Chapter 30
Science for Sustainability – A Societal and Political Perspective

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Abstract A changing world calls for advanced sustainability thinking. Recently, the notion of sustainability gains ever more momentum in the German entrepreneurial and political context. Science and the humanities can and should increase delivery against the Sustainable Development Goals in the post-2015 development agenda. But still, society needs broader and multiplied hubs for advanced sustainability thinking. Therefore, transformational research schemes must be part of the top agenda. Transformation must be made part of any institution's performance. Thus, twofold approach suggests fostering both "science for sustainability" and "sustainability in science." The German Sustainability Code and compatible schemes might be used as reference. More evidence based input into the ways and means societies use for choice editing, e.g., in consumption and production, but also in education and visionary thinking may prove as a major leverage to overcome mental path dependencies.

Keywords Carlowitz • Resource crisis • Sustainable Development Goals • Transformation

When Carl von Carlowitz first talked about the need for sustainable forest management 300 years ago, he followed an evidence-based approach. The mining business relied heavily on the limitless availability of wood for smelter facilities and other mining practices. Carlowitz observed a dramatic dwindling of forest resources. It was evident that resource depletion was driving societal prosperity and well-being to a brink. The environment set limits to growth. He came to the conclusion that, for the Saxon economy and society, the resilience and vulnerability of timber made it necessary to change the way of sourcing timber, and in general, of handling natural resources. The same happened in various places throughout Europe.

Then, instead of turning into a sustainable economy, history went another way. For hundreds of years, coal and oil, and finally also nuclear energy, made people

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H. Heinrichs et al. (eds.), *Sustainability Science*, DOI 10.1007/978-94-017-7242-6_30

forget about finite resources. That turned those preindustrial limits to growth into new frontiers for growth and what appeared (and still appears) to be an unlimited development. Politically, that marginalized the notion of sustainability and basically laid it to rest for a long time.

In our days, however, we are again experiencing crises, but this time on both a larger scale and systemic scope, globally and regionally. It is all about the quality and quantity of natural resources, and in some cases, the limits set by quality are outscoring those set by quantity. For example, the emissions of carbon dioxide are likely to be more restrictive than are the limits exposed by the remaining volume of known fossil resources. It is good to have the historical reference of Carlowitz. It shows to us that change in the direction of sustainability concepts is nothing out of touch, and reasonable thoughts have been presented on this matter in the past. Although, the materiality of today's challenges makes more advanced concepts mandatory. Increasingly, the case of sustainability is relevant for the agenda of science and research. Measuring and managing natural resources requires scientific input. Assessing impacts on social, economic, and ecological goods is getting prime importance and requires new methods. Furthermore, research is required to deliver solution options and even guide the way onto sustainability trajectories. Also, when it comes to action the institutions of science are actors in their own case. The careful use of energy and resources, the switch to renewable energy supplies, the dealing with ecosystem services, and the social dimension of sustainability are challenges the scientific institutions must be facing like any other organization or company. Thus, sustainability science is necessary in order to keep pace with societal (including economic) and political demands and to renew and strengthen the credibility and political acceptance. What the private sector calls the "license to operate" is increasingly relevant also for the social and political perspective of science.

This article expresses a practitioners' view on the societal and political perspective of sustainability science. That does not mean to underestimate the growing discourse on theory and methodological implications of transformational science. The importance of sustainability and the natural, social, and human sciences and engineering is currently underscored by the appointment of a UN Secretary-General's Scientific Advisory Board. The board is tasked with strengthening the connection between science and policy by giving advice to the United Nations on science, technology, and innovation for sustainable development.

Global policies require substantial scientific input. Knowledge is required in order to inform the deliberations on Sustainable Development Goals and the post-2015 development agenda. Stakeholders from all societal fields including the academic community are currently invited to input into the intergovernmental process on Sustainable Development Goals[1]. It can be assumed that sustainability science acquires more traction. At the same time the pressure to deliver increases. In Germany, however, the national Council for Sustainable Development, on request

[1] German Council for Sustainable Development (2015) Germany's sustainability architecture and the SDGs. Statement to Federal Minister Peter Altmaier, dated 2015, May 26. http://www.nachhaltigkeitsrat.de/uploads/media/20150526_German_RNE_recommendation_on_national_SDG_implementation.pdf

of the Government, has already presented a pre-SDG analyses on how the German national architecture on sustainability will cope with SDGs.

The term "science for sustainability" (or sustainability science) is new, as is the theory-driven thinking around the issues of sustainability and knowledge transfer. As the notion of sustainability addresses natural science and engineering as well as social sciences and the humanities, the English term "science" is used in an all-inclusive way (in the sense of the German "Wissenschaften"). The term sustainability science emerges in the context of politics and in the academic context, both interlinked and mutually enforcing. The political framing goes back to the report of the UN Commission lead by Gro Harlem Brundtland that prompted the "Rio Process" and the Earth Summit in 1992. A number of multilateral environmental agreements and a series of global conferences followed. Enforcing the notion of sustainability as a global, regional, and local way of tackling the challenges of growth, resource depletion, and climate (to name only a few) has been placed on the agenda. Although much has been achieved, more leaves to be done. There is progress in terms of awareness raising and capacity building. Referring to some specialized aspects, the international community even agreed on meaningful measures. But the overall picture is threatening. The changing Earth, the extent to which humankind interferes with the geosphere (expressed so nicely by the notion of the Anthropocene), and the global food disaster are more challenging than ever before. And the progression of sustainability concepts is slow. It confronts the actors with unprecedented challenges.

The academic framing evolved from major scientific programs on global change and its human dimension. Domestically in Germany, long-standing work profiles of environmental sciences and in particular on the connectedness of social–ecological research successfully laid out the ground for developing first principles and practices of sustainability science. This is work in progress.

1 The Normative Implication

Sustainability science is shorthand for the way science, social sciences, and the humanities address the issues that are placed right in front of us by the unsustainable way the development of humankind is currently headed. Those issues may be addressed by using all kinds of already established methods and procedures and to redesign and elaborate new ones. What proved to be successful in the past must not be dismissed or sidelined. The complex dynamics of the mentioned problems, however, demand an in-depth rethinking of programming and procedures. What delivered in the past does not automatically deliver in the future. This is the normative imperative to sustainability science.

It is safe to assume that any one-size-fits-all approach to sustainability science will most probably fail. It will most likely add to the problems instead of being part of the solution. Sustainability science will rather be sketchy and bound to trial and error. Already now, we can build on practical experience and initiatives at universities and research facilities. Advanced universities and academic institutions create

some sustainability science institutes or centers in order to provide a gateway to research, education, and activities in sustainability. Public research institutions begin to report back to the public about their ecological and social footprint. They access sustainability reporting schemes that are well known in the private sector. Frontrunner companies benefit from sustainability reporting since several years. First movers gain competitive advantages by applying the German Sustainability Code or compatible schemes.

All best practices granted, the overall state of the art is currently nowhere near to sufficient or satisfactory. It now even lives up to the possibilities. Students and researchers should feel encouraged to get themselves more engaged in shaping a meaningful relationship between research and sustainability. There is the chance that more emphasis on sustainability and research may also add value to career tracks.

2 Freedom of Research

In general, we find the term sustainability used fairly often in the public and private sector, as well as in academic discourses. This is both an achievement and a challenge. In any case it must be viewed critically. There is always a chance that the term is used for window-dressing purposes or that it is used in a shallow-brained way to catch up with the talk of the town. Used more seriously the term gives access to the benefits of out-of-the-box thinking. Building on disciplinary excellence, the term's rationality reaches out beyond the limits of disciplinary excellence. The first advanced sustainability institute in Germany, the Institute for Advanced Sustainability Studies, IASS, shows the essence of sustainability science: Transformation is not only described and analyzed scientifically, but transformation is made part of the Institutes' performance.

The notion of freedom of research might be seen as controversial to sustainability science. Some advocates of freedom of research may ward off the idea of science for sustainability because, to them, this would spoil pure (and even applied) science. A diversion of the scientific agenda is being feared when special interests use the normative imperative as a backdoor to the agenda setting and to tapping financial grants.

This raises important points, but nevertheless on the basis of a misconception. Freedom of research is a historic icon with lasting merits. It successfully liberated science and the humanities from religious doctrines and lobbyist influence and still does so. Whether the freedom of science was ever applied full scale may be questioned, though. However, the concept clearly has its merits. It should be defended. But it must not be held against the notion of sustainability science. I rather suggest a bridging link. Freedom is a moving target. Freedom is a social category that emerges and changes with the contingency of social development. In Gutenberg times the freedom (of information, of press) was different from the freedom axiom

in times of Web-based big-data information. The same is true for science and the science–society interface.

Path dependency and captured science are keywords, as is the reflexivity in choice editing. Life cycle analysis and other complexities, e.g., trans-sectoral cooperation, add to the variety of what allegedly are state-of-the-art results. In modern times, the process of sorting out scientific "truth" is not exclusively an academic business. Significant aspects are being relocated from the inner field of the academic community to the midfield of the science–society interface. Of course, this is not a smooth process. Controversies and challenging issues are most likely to surface as the example of the climate change science demonstrates.

I suggest differentiating between two anchoring concepts for linking science and sustainability. "Science *for* sustainability" relates to the output scientific research delivers in terms of results, insights, long-term forecast, assessment of basic processes and impacts, and designing solutions. "Sustainability *in* science" relates to the input side. It addresses the working modality and the experiment design, e.g., the energy intensity of server farms and modeling, and the resource efficiency of experiments including livestock and animal welfare. It also includes a look at the social side, e.g., on working conditions in research facilities. Thus, the latter aspect addresses the housekeeping, with virtually no difference to the corporate social responsibility for which companies are held liable. Both aspects are essential ingredients for the necessary rethinking of the relationship between science and society. This is unfinished business – challenging and demanding.

3 Not on the Right Track…

I am surprised how conservative the public and scientific conversation on sustainability often is and how much time is being spent on the review (and defense) of the past and the present instead of time devoted to envisioning the future and rethinking ways and means of proceeding.

Precious time is being wasted by delaying possible change. Looking ahead towards the year 2050, all indicators on climate change; energy dependency, or biodiversity loss; and social equity and coherence show that societies and economies are on the wrong track, globally and that science is not playing its part in forging a sustainable future. This is a strong view, but it seems defendable.

The world population is expected to exceed nine billion people by 2050. Carbon constraints and restrictions in the use of natural resources challenge competitiveness. The geopolitical lineup is changing, and social equity is strikingly in disproportion beyond any reason. Solutions are not keeping pace with the scale of the challenge expressed by food loss and malnutrition, climate change, soil damage, and decline of biodiversity (to name only a few top issues). One example may show the complexity and scale of the challenge: To meet targets that would limit global warming to two degrees increase in worldwide average temperature, it is a fair assessment that pretty much all decades-long stable trends in carbon intensity must

be broken. Carbon intensity needs to be reduced in a way that is unprecedented. The regular innovation rate would need to be x-times magnified and then continued on this scale for 35 consecutive years. All externalities assumed to be steady; this is far from even potentially realistic. To say the least, those trends require very serious efforts in rethinking concepts and ideas.

4 … But There Is Also Evidence for Change

Nevertheless, a lot is currently being done, and that is good. First, moving universities and research facilities tackles the sustainability agenda as mentioned above. Long gone are the days when research into sustainability immediately made the scientist an outsider, sometimes to the extent of even an academic pariah. Serious money is now being spent to foster research into social and ecological issues associated with production and consumption patterns, the agenda of, e.g., urbanism, energy, water, biodiversity, land management, and climate change. Most important are recent research clusters that look into the methods for excellence in sustainability research, and more and more researchers from all academic levels have gotten themselves involved with these issues.

In Germany, federal research funds for sustainability research have nearly doubled since 2005, together with an overall increase in funding of R&D and sector programs such as the Sixth Federal Energy Research Program. The Federal Government places emphasis on cooperation in research on sustainable development and on encouraging research and innovation in small- and medium-sized enterprises.

For Germany in particular, an ambitious commitment to science and advanced technology is the basis for strong industrial performance together with regulation assuring decent working conditions. This notion, inter alia, has been subject to the assessment and deliberations of the high-level peer review on German's sustainability performance. The peers have been mandated by the Federal Government. Chaired by Prof. Dr. Björn Stigson,[2] they conducted the review in 2013 and put emphasis on the science and research. Here is what they recommended: "There is a need for funding new ideas outside mainstream research that will ensure innovation in sustainability of land use and future cities, efficient use and re-use of resources, reliable climate forecasts and the impact of adaptation strategies. The topics of lifestyle, food and health also need a major boost in science and research programs. Advancing transformational knowledge for a sustainable future should be made a criterion for funding and for assessing scientific excellence. The issue of energy system integration and all energy-related topics (including energy production, sustainable mobility and sustainable buildings) should remain high on the agenda, as well as resource productivity and recycling, sustainable food strategies, organic

[2] Sustainability made in Germany, the Second Peer Review, Berlin Sept. 2013, downloadable from http://www.nachhaltigkeitsrat.de/uploads/media/20130925_Peer_Review_Sustainability_Germany_2013_02.pdf (accessed March 27, 2014).

farming, sustainable agriculture and lifestyles. We recommend increasing and expanding spending for projects as opposed to funding for institutions and structures, a need that we heard repeatedly in our stocktaking. We recommend fostering a systems approach in researching resource issues and in the earth sciences so as to take better account of the interconnectedness of nature as a system and the relation between humans, nature and technology. A better understanding of this interconnectedness is needed. This often involves encouraging transdisciplinary approaches and breaking out of the traditional silos of individual academic disciplines and their associated research programs. The nexus approach is one of the instruments that need to be further explored in this respect. For research policy, we recommend furthering the link between science and the national sustainability agenda, as far as this is appropriate. Just as the objectives of this agenda itself need to be based on engagement with business and all parts of civil society, so, too, we recommend that more use should be made of well-researched evidence and the co-designing of research programs. Co-designing efforts should involve civil society and practitioners in the formation of academic research goals and objectives. Innovation in more sustainable products and processes is crucial in all sectors. In both the public and the private sector, such innovations should in the first instance help to improve the originator's own sustainability performance but should then be assessed further in terms of how they could contribute to the sustainability performance of others, both within Germany and ultimately on a global scale."

Does that mean that science is already on track to meeting the sustainability challenge? Science, politics, and the business community are on the same page. A metaphor best describes the situation: The overall picture is that of a plateau filled with model lighthouse charges run by sustainability pioneers. On this plateau, you find high-end technical and cultural innovations, and all kinds of tracks and junctions, and the most up-to-date traffic light systems. But there is no clear way up to the summit, and the summit is where you need to go.

5 The Disconnect

One may conclude that funds and political regulation do not yet provide a big-enough impact to bridge the gap between what is necessary and what is possible. Certainly, this argument has substance, and an increase in funds and improved involvement of civil society may indeed be helpful. One may, however, also rethink the way the principle of self-organizing is implemented. It is a very important tool and, in the past, has proved a good approach to fostering innovation and critical thinking. When it comes to sustainability, it must again prove its merits, but this time, it has to develop out-of-area traction. Stakeholder interests outside of the formal academic system are a legitimate source for scientific agenda processes, and they might express opinions that are most relevant to the implementation of research budgets. This argument, too, has its justification.

Dedicated leadership and personal sustainability skills are needed on all levels. For private companies and public entities, the tools and means may be different, but

responsibility for a common future is not. Thus, approaches should be centered on social responsibility, compliance, mitigation, and the license to operate. Value creation and innovation can and must be sourced from those approaches.

For mature economies, such as that of Germany, traditional growth patterns measured in gross output do not provide sound perspectives, but sustainability strategies do, and they must be based on scientific evidence. But conversely, one may ask what kind of understanding of its own role and performance science is following and how this translates into specific approaches to sustainability accounting and human resources management.

Observation is the methodological link between all empiric sciences. This will remain the working modality. The concept of sustainability requires a comprehensive approach to observation. *Observing the observers* is a relatively new and challenging idea. On first glimpse, this idea seems a bit generic or cloudy. But think of the issue of storing nuclear waste, with all its facets of scientific advice, malfunctioning, power structures, and organized protest, and the idea gains momentum immediately.

Transdisciplinarity is subject to self-organization of actors. If conducted properly it makes the scoping, design, performance, and communication of scientific excellence a part of transformational solutions. This is not specifically necessary for all kinds of research, but for a fair number of items, it is. The understanding of excellence for sustainability builds on disciplinary excellence, and, to be very clear, it does not replace disciplinary excellence. It rather requires a comprehensive reflection on the role of science, its structures, and the ways in which it may cooperate in a transdisciplinary mode. Explicitly, this is true for the upcoming implementation period of universe Sustainable Development Goals in all countries.

6 Iconic Game Changer

Nobel Prize awardees are often seen as near to changing the game as possible. More effectively, however, the political and societal perspective towards sustainability could capture the imagination and dedication of students, researchers, and the society as a whole. For example, the complete recycling of all waste, be it plastics, glass, and paper, or electronic waste and its rare earth components; turning carbon dioxide from undesired waste into usable raw materials; and combining sufficiency and efficiency strategies in the notion of green growth and sharing economies. Last, but not least, the German Energiewende can (and must, actually) be seen as a large-scale society lab for finding the sustainability trajectory.

Of course, this perspective requires increasing research in this area and developing an enhanced reporting system on sustainability performance that could make a difference.

Science is constitutive for the trustworthiness, credibility, and modality of sustainability trajectories. The future of science relies on the extent to which the society puts itself on the track towards an effective sustainable development. The dichot-

omy between science and society and between knowledge and practical change, although often repeated and evoked, might be a misleading concept in the long run. For "science for sustainability," the raison d'être lies in combination and cooperation. Combining externally recognized leadership with market-lead business performance and wise regulatory approaches is key. Most important are national sustainability strategies. If well sketched out they would provide room for leaders and advanced thinking. They would encourage leadership that does not wait for others to allow them to proceed and uncover what is already possible by today's standards. It is in the spirit of this meaning that sustainability science must be built into the academic mainstream.

Carl von Carlowitz, in his time, was called the Elector of Saxony's leading mining officer, and he was responsible for the ongoing creation of wealth and luxury goods that would add to the fortune of the Elector and the prosperity of the country. In today's framing, we would address him as a leading minister, and his concern would be how to continue essential ecosystem services in all three dimensions of sustainability.