Sustainability Science

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Without Abstract

Synonyms

Sustainable development; Sustainability

Definition

Sustainability science is an academic discipline focusing on understanding complex social-ecological systems in order to enhance solutions-oriented decision-making and the ability of institutions and citizens to pursue a sustainable future for human and nonhuman entities that interact with each other.

Evolution of Sustainability Science

Sustainability science is a growing branch of science. The evolution of sustainability science began 20 years ago as a solution proposed by the scientific community to better understand cross-disciplinary boundaries in tackling global sustainability issues such as climate change. The notion of sustainability science was established as an international science policy project during the World Summit on Sustainable Development in 2002. It announced a shared vision of bringing together different branches of science for reaching sustainability and consolidating the bond between science and society (Clark and Dickson *2003*; Jäger *2009*).

Three priority themes formed the basis for the evolution of sustainability science: (a) developing a research frame for sustainable development, drawing on a planetary point of view to create a shared understanding of the interconnectedness of society and environment; (b) carrying out targeted research on the understudied key questions that are critical for gaining a deeper understanding of the interconnectedness; and (c) linking knowledge to action for achieving transformative change toward sustainability (National Research Council *1999*).

There are two orientations to sustainability science: environmental and developmental (Bettencourt and Kaur *2011*). Kates et al. (*2001*) determined the basis for sustainability science by specifying three targets: (a) exploring the interactive system between the human and nonhuman worlds; (b) guiding human and nonhuman interactions; and (c) promoting individual, social, and institutional learning to navigate the transition to a sustainable future. Taking a more detailed look, ten fields of sustainability-related research were identified through meta-analysis. The human dimension of research included economic development, health, and lifestyle. The nonhuman world was presented by climate, biodiversity, agriculture, energy and resources, fishery, forestry, and water. These provided the foundation for a research framework for the following aspects of sustainability science, "goal setting, indicator setting, indicator measurement, causal chain analysis, forecasting, backcasting, and problem–solution chain analysis" (Kajikawa *2008*, 231). Thus, one of the core questions of sustainability science is "How can the dynamic interactions between nature and society be better subsumed into emerging models and conceptualizations that integrate the Earth system, human development, and sustainability?" (Kates et al. *2001*, 642).

Currently, sustainability science is based on understanding of systemic and transformative societal change to achieve the 17 sustainable development goals of the United Nations Agenda 2030 (UNESCO *2018*). Smith et al. (*2018*) call for a "deep interdisciplinarity and transdisciplinary to support the indivisibility and universality of sustainable development" accordance with the sustainable development goals of Agenda 2030. According to Schneider et al. (*2019*), the scientific community willing to take on Agenda 2030 as a leading guideline should address the following tasks: (a) reflecting on the values, (b) elaborating how values are linked to activities, and (c) finding a common value-basis for sustainable futures. By doing so, the scientific community improves accountability and clarifies its ethical and epistemic basis.

Research in sustainability science combines human and nonhuman reality in order to understand complex social-ecological dynamics on local and global level (Miller et al. *2014*). The field of research is administered by contributions from various disciplines and researchers with different world views, values, and paradigms. Thus, the concept of sustainability remains elusive, and its nature seems mostly indistinct (Joon and Oki *2011*, 247). In this sense, sustainability science may be appropriately described as a metadiscipline, like the environmental studies in the 1980s (Caldwell *1983*).

Comparing Different Approaches to Sustainability

Barriers to sustainability transformations often exist due to "complexity, uncertainty, and contested values" (Funtowicz and Ravetz *1993*; also Rittel and Webber *1973*). Interdependencies between human and nonhuman reality underscore the need for systems thinking. Systems thinking is associated with a holistic worldview. A person with a holistic worldview is able to interpret the world as an integrated whole rather than as a collection of individual pieces (Capra *1996*). According to Capra (ibid.), the systems approach is a new paradigm in modern science. It is possible for the systems approach to become a science because "there is approximate knowledge," which means that there are limitations in every scientific concept (Capra *1996*, 41).

The concept of sustainable development is based on the idea of balancing environmental, social, and economic dimensions in research (O'Connor and Kenter *2019*). In a decision-making situation, however, balancing of the dimensions in cases of trade-offs or conflicts is difficult. As a result of balancing, a sustainability transformation may result to *weak sustainability*. It prioritizes short-term well-being, well-being of nation, and linear economy. If we view the case from a scientific point of view, the vital ecosystem services provided by nature are essential for mankind's survival. The concept of *strong sustainability* assumes that the natural environment – as the basis for biodiversity and human and social well-being – is of primary and intrinsic value in sustainable development. In order to have a fair, efficient, and thorough transition to a sustainable future, Neumann et al. (*2017*) suggested that "an applicable and detailed concept of strong sustainability should be developed that holds for all natural capitals addressed in the 2030 Agenda and guides the implementation process ahead." In other words, decision-making, policies, consumption habits of citizens, and any kind of human actions in accordance with the idea of strong sustainability should maintain, in the following order: first, diverse life; second, social justice; and third, a robust economy that is instrumentally valuable (Barry *2002*; Bauman *2008*; Hediger *1999*; Kidder *1995*; Marshall and Toffel *2005*; Ott *2003*). This could also be a question of temporal, regional, and material orientations, as demonstrated in Table 1.**Table 1**

Applying the concept of strong sustainability versus weak sustainability (adapted from Salonen and Hakari *2018*)

	Strong sustainability	**Weak sustainability**
Temporal orientation	Long-term Well-being	Short-term Well-being
Regional orientation	Planetary Well-being	Well-being of nation
Material orientation	Circular economy (cradle-to-cradle)	Linear economy (cradle-to-grave)

Solutions that are in accordance with a strong sustainability approach thus prioritize long-term well-being over short-term well-being, planetary well-being over national well-being, and circular economy over linear economy.

Future Directions

Sustainability science helps us rise to the great environmental and developmental challenges of our time (Kates *2011*). In this planetary transformation, the role of values and visions is essential. A key question is what *values* are related to wicked sustainability problems that societies face around the world. More specifically: What kinds of values are associated with a sustainable future and how can they be activated in a local and global level? And what are viable *visions* for sustainable future accordance with the Agenda 2030 and how do these visions translate into action? (Miller et al. *2014*; Horcea-Milcu et al. *2019*.) As an example, Society's Commitment to Sustainable Development (*2016*) shares a vision of the Finland we want by 2050, "A prosperous Finland with global responsibility for sustainability and the carrying capacity of nature."

How have *socio-technical changes* been navigated in the past, and what strategies, tactics, and interventions could be promising in the future (Miller et al. *2014*)? The Antarctic ozone hole is one of the most visible human impacts on the Earth. Since the implementation of the Montreal Protocol, research has shown that levels of ozone-destroying chlorine are declining, resulting in less ozone depletion (Strahan and Douglass *2018*). The recovery of the ozone hole can now be seen as a success story of sustainability science, politics, and international cooperation (Sachs *2008*, 113–114).

Values, visions, and socio-technical changes are a basis of the sustainability transformation which refers to the cultural evolution. In the future, solution-oriented research could be further emphasized in sustainability science (Sarewitz et al. *2012*; Wiek et al. *2012*). Further research could therefore be driven by the question of how citizens, society, and institutions can adjust their visions toward sustainable futures and implement just socio-technical change to achieve these ends. In order to support sustainability transformation, according to Miller et al. (*2014*), sustainability science can: (a) enrich the role of values in decision-making process; (b) support individuals, institutions, and societies in pursuing sustainability; (c) foster socio-technical transition (for example, in consumption

and production); and (d) promote lifelong learning for education for sustainable development (Miller et al. *2014*).

Continuous *learning* in society is at the center of a sustainable future. Phenomenon-based learning may be a way forward for facilitating transdisciplinary education in society (Lehtonen et al. *2018*). According to UNESCO (*2018*), understanding of how transformative actions occur is the core of capacity building in a society. It is based on intertwined planetary reality. For example, peace is a question of social harmony and justice (Galtung *1969*). Peace and sustainable development are closely tied to processes of globalization and socio-economic development. There is also an evident need to research the interconnectedness of sustainability and peace in the context of sustainability science.

Sustainability science is a solution-based interdisciplinary field of research. It deals with the deep systematic changes that are needed to meet the needs of present and future generations while building inclusive societies and conserving the planet's life-support systems. These changes permeate every dimension of society and touch the values and ways of every human life.

Cross-References

- Agenda 2030
- Climate Change
- Education for Sustainable Development
- Sustainable Development
- Sustainable Development Goals (SDGs)
- Sustainable Development Goals (UN Global Goals)
- Sustainable Development in Transforming Economies
- Sustainable Transition
- Systemic Transition
- The 2030 Agenda for Development
- Transition Sustainability

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