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Mind the sustainability gap

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Despite increasing efforts to reach sustainability, key global biophysical indicators such as climate change and biodiversity loss continue to deteriorate rather than improve. Ongoing failure to move towards sustainability calls into question the focus of current research and policy. We recommend two strategies for progress. First, sustainability must be conceptualized as a hierarchy of considerations, with the biophysical limits of the Earth setting the ultimate boundaries within which social and economic goals must be achieved. Second, transdisciplinary research programs must confront key normative questions facing modern consumer societies. The humanities should have a key role in such programs. Assisted by these strategies, ambitious targets that realistically reflect the biophysical limits of the life-support system of the Earth must be set and relentlessly worked towards.

Introduction

Despite increasing efforts at all levels of society to create a sustainable future, global-scale indicators show that humanity is moving away from sustainability rather than towards it [1–3]. Several high-profile reports have recently emphasized the potential risk of existing trends to the long-term viability of ecological, social and economic systems [2–4]. Here, we argue that the widening gap between our current trajectory and meaningful sustainability targets calls for a new model of sustainability – one that is built on a hierarchical conceptualization of ecological, social and economic considerations, and addresses key ethical and normative dilemmas of modern consumer life styles. We propose tangible actions for academics, natural resource managers and policy makers that can help to close the sustainability gap.

For the first time in human history, our activities are so pervasively modifying our own life-support system that the ability of the Earth to provide conditions suitable for our species to thrive can no longer be taken for granted [2]. Nearly 50% of land has been transformed by direct human action, with negative consequences for biodiversity, nutrient cycling and soil structure. Approximately 75% of fisheries worldwide are fully exploited, overexploited or depleted, and some might never recover [5]. More nitrogen is now fixed into reactive forms by fertilizer production and fossil fuel combustion than is fixed naturally in all terrestrial systems [6]. The Earth is in the midst of its sixth great extinction event, but the first caused by the activities of just one biological species (*Homo sapiens*). The global climate is changing beyond known patterns of natural variability, with potentially serious consequences for the well being of humans and other biota [2,3,7].

Although there have been regional-scale improvements in some indicators of poverty, food supplies and the environment [2], these are overshadowed by the ongoing deterioration of key biophysical indicators at the global scale [2,3]. For example, rates of biodiversity loss and global warming continue to increase rather than decrease [3]. The growing 'sustainability gap' between what needs to be done and what is actually being done calls into question current approaches to sustainability research, policy and management.

Current approaches to sustainability

Sustainability has been defined in many different ways. Examples of definitions include: 'sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs' [8]; the 'triple bottom line', in which environmental, social and financial outcomes are taken into account [9]; a systems perspective where sustainability exists when no elements of the system are overloaded [10]; and an ecosystem perspective, which considers sustainability to be 'the capacity to create, test, and maintain adaptive capability' [11]. Although sustainability is a relevant concept at many scales, our main concern in this paper is the global scale. Specifically, we are concerned that current actions might be insufficient to safeguard human well being and the adaptive capability of ecosystems over the next decades and centuries.

Two sets of action are widely accepted as being vital to tackling the sustainability challenge: (i) integration across academic disciplines; and (ii) integration of academic insights with societal action. Integration across academic disciplines has drawn strongly on the biophysical and social sciences, particularly ecology and economics [12]. Integration of research with societal action increasingly occurs through participatory methods, such as scenario planning [2], and novel policy and management tools, such as markets for ecosystem services [13]. Yet despite progress on both fronts, humanity continues to move away from sustainability [2,3].

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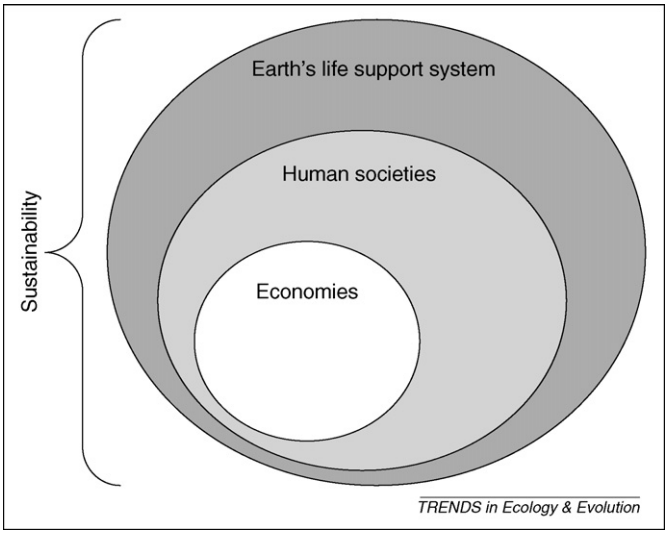

Figure 1. Conceptualization of sustainability. Biophysical, social and economic considerations represent a nested hierarchy. Without a functioning life-support system, societies cannot thrive; without functioning social structures and institutions, economies cannot flourish. This hierarchical approach to sustainability is in contrast to the widely held notion of the 'triple bottom line', which treats biophysical, social and economic considerations as parallel rather than nested concepts. Modified, with permission, from Ref. [14].

Do we simply need to apply current approaches to sustainability more resolutely? Or are there fundamental gaps in our efforts to reach sustainability?

Key ingredients for sustainability

Sustainability is not a relativistic concept because the biophysical limits to sustaining life on Earth are absolute. Societies cannot exist without a functioning life-support system, and economies can only flourish within a functioning social system with effective institutions and governance structures [14] (Figure 1). Thus, a hierarchical conceptualization of sustainability is more appropriate than a balancing framework, such as the 'triple bottom line' [9]. A hierarchical conceptualization recognizes that although some trade-offs between the biophysical, social and economic spheres are possible, the absolute limits of these trade-offs are dictated by the need to maintain a functioning life-support system.

Sustainability demands that we develop resilient social-ecological systems that can embrace both the environmental and social consequences of global change [15]. In particular, three key ingredients are required to achieve sustainability (Figure 2).

First, meaningful sustainability targets must be identified, and the sustainability gap must be explicitly recognized and quantified (Figure 2). Targets relating to the life-support system and key ecosystem services of the Earth can be derived from a risk framework informed by the biophysical sciences. Social and economic targets, compatible with the ultimate biophysical imperative to maintain a well-functioning life-support system, can be informed by the social sciences and humanities. Targets are vital because they provide the means for evaluating the success of the actions taken. Some targets are a matter of debate (e.g. what level of healthcare should be universally available?), whereas others might relate more directly to scientific expert knowledge (e.g. life-support systems are likely to be seriously compromised if global warming exceeds 4–5°C [16]). Examples of targets are the Millennium Development Goals (www.un.org/millenniumgoals), or the Kyoto Protocol on reducing greenhouse gas emissions (unfccc.int/kyoto_protocol/items/2830.php). Existing indicators, such as the global footprint, can provide useful information on our trajectory in relation to meaningful targets (www.footprintnetwork.org).

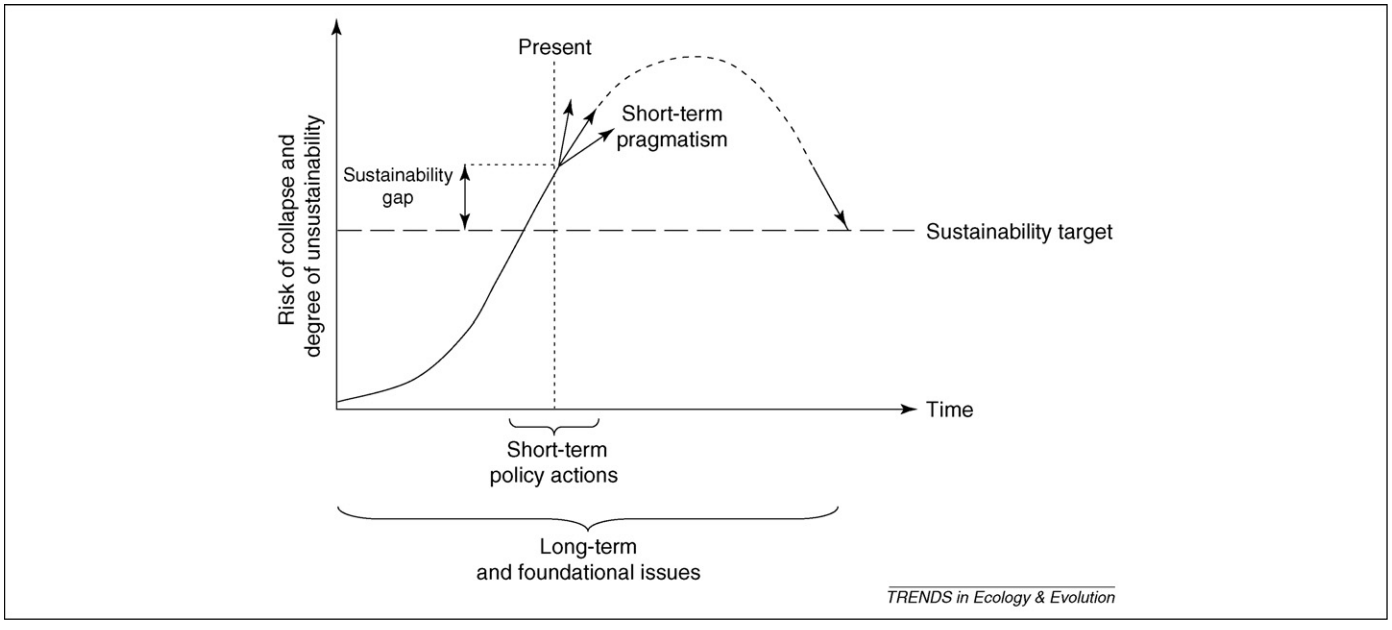

Figure 2. Conceptual framework summarizing the sustainability challenge. Sustainability targets must be identified, and the sustainability gap must be recognized and quantified. Targets should consider biophysical, social and economic aspects of sustainability in a nested approach (Figure 1). Long-term and foundational issues need to be examined to identify the values and institutions required to reach sustainability. Shorter-term policy actions are needed to provide incentives and regulations to encourage sustainable behaviors. The dashed curve indicates a potential future trajectory towards sustainability, and highlights the challenge of turning around the current unsustainable trend.

Second, policy tools must be applied to alter the current trajectory of society where it is not sustainable (Figure 2). Many of these tools are developed in the social sciences, and include regulations, incentives and institutional reform. Widely known policy tools include agri-environment schemes, pollution regulations or markets for emissions trading. In addition, corporate social and environmental responsibility is increasing in some sectors. An example is the coffee industry, where 'fairly traded', 'certified organic' or 'wildlife-friendly' production is increasingly common.

Third, critical analysis of foundational and longer-term issues (e.g. values, beliefs and motivations) is needed to link short-term policy actions with agreed longer-term sustainability targets (Figure 2). Such analysis should draw on the humanities (e.g. history, anthropology and moral philosophy) and social sciences (e.g. institutional theory) to reflect on alternative values and institutions, and how they can foster or prevent the attainment of sustainability. Arguably, one of the greatest challenges at a societal level is to engage in constructive discussion aimed at identifying core values that can be sustained and that are worth sustaining [17]. That is, the analysis of foundational issues must go beyond which institutional arrangements are needed, and must confront the ethical and normative dilemmas of modern consumer and aspirational societies.

Although targets and policy tools are now widely used, the chosen targets often are not biophysically meaningful, or they lack an effective mechanism for linking to policy action. Furthermore, most existing sustainability initiatives fail to reflect on foundational issues, and do not adequately confront potentially uncomfortable ethical questions. Instead, most sustainability initiatives are firmly situated within the jurisdictional and political context of the present, where pragmatism reduces the set of potential actions to a relatively narrow range that is deemed politically feasible. Often, the resulting short-term responses are only minor perturbations (positive or negative) to the dominant trajectory of increasing un-sustainability (Figure 2). The Kyoto Protocol is an example of a pragmatic, politically mediated compromise that falls far short of what climate scientists believe is needed to avoid 'dangerous' climate change with serious consequences for human well being [16]. Although short-term pragmatism is valuable, small uncoordinated steps, by themselves, are unlikely ever to lead to sustainability. Political pressure frequently decouples policy actions from credible sustainability targets, and sustainability is falsely treated as a relativistic concept. This decoupling is responsible for an ever-widening gap between what needs to be done to reach sustainability and what is actually being done.

Actions to close the sustainability gap

Given the key ingredients for sustainability identified above, we propose three tangible actions to help close the sustainability gap.

Critically analyze foundational issues underlying the sustainability crisis

Some sustainability targets relate to vital ecosystem services without which societies and economies cannot survive. Failing to meet these targets will have fatal consequences; yet such biophysical targets often seem impossible to reach. How can we rapidly reduce CO_2 emissions to avoid dangerous climate change? How can we stop the mass extinction we are causing, and sustainably share the biosphere of the Earth with other species? Although new technologies could help us with some of these issues [18], the sustainability challenge requires far more than technical expertise. It requires us to consider long-term and foundational issues, and it challenges some of our most deeply held values and beliefs. Aside from some notable exceptions [19–21], compared with more dominant disciplines such as ecology and economics, the analysis of foundational issues has typically been marginal in sustainability research. Key contributions for the analysis of long-term and foundational issues come from 'interdisciplines', such as human ecology and environmental politics; social sciences such as sociology and institutional theory; and disciplines within the humanities, such as history and philosophy. The humanities, in particular, have been marginal to sustainability research to date, which reflects the science–arts divide that has pervaded both the academic world and much of policy, legislation and management for many decades.

Long before sustainability became a topic of global concern, the famous American naturalist Aldo Leopold commented on the dissonance between the ideas of humanity as the conqueror of nature, and humanity as part of the wider biotic community [22]. Sustainability demands that modern consumer culture shift from paradigms of conquest to paradigms of connectivity. There is a growing awareness within the humanities of the significance and urgency of cross-cultural, historical and philosophical investigations of our conceptions of our role in the world. To understand the biophysical world requires science; to conceptualize our role within this world requires the humanities; and to reach sustainability requires their integration. Human action in the world emerges from a complex dialectic among the living world itself, the social contexts of human life and action, and the conceptualizations through which human life is made meaningful. Fundamentally enhanced collaboration among natural and social scientists and scholars of human contexts, symbols and meanings would signal the beginning of a new paradigm for addressing the sustainability gap. Starting within academia, this paradigm shift could be a vital step for policy makers and the wider community to seriously rethink the current trajectory of humanity. To achieve this, we need new forms of transdisciplinary scholarship that cut across traditional science–humanities barriers. This will require new funding opportunities tied to innovative measures of success for sustainability scholars. Active engagement with policy makers and society at large must be a vital part of credible transdisciplinary sustainability research.

Use stretch goals and back-casting to guide policy actions towards agreed sustainability targets

Stretch goals are ambitious targets used to inspire creativity and innovation to achieve outcomes that currently seem impossible. Back-casting is a technique specifically

designed to achieve such ambitious targets. In back-casting, the desired endpoint is first agreed upon, and then steps to reach this point are worked out retrospectively. President Kennedy's decision to put a man on the moon is an example of the successful application of stretch goals and back-casting. Articulation of this ambitious goal drove the innovation which ultimately led to an achievement that did not seem technologically feasible when the goal was set [23]. This example illustrates that, although use of stretch goals and back-casting requires political will, it is not inherently beyond the means of current political systems. Given the magnitude and complexity of sustainability problems, stretch goals and back-casting are ideally suited to the sustainability challenge.

Apply existing approaches more imaginatively and resolutely

Built firmly on an analysis of foundational issues, and guided by stretch goals and back-casting, the more resolute application of existing approaches to close the sustainability gap will become more effective. Such approaches link biophysical aspects of the Earth system to human well-being, and use existing institutions to translate academic insights into policy action [12,13].

Conclusion

Some scholars have pleaded for scientists and economists to overcome their language barriers to ensure the conservation of biodiversity [24]. Although we endorse this plea, the sustainability challenge goes far beyond finding a common language. Indeed, the superficial use of a common language can easily mask incompatible worldviews. Both within and beyond the realm of academia, we must work together to construct conceptual frameworks that foster a deeper understanding of the dynamics of our complex world [25]. Academics can have key roles in initiating, focusing and fostering this discussion, and helping to translate it into behavioral change and policy action. Ultimately, the task of closing the sustainability gap, rather than watching it grow ever larger, must become the core business of all modern societies in the 21st century.

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