Thorén, Henrik; Nagatsu, Michiru; Schönach, Paula

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CHAPTER 2

Interdisciplinarity

Henrik Thorén
Lund University
Michiru Nagatsu
University of Helsinki and Helsinki Institute of Sustainability Science
Paula Schönach
Aalto University

Abstract

Sustainability science is fundamentally an interdisciplinary venture, but what does this interdisciplinarity imply in practice? And how can, and should, we think about interdisciplinarity more generally? These are important philosophical and methodological questions for sustainability science, the answers to which remain at least partially out of sight for a variety of reasons. This chapter has three main aims. First, it provides a discussion of various dimensions of interdisciplinarity and how it can be understood from a philosophical perspective. Second, a historical perspective

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is assumed as well, as it introduces the history of interdisciplinarity and problem-driven science governance and some previous attempts at establishing interdisciplinary fields (ecological economics and cognitive science). And third, it provides an outline of an important strategy within sustainability science, suggesting that the focus has been on institutional reform.

Interdisciplinarity

What kind of science is sustainability science? One aspect of this field that stands out is its *interdisciplinary* nature. Sustainability science has been understood from its inception as an intellectual and practical venture, the success of which is conditional on integrating knowledge, concepts, and methods from a wide array of disciplines from the natural as well as the social sciences (Jerneck et al. 2011; Kates et al. 2001; Komiyama and Takeuchi 2007; Martens 2006).

But how should this feature of sustainability science be understood, and what kind of interdisciplinarity best serves the overarching aims of the field—promoting and advancing a societal transition toward sustainability? It depends on what we mean by interdisciplinarity to begin with.

Dimensions of Interdisciplinarity

One initial issue to consider when discussing interdisciplinarity is what it is to be contrasted against. What is interdisciplinarity an alternative to? According to the most common, and simplest, taxonomy of ways in which academic disciplines interact, interdisciplinarity is placed between *multidisciplinarity* on the one hand and *transdisciplinarity* on the other (Klein 1990). Multidisciplinarity is, on this schema, the simplest and least substantive form of cross-disciplinary interaction in that it is merely an *additive* affair: the juxtaposition of knowledge claims from different disciplines. Interdisciplinarity, on the other hand, is *integrative*. Transdisciplinarity, which is comparatively more demanding, is distinguished from interdisciplinarity either by being participatory

(Lang et al. 2012; Wiek et al. 2012) or by being more global in character (OECD 1972; Bernstein 2015). However, the boundaries between these categories are less than sharp (see Klein 2010).

Another way of getting at the meaning of interdisciplinarity is to contrast it with *disciplinarity*. Following Karl Popper (1963: 88), we might think of disciplines as epistemically inert—the products of historical accident and administrative convenience.[1] In this view, dogmatism ensues when disciplines constrain science. The pivotal distinction, for those following Popper's line of thinking, is not between disciplinary and interdisciplinary science but between what is good science and what is not. All science *proper*, as it were, needs to be interdisciplinary, at least in the sense that it should remain open to the fact that most of our problems cut right across disciplinary boundaries (Persson et al. 2018; see also Jacobs 2012).

Following this argument through interdisciplinarity is not an alternative way of conducting science—again, all science proper is interdisciplinary—but an alternative way of organizing academia that is more conducive to exposing and challenging entrenched priorities and values in the disciplinary system and bringing them in line with society at large. Such reasoning informed early thinking on inter- and transdisciplinarity in general (Jantsch 1972; OECD 1972), as well as specific discussions of, for example, the environmental sciences (Brewer 1999) and sustainability science (Jerneck et al. 2011).

Another way through the thicket is to think of disciplines as actually important in structuring scientific enquiry *qua* scientific enquiry. Thomas Kuhn ([1962] 1996) famously thought of disciplines as fundamental to normal science. From a strictly Kuhnian perspective, it is intuitive to think of interdisciplinary science as extraordinary science; innovative, to be sure, but intermittent, unstable, and (crucially) non-cumulative. It is a natural part of the development of science, but only as a transient phase: today's interdisciplines are tomorrow's disciplines. The continual formation of various so-called hybrid

[1] The diagnosis of academia that approximates this position is well-represented in the literature; see, for example, Bursztyn and Drummond (2014) and Clarke and Wallace (2015).

disciplines—such as econophysics or neuroeconomics—appear to testify to this idea. Indeed, Silvio Funtowicz and Jerome Ravetz (1993) departed from what they perceived to be the limitations of Kuhnian normal science in their influential paper on post-normal science. The challenge is to retain innovation and an appropriate orientation toward societally relevant issues, but without the Kuhnian downsides.

But when focusing on interdisciplinarity in the narrower sense, further questions arise. Disciplines are complex entities with many component parts. What is to be integrated? How is integration best achieved? And what conditions are most conducive to integration? Disciplines are typically associated with certain sets of cognitive tools (Bechtel 1986)—theories, methods, models, and modelling preferences, and so on—as well as certain (epistemic) values (Kuhn 1977). What interdisciplinarity amounts to depends on what one focuses on: blending different methods, developing new integrated theories, or constructing coupled models, for example. Interdisciplinarity, furthermore, exhibits a distinct social or collaborative aspect. In practice, it is not something that happens only 'in the head' of individual scientists, but rather within groups of scientists with differing disciplinary backgrounds and expertise. Given that disciplines are important units of organization in scientific enquiry, another problem is to develop models and methods that structure interdisciplinary interactions in fruitful and productive ways (MacLeod and Nagatsu 2016; 2018; Thorén and Persson 2013). This, too, is somewhat contentious, as some argue that the distinguishing feature of interdisciplinarity is precisely that it represents a break with such a structure (Frodeman 2013). A third set of issues revolves around institutional arrangements.

Here there is room for thinking about interdisciplinarity, and especially interdisciplinarians, as possessing specific abilities. If the archetypical disciplinarian is a researcher with highly specific and deep knowledge, the interdisciplinarian possesses broad—but perhaps shallower—knowledge, as well as skills specifically honed on interdisciplinary contexts: what Harry Collins calls

interactional expertise (Collins 2004). Within this perspective, interdisciplinarity is not an alternative to disciplinarity, but rather strongly dependent on it, as, for example, Bengt Hansson (1999) has noted.

To conclude this section, we wish to underline two points. First, actually engaging in interdisciplinarity successfully has proved to be difficult (Brewer 1999; MacLeod 2018), and there is no shortage of barriers. Beyond the various difficulties associated with integration in practice—developing new theories, methods, and models is hard and time-consuming work, especially among researchers with relatively little in common—how academia and academic merit allocation is structured often impedes or disincentivizes interdisciplinarity. Interdisciplinary research is often risky and less prestigious than its disciplinary counterpart. For students who seek to acquire interdisciplinary competencies, how courses are typically structured around specific disciplines can be a major obstacle.

And second, there are few things that can be said about interdisciplinarity that are both generally true of the phenomenon and informative from a practical perspective. That is to say, what the specific conditions demand, the affordances they provide, and the constraints they impose are crucial in thinking about the ends and means of interdisciplinarity.

Historical and Comparative Perspectives

Scientific disciplines develop over time, and thus interdisciplinarity is also a historically conditioned phenomenon. This makes interdisciplinarity a 'moving target', with varying, context-dependent practices and motivations underlying it (Ash 2019). Understanding the historicity of interdisciplinarity is helpful in increasing our understanding of the current questions of interdisciplinarity, especially in the context of sustainability science. The recent history of science informs us about other fields of research with more fully developed interdisciplinarity, and a comparative perspective can enlighten us about the interdisciplinarity of

sustainability science. As two such examples, we consider ecological economics and cognitive science.

Ecological economics originated in the mid- to late-1980s and was originally defined as 'the science and management of sustainability' (Costanza 1991). Thus defined, ecological economics is a precursor or prototype of sustainability science. Ecological economics emphasizes that economies are a subsystem of the larger earth ecosystem, and from this perspective, derives theoretical commitments such as the non-substitutability of natural capital as well as particular valuation approaches to ecosystem services (Costanza et al. 2014). Although the focus of ecological economics on the interconnectedness between the natural and social systems has been inherited by sustainability science as its core intellectual interest, the former is distinct in its explicit theoretical confrontation with economics. In particular, it is contrasted to environmental economics, a subfield of economics that applies standard economic analytical tools to the issues of environmental protection and conservation and the management of natural resources. To use the jargon of the history of economics, ecological economics is a *heterodox economics*, or a different school of economic thought from mainstream economics (Douai, Mearman and Negru 2012). In contrast, sustainability science seems to be construed more ecumenically, including business and economics (e.g. Bettencourt and Kaur 2011). This ecumenicalism, however, implies the lack of a theoretical core, making sustainability science more like an alliance of the sciences that concern sustainability than *the* science of sustainability, as ecological economics aspired to become.

Note, however, that having a strong core theoretical idea does not necessarily end with interdisciplinary confrontation. Cognitive science, for example, emerged in the mid-1950s with a model of human mental processes analogous to computational or algorithmic models (Thagard 2017). The development of artificial intelligence (AI) was one of its main drivers, but cognitive science has also attracted researchers from fields such as psychology, philosophy, neuroscience, linguistics, and anthropology (Thagard 2005). Eventually, the computational view of the mind was widely

accepted as a fruitful way to understand the nature of mind and its relation to behaviour. As a result, it replaced behaviourism, the then-dominant position that attempted to model behaviour as direct responses to external stimuli while refraining from theorizing about inner mental processes. This change, often called the cognitive revolution, was a paradigm shift in psychology (see Gardner 1987). The sustainability scientists' idea that natural and social systems—sometimes called coupled human-nature systems or coupled social-ecological systems—are deeply interlinked is a powerful framework that could potentially reconfigure the relations between natural and social sciences, but this has not happened yet. In particular, while economists have been eager to adopt new methods—such as experimental and statistical methods, and more intensive use of data and computational power—they have been reluctant to change their core theoretical frameworks—such as anthropocentric welfare economics—in response to the criticisms of ecological economists.

Given such strong theoretical constraints on interdisciplinary theoretical integration, perhaps we should look into a different mode of interdisciplinarity that does not revolve around revolutionary theoretical ideas, but policy goals and the governance of science. In this respect, the impact of the two World Wars (plus the ensuing Cold War) on interdisciplinary practices is suggestive. First, it gave rise to the practice of teamwork science 'involving a pragmatic, sometimes rather rough and ready, blending of theories, models, and research practices with a common practical goal' (Ash 2019: 630). The project topics ranged from weapons development, troop morale, the nutritional impact of rationing, economic planning, and forced migration to the beginnings of climate science. Ash (2019) further notes that experience with these wartime collaborative projects laid the groundwork for the establishment of the interdisciplinary funding schemes and peer review systems of the post-war period in the West. The next development in science policy at the turn of the century, which is still ongoing, tried to stimulate goal-oriented interdisciplinary research through top-down programme funding (e.g. Horizon 2020 of European

Research Council) and organizational reforms. However, Ash (2019) wonders how the view 'that more and better networked science and scholarship necessarily yields epistemically 'better', economically more profitable, and socially more sustainable and 'robust' science' than disciplinary sciences do, has managed to become an established orthodoxy despite the lack of evidence. We suspect that the institutional memories of the 'successful' wartime mobilization of science are playing a role here. If we could fight (and eventually win) wars by mobilizing science, why can't we fight climate change and other 'grand challenges' in a similar, but less *ad hoc* and more conscious arrangement of disciplines? This hopeful thinking seems to drive the interdisciplinarity of sustainability science, as we will see in the next section.

Interdisciplinarity and Sustainability Science

Although the history of engaging intellectually and scientifically with issues pertaining to sustainability is both long and venerable (Caradonna 2014; Kates 2012; see also Grober 2012), sustainability science as a distinct field of enquiry is relatively young. In 2001, Robert Kates, together with a set of distinguished colleagues, published a paper titled *Sustainability Science* (Kates et al. 2001) that did much to name the field and provide a first attempt at giving it an intellectual centre of gravity. It was also around this time that co-authorship clusters formed around sustainability that warranted the epithet 'field' (Bettencourt and Kaur 2011). Looking to the establishment of research centres devoted to sustainability, this primarily takes place—with increasing intensity—after 2000 (Soini et al. 2018).

That sustainability science needs to be interdisciplinary has been widely appreciated from its very inception (Kates et al. 2001; Jerneck et al. 2011; Komiyama and Takeuchi 2006; Martens 2006). *What* precisely this interdisciplinarity amounts to, and *how* it is best achieved, is a different matter. Is sustainability science to become a discipline? And if so, in what sense? Is sustainability science in want of a philosophy? Some seem to think so. Some have

suggested that sustainability science should be based in methodological and theoretical pluralism (Isgren, Jerneck and O'Byrne 2017; Jerneck and Olsson 2020; Persson et al. 2018); others lean toward arguably more specific philosophical frameworks such as critical realism (Nastar, Boda and Olsson 2018). Or should a common and substantive theoretical framework serve to organize the field and bridge its component disciplines? Resilience theory (see e.g. Gunderson and Holling 2001) is perhaps the most well-known such candidate. A third option, alluded to in the previous section, is that it is more a matter of practice than theory (of either kind). The considerable and growing literature on transdisciplinarity in sustainability science is at least partially committed to this idea (see e.g. Lang et al. 2012; Wiek et al. 2012).

A different approach brackets such questions in favour of institutional reform, which we might call an 'institutions first, interdisciplinarity later' strategy. It is an approach more Popperian in flavour in its emphasis. The central obstacle to interdisciplinary progress is the way academic institutions are structured. In short, the conventional way of organizing intellectual activities around departments and faculties disincentivizes engagement across disciplinary boundaries, regardless of what it looks like. Thus, instead of solving philosophical, theoretical, and methodological problems, the focus can be on disrupting and replacing institutional structures.

In the institutional setting of higher education, the establishment of departments, centres, and institutes has been a key activity of universities globally in response to the prevalent sustainability challenges. Through these centres, institutions direct their activities in research, education, and campus operations toward sustainability (Soini et al. 2018). Internationally, there are examples of large-scale efforts to revise incentive structures and promote interdisciplinary interactions. One frequently mentioned example is Arizona State University (see McGregor and Volckman 2011). Improving societal relevance is often an important driver of such efforts, in line with the underpinning transdisciplinary ideals, and sustainability is usually a prioritized domain.

Before we move to our main case, the Helsinki Institute of Sustainability Science (HELSUS), there are several research centres with both a pronounced interdisciplinary profile and a devotion to sustainability, even if we constrain our perspective to the Nordic countries.

One is the Stockholm Resilience Centre (SRC), which was founded in 2007 with a grant from the Swedish research agency Mistra and remains its largest commitment to date. The SRC stands out with its comparatively narrow theoretical focus—grounding governance and sustainability issues in a 'social-ecological approach and resilience thinking' (SRC 2012: 3). The centre comes under the science faculty at Stockholm University, but interdisciplinary integration between natural and social sciences as well as the humanities is central to its mission (see e.g. SRC 2014). The SRC has been very influential on sustainability research internationally.

Another example is the centre of excellence LUCID (Lund University Center of Excellence for Integration of Social and Natural Dimensions of Sustainability) at Lund University. This centre was established in 2008 on a long-term (10-year) Linnaeus grant from the Swedish Research Council. The centre was closed in 2018 as its support from the Swedish Research Council ended. LUCID was a faculty-independent centre that was organized around the sustainability studies department (LUCSUS) at Lund University but included a wide range of departments and divisions such as political science, philosophy, human ecology, and physical geography. Unlike the SRC, there were no particular theoretical commitments around which the centre was organized. The idea was instead to involve already-existing departments to contribute and partake in the activities of the centre. A crucial component was the recruitment of a large number of doctoral students with dual affiliations that would retain their doctoral title from their 'home disciplines' but maintain a strong and continual bond with the centre.

Shifting to our main case, the Helsinki Institute of Sustainability Science (HELSUS) was established at the beginning of 2018 as part

of the profiling of the University of Helsinki of its research in sustainability science. In Finland, profiling actions of universities are based on a national research funding scheme, introduced in 2015, in which governmental funding is directed competitively toward specific profiling areas of proven excellence or toward emerging scholarly fields with significance and potential for excellence. During the foundation phase of HELSUS, personal contacts—especially to the SRC—were utilized to refine the ideation for a sustainability centre at the University of Helsinki. Although some ways of working—for example, the creation of a Brown Bag lunch-format as a venue for debate and dissemination—were informed by the model of the SRC, the two centres differ in a profound way. While the SRC has been established around an interdisciplinary but theoretically focused research group, HELSUS was created as a university-wide platform, thus combining much more heterogeneous approaches to sustainability research. In this sense, HELSUS is more similar to LUCID as it lacks a theoretical core, but the former is even more decentralized as it lacks an organizational core (LUCSUS for LUCID) and instead institutionalized entirely as an inter-faculty platform.

In the case of HELSUS, a track record of interdisciplinary research played an important role in the profiling of the University of Helsinki into sustainability science, which eventually materialized in the foundation of HELSUS. Past interdisciplinary endeavours—including interdisciplinary networks around thematic entities, such as the Helsinki University Center for Environment (HENVI), Helsinki Metropolitan Region Urban Research Program (KATUMETRO), and Helsinki University Global South (HUGS) network—laid the groundwork. Also, an interdisciplinary doctoral programme, DENVI, was established at the University of Helsinki in 2014 (Profi3, 2016). The tasks of HELSUS were defined as conducting high-quality research in sustainability science and 'build[ing] interdisciplinary research programmes' (Rector's Decision, 2017), among other goals. This was to be realized in part through 'joint research facilities to foster interdisciplinary interaction ... and interdisciplinary training in methods'

and the creation of an 'inspiring interdisciplinary research environment', including interdisciplinary seminars and proposal-writing workshops (Profi3 2016: 23). At the core of building up interdisciplinary research, a total of 11 new tenure-track positions with an interdisciplinary approach were made available. Apart from the thematic foci of these positions, one of them was targeted explicitly toward interdisciplinary methodologies in sustainability science.

In HELSUS, physical proximity of researchers from different disciplinary backgrounds is seen as a key to allow 'spontaneous movements between disciplines' (Profi3 2016: 24) and thus foster opportunities for interdisciplinarity. Apart from its reliance on such serendipitous attempts to build interdisciplinarity, the Institute incentivizes researchers to strive toward interdisciplinarity through funding schemes. In granting research funding, HELSUS explicitly states 'interdisciplinary quality' as one evaluation criterion for competitive funding. However, it is currently not very clearly stated what kind of interdisciplinarity is anticipated in the sustainability science research conducted within HELSUS, and what understanding of interdisciplinarity it should be based on.

Concluding Remarks

Ultimately the most important question for sustainability science has to do with making progress on the goals of the field itself: namely, promoting transitions toward sustainability. Structuring the field of sustainability science to make use of existing knowledge in different disciplines, promote innovation, synthesis and intellectual progress, and support the field itself (i.e. the 'sustainability' of sustainability science) is a crucial step toward that substantive aim.

We wish to conclude this chapter by making a few interrelated points. First, there are interesting differences between different centres regarding how institutional reform is coupled with theoretical underpinnings. The SRC is comparatively more theoretically homogeneous than either LUCID or HELSUS, although that homogeneity should not be overemphasized. To what extent this

has contributed to the success of the centre is difficult to evaluate, as many other factors play a role, not least long-term funding.

Second, as comparisons between sustainability science and other fields show, it is important to examine not only how various disciplines impinge on sustainability science but also how developments in sustainability science have repercussions on its constituent disciplines. There are real insights to be gleaned from sustainability science. It is arguably precisely this 'feeding back'—and thus coupling—of knowledge, questions, and answers that is the hallmark of productive interdisciplinarity (c.f. Thorén and Persson 2013).

Finally, we still lack a clear understanding of *how* exactly interdisciplinarity is carried out in practice within the field, and if templates for fruitful collaboration can be developed that may guide the field in the future. Several quantitative and bibliometric studies to assess the interdisciplinarity and general characteristics of sustainability science as a field (Bettencourt and Kaur 2011; Kajikawa 2008; Schoolman et al. 2012) have been conducted. However, we need a more practice-grounded approach to study the processes through which interdisciplinarity generates better outcomes in sustainability science. Now that several sustainability-focused centres are operating, systematic qualitative and comparative studies of these organizations and their operations should complement the 'big picture' studies of sustainability science.

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