Sustainability Science

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Editors

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The Emerging Paradigm and the Urban Environment

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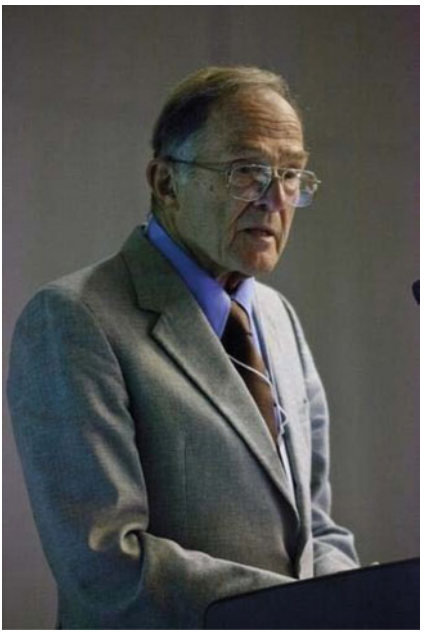

Photo by Mike Peters/Montclair State University

This book is dedicated to Robert W. Kates, a pioneer in Sustainability Science who inspired a generation of systems thinkers.

Preface

Balancing human needs with the ability of ecosystems to provide the goods and services that we all depend on is a fundamental formula for the global sustainability transition (Fig. 1). Equilibrium can be attained either by increasing these goods and services or by reducing our consumption of them, or in today's world, both!

Furthermore, demographic shifts and new patterns of settlement have placed unprecedented pressures on human well-being, ecosystem functions, and the interactions between them. Society has yet to adequately address the challenges of diminishing resources, i.e., by facing challenges that make sustainability more feasible technologically, and simultaneously more difficult politically and economically. First, there has been a dramatic growth in per capita domestic product in many regions of the globe and an increased ability to meet human needs. Second, despite recent successes in decreasing harmful consumption per unit value of product, worldwide consumption of energy and other natural resources in industrialized nations continues to accelerate (Kates and Parris 2003; Brown et al. 2011).

Authorities worldwide have called for the prioritization of uses in order to minimize conflicts, protect resources, and ensure that all uses are compatible with sustainability goals. The public interest is addressed through recommendations to balance long- and short-term strategies with greater decentralization of governance to regional and local levels. Ecosystem-based management has been widely advocated as a central organizing principle for addressing land-use impacts holistically and reconciling multiple use conflicts at different geographic scales. Nevertheless, academicians, governance organizations, decision-makers, and the general public have yet to confront one very real issue:

> Where multiple desirable but competing objectives exist, it is not possible to maximize each…[and] in any system with multiple competing objectives, it will not be possible to meet every one.
>
> United States Commission on Ocean Policy 2004

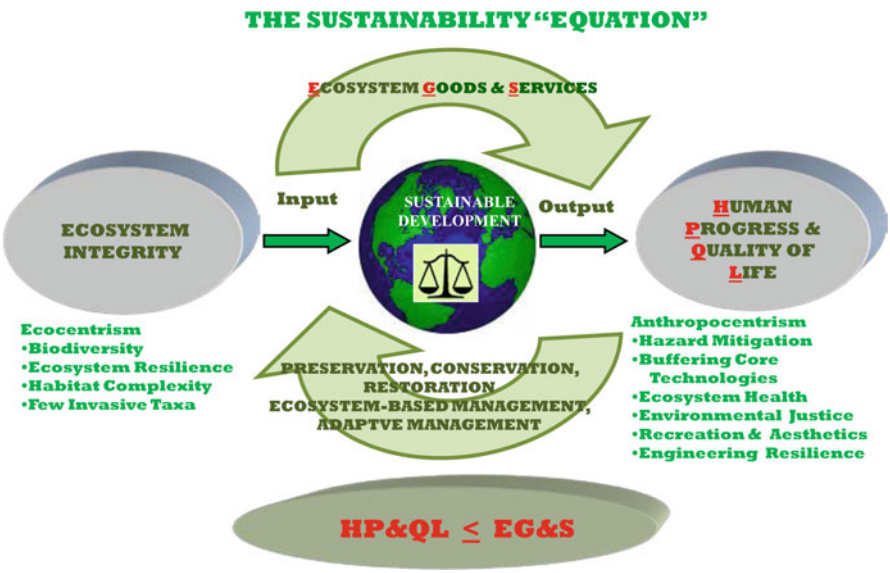

Fig. 1 The "Sustainability Equation" balancing human needs with ecosystem integrity

Any solution to the emerging conflicts arising on the path to long-term sustainability will, in part, require the integration of the biophysical and social sciences into a new transdisciplinary science that we refer to as "sustainability science,"[1] continued development and refinement of a number of new approaches and concepts including a systems approach to problem-solving, social learning, resolution of the "paradox of the dual mandate,"[2] and enhanced incorporation of human dimensions into resource management.

There is a growing awareness that the intractability of environmental problems can be explained in part by the social context in which they arise. When perceptions of a problem vary broadly, and when there is uncertainty in the scientific assumptions and outcomes that underlie the process, then a consensus is difficult to achieve. Under such circumstances, tensions can arise among stakeholders (Fig. 2), even

[1] There are many definitions of sustainability science; the National Academy of Sciences through its Proceedings offer the following: "…an emerging field of [transdisciplinary] research dealing with the interactions between natural and social systems … how those interactions affect the challenge of sustainability: meeting the needs of present and future generations while substantially reducing poverty and conserving the planet's life support systems."

[2] Whereas complexity, interdependence, high levels of uncertainty, unpredictability, and dynamism characterize natural systems—traits that prevent competitive dominance by any one species—human-dominated systems require predictability and stability to ensure uninterrupted provision of resources for human use. The paradox of the dual mandate arises from the need to reconcile society's desire to preserve, restore, and rehabilitate natural ecosystems while at the same time ensuring the provision of reliable, predictable, and stable supplies of goods and services at a time of escalating demand (Roe and van Eeten 2001; Berkes 2006).

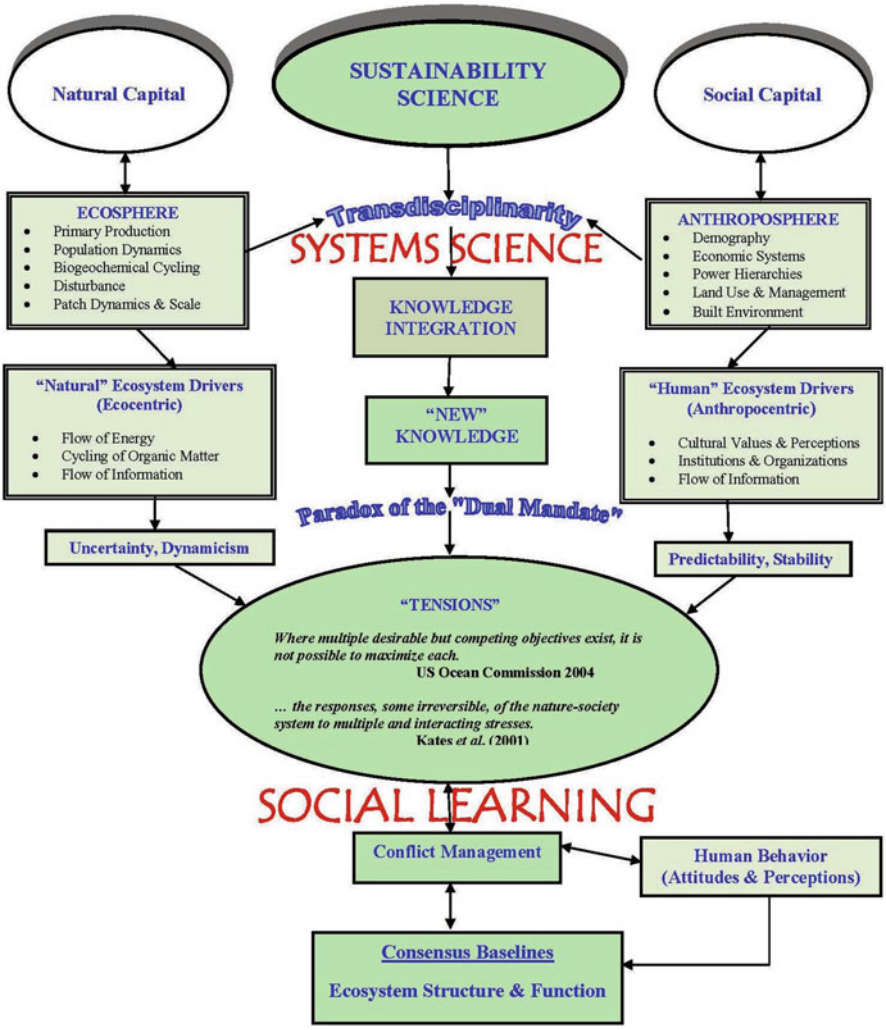

Fig. 2 (modified from Weinstein 2009) A conceptual framework for achieving the sustainability transition through the integration of the natural and social sciences in a transdisciplinary, systems approach to managing natural and social capital. Developing "new knowledge", changing human behavior and perceptions through a lens of social learning, and achieving consensus on how to effectively manage ecosystems for sustainability will be consummated through the emerging discipline of Sustainability Science and Conflict Management. Resolution of the "paradox of the dual mandate"—reconciling society's desire to preserve, restore, and rehabilitate natural ecosystems while at the same time ensuring the provision of reliable, predictable, and stable supplies of goods and services—will be a key component of any future success

when all are committed to sustainable development (Weinstein et al. 2007). This understanding of the social character of environmental problems has focused the attention of researchers, stakeholders, and policy-makers on the important role of governance, participation, and collaborative decision-making in better managing, if

not solving, environmental problems. The human dimensions of natural resource management incorporate the ways people affect, value, utilize, and benefit from ecosystems (Salz and Loomis 2005). While ecological considerations are essential, the successful implementation of sustainable management depends on, and is driven by, societal values. We need a better understanding of the human-induced causes and social drivers of environmental change and how human behavior can be made to coincide with environmental and social priorities.

Although political, economic, and social systems make up the human dimensions of natural resource management, natural resource values originate in only the social system (Kennedy and Thomas 1995; Ayensu et al. 2003). These values are manifested as environmental laws, national and local budgets, volunteerism, voting behavior, and management decisions and largely determine the fate of the natural systems that sustain societies. Implicit in the human dimensions approach is not whether ecosystems will persist—they will—but rather what trade-offs will be struck and what kinds of ecosystems will be desired by individual social groups, based on their demographics, cultural identity, and existing and expected resource requirements. The present scenario is one in which issues tend to be treated in isolation, instead of being considered as part of an integrated system, and broad-scale decisions are generally avoided. Accordingly, policy-makers may too easily avoid the trade-offs and there are therefore many conflicts and few solutions.

Difficult Choices

Most citizens now recognize that natural resources are not inexhaustible, and an international call for fundamental shifts in governance, political will, and resource management is underway. The challenges we face in the move towards global sustainability are substantial and often underappreciated:

1. The complexity of natural systems precludes a reductionist experimental approach to management. Moreover, the scale of large ecosystems make controlled and replicated experiments virtually impossible. Consequently, our "imperfect science" and the effects of natural variability and uncertainty lead to an inability to reach consensus and accurately predict the environmental consequences of our actions. We are often left with a wide range of opinions on the issues (Ludwig et al. 1993).
2. With acquired wealth comes political and social power that is often used to promote further unlimited exploitation of natural resources (Ludwig et al. 1993).
3. Traditional demography and economics do not incorporate sufficient appreciation of environmental principles. Furthermore, ecologists tend to disregard human influence and instead concentrate on ecosystem function and dynamics. Numerous authors have suggested that the failure to agree on a collective vision of how to attain sustainability lies in the limitations and disconnects among disciplines (Kaufman and Cleveland 1995; Holling 2000; Clark and Dickson 2003; McMichael et al. 2003; Naveh 2005).

4. Anthropocentrism and the "we versus them" mentality stemming from the "arrogance of humanism" is a concept that expresses humankind's faith in its technology to manage nature so that all can prosper (Ehrenfeld 1981). In anthropocentric terms, humans have the "right" to control the natural world for the benefit of humanity. Even a cursory examination of the published literature reveals the sometimes large divide between ecocentrists and anthropocentrists, scholars and practitioners, functionalists and compositionalists (Callicott et al. 1999), environmental organizations and industry, commercial and recreational fishermen, public and government, etc. (Weinstein and Reed 2005). Thus, the ultimate compromises and sacrifices required—a distasteful concept to many, and possibly the root cause of the "we versus them" mentality that pervades sustainability management—will be necessary to accommodate human needs. Thomas Friedman (2007) stated this idea succinctly: "if you think we can deal with these huge problems without asking [the American] people to do anything hard, you're a fool or a fraud." Successfully balancing the demands of competing uses is perhaps the greatest challenge we face.

In the end, the successful transition to sustainability rests on a complex infrastructure that translates science-based information into public policy. This, in turn, elicits effective responses from society at large (Baird 2005). It is the performance and long-term capacity of this diverse array of entities (including scientific and educational institutions) from global to local scales that will ultimately determine the tempo and mode of the transition. Our fate rests in societal action involving all stakeholders, consensus building, and accepting the compromises and sacrifices that will ensure environmental and social justice for all. We hope that this book will contribute towards those goals, and quickly!

This book is organized into five thematic sections and an Epilogue; a summary of which precedes each compilation of chapters: Part I. Managing the Earth's Life Support Systems: The Emergence of Sustainability Science and Transdisciplinarity; Part II. Balancing Ecology and Economy: Natural Capital and Quality of Life; Part III. From Science to Policy: Managing the Commons, Social Learning, and Social Responsibility; Part IV. The Ecology of Cities; Part V. Restoring and Rehabilitating Ecosystems: Return from the Precipice; and Epilogue: The Challenge of Sustainability—Lessons from an Evolutionary Perspective. Key topics address emerging research and policy in (a) sustainability science, (b) the ecology *of* cities, (c) landscape ecology—scale, spatial patterns, organizational levels, and ecological processes, and (d) related topics in resource exploitation and management, ecosystem health and habitat restoration, the valuation of natural and social capital, habitat and biodiversity conservation, social learning, ecosystem-based management, and integrated watershed-coastal zone management.

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