Glossary

The key concepts of the glossary (section a) are marked in the text with a double asterisk (**), upon their first appearance in the text.

The key technical terms of the glossary (section b) are marked in the text with a single asterisk (*), upon their first appearance in the text.

A. GLOSSARY OF KEY CONCEPTS

Descriptive–Analytical Versus Transformational Mode of Research

Sustainability science is being developed in a constructive tension between a descriptive–analytical and a transformational mode of research (Wiek et al., 2012). These two modes are necessary research components of sustainability research (Clark and Dickson, 2003). The descriptive–analytical mode of sustainability research is basically an advanced form of complex system analysis, applied to complex and dynamic socio-ecological systems (see for example Ostrom et al., 2007; Matson, 2009). The transformational mode is oriented towards practical solutions for sustainability problems. Therefore sustainability research in the transformational mode is confronted with the challenges of generating actionable knowledge, incorporating knowledge from outside academia, and dealing with different values and political interests. Typical research questions in the transformational mode are: (1) how socio-ecological systems would function and look in compliance with various values (for example different ways to balance socio-economic needs and environmental capacities); (2) which transition pathways are viable and what strategies could be explored to move towards solutions.

References and further reading: Ostrom et al. (2007); Matson (2009); Wiek et al. (2012); Clark and Dickson (2003).

Interdisciplinarity

The US National Academies' report on interdisciplinarity defines interdisciplinary research as a mode of research by teams or individuals that integrates information, data, techniques, tools, perspectives, concepts and/or theories from two or more disciplines or bodies of specialized knowledge to advance fundamental understanding or to solve problems whose solutions are beyond the scope of a single discipline or area of research practice (National Academies, 2004). In the particular context of sustainability science, the practice of interdisciplinary research results more specifically from the need to combine descriptive–analytical modes of research and transformational modes of research (see the glossary entry for descriptive–analytical versus transformational mode of research). In practice, this means to integrate research results from descriptive–analytical disciplines such as economics and environmental sciences, with research results from value-based ethical inquiry and exploration of socially legitimate transition pathways.

References and further reading: National Academies (2004); Jerneck et al. (2010).

Socio-ecological Systems

The term "socio-ecological system" is used to model situations where social and ecological systems are linked through a set of dynamic interactions, which makes the delineation between the social and the natural system artificial and arbitrary (Berkes et al., 2003b). Human actions have had major impacts on biophysical systems for thousands of years. Yet the scope and magnitude of the human forces operating in socio-ecological systems have risen dramatically, leading prominent scientists to conclude that we have entered a world of human-dominated ecosystems (Vitousek et al., 1997), even on a planetary scale (Crutzen and Stoermer, 2000; Crutzen, 2002). The specific objective of the research on socio-ecological systems is to investigate how human societies deal with change in these coupled systems, and how capacity can be built to adapt to future change. Dealing with separated ecological, social or economic systems alone is challenging enough. But the resultant socio-ecological systems are far more complex and dynamic than any ecosystem human societies have encountered previously. It follows that non-linearities and the inevitable uncertainties associated with complex and highly dynamic systems need to be taken into account in the analysis of institutions to govern these systems.

References and further reading: Berkes et al. (2003b); Crutzen (2002); Crutzen and Stoermer (2000); Vitousek et al. (1997).

Transdisciplinarity

Transdisciplinary research complements conventional basic and applied research in problem fields characterized by complexity and uncertainty: "There is a need for transdisciplinary research when knowledge about a societally relevant problem field is uncertain, when the concrete nature of problems is disputed, and when there is a great deal at stake for those concerned by the problems and involved in dealing with them" (Pohl and Hirsch Hadorn, 2006, p. 20). Examples of such problem fields are migration, violence, health, poverty, global environmental change and cultural transformation processes, among others. Transdisciplinarity implies that the precise nature of a problem to be addressed and solved is not predetermined and needs to be defined cooperatively by actors from science and the life-world. To enable the refining of problem definition as well as the joint commitment in solving or mitigating problems, transdisciplinary research connects problem identification and structuring, searching for solutions, and bringing results to fruition "in a recursive research and negotiation process" (Wiesmann et al., 2008, p. 436). More specifically, sustainability scholars define transdisciplinary research as a "reflexive, integrative, method-driven scientific principle aiming at the solution or transition of societal problems, and concurrently of related scientific problems, by differentiating and integrating knowledge from various scientific and societal bodies of knowledge" (Jahn et al., 2012, pp. 26–7).

References and further reading: Wiesmann et al. (2008); Jahn et al. (2012); Pohl and Hirsch Hadorn (2006).

Transition

The term "transition" has emerged as a key theoretical concept in the analysis of the sustainability crisis over the last decade. It refers to profound processes of change that involve both innovative practices and structural and cultural adaptations (Grin et al., 2010). This notion of structure has to be understood broadly, including physical infrastructure (physical stocks and flows), economic infrastructure (market, consumption, production), and institutions (rules, regulations, collective actors such as organizations, and individual actors). The notion of culture refers to the collective set of values, norms, perspectives (in terms of coherent, shared orientation) and paradigm (in terms of the way of defining problems and solutions) (Loorbach and Rotmans, 2006).

References and further reading: Grin et al. (2010); Loorbach and Rotmans (2006).

Uncertainty

Despite the enormous effort and resources that have gone into developing and applying methods for addressing uncertainty, there has been little concerted effort to see whether they contribute significantly either to knowledge or to policy. Even when there is little empirical data for solving policy problems, it is mostly treated by traditional statistical techniques. However, as John Christian Bailar, an expert in statistical methodologies, put it, all the statistical algebra and all the statistical computations may work against the need for disciplined thought and scientific rigour, because "the kind of random variability that we see in the big problems of the day tend to be small relative to other uncertainties". In particular, "random variability – the stuff of p-values and confidence limits, is simply swamped by other kinds of uncertainties in assessing the health risks of chemical exposure, or tracking the movement of an environmental contaminant, or predicting the effects of human activities on global temperature or the ozone layer" (Bailar, 1988, p. 19). Thus, from a scientific perspective, the validity of the conventional statistical approach to uncertainty for addressing sustainability problems is, at best, dubious. New methods must be developed for making our "ignorance usable" (Ravetz, 1990). In particular, different kinds of uncertainty need to be clearly expressed and analysed. As discussed in more detail by Funtowicz and Ravetz (1993, pp. 743–4), there is a need to distinguish among inexactness, unreliability and irremediable uncertainty.

References and further reading: Bailar (1988); Ravetz (1990); Funtowicz and Ravetz (1993).

Weak, Intermediate and Strong Sustainability

Sustainability can be described as the "maintenance of capital" (Goodland and Daly, 1996). In the case of economic sustainability it refers mainly to financial capital. For example, historically, at least as early as the Middle Ages, merchants wanted to know how much of their sales receipts could be consumed by their families without depleting the capital of their business (for example by using only the net profits, minus investment costs, for private consumption). More recently, the concept of sustainability is increasingly used in the context of the ecological crisis, where the term "environmental sustainability" refers to the maintenance, or at least non-declining, of natural capital. The latter is defined as the stock of environmentally-provided assets (such as soil and its microbes and fauna, atmosphere, forests, water, wetlands) that provides a useful flow of goods or services (see the concept of ecosystem services discussed in section 3.1). Due to the degradation of natural capital, such natural capital, and not lack of technology or human-made capital, has in many situations become the limiting factor of socio-economic activities. For example, timber is limited by the remaining forests, not by sawmills, marine fishing by the remaining fish, not by fishing boats and so on. In this context, one can distinguish between three degrees of sustainability: weak, intermediate and strong. These refer respectively to situations where only total level of capital has to be remain intact (so one type of capital can be totally depleted, without loss of well-being), only critical thresholds of each kind of capital have to be maintained and the different kinds of capital have to be kept intact separately. Strong sustainability is important when the different forms of capital are complements and not substitutes, for example a sawmill (human-made capital) is worthless without the complementary capital of a forest.

References and further reading: Goodland and Daly (1996); Common and Stagl (2005).

B. GLOSSARY OF KEY TECHNICAL TERMS

Dynamic Stochastic General Equilibrium Models

These models aim to describe the behaviour of the economy as a whole by analysing the interaction of many microeconomic decisions, taking into account the fact that the economy is affected by random ("stochastic") shocks such as technological change, fluctuations in the price of oil, or changes in macroeconomic policy-making. The core set of microeconomic variables typically used as the starting point of these models are economic preferences (maximizing personal utility or maximizing firms' profits), productive capacity of the agents (for firms, typically specifying their capacity to produce a certain amount of goods, in function of given amounts of labour, capital and other inputs that are employed), and economic institutions (such as budget constraints, rules of monetary and fiscal policy) (Kydland and Prescott, 1982).

General/Partial Equilibrium Analysis

General equilibrium analysis tries to give an understanding of the whole economy at equilibrium, starting with individual markets and agents. The first attempt in neoclassical economics to model prices for a whole economy was made by Léon Walras (1874). In partial equilibrium analysis, the determination of the price of a good is simplified by just looking at the price of one good and assuming that the prices of all other goods remain constant.

Lexicographic Preferences and Ordinal Utility

An agent using "lexicographic preferences" ranks entities or aspects in order of choice but rejects the possibility of trading or substitution amongst these entities (Spash, 1998). Such preferences may be absolute, as animal rights, or bounded, as when some minimum living standard is required before such rights become operative (O'Neill and Spash, 2000). These types of preferences conform to the basic axioms of rationality in neoclassical economics but deny the principle of (gross) substitution, which implies that everything has a trade/exchange price. Many economists assume these preferences represent irrational viewpoints but evidence exists that they may be relatively common especially for environmental issues. In presence of lexicographic preferences, one cannot apply ordinal utility theory, which supposes that all pairs of alternative bundles (combinations) of goods can be ordered such that one is considered by an individual to be worse than, equal to, or better than the other.

Maximum Sustainable Yield

The maximum sustainable yield is the largest catch that can be taken, or the largest yield that can be harvested, that still allows the population to continue to reproduce indefinitely. However, conservation biologists widely regard the concept as misused because it focuses solely on the species in question, ignoring the damage to the ecosystem caused by the designated level of exploitation and the issue of bycatch (Walters and Maguire, 1996).

Multi-criteria Evaluation

A typical multi-criteria problem is described by a finite set of feasible actions and a finite set of evaluation criteria (Funtowicz et al., 2002). In general, in a multi-criteria problem, there is no solution optimizing all the criteria at the same time. The multi-criteria evaluation methods allow decision makers to find compromise solutions taking into account different conflicting values. Increasingly multi-criteria analysis uses software and methods from qualitative comparative research (for an overview of these methods see Rihoux and Ragin, 2009).