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The Discipline in Interdisciplinarity: Flagging a Blind-Spot in Sustainability Science

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Abstract: *In the last few decades, sustainability science has developed into a formidable field of interdisciplinary scholarship aimed broadly at contributing to the global sustainability agenda. As a problem-driven science, sustainability science is necessarily interdisciplinary, though the field's practitioners generally lack an explicit justification for the procedure of interdisciplinary research performed. In this commentary, we want to flag what we see as a significant blind-spot in the way interdisciplinarity is conducted in sustainability science currently, namely the necessity of following a systematic procedure in interdisciplinary research.*

Keywords: Interdisciplinary research; methodology; sustainability science; heuristic; values

Introduction

Over the last several decades sustainability science has developed into a formidable interdisciplinary field of problem-driven and action-oriented research geared generally toward contributing to the global sustainability agenda (Kates, 2011, Miller et al., 2014). Because sustainability science, broadly conceived, is considered to be defined by the problem it addresses rather than the discipline it employs (Clark, 2007), the field necessarily borrows concepts from other disciplines to construct interdisciplinary explanations of and develop solutions to complex sustainability problems.

The question for sustainability scientists, then, is not *if* they should work interdisciplinarily, but *how*. In other words, what is an appropriate methodological procedure for bringing concepts from other disciplines into sustainability science research?

In this commentary, we want to flag what we see as a general blind-spot in interdisciplinary sustainability science as it is currently practiced, namely the necessity of following a systematic and coherent procedure in interdisciplinary research practice. Our main purpose is to suggest the skeleton, that is, the first steps, of a heuristic for interdisciplinary research in sustainability science. To this purpose, in addition to outlining the heuristic, we put forward

our ideas vis-à-vis a recent contribution which we see as representing a step forward in the sustainability science literature beyond generic calls for interdisciplinarity, while at the same time suffering from the typical shortcomings of non-systematic practice.

We demonstrate how the lack of a systematic review of borrowed concepts as they have been dealt with in their home-disciplines can create avoidable problems with interdisciplinary research outcomes, namely significant blind-spots, recreating the wheel and problems with the scientificity, in particular reproducibility, of the research results.

What we mean by interdisciplinarity

There is clear heterogeneity across the various modes and logics of cross-disciplinary practice, and definitions are many. A useful distinction is often made between multi-, inter-, and trans-disciplinary research (Stock and Burton, 2011). The terms are used to describe different practices, including (1) how to combine knowledge from different disciplines in communication between several disciplinary specialists (O'Rourke et al., 2013); (2); one person/team moving from one discipline to another in producing synthetic knowledge of a complex problem (Bhaskar, 2010); (3) and incorporating knowledge from non-scientists, community members, civil society – in short, *stakeholders* – perhaps best captured by the concept of boundary work (Clark et al., 2016b).

While sustainability science researchers are often preoccupied specifically with *transdisciplinarity*, these definitions of different kinds of cross-boundary activity lay on a more generic spectrum of interdisciplinary scientific practice rather than representing isolated types (Petts et al., 2008, 597).

Our understanding of interdisciplinarity, in the terminology of Barry et al. (2008), is more-or-less in line with the *integrative-synthesis* mode of interdisciplinary scientific research which aims to "integrate knowledge from two or more disciplines so as to generate an increase in understanding of the causes of a complicated problem which would not be possible were the problem to be addressed from multiple yet disconnected disciplinary perspectives" (Holland, 2013, 3). We do not claim to adhere to any *correct* classification, but we adopt a useful classification (i.e. inter-) for our current purpose, i.e. our concern with how to bring concepts from other disciplines into sustainability science.

It is necessary to note here the prominence of boundary work in sustainability science, often discussed under the rubric of knowledge *co-production*, namely because we exclude it from our understanding of interdisciplinarity. Boundary work occurs at the interface between scientific experts and policy-makers, and there are a variety of different strategies for navigating this interface. These strategies, which Cash et al. (2003) refer to as forms of *science advising*, are, however, not about the production of scientific knowledge specifically.

The fact that *co-produced* knowledge coming from boundary work is beyond the scope of scientific knowledge production is reflected in its criteria for success; that is, the criteria for

good boundary work are not scientific criteria, but extra-scientific concerns regarding relevance to a decision or policy (*salience*); technical adequacy in handling of evidence (*credibility*); and respectfulness of all stakeholders (*legitimacy*) (Clark et al., 2016a). We are here specifically concerned with the procedure of *scientific* knowledge production, not its communication/translation to social actors. We thus see scientific knowledge as a particular kind of knowledge with a unique and significant, but limited, area of jurisdiction (Faran and O'Byrne, 2015). Boundary work is about how this scientific knowledge interacts with other kinds of knowledge and those actors with an interest in using it.

A heuristic for interdisciplinary research in sustainability science

At the start of the field of sustainability science, it was emphasized that interdisciplinarity is central (Kates et al., 2001). The question of *how* to do interdisciplinary research, however, has been largely neglected. For example, in a recent paper Roy et al. (2019) emphasize the importance of interdisciplinarity in training sustainability scientists, but do not offer any guidance regarding how interdisciplinary research should be done. They instead refer for justification back to Yarime et al. (2012), which likewise emphasize the importance of interdisciplinarity while saying nothing about how to do it. This continuous neglect of the *how* question is not only an issue in sustainability science, but other interdisciplinary fields of research as well.

Interdisciplinarity is promoted, for example, by Fraccascia et al. (2018) and Lade and Peterson, (2019) for resilience research, Filho et al. (2018) for climate change research, and Bergendahl et al. (2018) for research on the food-energy-water nexus, all without addressing the crucial question of how.

For us this lack of a foundation for performing interdisciplinarity suggests the need for epistemologically grounded heuristics (i.e. guiding principles, rules of thumb) to help direct interdisciplinary research in sustainability science (Abbott, 2004). That is, we are here concerned specifically with the methodological question of *how*, that is, *by what procedure*, to bring key concepts from other disciplines into interdisciplinary sustainability research. We propose three basic steps, presented below and schematized in Figure 1.

While these steps may be self-evident, it is important to stress the procedure because of its historic neglect in sustainability science and other interdisciplinary fields. In the next section, we review a recent example of sustainability science research to discuss problems with non-systematic interdisciplinary practice. In the final section, we recap the heuristic and provide examples of it employed in research.

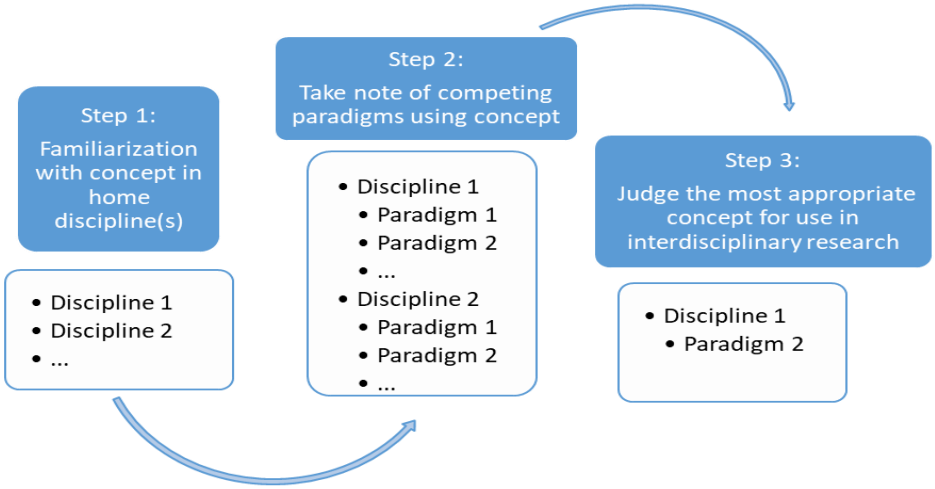

Figure 1. Idealized process for bringing concepts into interdisciplinary sustainability science research

We suggest that interdisciplinary research for sustainability would benefit by starting from a *systematic familiarization with key concepts within their traditional disciplines*. From this, researchers, it seems to us, should then proceed by *taking note of competing paradigms in these disciplines* which share the use of such concepts, and only then are researchers in a position to *judge the most adequate perspective/conceptualization* for the purpose of particular research. It is not our purpose here to lay out a comprehensive, and tested, heuristic, but only the orientation of such a method which can then be further elaborated.

Step 1: The first step in conducting interdisciplinary sustainability research involves a general familiarization with key concept(s) in traditional discipline(s). The concepts that sustainability science borrows from other disciplines have an intellectual history independent of sustainability science itself, in some cases encompassing debates spanning decades if not centuries. Sustainability scientists need to familiarize themselves with how concepts have developed in their home-disciplines, and what standing the concept has in the field as understood by disciplinary practitioners. The point is not so much that the popularity of a concept in its traditional discipline(s) is a reflection of its merit, but to note that a seemingly useful concept may possibly lack scientific coherence and, when employed in interdisciplinary research, perpetuate confused analysis and results.

Consider for example Österblom et al. (2015) attempt to import the popularly known concept of *keystone species* from ecology for use in interdisciplinary sustainability research. Österblom et al. use the concept to describe socio-economic interrelations in the global seafood industry. However, the debate over keystone species has a long history in ecology, and the concept has been criticized as both too broad to be useful and too technically difficult to be operational by disciplinary practitioners (Cottee-Jones and Whittaker, 2012). Without consideration of this disciplinary history, Österblom et al.'s unceremonious importation of the

concept into sustainability research creates double trouble. First, it works to further muddle the meaning of the concept, which was already marked by some ecologists as being on the verge of meaninglessness. Second, the application of the vague and contested concept undermines the research analysis and results by obfuscating the researchers' theorizing of crucial social dynamics (Österblom et al., 2015).

Step 2: The second step is then to take note of competing paradigms. Different theoretical paradigms often share the use of concepts relevant to sustainability. Taking note of these competing paradigms and how their use of a particular concept may differ from one another is necessary to clarify the implications for research of adopting one conceptualization or another. We do not mean to imply, however, that there are as a matter of course several paradigms that will use each concept that sustainability science employs.
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While competing paradigms might indeed employ the same concept in certain cases, other paradigms may also conceptualize the same phenomenon in a way that has no use for some concepts of the rival paradigm, and indeed may render such concepts redundant. Take for example the well-developed, distinct paradigms coming from the discipline of economics, namely Marxian, Keynesian and Hayekian (Wolff and Resnick, 2012). While these paradigms share some concepts, they do not share others. One example would be Hayek's concept of "tacit knowledge", which is not only absent in Marxian or Keynesian paradigms, but indeed the latter's conceptualizations of the economy have no need for examining the concept of *knowledge*, and as a result have no occurrence of the concept *tacit knowledge*. This lack of one-to-one correspondence between paradigms is why Lakatos (1978) argued (against Popper) that there can be no single *crucial test* of a concept or theory that is *crucial* for all competing paradigms.

It is likewise important to note that not all research areas are equally well developed, and some work may still need to be done before a concept can be usefully employed in interdisciplinary research. While many disciplines have clearly competing paradigms, for developing research areas the best one can do is to become familiar with relevant concepts to whatever degree they have been historically developed thus far. Such a systematic survey can help in bringing some order to these early fields, which is important for promoting the maturation of budding disciplines/fields as well. It also helps in demarcating the state-of-the-art for developing a field and its relevant concepts further.

One example of a high-profile yet significantly underdeveloped area of research is the area of climate change-related *loss and damage*. Only taking off as a distinct area of scholarship in 2013, loss and damage research, even with significant support from the United Nation's research agenda, is currently characterized by disagreement and confusion on even the most basic questions of definition and data (McNamara and Jackson, 2019). Adopting a concept like loss and damage for interdisciplinary research would likely require some further conceptual development, or at very least some parsing of the major disagreements in the ongoing discussion.

Step 3: The final step is to judge the most adequate conceptualization for purposes of research. Once a researcher is familiar with a concept's history and standing in its home-disciplines, and has taken note of the competing paradigms which share the use of this concept, then the researcher is in a position to reasonably judge the most appropriate version of the concept in question to be deployed for the purpose of interdisciplinary research. This of course comes with the important caveat noted above that comparing different paradigms, especially in a single discipline, may equally convince the researcher to use a conceptualization that fits the purpose of the current research without using the concept that the researcher started with.

When it comes to selecting a particular version of a concept, it may seem expedient to simply take the version of the dominant paradigm in a discipline. However, the most dominant version, scientifically speaking, is not necessarily the *best*. So one has to (a) become familiar with the competing paradigms, and (b) one has to *reason* why one version of a concept should be used and not the rival ones (Isaksen, 2016). Boda's (2018a) work on sustainable coastal development in the United States, in particular his use of the concept of well-being. When looking into the development literature, the clearly dominant approach to well-being is derived from neoclassical economics, which views well-being in terms of income metrics and standard of living. This approach to well-being was also found to be dominant in practice in Boda's research case study, where it was employed by powerful actors who formally dictate decision making, e.g. the Army Corps of Engineers. Rather than adopting this perspective, Boda, however, reasoned that well-being, understood as a function of one's capabilities rather than in terms of standard of living (Sen, 1993), provided a more comprehensive and accurate, and thus scientifically appropriate, perspective on well-being fit for the case context (Boda, 2018b).

Concepts such as justice, equality, normativity (especially normativity – on its treatment in sustainability science much more below), etc. which sustainability science practitioners commonly bring in to embrace the social aspects of sustainability, e.g. in political ecology, are equally in need of the treatment we outlined above, as indeed great scholars in other fields have already shown, for example, Amartya Sen's investigation of the concept of equality (Sen, 1979).

The problem with unsystematic interdisciplinarity

Our insistence on following a rigorous systematic procedure in interdisciplinary research does not stem from any fundamentalist preoccupation with a particular methodology. Rather, we find the lack of a systematic treatment of concepts in their home-disciplines, and the more general methodological problem it signifies in sustainability science, troubling because it can lead to incoherent conclusions.

We demonstrate this vis-à-vis a recent article by Horcea-Milcu et al. (2019) entitled *Values in transformational sustainability science: four perspectives for change*. The author team

includes several high-profile sustainability science researchers, and the reported results build on a ca. 25 person research project. The article was published as part of an entire special issue on values in sustainability research. While we find shortcomings with their work, we also appreciate their contribution as an important step forward in interdisciplinary sustainability science. We find Horcea-Milcu et al. (2019) contribution particularly interesting because it tries to show how the use of an interdisciplinary concept is done in practice.

We also appreciate the centrality of the questions they (and the related special feature more broadly) are trying to address for sustainability science, i.e. the inclusion of normativity and values in science, which, like interdisciplinarity itself, is a crucial and crosscutting problematic in sustainability research, as we have argued elsewhere (Boda and Faran, 2018). Horcea-Milcu et al. (2019) aims to explore how values are incorporated into sustainability science research, which they then turn into suggestions for how the use of this interdisciplinary concept should be included in research practice. As the final output of their efforts, they present readers with a classification of value perspectives meant to be useful for interdisciplinary research aimed at addressing sustainability problems. The four perspectives include (1) surfacing implicit values; (2) negotiating values, (3) eliciting values, and (4) transforming through values.

Horcea-Milcu et al. (2019), however, do not start their interdisciplinary investigation by looking into the way the value concept has been treated in traditionally home-disciplines. This lack of systematic disciplinary review leads to avoidable problems with their research outcomes. Most notably, of which more below, (1) the results suffer from substantial blind-spots; (2) the authors put substantial effort into the reproduction of insights which have been well-established, in more sophisticated ways, historically, thus neglecting the accumulated intellectual labor of the past and; (3) there is methodological confusion regarding the authors' reasoning process and logic of scientific discovery. This includes the scientific motivation for how and why to bring in new concepts, values, etc. into sustainability research.

Blind-spot

The authors are the first to point out that their classification of four perspectives is not comprehensive, or, as they put it, *does not encompass the diversity* of values. Moreover, the four perspectives they classify are not mutually exclusive but substantially overlapping (as seems to be acknowledged by the authors referring to the four perspectives as *interconnected*). This non-exclusivity and non-exhaustiveness comes with substantial blind-spots.

One notable example is the authors' *assertion that values are inherent in sustainability science. Sustainability transformations concern fundamental ethical questions and are unavoidably influenced by assumptions sustainability scientists hold in their interactions with society*. The authors seem to neglect to even consider value-free science as an option, and give no justification for its exclusion. That this is a significant blind-spot is made clear by the fact that the value-free science perspective was historically the explicit starting point for

sustainability science. In the first pages of the National Resource Council's report *Our Common Journey*, the original document to call for sustainability science as a research field (Mooney et al., 2013), values are explicitly excluded from the purview of science: "Of course, which goals should be pursued [by sustainability science] is a normative question, not a scientific one" (Kates and Clark, 1999, 2)[1].Science provides the means, but values relate to the act of setting the goals, which is the job of politics. For sustainability science, the goals chosen, broadly put, were "human well-being and environmental preservation" which have been set by "international political debate and action, and sanctioned at intergovernmental conferences" and "outlined in international conventions" (Kates and Clark, 1999), 2-3, 31). A recent example would be the Sustainable Development Goals. This perspective on value-free science is in the tradition of Max Weber, which has roots in the philosophy of Immanuel Kant, neither of whom are mentioned by the authors. Our point is not about Weber or Kant *per se*, but to repeat an obvious advantage of systematic interdisciplinary work; that is, that by relying on decades, if not centuries, of intellectual labor, one more easily avoids such pitfalls.

In addition to overlooking the actual intellectual origins of sustainability science, Horcea-Milcu et al. (2019) do not recognize the possibility of objective values in science either. As advanced e.g. by critical realists (Collier, 1999, Bhaskar, 1998), there are theoretical traditions that maintain the possibility of inferring objective normative values (what ought to be) from an analysis of the current state of the world (what is). The silence on this position is not, however, surprising; we have yet to come across it anywhere in sustainability science to date other than our own promotion of a related approach (we return to this later in the section Heuristic Recapped). Still, its neglect is worth mentioning.

Recreating the wheel

In addition to blind-spots, the lack of a systematic review of the value concept in home-disciplines leads the authors to reproduce insights which have already been far better elaborated and established. Take for example the first perspective on values constructed by Horcea-Milcu et al. (2019) which underlines the fact that scientists, consciously or unconsciously, hold certain values. They emphasize the necessity for making such values on the part of the scientist explicit: "surfacing and acknowledging the underpinning assumptions (or pre-analytic visions) of scientists are a vital first step". To this end, the authors pose a series of questions they say are *overlooked*, such as: "What are the normative assumptions that I bring to the research that I am carrying out?" and "How does this influence my choices about methodological and conceptual approaches?" While it may be true that these questions are sometimes overlooked by sustainability scientists, they have hardly been neglected in social science generally.

[1] We raise this point not because we are advocates of value-free science, but as a principle, recognizing the fact that it is not only a feasible position, but that the value-free standpoint has been championed in science by a giant of a thinker no less than Max Weber.

More than half a century ago, the Swedish social scientist and Nobel laureate, Gunnar Myrdal, by critically reflecting on Weberian *value-free* social science, elaborated an enduring account of the problem of the role of scientist's values in research. Not only did Myrdal recognize the existence of researchers' values, and their impact on analysis and policy (which he discussed under the rubric of *programme* and prognosis but he also called for making these values explicit from the beginning (Myrdal, 1958). Yet, his most crucial contribution is that he warns against the arbitrariness of the values social scientists willy-nilly bring into research, and insists on the *objectivity* of the values that inform science, and sets forward criteria to this end: "To be founded in reality, in the sense of not being arbitrary, the value premises [which direct scientific research] should not be taken out of the air by intelligent guesswork" (Myrdal, 1958; Boda and Faran, 2018). Myrdal argued in particular that such values should correspond to an actually existing and adequately informed social group with the power to make them a reality. Clearly, if the authors had systematically reviewed the sociological literature on the question of values in science, the first perspective they construct would at very least have had more content. The point is, by not starting with the home-discipline of the concepts, sustainability science research may be at best reinventing the wheel of other disciplines in the name of interdisciplinary research, rather than fruitfully benefiting from engagement with them.

It can be noted here that the other three value *perspectives* proposed by the authors, without unpacking each, likewise repeat in many ways well-developed ideas without reference to their intellectual history. These issues, such as how (inter-)personal values develop, what role values play in social negotiation, etc., have been seriously debated in social theory for decades, not least in the work of Jürgen Habermas and his theory of communicative reason and value formation (Habermas, 1990), or Amartya Sen's social choice approach to collective decision making (Sen, 1999), to name only two prominent examples.

Confused logic of discovery

The title of their article suggests that Horcea-Milcu et al. (2019) restrict their review of the literature on values to that *within* the sustainability science field. They then presumably construct their perspectives on values from their analysis of this literature and reflections on experience from their research group. Limiting such a review to sustainability science can be particularly problematic since other sustainability science contributions may very well suffer from similar methodological problems (which does not concern only the researchers, but equally the editors and reviewers of the field's journals). For example, for a *comprehensive overview* of the *diverse range of theoretical conceptualizations of values* Horcea-Milcu et al. (2019) refer to Rawluk et al. (2019), another article in the same special feature. However, when looking into this pivotal reference, we again find a lack of systematic treatment of the topic in traditional disciplines. The conceptual framework presented in Rawluk et al's (2019) article, rather than "emphasis[ing] the breadth of conceptualisations from the social sciences", as claimed by the authors, seems to have been arrived at via aleatory discussions in a research team from which they conjure up dichotomies such as *tangible – intangible* values.

In the course of our research, Rawluk et al. (2019) tell us, "we became aware of the subtle differences in how values are described, and the way the term denotes different assumptions about the nature of values and of valuing…" The problem with such a haphazard logic of discovery is that it negates the most fundamental item of protocol for scientific research, namely replicability. Adopting a rigorous systematic procedure for interdisciplinary research would help avoid such methodological vagueness by bringing structure to the reasoning process.

This concerns the issue of transparency which Horcea-Milcu et al. (2019) rightfully emphasize repeatedly in their article. Transparency in science is related to concepts such as methodology and objectivity; that is, transparency in science comes from not just stating one's position or approach, but providing a *reasoned justification* for why such a position or approach is appropriate. Being transparent in itself cannot excuse subjectivity in scientific practice, which should not be purely subjective or at the whim of an individual researcher's value position, as Myrdal emphasized.

Transparency is facilitated not by simply stating one's research choices, but through a systematic research procedure which tracks the reasoning process and developing argumentation, which are indispensable if scientific research is to meet the criterion of replicability. This entire question of process and justification is however skirted by Horcea-Milcu et al. (2019). The authors never engage with questions of *how* to bring in concepts from other disciplines, and invite no discussion regarding how to justify the inclusion of values in sustainability research from a scientific perspective beyond simply asserting their relevance.

Horcea-Milcu et al. (2019) sum up the contribution of their paper as helping researchers, "(1) move beyond general discussions implying that values matter; (2) gain an awareness of the positionality of one's own values and perspectives … and (3) reflect on the operationalizations [sic] of values in different contexts." These are, as the authors graciously acknowledge, modest contributions. Our contention is that their collective efforts could have much more impact in advancing scientific knowledge had they followed a systematic procedure for interdisciplinary research, which in their case means tracking the status of the concept of *value*, not primarily in sustainability science literature, but in established/long-standing disciplines of social science.

Heuristic recapped: a systematic approach to interdisciplinary sustainability science

To recap, we presented above a three step heuristic for bringing concepts into interdisciplinary sustainability science. The steps involved familiarization with the concepts in home-disciplines, taking note of competing paradigms which share use of the concept or advance alternative concepts, and reasonably motivating the selection of a particular version of the concept or an alternative for use in interdisciplinary research. It is hopefully clear by now that the review of sustainability science literature cannot substitute for familiarity with concepts as they have been elaborated in their home-disciplines. Sustainability researchers

would benefit from reviewing the disciplinary literature to have a strong foundation in the concepts that they borrow from other disciplines. Based on this strong foundation, the review of sustainability science literature becomes crucial to grasp how such concepts have been fruitfully applied in the service of sustainability research.

As a brief example, we summarize our own review of values in sustainability science in relation to the three step heuristic proposed above (to read the fully elaborated argument, (Boda and Faran, 2018). Like other sustainability scientists, we noted as peculiar the normative ambition of this action-oriented field, but were concerned with how such normative ambitions could be accomplished scientifically. Recognizing that the justification of values in science is important, we sought a conceptualization of values appropriate for a normative *science.* This led us to turn to the disciplinary literature on values in science in an effort to select an approach for purposes of interdisciplinary research within sustainability science.

In Step 1, we first reviewed how values in science more generally have been handled by traditional disciplines, which led us in particular to become familiar with major contributions in sociology and moral philosophy. In Step 2, within these disciplines, we reviewed and contrasted competing paradigms, which allowed us to formulate a typology of perspectives on values in science. For the first type, we identified (via Kant) the Weberian perspective of value-free science, where the values that guide science are left to the realm of politics. For the second type, we identified the Myrdalian critique of value-free science and his advancement of a perspective for value-laden science, including his important reservation that the values chosen to guide science must adhere to certain criteria of objectivity. For the third type, we identified the Hegelian perspective of the objectivity of values, developed out of a critique of Kantian ethics, where values can be scientifically shown to be *necessary*.

With this strong disciplinary foundation, we were then in a position to review the literature in sustainability science in light of this typology. In doing so we found that 1) as we have seen, the Weberian perspective was the initial position of the founders of the field, where values are considered beyond science, and 2) as we have also seen, a (semi-) Mydralian perspective is by far the most prominent in current research practice. (We say semi- because generally the values guiding sustainability science research are defended as *inherent* without justifying the objectivity of these values as Myrdal insisted).

In Step 3, we reasoned for Hegel's immanent critique in sustainability science as part of an emerging paradigm, which we argued overcomes the limitations of these other positions which cannot sufficiently account for the objective need of the values they adhere to. Now, having reasoned for an approach to incorporating values in sustainability research, we then applied this perspective to the literature on Sustainable Development (Boda and Faran, 2018). In doing so, we tried to demonstrate that one could see the non-arbitrariness of values included in the Sustainable Development debate, that is, the logic/reasoning in how and why different scientists have introduced specific values for different perspectives on Sustainable Development. We showed, for example how the necessity of valuing the environment in its

own right was not arbitrarily demanded but rationally deduced from a critical analysis, by *strong sustainability* advocates like Herman Daly, of the shortcomings of the growth-oriented *weak sustainability* approach championed by Nobel laureate economist Robert Solow. In turn, Solow's exclusive focus on economic value is shown to be a serious attempt to operationalize the idea of Sustainable Development as laid out by the Brundtland Commission, namely maintaining capacity to meet the needs of current and future generations.

It is worth noting that the point of such a review of sustainability literature is not just bringing order to the *past* in the field, which is useful in its own right. Such a systematic procedure equally allows us to move the debate *forward*. By identifying and resolving tensions with the currently most advanced theories, one is able to build on and surpass contributions at the current cutting-edge of research. In this way, the systematic procedure we advocate also acts as a positive heuristic for advancing the research frontier. For example, in our review of Sustainable Development literature described above, we attempted to drive the debate forward by advancing a systematic critique of the dominant Capital Theory Approach to Sustainable Development. This led us to argue for the necessity of incorporating the work of Nobel laureate Amartya Sen as providing a more adequate approach to Sustainable Development than the dominant paradigm, despite the fact that Sen has not normally been recognized as a central figure in the mainstream of sustainability development literature (Quental and Lourenço, 2012).

Concluding remarks

To conclude, we see it as necessary that sustainability science researchers, who have little choice but to be interdisciplinary, become familiar with the disciplinary debates underpinning concepts deemed relevant to sustainability. The real danger of an inadequate interdisciplinary procedure for the sustainability science field in general is that, instead of producing meaningful interdisciplinary research that builds on, and advances, historical contributions, sustainability science may fall into the cracks *between* intersecting scientific disciplines and end up discussing within itself and not much else. As a result, while sustainability science researchers may hope to contribute through their science to sustainability, they may unwittingly be weaving the emperor's new clothes.

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