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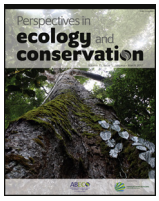

Essays and Perspectives

Ecosystem-based adaptation to climate change: concept, scalability and a role for conservation science

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ABSTRACT

Societal adaptation to climate change requires measures that simultaneously reduce poverty, protect or restore biodiversity and ecosystem services, and remove atmospheric greenhouse gases. Ecosystem-based adaptation to climate change is the type of adaptation that aims to combine these outcomes and is particularly relevant to developing nations that safeguard most of the planetary biodiversity and healthy ecosystems. Although conceptually new, ecosystem-based adaptation is fastly gaining traction both as a research arena and as an integrated policy instrument. This paper aims to revisit this concept and to discuss the science and policy challenges faced by it. It argues that ecosystem-based adaptation is a policy mix that promotes adaptive transition, which is a step towards sustainability transitions. It faces two major challenges in promoting transitions towards adaptation and sustainability. First, research on ecosystem-based adaptation mostly takes place within the socio-ecological systems framework, which is often carried out in isolation from socio-technical systems research. It is widely recognized that both types of research should be integrated, for the benefit of science and policy-making, and the paper discusses the potential of ecosystem-based adaptation in providing such bridge. Second, there is a divide between global and local research and policy, while at local level this divide is related to the setting (e.g., coastal, urban, rural). The resulting mosaic of information lacks integration, which hinders scalability of actions and policies. Finally, I examine the opportunity for ecological and conservation scientists to interact with social, economic and political scientists on ecosystem-based adaptation research, and discuss how timely this opportunity is for Brazil.

Introduction

Even in the most optimistic greenhouse gas emission (GHG) scenarios mean planet temperature is likely to increase at least by 2 °C until the year 2100 (IPCC, 2013). The Paris Agreement to combat climate change adopted in December 2015 under the United Nations Framework Convention on Climate Change (UNFCCC) stipulates that parties will pursue efforts to limit temperature increase to 1.5 °C above pre-industrial levels by 2050. However, even if all national commitments in the Paris agreement are accomplished, mean planet temperature is likely to increase at least by 2.6–3.1 °C until the year 2100 compared to pre-industrial levels (Rogelj et al., 2016). Consequences of a temperature increase equal or beyond 2 °C include ice-melting in the Arctic and glaciers with consequent sea-level rise and continental flooding (Grémillet et al., 2015), negative impacts upon human health (Watts et al., 2015), increased species extinction rates (Urban, 2015), biome shifts (Anadón et al., 2014), marked decline in agriculture productivity (Rosenzweig et al., 2013), and negative impact on energy generation (Vliet et al., 2016). Such bleak future scenarios suggest that carbon mitigation will continue to be relevant and must speed up, but alone will not suffice to halt or circumvent ongoing climate trends. Thus, adaptation strategies are needed to boost resilience of vulnerable socio-ecological systems (for definitions of these and other concepts used in this paper, see the Glossary in Table 1). Nevertheless, the extreme scenarios projected at >2 °C, or even worse at >4 °C, by the end of this century, also suggest that there are limits to adaptation, which is in harmony with the notion that climate change and biosphere integrity are two core planetary boundaries that, if continuously transgressed, may drive the Earth system into a new state, undesirable for humankind (Steffen et al., 2015).

As compared to human systems, there is more abundant and comprehensive evidence of climate-change impacts for natural systems, and the most vulnerable are those that lost a significant

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Table 1
Glossary of terms used across this paper.

Concept	Definition	References
Adaptation	'The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects.'	Field et al. (2014)
Adaptive development	'A form of development that mitigates climate change risks without negatively influencing the well-being of human subjects and ecosystems by using incentives, institutions, and information-based policy interventions to address different components of climate risks.'	Agrawal and Lemos (2015)
Adaptive transition	Pathway towards sustainability transitions that combine processes of transformations in technologies, ecologies, economies, livelihoods and lifestyles, while developing local adaptive capacity. It increases accessibility and adaptability of modern as well as local/indigenous technologies and practices and thus reduces vulnerability.	Pant et al. (2015)
Conventional development	Currently predominant development model, where economy is central and social capital and natural capital are perceived as externalities. Built capital – houses, cars, roads, factories – is the limiting factor in this model.	Costanza (2015)
Green infrastructure	'A network of natural, semi-natural and restored areas designed and managed at different spatial scales (from local to global), that encompasses all major types of ecosystems (marine, terrestrial and freshwater), and that aims to conserve biodiversity, mitigate emissions of greenhouse gases, enable societal adaptation to climate change, and deliver a wide range of other ecosystem services'.	Silva and Wheeler (2017)
Impact	'Effects on lives, livelihoods, health, ecosystems, economies, societies, cultures, services, and infrastructure due to the interaction of climate changes or hazardous climate events occurring within a specific time period.'	Agard and Schipper (2014)
Life supporting systems	The portion of natural systems that provides the physiological necessities of life, such as water, air, nutrients, food.	Folke (1991)
Planetary boundaries	'Scientifically based levels of human perturbation of the Earth System beyond which planetary functioning may be substantially altered. Transgression of such boundaries creates substantial risk of destabilizing the Holocene state of the Earth System in which modern societies have evolved.'	Steffen et al. (2015)
Policy mix	Interactions and interdependencies between different policies as they affect the extent to which intended policy outcomes are achieved.	Flanagan et al. (2011)
Resilience	The capacity of systems (natural and human) to cope with hazardous events responding or reorganizing so that structure, function and identity are maintained, while capacity for adaptation, transformation and learning is also maintained.	Field et al. (2014)
Socio-ecological systems research	'How resource dependent society interacts with nature to develop an adaptive capacity in response to various shocks and stresses' (e.g., climate change, extreme events, biodiversity loss, and desertification).	Pant et al. (2015)
Socio-technical systems research	'Science-society interactions for effective change management, such as transitions to low carbon systems of ecological farming, plant-based diets, ecotourism and renewable energy, in response to unprecedented social and environmental impacts of industrialization in developed countries.'	Pant et al. (2015)
Sustainable adaptation	'Adaptation measures that also contribute towards social equity and environmental integrity.'	Brown (2011)
Sustainable development	A type of development whereby the Earth, its ecosystems, and its people interact towards the mutual benefit and sustenance of all, at multiple scales, and over succeeding generations. What is considered sustainable may vary in space and time throughout a given transition process towards sustainability.	Spangenberg (2011)
Sustainability science	Focuses on understanding the complex dynamics that arise from interactions between human and ecological systems. It "requires collaboration between perspectives in developed and developing human societies, among theoretical and applied scientific disciplines, and must bridge the gap between theory, practice, and policy."	Clark (2007), Bettencourt and Kaur (2011)
Sustainability transitions	Transformation process by which traditional systems shift to more sustainable modes of production and consumption. It is multistakeholder, multidimensional, and often operates in the long-term.	Markard et al. (2012)
Vulnerability	Propensity or predisposition of a given system (natural or social) to be adversely affected by a given driver. In the case of climate change, types of driver include climate variability, extremes and hazards.	Burkett et al. (2014)

portion of their life supporting systems (IPCC, 2014). For human systems, the IPCC recognizes that the poor people are the most vulnerable to climate impacts (Fisher et al., 2014; Magrin et al., 2014). Indeed, one of the main conclusions of the Working Group II in the fifth assessment report of the IPCC (2014) is that practices that promote sustainable development in the present – by combining social justice, environmental health and economic productivity – reduce future risks imposed by climate change and are thus adaptive. Starting from this premise, the question is how a given society moves from a conventional development pathway to sustainable development. This paper's argument is that ecosystem-based adaptation to climate change (EbA) is a key instrument to drive such transition to sustainability and that it is as much a political challenge as it is a scientific and technological endeavor. It has three central objectives: (1) to add precision to the definition of EbA, by bridging literature on climate change adaptation and literature on sustainability transition; (2) to discuss how EbA research and policy moves from local to global and vice versa; and (3) to discuss the need for conservation scientists to adhere to the EbA research and policy agenda. Finally, we use Brazil as an example of the opportunity for sustainability transition that EbA might represent to a developing country rich in natural wealth.

Issues with a new concept

Table 2 shows various definitions of EbA, but clearly the one used by the United Nations' Convention of Biological Diversity (CBD, 2009) is the most widely adopted: the use of biodiversity and ecosystem services (BES) *as part* of an overall adaptation

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