies identified which determinants have an influence on mobility behavior. In *R131*, key actors were interviewed to gain basic knowledge about the project area. Two further scientific OTs at *R131* are 1. the conception and implementation of an (integrative) sustainability assessment of city districts, and 2. the development of a web-based interactive “map of sustainability”<sup>4</sup>. On a more general level, accompanying research (German “Begleitforschung”) is also a crucial scientific OT. In our cases, the two teams of the *BaWü Lab Begleitforschung* – one team more formative and supporting, the other more distant analytically – assume this OT (Defila and Di Giulio 2018, in this issue) and help to significantly increase the reflexivity, quality and consistency of our RwL work. Scientific OTs are very valuable for TRI support and are implemented in all three labs. Often they should be started early to orient TRI, but in our cases problems sometimes occurred due to lack of time.

General OTs are, in particular, organizational and structure forming. They (help to) enable, build up and maintain the organizational settings for TRI and, beyond that, (sometimes) stabilize new networks, cooperation and structures emerging from RwL work. General OTs in all three labs form RwL-overarching working groups and they develop and establish the linkage between research, practice and education. This linkage is – as trio – neither

2 In fact, based on the experiences of the previous RwL *Quartier Zukunft* (since 2012) *R131* was explicitly designed that way, but in all three labs a similar hierarchy of tasks has developed.

3 On a societal level RwLs aim at learning, transformation and sustainability. More accurately, these RwLs’ aims can be ordered in a “chain of objectives”: first, RwLs aim at societal learning, this learning aims at societal transformation, and finally, this transformation aims at sustainability (figure 1).

4 [www.quartierzukunft.de/mach-mit-2/nachhaltigkeitskarte](http://www.quartierzukunft.de/mach-mit-2/nachhaltigkeitskarte)

common practice nor institutionalized in our universities. As a result, transdisciplinary project seminars of *R131* were implemented in the university curricula. In *WiNo*, the highly inspired cooperation between students and practitioners led to a new teaching concept based on a mentorship model. A very crucial general OT in RwLs is to organize and conduct (self-)reflection on the RwL actions. RwLs drive plenty of actions, interventions, research and transformation projects, and it is crucial to regularly reflect on and evaluate the coherence and interaction of these components. Furthermore, RwLs – at least ours – are characterized by “dense transdisciplinary acting”. That is, research and transformation are very close together, converge, overlap and cumulate (sometimes in one person). Therefore, reflection on the role of the RwL scientists (as researchers, facilitators and/or change agents) is necessary for scientific quality (Wittmayer and Schöpke 2014), the aim of transformation and the well-being of the RwL scientists. All three labs developed and implemented such (self-)reflective formats (see section on learning below), leading to iterative adjustment of transdisciplinary methods, balancing of various aims of RwLs and establishing trustful and stable connections between the different actors. However, we perceive that more (self-)reflection would be appropriate and support the (quality of) TRI.

### Transdisciplinary Research and Intervention

Located at the top of the RwL interior design hierarchy is the level of TRI – including transdisciplinary projects and RwEs. (Given that this level of tasks is well discussed in literature, with much more attention paid to it compared to the levels of OTs and TI, we discuss it only briefly here.) Two of our three RwLs perform RwEs but all three run transdisciplinary projects embedded in the RwL framework, supported by TI and OTs. *WiNo* runs seven transdisciplinary subprojects<sup>5</sup> within the field of ecology and tourism, including public events. *R131* carries out transdisciplinary projects and an RwE series on the topics “deceleration” and “community building” as prerequisites for sustainable development (Trenks et al. forthcoming). In *RNM*, a transdisciplinary, participatory “vision workshop” was developed and held (Alcántara et al. forthcoming), and a series of RwEs dealing with sustainable transportation, health, community and urban space (Puttrowait et al. forthcoming) was initiated. Our experience in running RwEs is that they (resp. their transformation outcomes) are highly contextual – their settings and processes cannot be planned in detail years before. At least *RNM* and *R131* had to modify their TRI activities during project duration, compared to the proposal. Driving RwEs in particular, means coping with high degrees of openness and limited calculability – exactly those properties which scientists try to minimize by performing experiments.

### Preliminary Recommendations

It has become apparent that the interior design of RwLs as a hierarchy of tasks has proven its worth and we recommend organizing future RwLs along this scheme. This makes it possible to distinguish between types of tasks and helps to clarify which parts of the RwL have qualities of a laboratory – in particular the TI but al-

so the OTs – and which are experimental research – in particular RwEs but also other forms of (transformative) transdisciplinary research or interventions (TRI) (cf. figure 1). Correspondingly, this assists decisions about appropriate equipment (regarding required competencies, time frames, inner logic and procedures).

For future RWL design, we want to highlight the “supporting levels” of TI and OTs, as these tend to be marginalized but are characteristic of the labs and essential for their prosperity. This includes (formative) accompanying research, a local transdisciplinary advisory board, capacities for (self-)reflection, evaluation of the RwL processes and time and funding for competency development (see Parodi et al. forthcoming). Further, establishing a location in the middle of the geographical lab area as part of the RwL infrastructure supports the transdisciplinary and transformative aims.

From our experience and in view of the described interior design we recommend funding and running RwLs (in the ballpark of our three RwLs) much longer than the currently funded period of three years. Considering the time needed to build up the labs’ infrastructure, establish the linkage between science and practitioners (as a viable relationship of trust), organize the complex interior design, and for reflection processes, five years or more appear appropriate. Furthermore, the “lab” parts of the tasks, in particular the TI, could be installed and institutionalized for a much longer time (decades) wherever appropriate.<sup>6</sup> This kind of investment would promise returns over a long time.

## Sustainable Development as Guiding Principle

### Theoretical Background

RwLs aim for transformation – and thus refer to a goal or guiding principle in order to orient the change process. Our three RwLs are part of the federal initiative *Wissenschaft für Nachhaltigkeit* (*Sciences for Sustainability*) and are therefore dedicated to sustainable development (SD).<sup>7</sup> Also, the term “Reallabor” (RwL) and the debates surrounding it emerged from the discourse of sustainability science (Schneidewind and Scheck 2013). While RwLs generally are understood to contribute to SD, we briefly compare how our RwLs relate to the normative aim of SD and how they operationalize it through transdisciplinary action.

### Comparative Insights

Even if our three labs share the guiding principle of SD scientifically and in transformational terms, they differ widely in their conceptual background and in terms of their operationalization and application.

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5 For the different terminology see Pregernig et al. (2018, in this issue).

6 There are additional reasons for a longer duration of RwLs, namely that societal and cultural transformation processes occur over long periods of time. In order to support, study and evaluate such processes, RwLs need to be established over decades (cf. Schneidewind et al. 2018, in this issue).

7 <https://mwk.baden-wuerttemberg.de/de/forschung/forschungspolitik/wissenschaft-fuer-nachhaltigkeit>

*R131* is explicitly grounded on a scientific-ethical “integrative concept of SD” (Kopfmüller et al. 2001), that operationalizes an integrative and comprehensive understanding of SD. It aims for a “dense SD” in the long term, which means concentrating diverse SD innovations within a limited space to allow synergies and conflicts to appear (Meyer-Soylu et al. 2016). As an OT, an accompanying assessment system was set up at district level (Lützkendorf and Balouktsi 2016). However, this could not be finalized within the funding period. Moreover, in *R131* the “integrative concept of SD” was a starting point for and was operationalized in the (topics of the) *RwEs* and transdisciplinary projects. It was implemented in a civil forum called *BürgerForum* and communicatively operationalized as a *Leporello*<sup>8</sup> in everyday language.

*RNM* started without a defined conceptual basis of SD. Its working definition of SD regarding a future mobility culture in Stuttgart was developed through a transdisciplinary multi-stakeholder workshop right at the beginning. On the basis of a dialogic process from a first workshop through to the reflecting phase, *RNM* acquired a specific common and actor-connecting understanding of SD. Interestingly, during this process the civil society actors involved shifted the focus from ecological to social and cultural issues of mobility.

The sustainability orientation of *WiNo* is strongly linked to the Black Forest national park and thus to the human-nature relationship. While the national park itself aims at a mainly ecological SD, *WiNo* explores the catalytic role that may be played by the national park in fostering social, economic, and ecological sustainability. Mostly, each subproject focused (only) on one dimension of SD, but the broad and open understanding of SD offered a baseline for communication between even conflicting regional actors and with those who had a more skeptical attitude towards the park.

### Preliminary Recommendations

Differentiating the format “*RwL*” from other labs (e.g., innovation labs, Magadley and Birdi 2009, generally: Parodi et al. 2016 b, pp. 11 f.), we recommend keeping SD as guiding principle. Furthermore, SD should be specified for the *RwL* work – at best with recourse to an elaborated concept of SD (e.g., *Sustainable Development Goals [SDGs]*, the “integrative concept” [Kopfmüller et al. 2001] or a national sustainability strategy). The concept should be made explicit and has to be operationalized. Beyond this, (working out together) a common understanding of SD can increase social cohesion and contribute to a shared identity of different *RwL* actors. In order to conceive of and subsequently assess the sustainability outcomes of transformative interventions (e.g., *RwEs*), adequate tools are needed that fit the often small-scale, local, participatory and dynamic experiments (e.g., Luederitz et al. 2017, Lützkendorf and Balouktsi 2017).

To adequately discuss, operationalize and assess SD requires a lot of time and effort. This has to be taken into account in the

running and funding of *RwLs*. Furthermore, a rigorous evaluation of the sustainability impact of *RwLs* can only be made many years after the interventions. Thus, we recommend the development of *RwL*-overarching SD assessment tools. In addition, we encourage the installation of a specialized *RwL* center or institute that develops, bundles and applies assessment competencies and capacities over longer periods (decades) as a next step towards fostering a prosperous future *RwL* landscape.

## Claim for Transformation

### Theoretical Background

Transformation to sustainability in the context of mostly local level *RwLs* means aiming for changed daily routines and everyday cultures. Using, for example, an interventionist approach to empower civil society actors as change agents and multipliers to transform their own living environment, seems appropriate (Baumheier and Vogelpohl 2010, Griefshammer and Brohmann 2015). The overarching question, therefore, is whether and how research outcomes in *RwLs* address sustainable transformation. This entails not only producing knowledge about transformation but also initiating and undertaking transformation processes within the *RwEs*. Doing transformative work, *RwEs* oscillate between controlled framework conditions and unforeseen – but mainly welcome – dynamics within contextual and situational circumstances (Caniglia et al. 2017). The initiation of change originates within the (controlled) framework of the *RwEs* and is then taken on by members of the civil society involved in the experiment. They are enabled to disseminate their ideas for enhanced sustainability and functioning as change catalysts (Frantzeskaki et al. 2016). Against this background, we took a closer look and compared how transformation processes were initiated by *RwL* actions.

### Comparative Insights

In our *RwLs*, a close connection to daily routines and everyday cultures is essential. So, the identification of the claim for transformation was strongly connected with involving all actors to include their interests in the *RwL* research design. For example, in *WiNo*, the consortium selected research areas based on interviews with practitioners, developed research ideas, and discussed them in a *Knowledge Dialogue* event with more than 70 regional stakeholders and citizens. The statements of the participants led to redefinitions of subprojects and addressed sustainability topics (Pregernig et al. 2018, in this issue).

Both *R131* and *RNM*, as parts of major research institutions, strengthened the involved civil society actors, enhanced their reputation and opened up possibilities for them. Overall, *R131* probably has its greatest transformative effects in serving as a strong and visible platform, focal point and network for existing and emerging SD actors.

The *RwE* “Parklets” of *RNM* illustrates how civil society actors can be empowered through gaining legitimacy. Further, an effect on legal requirements can be one result of an intervention. Sub-

8 [www.quartierzukunfts.de/wp-content/uploads/2016/05/12\\_2016\\_web\\_Leporello\\_IKONE\\_de.pdf](http://www.quartierzukunfts.de/wp-content/uploads/2016/05/12_2016_web_Leporello_IKONE_de.pdf)

sequently, *RNM* provided the actors with an opportunity to install parklets across the city through the development of a research plan. This intervention had two effects: first, growing discourses in the urban community, and second, initiating a debate in the district councils of Stuttgart. The team of *RNM* reacted to both by setting up a public panel discussion and supporting the civil society actors in the different district councils. After a file application in the city district councils, the formerly prohibited form of reusing parking spaces became legal. *WiNo* supported a transformation of initially adverse attitudes towards the newly established park into a cooperative mind-set. This serves as a precondition for the national park's ability to catalyze SD in the region.

RwLs need an opportunity for a collaborative set-up of the transformative process as well as formats for reflection. In *RNM*, both steps were carried out through workshops for each RwE in which the transformative process was defined. Data gathering and analysis occurred throughout the whole operational period of the experiment and there was also a workshop to reflect on the results.

It became evident in all three labs that by aspiring to transformative change, science – and in the end the scientists – take on a new and stronger interventionist role (Wittmayer and Schöpke 2014). In RwLs, the focus shifts away from the generation of knowledge to action. This is often met with a lack of understanding since it differs greatly from the more passive role of traditional scientific and even transdisciplinary research (Wiek et al. 2012).

But what aspects of RwL work push transformation? Our observation and hypothesis is that the direct and indirect transformative effects of RwLs stem indirectly from knowledge-based effects, for example, reframing, explaining and applying tacit knowledge or learning and educational processes. This has an effect on developing competencies and empowering actors, which in turn has the long-term potential to change practices and cultures. Further transformative effects may stem from entirely different aspects: RwLs build synergies as networkers, function as a kind of “neutral” but political lobbyist and provide civil actors with practical support by doing organizational and communicative work.

### Preliminary Recommendations

Transformative settings of RwLs mainly address long-term effects and cultural change. All three RwLs had an operational period of three years, within which it is not possible to validate all effects of interventions and RwEs. Furthermore, it remains unclear at this point what exactly causes the transformation processes.

Referring to this and the question of control and openness in RwEs, we recommend a dialogic double level approach for RwEs: 1. to involve scientists (going one step native) as change agents, operating the experiment from inside in immediate dialogue with the practice actors and gaining valuable insights, and 2. to conduct accompanying research without being involved in the RwEs for (scientific) quality control.

Further, we recommend installing a long-term, RwL-overarching research program to collect data about and analyze – in cooperation with the respective labs – transformation processes. Special attention should be given to the role of scientists and knowl-

edge-based “side-” effects. Moreover, this program could include a set of RwEs or transdisciplinary projects that might start similarly in different RwLs and societal settings. This would allow for cross-case comparison between context-dependent and open RwEs to gain overarching insights. Further, more attention should be given to how knowledge about transformative effects can be generalized and transferred to other places and settings in order to create a more widespread and larger-scaled transformation.

## Learning

### Theoretical Background

Experiential, consecutive learning has been found to be characteristic of RwLs (Schneidewind and Singer-Brodowski 2015). According to Kolb's experiential learning cycle, knowledge is created by gathering experiences, by reflecting on these and by formulating generalized conclusions. These conclusions are then tested with new experimental actions, which serve as a starting point for new experiences, reflection and generalization (Kolb 2015). Learning, therefore, is characterized by two fields of tension: active experimentation vs. reflective observation and concrete experience vs. abstract conceptualization (Kolb and Kolb 2005). Indeed, RwLs have been described as “learning environments” (Singer-Brodowski et al. 2018, in this issue) that aim at empowerment and capacity building (Ozanne and Saatcioglu 2008). In the following, we take a brief look at the fields of tension of experiential learning as mentioned above and at the learning outcomes connected with these in RwLs.

### Comparative Insights

All three RwLs exhibit characteristics of experiential learning. However, there are differences as to how far the RwL were able to balance the tensions between conceptual and experiential elements. For *WiNo* it can be stated that most of the subprojects as well as the overall project focus on reflection and generalization processes. To ensure continuous self-reflection, an interdisciplinary working group was established focusing, amongst others, on questions of quality standards in transdisciplinary research. In *R131*, the RwEs consist of active experimentation and reflective observation generating real-world experiences as well as hints for further conceptualization of RwEs. Also in *RNM*, experiments offer opportunities for concrete experiences. Self-reflection was a component of workshops at all levels, from the level of the entire project as well as the RwE level. In all three labs special emphasis was put on feed-back loops between scientists and practitioners in order to not only share scientific findings but also experiences in being part of transformative acting. Due to the limited funding period, however, none of the three RwLs is able to embark on a consecutive learning cycle at present.

As regards empowerment and capacity building, all three RwLs had effects on a broad range of actors and related competencies. In *WiNo*, for example, scientists and civil society actors not only exchange knowledge, but also develop a new way of interacting: >

especially for young scientists, the project offers opportunities to get acquainted with research in politically difficult contexts. Also in *RNM* and *R131*, scientists find themselves in unusual roles, for example, negotiating with town administrations. They, furthermore, are able to better understand the requirements for communicating scientific findings to a broad audience. Civil society actors, in turn, gain insights into scientific methods. In this way, the groups involved could acquire competencies, which may be called “cooperative or relational competencies” (Pechlaner et al. 2014).

### Preliminary Recommendations

A special feature of *RwLs* seems to be that actors involved are enabled to develop “doing competencies” that bridge the gap between understanding/sense-making and implementation of actions. These competencies are decisive for balancing the two fields of tensions described for experiential learning above. In this sense, *RwLs* may indeed be understood as catalysts for change, since they empower human beings to act based upon reflection. However, we have seen that the balance between conceptual and experiential elements of the learning cycle is hard to maintain, probably because this also requires balancing interests and power relations. Learning, furthermore, takes place at different project levels and in different intensities in various groups of actors. All this may pose challenges for everyone involved, because different learning outcomes have to be aligned in different reflection formats. It therefore seems helpful to establish a parallel strand of activities for capacity building with the aim of supporting the development of relational and integrative capabilities. This could mean installing a didactic concept in *RwLs* which addresses transdisciplinary learning for scientists and civil society actors. This didactic concept should be pursued through (mandatory) education and training modules for all those newly involved in *RwLs*. Lastly, experiences in all three *RwLs* indicate that it would have been very useful to pass through a second learning cycle. However, this would need much more time.

### Final Remarks

Summarizing, as insights from our *RwL* practice we strongly recommend keeping and operationalizing *SD* as the guiding principle for differentiating the format “*RwL*” from other labs; establishing overarching research programs for assessing transformative effects of *RwLs*; and developing didactic concepts suitable for *RwL* circumstances. Finally, a very simple but also very clear finding of our comparison is: *RwLs* need more time. Initiating, establishing and evaluating transformation to sustainability, organizing profound and self-reflective learning processes and even building up (and profiting over the long term from) the labs’ *TI*, takes time. Hereby it should be taken into account – even if *RwLs* aim at accelerating transformation – that *RwLs* work cannot be accelerated arbitrarily (e.g., by expanding the working capacities) because it operates in real-world contexts and is therefore dependent on

societal, political and cultural “*Eigenzeiten*” (proper time). A further development of the format “*RwL*” should focus on the three different levels of tasks. A greater distinction between the lab like characteristics (*TI* and *OTs*) and the experimental research formats like *RwEs* (*TRI*) allows for a more differentiated view of duration of tasks and funding: *TI* and *OTs* could be funded as (medium-term or long-lasting) scientific structures and *RwEs* as (short-term) transdisciplinary research projects taking place and using *RwLs* as scientific infrastructure.

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