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Twenty years of ecosystem services: How far have we come and how far do we still need to go?

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ABSTRACT

It has been 20 years since two seminal publications about ecosystem services came out: an edited book by Gretchen Daily and an article in *Nature* by a group of ecologists and economists on the value of the world's ecosystem services. Both of these have been very highly cited and kicked off an explosion of research, policy, and applications of the idea, including the establishment of this journal. This article traces the history leading up to these publications and the subsequent debates, research, institutions, policies, on-the-ground actions, and controversies they triggered. It also explores what we have learned during this period about the key issues: from definitions to classification to valuation, from integrated modelling to public participation and communication, and the evolution of institutions and governance innovation. Finally, it provides recommendations for the future. In particular, it points to the weakness of the mainstream economic approaches to valuation, growth, and development. It concludes that the substantial contributions of ecosystem services to the sustainable wellbeing of humans and the rest of nature should be at the core of the fundamental change needed in economic theory and practice if we are to achieve a societal transformation to a sustainable and desirable future.

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1. Introduction

1.1. Scope and ambition

Twenty years ago, two seminal publications about ecosystem services came out: an edited book by Gretchen Daily (1997) and an article in *Nature* on the value of the world's ecosystem services (Costanza et al., 1997). These publications kicked off an explosion of research, policy, and applications of the idea, including the establishment of the journal *Ecosystem Services* (Braat and de Groot, 2012). This article first traces the history leading up to these publications and the subsequent debates, research, institutions, policies, on-the-ground actions, and controversies they triggered (Section 1.2). It then summarises and evaluates a set of publications on key issues: definitions (Section 2), classification (Section 3), valuation (Section 4), research topics (Section 5.1), integrated modelling (Section 5.2), institutions and programmes (Section 5.3), and the evolution of institutions and governance innovation (Section 6). Finally, it provides recommendations for the future (Section 7). The major thread connecting the sections is the "evolutionary history" of the topics. Given this scope, the paper is of necessity a hybrid. It combines elements of a research review, stock taking, and our opinions about the way forward. We have identified where we voice our opinions versus the results of research. In particular, we have focused on what we think are the weaknesses of the mainstream economic approaches to valuation, growth, and development.

1.2. A short history of ecosystem services and natural capital pre-1997

The term 'nature's services' first appeared in the academic literature in a 1977 paper in *Science* by Walter Westman titled 'How Much Are Nature's Services Worth?' (Westman, 1977). The synonymous term 'ecosystem services' first appeared in Ehrlich and Ehrlich (1981) and more systematically in Ehrlich and Mooney (1983). However, related ideas had been brewing in the academic literature for decades, and one could argue that the idea that natural systems provide benefits that support human wellbeing is as old as humans themselves. Gómez-Baggethun et al. (2010) provide a more detailed history of the ecosystems services concept, focusing on its economic roots. Braat and De Groot (2012) summarised the history of the concept tracing the disciplinary backgrounds, both in economics and ecology and the synthesis in ecological economics.

What changed in the second half of the 20th century was that the loss of these ecosystem services became much more apparent, as natural capital was quickly being depleted (Beddoe et al., 2009). There was also a growing understanding of ecology, especially the ecology of whole ecosystems, and of the non-market value of natural amenities. Seminal publications in the 1960–1980 period include: Boulding (1966), Daly (1968), Ayres and Kneese (1969), Odum (1971), and Freeman et al. (1973).

For some time, these two streams of work proceeded in parallel, with limited contact and cross-fertilization: the ecosystem ecology community, on the one hand, and the environmental and resource economics community, on the other. Then, in the 1980 s, a new transdisciplinary field known as 'ecological economics' was established (Jansson, 1984; Costanza, 1989) with a view to bridging the gap between these two communities, while also embracing other strands of research, including psychology, political science, and earth system sciences as well as connecting academic work with practice and traditional knowledge (de Groot 1987; Braat 1992; de Groot 1992). Ecosystem services were an explicit part of the research agenda of ecological economics from the beginning (Costanza et al., 1991).

A key event in the history of ecosystem services was a meeting in October 1995 of Pew Scholars in Conservation and the Environment in New Hampshire. This group included Jane Lubchenco, Stephen Carpenter, Paul Ehrlich, Gretchen Daily, Hal Mooney, Robert Costanza, and others. The meeting was organized around the idea of producing an edited book on ecosystem services. Gretchen Daily was invited to be the editor and twenty-one chapters were assigned to over thirty authors. This book was eventually published as *Nature's services: societal dependence on natural ecosystems* (Daily, 1997). The chapters covered definitions, history, economic valuation, overarching services like climate and biodiversity, services from specific biomes including marine, freshwater, forests, and grasslands, and case studies in specific ecosystems including wetlands and South African fynbos.

During the meeting, Robert Costanza proposed the idea to synthesize all the information being assembled into a quantitative global assessment of the value of ecosystem services. The NSF-funded National Center for Ecological Analysis and Synthesis (NCEAS) was just getting underway in Santa Barbara, California and Steve Carpenter, who was at the PEW meeting and on the NCEAS advisory board at the time, suggested that NCEAS might be a good place to host a workshop aimed at undertaking this synthesis. A proposal was accepted and the workshop, titled 'The Total Value of the World's Ecosystem Services and Natural Capital', was held on 17–21 June 1996 with 13 participants (including several of the co-authors of this article) representing a range of natural and social sciences. The synthesis was a 'meta-analysis' of all existing literature on seventeen ecosystem services across sixteen biomes, using a basic value transfer technique that assumed a constant value per