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# One Metaphor—Several Meanings: An Interdisciplinary Approach to Sustainable Development

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## Abstract

This paper presents reflections on how sustainable development (SD) is defined as a research topic and on differences in references to SD in research. The paper argues that the reference of SD as a research topic must expand to include a broader range of research subjects. During two years of methodical discussions and workshops conducted through the interdisciplinary postdoctoral research group *Sustainable Future* at the Universität Hamburg (Germany), the authors have observed that SD has played a major role in natural sciences (i.e. environmental and earth system sciences) and engineering, and a far lesser role in the social sciences and humanities (SSH). This imbalance in the discourse on SD in research impedes a full understanding of the diverse tasks and challenges that must be addressed in SD. An integrated approach is suggested to unite perspectives from natural sciences, engineering and SSH. The authors therefore encourage a more explicit notion of the concept of SD in SSH research, which builds upon and goes beyond current approaches to SD in SSH. The paper presents some illustrative examples which investigate the implications of expanding or restricting the disciplinary boundaries of sustainability research. The examples advocate an inclusive approach for which the authors describe and clarify several methods for expanding research towards cross-disciplinary methods. To this end, the authors present some practical recommendations for the integration of sustainability into the design and implementation of research academic practice. The paper closes up with an argument that all disciplines

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should expand their definition of sustainability in order to hasten research outcomes from all the diverse sectors of sustainability research.

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**Keywords**

Sustainability Goals · Discourses on sustainable development · Imbalance in sustainability research · Transdisciplinary research

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## **1 Introduction: One Metaphor—Several Meanings**

The framework of sustainability generally comes out of the Stockholm conference (1972) with origins in environmental law and the promotion of intergenerational equity with respect to natural resources (Wright 2002). Since the Brundtland Report (WCED 1987) though, which claims that SD is about meeting “the needs of the present without compromising the ability of future generations to meet their own needs”, a broader definition of the concept has been established. According to Theis and Tomkin (2012), the idea of sustainable development is to improve the quality of life for all people and therefore ranks among historical human social movements such as human rights, racial equality, gender equity or labour relations.

This paper examines the manner in which these ideas have been translated into the use of SD as a research topic and the ways in which SD has been used to justify or define research focal points. This work is based on a set of discussions and workshops held at the Universität Hamburg through its interdisciplinary post-doctoral college, *Sustainable Future*. Because the paper comes out of a series of guided and monitored discussions, it is not empirical in a traditional sense, and instead lays out reflective arguments to help push different members of the SD community (and beyond) towards a more expansive notion of SD research.

The first chapter of the paper presents a variety of perspectives and aims of SD as a research topic. The diverse approaches to SD are illustrated through examples of how different disciplines traditionally define the SD challenge and the common questions that are posed in relation to it. The following chapter discusses the imbalance in the approach towards SD in research. In the last chapter it is argued that there is a need for an integrated approach in order to understand the full set of challenges for SD. It concludes with a set of suggestions for advancing a more balanced approach to research within SD. Within each section the critical and relevant literature is reviewed.

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## **2 Different Perspectives on Sustainable Development**

In this section, disciplinary perspectives on SD research subjects are described based on the membership of the Universität Hamburg post-doctoral college, *Sustainable Future*. To develop these perspectives the college fellows examined the

literature in their individual fields and led critical and focused discussions with their disciplinary peers.

In the field of natural sciences, research in the arena of sustainability typically examines the impacts of anthropogenic pressures on the earth system and the development of materials, procedures or concepts to reduce this impact. Research topics include anthropogenic climate change, ocean acidification, stratospheric ozone depletion, human interference with the biogeochemical nitrogen and phosphorus cycle, freshwater use, land use change, biodiversity loss, chemical pollution and atmospheric aerosol loading (Rockström et al. 2009). The rationale here is that these phenomena are consequences of the non-sustainable use of natural resources. The scientific and subsequent societal and political solutions to these problems pose significant challenges for SD and the survival of humankind as well as fundamental shifts in how the earth's systems behave.

In engineering research, sustainability implies a concern with the interface between societal needs and the natural resources those needs demand. The research topics therefore often involve maximising some needed output while minimising the environmental or resource inputs (Anastas and Zimmerman 2003). These projects are often designed around goals seen as fundamental to a high quality of life or to a society's sense of 'civilisation'. Many engineering disciplines have sustainability components related to food supply, including the biological engineering of crop varieties, watershed engineering of water supplies and decision-making regarding irrigation scheduling, chemical engineering of fertilizer resources and the mechanical engineering of farm equipment. An engineer focused on sustainability would also research technical approaches to climate change mitigation, adaptation strategies to climate change and the development of renewable energy supplies. Finally, concerns about poorer or less powerful communities often arise in engineering research in the development of cost-efficient or very low-cost solutions to societal needs (including light for reading, sunlight for power or water purification or redesigned cities for public transportation).

Economists research SD by analysing the conditions under which an individual's efforts to maximise her own well-being simultaneously promote the welfare of the larger society. In ideal conditions markets ensure that the individual's interests are aligned with those of society. Even if such 'interpersonal' alignment is achieved, however, the outcomes need not be compatible with sustainable development. In fact, markets routinely fail to produce sustainable outcomes due to their limited ability to incorporate 'intertemporal' aspects. Climate change, for example, has been referred to as the greatest market failure in history (Stern 2008), where a market failure is the incorrect and suboptimal assignment of costs and benefits (Mankiw 2012).

Economic theory proposes two general approaches to overcoming the market failures that stand in the way of SD (Hess 2013). Firstly, it may be possible to internalise the external benefits and costs that lead individuals to make unsustainable choices. For that purpose it is necessary to attach prices to those external (future) costs and benefits, which is not an easy task. The second approach consists in regulating potentially unsustainable activity. Both approaches require

international cooperation to tackle the global issue of SD as well as new research within and including the field of economics. The economic and business literature thus examines the conditions under which self-interested optimisation by individuals, societies or firms will produce outcomes that are compatible with SD, where the issue of climate change attracts most research attention.

Sociologists have also engaged in the debate on sustainability in terms of the social and cultural aspects in environmental challenges; see the summaries provided by Burns (2012) and Jetzkowitz (2012). For instance, they see the threats posed to the environment on account of consumer behaviour or the ways in which people (have to) manage their lives (Jetzkowitz 2012). There are also numerous opportunities within the sociological approach to intuitional actors in SD (see Box 1). Such approaches share the perspectives on SD as an environmental challenge, as mentioned above.

**Box 1: The sociological approach promises much potential in sustainability research**

The capability of current sociology goes far beyond previous contributions to sustainability in research. State-of-the-art sociological theory (Kroneberg 2011; Maurer and Schmid 2010) allows for understanding (un-)sustainable phenomena in a holistic way—both as individual action and embedded in collective structures in social and ecological contexts. Sustainable topics, practices and gaps can be analysed on the micro level as resulting from influences in societal structures, norms and institutions. Intentional actors with limited rationality have to solve challenges of social coordination and create aggregated (un-)sustainable solutions on the macro level. In doing so, their intentions vary from ecological and social considerations to (socio-) political claims to power and economic profit. From this perspective, sociological theory and behavioural economics complement and cross-fertilise each other, not least because they build on similar theoretical roots. Combined with deep insights on the mechanisms of institutional path dependence (Beyer 2006), the long-term process of sustainable development with its reinforcements and hindrances should be looked at in its entirety (Lottermoser 2014). Taken as a whole, the sociological approach has much to contribute to sustainability research. Together with economic approaches, it can identify, describe and quantify societal and individual forces, goals, triggers and obstacles, and can subsequently transfer such findings to practical support systems for SD.

There are also other areas of research where sociologists can explicitly engage with SD—for instance on issues of social inequality. Research on social inequality is highly relevant to the wider understanding of SD in terms of providing future generations with the skills they need in order to improve their position in the socio-economic hierarchy (cf. the Brundtland definition). Hence research considering the

(unequal) distribution of economic and social resources (including education) and the mechanisms for the (re-) production of social inequality are also to be considered as SD research.

In the report *Urban Future 21, A Global Agenda for 21st Century Cities* provided by Hall and Pfeiffer (2000), social inequality and exclusion are defined as SD challenges. SD is thus not necessarily confined to the ecological framework. It can also address the conditions for social mobility of disadvantaged groups. Based on this wider understanding of SD and the interpretation of its challenges, research on the quality of schools and their ability to compensate for social disadvantage also forms part of the sustainability discourse. However, research on social inequality and obstacles to social mobility is seldom labelled as SD research.

Language, too, is a resource that is necessary for participation in society yet whose marginalisation can lead to social exclusion. Since language is critical to how individuals and societies function, it should play a much broader role in SD research. The special resource status of language and its role in the social sciences and humanities (SSH) contribution to SD is explicated further in Box 2.

**Box 2: Language as resource: one field's guide towards a broader concept of sustainability research**

A stronger involvement of linguistic scholars in sustainability research would enhance the inclusion of 'language as resource' in SD discourses. The role of language in such discourses is often limited to the preservation of endangered languages which are likened to biological species that must be maintained in the interest of diversity. Stanford and Whaley (2010) propose the discourse of sustainability to conceive of language as a valuable cultural resource whose continued use must be ensured for future generations. 'Language as resource' is both sensible and multilayered, yet it is necessary to move beyond the 'endangered language' phenomenon when considering language in terms of sustainability. Languages are not biological organisms and attempts at comparison to endangered species present language in a rather static fashion, rather than as a dynamic resource drawn upon by speakers in a range of situations.

This argument does not overlook the language endangerment phenomenon; policies for the promotion and protection of lesser-used languages are critical. Rather, it seeks a broader perspective on language in sustainability research in two main respects:

- (1) Language *per se* must be considered as an individual and societal resource that does not require biological and environmental metaphors for inclusion in SD discourses.

- (2) Linguistic inclusion is not just an aspiration for ‘endangered’ languages, but for all globalised societies where multilingual constellations have emerged through migration.

Language must be considered a significant factor in SD in the current era of globalisation where most societies are dramatically diversifying, yet do not always recognise or accommodate the variety of languages that are spoken or understood. Language is an individual resource—cultural, educational and social—and failure to cultivate it can result in inequality. In the form of multilingualism, language is a societal resource that also poses significant challenges for social cohesion. A focus on inclusion and participation would also serve the so-called endangered languages within a broader discourse.

Linguistics and its sub and cognate disciplines can thus make significant contributions to sustainability discourses that are concerned with the future development of society. A shift from ‘the sustainability of languages’ to ‘languages for sustainability’ would present a more holistic approach to issues of human and educational rights. However, as yet, the discourse of SD has no great presence in language studies research. As such, it is hardly considered to be a ‘typical’ topic in discussions on sustainability, both within and outside academic research.

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### 3 Imbalance in the Discussion on SD

Although different research disciplines are engaged with and address various challenges for SD, there is a bias in the role of SD across these disciplines. While SD is virtually omnipresent in the natural sciences, engineering and economics, it is not explicitly defined in other fields of research (Jetzkowitz 2012). The lack of sociological involvement in discussions on sustainability becomes apparent by looking at the backgrounds of those engaged in such discussions: many of the contributors are natural scientists or engineers, or sociologists working in institutions concerned with environmental issues. In comparison, sociologists seldom participate in the same discussions. When they do, as stated above, their engagement tends to relate to lifestyle choices that threaten stocks of natural resources and cause environmental pollution. Sustainability in the field of sociology is thus largely bound to sustainability in terms of the natural environment and is mainly discussed in the sub discipline of environmental sociology (Lange 2011). The role of sociologists here is to monitor and collect data, as well as to analyse, identify and explain the impact of society on environmental changes (Renn 1996). In some sustainability projects dominated by natural sciences, the role of sociologists is seen to be restricted to developing communication or acceptance strategies that push society towards more sustainable development.

At the same time, this interpretation does not mean that research on SD only considers environmental challenges. Up to the mid-1990s social concerns were generally brought into the environmental context, for example the role of poverty in exacerbating ecological degradation (Lozano et al. 2013). Following this period there were calls for a broad sense of social responsibility in various sustainability initiatives, ranging from the 2005 Graz Declaration to the 2009 Turin Declaration that emphasised new models of social and economic development consistent with sustainability principles. Newer research has highlighted the role of cultural influences on the implementation of sustainability and has integrated social concerns alongside environmental and technical orientations of sustainable development (Stephens et al. 2008).

But this widening of theoretical discussions on sustainability (Graedel 2002) has not yet led to a broad usage of the term in all kinds of research. The Intergovernmental Panel on Climate Change, which may itself symbolise the dominance of environmental subjects in discussions of SD, acknowledges that discourses of SD have historically focused on the environmental and economic dimensions and have overlooked the need for more holistic change. The importance of issues such as poverty, social equity or governance, has only recently gained recognition in climate change research that is dominated by the natural sciences (Sathaye et al. 2007). Much research in the social sciences engages with the development of society and the distribution of (social) resources, yet there is hardly an explicit link between such research and debates on SD.

In many disciplines, either the sustainability concept still appears as externally ‘bolted on’ to the core disciplinary pursuit or, conversely, researchers in sustainability appear to ‘bolt on’ findings from other disciplines. The lack of translation or, say, transformation of the concept of SD across disciplines is clear when we look at research on linguistic diversity (as referred to in Box 2). Interdisciplinary thinking has investigated the links between biological, cultural and linguistic diversity “as manifestations of the diversity of life” (Maffi 2005 p 599). Threats to linguistic and biological diversity have been linked regarding the importance of local knowledge—which is contained in and transmitted through language—to sustaining the natural environment. A language and the physical environment in which it is spoken most certainly have links. However, the inclusion of language and linguistic disciplines in SD discourses has a much greater potential than merely adding to the environmental issues that already dominate such discourses, as discussed in Box 2.

The imbalance in the discussion on SD also becomes obvious when we look at how higher education institutions deal with the concept. Here, environmental and ecological aspects are stressed and are often seen as the most essential component of any SD initiative. Even recent initiatives on sustainability that take a ‘whole university’ approach may weight ‘greening’ and (natural) resources more heavily than, or separately from, social justice concerns (McMillin and Dyball 2009).

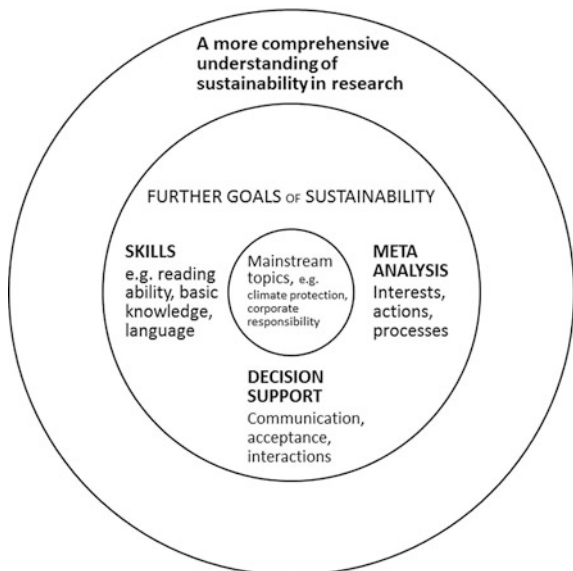
## 4 The Imbalance Impedes a Full Understanding of the (Diverse) Challenges for SD

We have argued that there is a lack of engagement from SSH in debates on sustainability. This imbalance impedes a full understanding of the diverse academic and societal tasks related to SD and inhibits a mutually beneficial cross-fertilisation of different research disciplines.

Although a number of researchers from SSH already actively engage with SD topics, their inclusion in the field is clearly not as ‘taken for granted’ as that of natural scientists and engineers. Indeed, there is often a sense of having to justify or explain the role of SSH research here. The question has been raised within the humanities, “how might those of us who do something broadly defined as ‘literary and cultural studies’ contribute to the creation of a more sustainable world?” (Phillipon 2012 p 163). This question seems to be fair regarding an area that, after all, does have environmental roots. Yet Phillipon notes that “the humanities certainly need to make a place for ourselves at the sustainability table” (ibid p 169), thus confirming that certain disciplines remain on the relative outskirts of this supposedly interdisciplinary field.

In response to these inequities in research, we propose a model (see Fig. 1) to illustrate our argument that the goals of SD can touch upon very different issues and involves a range of perspectives. The division between the circles represents our interpretation that the diversity of perspectives on the goals of SD is not always recognised. The inner circle of this figure illustrates the ‘mainstream understanding’ of SD that is characterised by topics such as climate change and corporate responsibility. The additional circle highlights the research on social inequality as

**Fig. 1** Conceptual model of the proposed broadening of sustainability research subject areas





part of the research on SD as it seeks to enable disadvantaged or marginalised groups with skills for societal participation and social mobility. Language and linguistic diversity are considered as a particular cultural resource in this area.

A Meta research level is implemented whereby the exploration and realisation of sustainable development can be assisted by the analysis of sustainability goals, interests, actions and processes. Sociologists and economists can develop practice-oriented decision support systems in close theoretical and methodical collaboration. This integrated approach introduces a wide and explicit understanding of sustainable development. It enables researchers from more disciplines to engage with sustainability and the way to a future balance in sustainability research remains open.

A recent research controversy highlights the shifts in disciplinary mind-set when a more holistic approach to SD research is generated. The following example (Box 3) from the natural sciences helps demonstrate that while traditional research goals are justified within a narrow SD framework, the means and methods used to generate expected research outcomes may be at odds with a broader sustainability perspective. A multi-tiered approach is then seen to bring a broader, more nuanced set of benefits.

**Box 3: Broadening the scope of sustainability research shifts the focus, means, and intent of that research—an example regarding the ethics of genetic disease mutation research**

A recent research goal in the field of disease genetics was to expand understanding of the pivotal factors that favour the occurrence of a mutation of the virus H5N1 (avian influenza) towards resembling strain H1N1 (swine flu). Such a mutation has the potential to generate millions of casualties through the faster spread of these lethal viruses. The ability to study the evolution and properties of such a virus in a confined research laboratory was seen within the natural science discipline to fully satisfy the SD definition from a natural science perspective in that it helps to secure the existence of humans on earth. Indeed, in a series of ground-breaking studies, two research teams could demonstrate that conditions exist under which an influenza virus can naturally emerge which combines the large mortality rate of H5N1 with the high transmission rate of H1N1 (Herfst et al. 2012; Schrauwen et al. 2013; Zhang et al. 2013).

However, this research and its announcement generated considerable public outrage and controversy and produced considerable doubt as to whether *practical* conduct of an *idea* aiming at SD is actually sustainable at all. To allow time to develop a more holistic perspective on SD in this research subject, the natural scientist research teams then decided on a 60-day moratorium to pause research on this subject (Fouchier et al. 2012). The pause was

later expanded to 12 months in response to the growing critique that had evolved to include ethicists and policy makers, some of them arguing that these studies should not even have been approved for funding in the first place (Fauci and Collins 2012; Williams-Jones et al. 2014).

The pause resulting from the H5N1 mutant case stimulated a more holistic SD approach to assess the risks and benefits of such research projects. It became evident that rating a study simply by the anticipated outcome and knowledge gain can be short-sighted and does not meet the criteria of a real and integrated SD objective. During the 12-month pause, the possible benefits of the study were extensively communicated to the public and discussed openly and with room for debate. New biosafety recommendations were then announced as mandatory for laboratories interested in engaging in such research. The remaining risks were then evaluated by independent, public organizations and measures for their mitigation have been detailed. A majority of scientists and policy-makers have since decided that the research on H5N1 is to be continued in the light of a now much more positive benefit/risk relationship (Fouchier et al. 2013).

This case study represents an example where a one-sided approach to SD in the natural sciences has been replaced by a more general interpretation including not only scientific aspects but also risk-management, communication strategies, policy-making, etc. As Fauci and Collins (2012) have phrased it, “a social contract among the scientific community, policy-makers, and the general public that builds trust is essential for success of [such research projects].” In many ways, this multi-disciplinary and publically engaged approach applies to SD as well.

A complete integration of sustainability as a trans-disciplinary approach is necessary in both the questions asked by sustainability researchers and the methods used to resolve those questions. Lehtonen (2004) argues that the essence of SD can be found exactly at the interfaces and trade-offs between the often opposed objectives of economic and social development and environmental protection. Attention to these issues is highlighted by a recent focus in hydrological sciences towards ‘socio-hydrology’ that recognises the need to rebuild and expand hydrology as a discipline that is much more balanced with social actors, interests and disciplines (Lane 2014). This redesigned field would recognise more explicitly that any environment examined in hydrology is essentially socially constructed and determined—for example, the effects of land use change and climate change on hydrological systems are often analysed and both are clearly anthropologically influenced. Similar trans-disciplinary approaches have also been advocated in biodiversity research (Alves et al. 2013) where increased citizen engagement and inclusion of social perspectives have been recognized to expand both research and conservation outcomes.

## 5 Conclusion

The fact that SD is (mostly implicitly) considered in terms of environmental challenges leaves us with the impressions that (1) the concept has not yet been transferred to SSH as a relevant research topic and (2) the social questions of SD have not been fully transferred into the natural sciences and engineering disciplines. We argue that the incompleteness of this project may be the result of a fragmentary understanding of what SD aims to address. So long as the research community—either explicitly or implicitly—continues to conceive SD in terms of natural environmental challenges that have social and economic aspects, it seems reasonable that SSH researchers will fail to adequately connect with the concept. A wider and more explicit debate on the aims of SD could see more researchers engage with the topic from their respective disciplinary perspectives.

We conclude with some practical ideas toward the more complete integration of sustainability into research. First, the Brundtland report, which served to widen the understanding of aims in SD, does not determine how SD is to be implemented or negotiated. For this reason, further development and clarification of the target goals of SD are necessary. One critical point is that the report does not assess how to deal with the fact that developing certain courses of action may imply the narrowing of others. There is some tension in the concept of sustainability as both (1) improving the lives of individuals and (2) working toward the common good and the ‘just’ distribution of collective goods. There is moreover the question of the effects of actions taken in the name of sustainable development and their reach; for what might be considered sustainable at a local level may not be the case at the global level—and vice versa. It is thus clear that interpretations of what sustainability is and how it might be implemented provide ample material for conflict and debate.

Second, when SD is presented, an operational definition of SD should be provided to make clear its inclusion of many disciplines and cross-cutting goals (environmental, social, economic, cultural, etc.).

Third, educational and awareness efforts within each discipline by disciplinary practitioners themselves may encourage a realisation that the research already performed in these fields can fit within a framework of sustainability. If all fields are more aware of their potential and experience in SD research and can articulate their contributions to these goals, then an inclusive approach may be more quickly reached. This suggestion extends previous arguments (Fien 2002) that have encouraged all kinds of research approaches as part of the advance of sustainability in higher education.

Fourth, it should be more strongly acknowledged that studying the natural world is not sufficient to generate a holistic SD research program, even within the natural and applied sciences. Including non-environmentally oriented sustainability concerns from those perspectives is just as important for SD as well.

Fifth, truly cross-disciplinary research should be further stimulated and encouraged by funding agencies and research institutions to enable practical collaborative experiences that would help internalise the integrated SD approach.

Distinctions between different types of interactions within, between, and beyond disciplines, and a road-map towards their support in project development are proposed in Box 4.

#### **Box 4: Multi-, inter-, trans-disciplinary research for sustainability?**

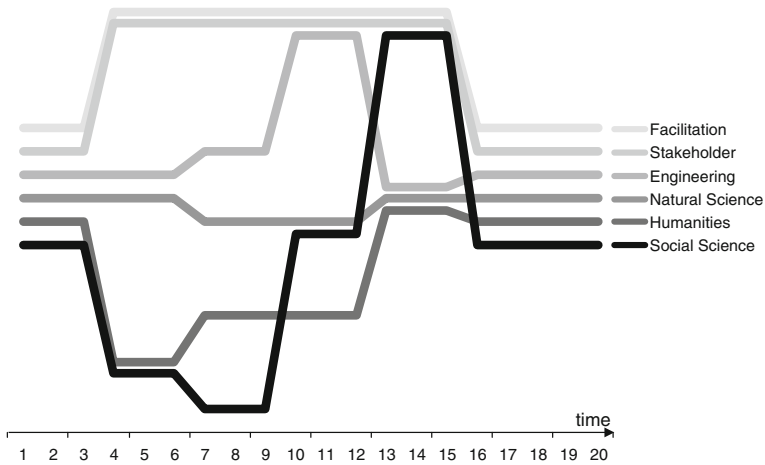
Whether multi-, inter-, or trans-disciplinary research is best suited for sustainability is of course a matter of target (research question) and context (case study). Nevertheless, we have the impression that there is an implicit assumption that only inter- and trans-disciplinary research is sustainable research (see e.g. Brandt et al. 2013).

In **multi-disciplinary research** diverse disciplines work separately in the same research field. The knowledge users can rely on discipline specific quality standards. But the knowledge user has to determine to what extent the chosen theory, method and related assumptions are suitable for the problem that has to be solved.

In **inter-disciplinary research** diverse disciplines work together to jointly generate knowledge that addresses a specific problem. The knowledge user trusts that the theory, methods and related assumptions reflect the scientific perspective and needs of the problem. When the scientific problem perspective does not match the perspective of the knowledge user it may be difficult to transfer the knowledge generated from this research into the user domain.

In **trans-disciplinary research** non-scientists (e.g. stakeholders, problem-owners, decision-makers) are involved systematically in the whole process of inter-disciplinary research (see e.g. Lang et al. 2012). The involved knowledge user is able to frame the research question in ways that her/his problem is addressed. But some scholars question the scientific quality of such practical and action-orientated research because of the normative orientation (for a good approach see Stokols 2006). One of the challenges of this approach is therefore to create a cooperative process while keeping the research independent and insulated against the dominance of interest groups (Gottschick 2014b). We suggest that the trans-disciplinary research project is distinguished into phases where trans-, inter-, multi- and mono-disciplinary tasks alternate (see Fig. 2).

And sixth, there should be more focus on the issue of evaluation to examine what exactly is the impact of a given research project on SD. There should be a more critical debate on how the concrete research projects handle (a) the tension in the concept of sustainability between the common good and the ‘just’ distribution of collective goods on the one hand, and the interest in improving the lives of individuals on the other and (b) the effects and their reach on a local level and at the global level—which do not necessarily correspond. Finally, further work is necessary to expand the scholarly concept of sustainability research questions, to



**Fig. 2** Schematic time-phases of trans-, inter-, multi- and mono-disciplinary tasks, the distance between lines symbolises the level of collaboration in this time phase (Gottschick 2014a)

incorporate new methods and techniques of trans-disciplinary interaction, and to push for greater recognition of social and cultural resources within the SD discourse.

The frameworks presented are broad and are meant to nudge community discussion towards a more inclusive framework without being explicitly proscriptive. The implementation of extra-disciplinary notions of sustainability in research will necessarily take on a different flavour at different institutions and for different targeted questions. The authors feel strongly that all disciplinary researchers should expand their notion of sustainability. The consequences for this paradigm shift may greatly hasten research outcomes in all the diverse sectors of sustainability research.

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## Authors Biography

**Biographical Note** The authors are members of the *Postdoc-Kolleg Sustainable Future*, a post-doctoral research group at the *Centre for a Sustainable University (KNU)* at Universität Hamburg. The remit of the KNU is to define and develop the Universität Hamburg towards a University for a Sustainable Future and to explore sustainability in the areas of research, critical reflection upon

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**Marcus Scheele** obtained a PhD in Chemistry from the Universität Hamburg and has been working in the field of material sciences and nanotechnology for many years. His current research interests focus on the development of new concepts to apply semiconductor nanoparticles for optoelectronic devices. An important aspect of his work is the size-property relationship of



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