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Review

Rethinking Sustainable Development Using Deep Ecology and Adaptive Governance of Social-Ecological Systems: Implications for Protected Areas Management

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Abstract: Since the late 1980s the idea of sustainable development has been gaining widespread recognition as a guiding framework for policies on development and the environment. However, the concept of sustainable development has received a number of criticisms, including its over-emphasis on meeting human needs through economic growth, as well as its failure to recognize dynamic human-environment interactions. In response to these shortfalls, the concepts of resilience and adaptive governance have emerged as alternative perspectives for pursuing sustainable development. Resilience in social-ecological systems emphasizes the capacity of coupled human-environment systems to deal with change while continuing to develop. Adaptive governance relies on diverse and nested institutional mechanisms for connecting actors across multiple scales to manage conflicts and uncertainties in ecosystem management processes. However, the ethical dimensions of resilience and adaptive governance have not received enough attention. A promising ethical perspective for guiding policies on human-environment interactions is the philosophy of deep ecology which highlights the need for recognition of the intrinsic values of all living things, as well as the nurturing of ecological and cultural diversity. We argue that an integration of the principles of deep ecology and adaptive governance provides a complementary set of ethical principles and institutional attributes that offers better prospects for pursuing sustainable development in the era of the Anthropocene. The implications of this integrative agenda include: adoption of a holistic conception of dynamic human-environment interactions; recognition of diverse knowledge systems through an anti-reductionist approach to knowledge; promotion of long term sustainability through respect for ecological and cultural diversity; and embracing decentralization and local autonomy. We further illustrate this integrative agenda using the management of protected areas as a case study.

Keywords: Anthropocene; resilience; social-ecological systems; sustainability; transitions; wilderness

1. Introduction

In recent years, there is growing recognition of the emergence of the era of the Anthropocene in which humanity has become the dominant driver of global environmental change [1-3]. Moreover, there is growing awareness that the acceleration of anthropogenic pressures on the earth system presents an increased risk of abrupt, non-linear and irreversible changes in the dynamics of the earth system with potential adverse implications for human well-being and ecosystem health [4-6]. These planetary dynamics in the era of the Anthropocene can be explained from the resilience and complex social-ecological systems perspectives that describe the dynamic and co-evolving interactions between social and ecological systems across multiple spatial and temporal scales [7-9]. In view of

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these insights, the concept of sustainable development as a guiding principle for the stewardship of the earth system is of relevance now more than ever [1-3,10,11].

It has been posited that achieving sustainable development in the era of the Anthropocene requires the use of innovative governance mechanisms that are multi-level and polycentric as opposed to the reliance on conventional top-down institutions [1]. In this regard, adaptive governance of social-ecological systems is increasingly seen as a promising institutional mechanism for promoting sustainable development at global, regional, and local scales [4,7,9]. Adaptive governance refers to flexible multi-level institutions that connect actors across multiple levels to facilitate ongoing learning and responding to conflicts and uncertainties in ecosystem-based management processes [12-14]. However, the ethical foundations of adaptive governance regimes have not received much attention in the resilience literature [15]. With the exception of a few studies [11,16-18], ethical considerations in the broader literature on social-ecological systems research have not received adequate research focus.

A promising ethical perspective that has the potential to inform current sustainability efforts at various levels from the local to the global is deep ecology [19-21]. Deep ecology is a philosophy that is informed by a holistic conception of human-environment relationships and offers an ethical prescription that emphasizes the intrinsic value of all members of the biotic community, as well as the need to nurture the diversity of ecological and cultural systems [22,23]. While the deep ecology perspective offers promise as a guide for long term sustainability, the institutional mechanisms for operationalizing these ethical principles have not been well-developed [22].

In this paper, we argue that the integration of deep ecology and adaptive governance of complex social-ecological systems provides a coherent set of institutional attributes and ethical considerations that holds promise for promoting sustainable development in the era of the Anthropocene. The integration of the principles of deep ecology and adaptive governance draws attention to a holistic conception of human-environment interactions, an anti-reductionist approach to knowledge, emphasis on diversity of cultures and ecosystems, and promotion of decentralization and local autonomy. We illustrate this argument using the management of protected areas.

2. Sustainable Development

The idea of sustainability has a long-standing history in the field of natural resource management where concepts, such as preservation, conservation, sustained yield, and carrying capacity have guided resource management efforts since the early twentieth century [24,25]. The application of the sustainability concept to the field of development planning began in the 1980s in response to growing awareness of the neglect of environmental and social issues in conventional development practices by national governments and international development agencies [25-28]. The origins of the sustainable development concept have been traced to two main sources [29]. One is the 1972 United Nations (UN) Conference on the Human Environment in Stockholm which was the first to acknowledge the conflicts between economic growth and the environment. The other source is a report, "World Conservation Strategy," prepared by the International Union for the Conservation of Nature (IUCN) in 1980 which called for the sustainable development and use of ecosystems. The IUCN report is widely regarded as the first to introduce the concept of sustainable development [24,30].

In the report, "Our Common Future" (the Brundtland Report), the World Commission on Environment and Development (WCED) defines sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" [31] (p. 43). The Brundtland Report identifies two key underlying components of the definition. One is the satisfaction of basic human needs and aspirations, such as food, clothing, shelter, and jobs. Consistent with the basic needs strategy of development that aims at providing opportunities for the full development of the individual [26,32], the report posits that "Sustainable development requires meeting the basic needs of all and extending to all the opportunity to satisfy their basic aspirations for a better life"[31] (p. 44). The report argues that when basic needs are not met, poverty and inequality pose threats to the environment. It, therefore, recommends economic

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growth as a necessary strategy to expand society's production capacity and to create equitable opportunities for all to meet their needs. The other component of the definition of sustainable development is the recognition of limits in the ability of the environment to meet the needs of present and future generations. The Brundtland Report notes that society's ability to meet the needs of present and future generations is compromised when resources are overexploited. For renewable resources, such as forest ecosystems, the report suggests the use of maximum sustained yield as a guiding principle to avoid exceeding resource carrying capacity. For non-renewable resources, such as fossil fuels, the report recommends the use of available technology to minimize resource depletion and to explore the availability of substitutes.

In all, the Brundtland Report identifies a number of strategies for achieving the social, economic and ecological goals of sustainable development: reviving economic growth, especially in the Least Developed Countries as a means of increasing the production potential; changing the quality of economic growth to ensure more equitable opportunities and less adverse ecological impacts; meeting essential human needs, such as food, energy, water, sanitation, and employment; ensuring a sustainable level of human population; and conserving the resource base by applying sustained-yield principles to avoid crossing ecological limits. Other strategies include managing technological risk; and integrating economic and ecological concerns in decision-making processes [24,31]. While the sustainable development concept has received broad-based support over the years, it has also received sustained criticisms. These include a lack of conceptual clarity; separation of social, ecological and economic components; inadequate recognition of the dynamic interactions between humans and nature; lack of clear ethical foundations; over-emphasis on human needs; and inadequate consideration of the diversity of cultures and needs [24,28,33-35].

Since the publication of the Brundtland Report, several international conferences have been held to further develop the sustainable development agenda. The UN Conference on Environment and Development (the Earth Summit) was held in Rio de Janeiro in 1992. That summit resulted in the adoption of a number of international conventions, including Agenda 21 which aims at promoting grassroots participation and cooperation as one of the key strategies for achieving sustainable development [27]. In 2002, the World Summit on Sustainable Development, held in Johannesburg, South Africa, reaffirmed the relationship between human well-being and ecosystem health in the sustainable development agenda and led to the adoption of the Millennium Development Goals (MDGs), including the eradication of extreme poverty and hunger, promotion of universal primary education, improvement in maternal health, and promotion of environmental sustainability [30,36]. During the 15-year implementation period of the MDGs, significant progress was made toward reducing hunger, poverty and disease in the developing world, although the progress was variable across goals, countries and regions [2,37]. In a report on the MDGs, the then UN Secretary General, Ban Ki-Moon, called for greater political will and better integration of the social, economic, and ecological aspects of sustainable development [37]. At the UN Conference on Sustainable Development, held in Rio de Janeiro (Rio + 20) in 2012, the need for new Sustainable Development Goals to replace the MDGs was highlighted [10]. At the 2015 UN Sustainable Development Summit in New York, the Sustainable Development Goals (SDGs) were finally adopted. The 17 development goals address a range of challenges including poverty, food, energy, and water security, as well as climate change [38]. However, recent analysis suggests the SDGs may have inherited some of the shortfalls associated with the Brundtland Report, such as an over-emphasis on market-based approaches to economic growth and lack of cross-sectoral integration [35,39].

3. An alternative Paradigm for Sustainable Development: Panarchy and Social-ecological Resilience

In recent decades, there is growing awareness that most of the conservation challenges facing resource managers in the field of forestry, fisheries and other resource management arenas stem from a failure to recognize the dynamic interdependence between social and ecological systems [40,41]. In view of these insights on the failure of past policies, the conventional paradigm that assumed stability and predictability of ecosystems is increasingly being questioned and rejected in

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favor of an alternative paradigm that posits that social and ecological systems are intricately interconnected as coupled social-ecological systems and that it is unreasonable to try to study or manage the two as separate entities [41,42]. The dynamics of coupled social-ecological systems have been described using the attributes of complex adaptive systems, such as scale, thresholds, nonlinearity, emergence, surprise, heterogeneity, and path-dependency [40,43-45]. These dynamics can be modeled using the concepts of adaptive cycles and panarchy [46]. The concept of adaptive cycles departs from conventional assumptions on the stability and equilibrium of ecosystems by positing that dynamic social and ecological systems pass through four phases that comprise growth and exploitation, conservation, collapse, and reorganization [47]. Panarchy is a grand theory that depicts complex social-ecological systems as interactions among adaptive cycles that are nested across multiple scales [46]. Within the panarchy, collapses of smaller and faster adaptive cycles have the potential to trigger cascading effects across the entire panarchy. Similarly, larger and slower adaptive cycles at higher levels have a conditioning effect on the smaller and faster adaptive cycles below [48,49]. These dynamic cross-scale interactions account for the balance between change and stability in social-ecological systems [50].

The sustainable management of complex social-ecological systems requires building resilience to change and surprise [7,51-53]. The resilience concept has its origins in the field of ecology in the 1960s and 1970s [54]. As opposed to traditional ecological assumptions of ecosystem stability around a single equilibrium, the resilience concept explains ecosystem dynamics based on the assumption of the existence of multiple stable equilibria. Based on this assumption, resilience is the amount of disturbance a system can absorb before shifting to another state [47,54,55]. In complex social-ecological systems, the resilience concept refers to the capacity to cope, adapt and transform in response to drivers of change [51,56,57]. Coping refers to short-term responses by individuals and groups aimed at reducing the adverse impacts of drivers of change [56]. Adaptation refers to the processes by which social-ecological systems learn and adjust to external drivers and internal processes in order to take advantage of opportunities for continued development along the current trajectory [41,56]. Transformation entails the ability to initiate change that involves crossing critical thresholds into new development trajectories when existing social, economic and ecological conditions become unsustainable [41,58,59]. All these three types of social-ecological responses appear to require various combinations of capital assets and institutions [57].

The requirements for transformational change in social-ecological systems have been receiving particular attention in the literature in recent years, as the need for such change is increasingly seen as essential for the attainment of sustainable development in the Anthropocene era [8,41,52]. Growing evidence suggests that critical factors influencing transformational change in social-ecological systems include crises, windows of opportunity, leadership, incentives, enabling legislation, and arenas for deliberation [12,41,60-62]. Navigating change in social-ecological systems requires institutions for connecting social and ecological systems across scales.

4. Institutional Requirements: Adaptive Governance of Social-ecological Systems

The growing knowledge on the uncertainties and conflicts resulting from the complex cross-scale interactions in social-ecological systems and the influence of external drivers of change present a number of challenges for the design of effective institutions for the sustainable governance of social-ecological systems [51,63,64]. One of the major challenges is the design of institutions with the capacity to provide the knowledge and incentives for learning and experimentation processes in adaptive ecosystem-based management [7,54]. Also, in view of the increased emphasis on transformational capacity in recent years, the design of institutions for social-ecological governance need to account for the broader processes of social-ecological change [50,65]. Moreover, recognition of the importance of scale and problems associated with scale mismatch in conventional resource management policies call for the design of multi-level institutions capable of enhancing the fit between various components of social and ecological systems across multiple scales [7,40,66]. Conventional top-down institutions that rely on reductionist scientific knowledge to achieve narrow

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sectoral goals based on assumptions of stability and equilibrium are ill-suited for meeting these challenges [9,12,67].

To address these governance challenges, adaptive governance of social-ecological systems [63,68,69] has been receiving attention among researchers and policy-makers as a promising alternative to conventional resource management approaches. Adaptive governance refers to flexible and collaborative learning-based governance mechanisms that connect individuals, organizations, and institutions across multiple scales in ecosystem-based management of land and water resources [13,14,70]. The focus of adaptive governance regimes goes beyond the narrow emphasis on the resource management arena toward consideration of the broader social and institutional context within which resource management occurs [68,71,72]. In this regard, [73] build on [63] to define adaptive governance as "a process of dealing with complexity and change under uncertain conditions that are difficult to control, involving diverse interest, and reconciling conflict among people and groups who differ in values, interests, perspectives, and power, and the kinds of information they bring to situations" (p. 2). This makes adaptive governance an appropriate mechanism for managing the wicked problems that are entailed in the implementation of adaptive management and ecosystem management [45,69,74]. Adaptive governance is also seen as an effective mechanism for promoting transformational change in social-ecological systems when existing conditions become undesirable [54,70,75,76].

The key features of adaptive governance have received considerable attention in the resilience literature and they include: recognition of change and uncertainty; integration of diverse sources of knowledge; promotion of integrative and adaptive management goals; and reliance on diverse and nested institutional structures within polycentric systems [9,45,63,68,69]. These attributes of adaptive governance could help overcome the conceptual and implementation shortfalls associated with current approaches to promoting sustainable development, such as the neglect of complexity, lack of integrated goals, dominance of science and technology, and overreliance on top-down decision-making. In spite of its promise, a number of knowledge gaps continue to limit the widespread adoption of adaptive governance regimes. Notable among these knowledge gaps is the neglect of the ethical foundations for adaptive governance regimes [15]. [11] have highlighted the need for embracing attitudes and worldviews that support the active stewardship of ecosystem processes as a key component of mechanisms for realizing the sustainable development agenda. In the next section, we contribute to the discussion on the ethical aspects of adaptive governance by drawing from insights on deep ecology.

5. Deep Ecology, Adaptive Governance, and Sustainable Development

Since the birth of the field of environmental ethics in the 1970s, several ethical perspectives have emerged to explore human-environment interactions. Among them, deep ecology is probably the most widely known [77]. The term deep ecology was coined by the late Norwegian Philosopher, Arne Naess in a paper titled "The Shallow and the Deep Long Range Ecology Movements" published in the journal Inquiry in 1973. The idea was further developed with contributions from Bill Devall and George Sessions among others [22]. [78] made a number of distinctions between his proposed deep ecology and the conventional approach to development and the environment, which he referred to as shallow ecology. In this section, we argue for the integration of deep ecology and adaptive governance by highlighting their shared assumptions and goals, as well as knowledge and institutional prescriptions. In doing this, we also show how these shared attributes of deep ecology and adaptive governance differ from, and offer an alternative to the conventional approach to sustainable development which exhibits the attributes of shallow ecology.

Assumptions about Human-nature Relationships

At the metaphysical level, shallow ecology is based on the mechanistic view of humans as separate from their environment, and the world as composed of discrete, atomistic entities [79]. Consistent with this characterization, a major criticism of the sustainable development agenda as proposed in the Brundtland Report is its failure to fully appreciate the complexity and uncertainties

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that characterize human-environment relationships. Following that report, social, economic, and ecological systems are conceptualized as separate but interconnected components representing the three pillars of sustainable development [3,11]. This conceptualization has been critiqued for failing to recognize the diversity of societies, economies, and ecosystems across scales, separating human activities from the natural environment, and also reinforcing a static view of the relationships between humans and nature [33,80].

In contrast with these shallow ecological assumptions that underpin the conventional approach to sustainable development, deep ecology is informed by a "rejection of the man-in-environment image in favor of the relational total-field image" [81] (p. 3). The relational, total-field holism of deep ecology posits that "there is no firm ontological divide in the field of existence. In other word, the world simply is not divided up into independently existing subjects and objects, nor is there any bifurcation in reality between the human and nonhuman realms" [79] (p. 157). From this perspective, humans are not separate from, or above nature but part of a complex web of relationships in a constant state of flux [21,23,77,82]. Following from this, deep ecology also maintains the possibility for humans to extend their self-identification to include others [23]. Such an expanded definition of the self is necessary for achieving the state of self-realization [77]. As Palmer [23] (p. 31) succinctly noted, "If everything is part of ones' self, and one is aiming at self-realization (which deep ecologists argue to be the case) then the clear conclusion to be drawn is that the realization of all (living) organisms is necessary for one's own full self-realization."

In line with deep ecology's holistic and dynamic conception of human-nature interactions, the adaptive governance approach is informed by the view of social and ecological systems as integrated complex adaptive social-ecological systems that shape each other in a co-evolutionary fashion across space and time [9,43]. Panarchy theory suggests that the dynamic cross-scale interactions among adaptive cycles in social-ecological systems give rise to periods of gradual predictable change, as well as occasional abrupt changes that are characterized by high levels of uncertainties [45,49,83]. Adaptive governance provides the mechanisms for managing gradual and abrupt change in such complex social-ecological systems [12,71,84]. Adaptive governance prepares for these uncertainties by relying on adaptive management as a mechanism for building resilience and reducing vulnerability [85]. In active adaptive management, resource management actions are implemented as experiments to test competing policy hypotheses with the aim of generating knowledge about the system [86,87,88,89]. However, because adaptive management has largely been implemented as a technical resource management approach that fails to adequately recognize social and institutional considerations [69,90-92], adaptive governance provides an appropriate institutional context for the successful implementation of adaptive management [75,89,93].

Conservation and Development Goals

Ethically, shallow ecology is informed by an anthropocentric or human-centered perspective that views humans as the source of all values and assigns instrumental values to nonhuman natural entities based on their usefulness as means to meeting the needs of humans [22,77,94]. Arne Naess used anthropocentrism to refer to "the tendency to look at nonhumans and the ecosphere in general from the point of view of narrow utilitarianism, a devaluation of anything but humans and a focus on their narrow, shallow interests, not their deep ones" [95] (p. 231). For instance, a central emphasis of the Brundtland Report is the promotion of economic growth as a strategy for meeting basic human needs and improving upon environmental conditions [24,31,96]. However, the capacity of the earth's ecosystem to support the rate of economic growth recommended in the Brundtland Report has been questioned [96]. This over-emphasis on economic growth has also been identified as a shortfall in the SDGs [39]. As a result, the sustainable development agenda has been critiqued for adopting an anthropocentric perspective that prioritizes human needs over the value of other forms of life [33,97]. The shortfalls associated with the lack of integrated approaches to sustainable development are best illustrated in policies on food, energy, and water resource systems where the pursuit of narrow sectoral approaches have often resulted in adverse consequences that threaten food, energy, and water security [98-100].

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In contrast, deep ecology is non-anthropocentric in its orientation, as it recognizes the intrinsic values or inherent worth of the nonhuman natural world and considers humans as ordinary members of the biotic community [22]. Deep ecology's deep-seated respect for all forms of life is expressed in the principle of biospherical egalitarianism – the equal right of all to live and blossom [77,81,82]. Based on these principles, deep ecology offers a radical agenda that replaces the ideology of economic growth with ecological sustainability. The goal of long term ecological sustainability entails the protection and sustenance of the richness and diversity of life on earth [79,101]. Socially, deep ecology calls for promoting the diversity of cultures through the removal of all forms of domination, exploitation and suppression [19,81]. From a deep ecology perspective, "cultural diversity is an analogue on the human level to the biological richness and diversity of life forms" [19] (p. 267). Diversity of human cultures and non-human life forms enhances the chances of survival and also contributes to overall quality of life. Policies that erode this diversity also threaten opportunities for self-realization [81].

Similar to deep ecology, the adaptive governance approach addresses the need for adaptive and integrated management goals in the pursuit of sustainable development [14,102]. Adaptive governance regimes provide flexible institutional mechanisms for the implementation of integrated management goals covering the social, economic, and ecological components in ecosystem-based management processes in the face of unpredictability [7,13,65,103]. Ecosystem-based management often involves actors with diverse values and interests as well as competing knowledge claims who are dispersed across various scales. Managing these differences in perspectives calls for mechanisms for conflict management, such as those entailed in adaptive governance processes [63,67].

A key requirement of adaptive governance is analytic deliberation, a process of deliberation among scientists and resource managers that is also informed by scientific analysis [63,104,105]. Analytic deliberation serves as a means of managing conflicting values and knowledge uncertainties, thus making adaptive governance a promising approach for dealing with wicked problems in ecosystem management processes [45,106]. For instance, in their analysis of three case studies on the role of adaptive governance in ecosystem management, [13] found that the adaptive governance approach had led to procedural benefits, such as enhanced capacity for monitoring, communication, and responding to changes, as well as substantive benefits, such as the provision of multiple ecosystem services. The authors identified the role of adaptive governance in these processes to include system-wide knowledge mobilization to create awareness, facilitation of collaboration and negotiation across scales, and utilization of formal and informal institutional mechanisms.

Knowledge Systems

Another distinction between deep ecology and shallow ecology could be made with regard to their epistemological positions on science and technology. Shallow ecology endorses the Cartesian view of the universe as composed of atomistic elements that could be understood through the method of reductionism. As such, shallow ecology engenders the fragmentation of knowledge [22]. The shallow ecological approach also emphasizes the training of experts in the hard sciences to manage the environment in a way that combines economic growth with environmental health. Consistent with this approach, the adoption of Western technology is promoted without regard to differences in cultural context [19]. In the Brundtland Report, the need for technological solutions to emerging problems is strongly emphasized as a requirement for sustainability [31]. For instance, the report endorses the depletion of non-renewable natural resources where technological substitutes are available. This mainstream approach to sustainability has also been critiqued for its overreliance on science and technology, a further reflection of the enlightenment roots of the sustainable development agenda [80]. From the perspective of enlightenment thinkers, such as Francis Bacon and Rene Descates, the purpose of science was to serve as an instrument for the domination and exploitation of nature to ensure human progress [80,107]. The type of science that is promoted from the enlightenment perspective is positivist science that emphasizes the use of quantifiable data to derive generalizable explanations about objective realities [108]. The dominance of positivism has

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contributed to the fragmentation of disciplines and the marginalization of other ways of knowing [80,108]. For instance, policies on climate change mitigation and adaptation have continued to emphasize the search for engineering solutions, thus limiting opportunities for the utilization of the social sciences as well as local and traditional knowledge [109-111].

In view of these shortfalls, recent years have seen a growing appreciation of the knowledge systems of non-Western societies [112]. In line with these trends, deep ecology embraces epistemological pluralism that accommodates scientific and non-scientific ways of knowing, as a means of achieving broader social ideals, such as freedom and quality of life [113,114]. From this perspective, the promotion of cognitive diversity is seen as an integral part of efforts to enhance cultural diversity [113,115]. In this regard, deep ecology endorses a shift from the hard sciences to the soft sciences in a way that advances local and global cultures, promotes a critical analysis of Western technology by non-industrial societies to inform adoption decisions, and promotes culturally-sensitive local soft technologies [19].

Consistent with the deep ecology perspective, there is growing awareness that realization of the SDGs for global sustainability will require the mobilization of knowledge across scales and sectors through collaboration among disciplines, as well as between academics and non-academics [2,116]. In this regard, the adaptive governance approach promotes the integration of diverse sources and types of knowledge, including scientific and local knowledge [63,67,93]. The adaptive governance approach also provides institutional mechanisms for connecting actors within and across scales in promoting knowledge mobilization through social learning and knowledge co-production processes [9,12,14,72]. For instance, in their analysis of three successful case studies on ecosystem-based management, [13] identified the broad mobilization of various types of knowledge among diverse actors, including scientists, farmers, and conservationists through adaptive governance mechanisms as a key ingredient in generating awareness and support for collective responses to the perceived crises in each of the cases.

Institutional Mechanisms

The institutional dimensions of the sustainable development agenda have also received some criticism. [80] describes the emergence of a global "green diplomacy" since the 1972 Stockholm Conference as a mechanism for the implementation of the sustainable development agenda. She defines green diplomacy as "a way of seeing the world from a managerial perspective: a style of negotiating a solution to the problems facing the world that takes as its starting point a view of nature solidly based in Enlightenment thought" (p. x). Green diplomacy represents a top-down institutional mechanism that involves negotiations by government representatives and representatives of international organizations through which agreements are reached on how to address global conservation and development challenges. Global efforts on climate change illustrate the shortfalls of the top-down managerial approach of green diplomacy. Until recently, global efforts to negotiate an international agreement on the mitigation of anthropogenic climate change under the United Nations Framework Convention on Climate Change had gone on for over two decades without resulting in an effective treaty [109,117,118].

Politically, deep ecology recognizes the need for transformative changes in existing social and political institutions in order to achieve the goal of long term sustainability [19,119]. As [81] (p. 5) has noted, "The vulnerability of a form of life is roughly proportional to the weight of influences from afar, from outside the local region in which that form has achieved an ecological equilibrium." In this regard, deep ecology rejects the paternalistic and imperialistic relationships between industrialized societies and less powerful nonindustrial cultures that characterize current approaches to pursuing sustainable development. Rather, deep ecology embraces local autonomy and decentralization as governance mechanisms for promoting local self-sufficiency and self-determination [19,22,23,81]. One way to promote such decentralized forms of governance is to replace nation-states with bioregions as governance units [22]. Such bioregional communities could provide opportunities for the emergence of sense of place, development of local ecological knowledge, and the expression of local culture [115]. Beyond the local level, deep ecology also

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recognizes the need for coordinated action at the global level in order to effect the needed changes [19]. However, more clarity is needed on the political and institutional agenda of deep ecology [22].

In view of the shortfalls associated with the top-down approach to addressing global climate change and other sustainability challenges [109,120], increased attention is being paid to the search for governance mechanisms that coordinate the role of governments and the private sector across multiple levels in the mobilization and sharing of information and resources for realizing the SDGs [2]. Consistent with the focus of deep ecology on decentralized governance and local autonomy, the adaptive governance approach emphasizes the use of polycentric systems as a response to the shortfalls of conventional governance mechanisms [70,85,121]. Unlike monocentric systems in which decision-making authority is centered at one level, polycentric systems comprise multiple governing units at multiple levels with some degree of autonomy at each level [117]. Within polycentric systems, responsibilities among the governing units are allocated at the lowest most appropriate level according to the principle of subsidiarity [118]. Polycentric institutions are also characterized by an overlap and redundancy in functions among governing units at the various levels [85,121]. Polycentric governance systems offer several potential benefits, such as enhanced opportunities for experimentation and learning, enhanced trust and cooperation through opportunities for communication and interaction, as well as enhanced resilience and reduced vulnerability [117,118,121]. For instance, [118] illustrates how enhanced opportunities for communication and interaction resulted in rapid progress in bilateral climate change negotiations between the United States and China through the promotion of trust and cooperation. Although the emerging literature on polycentric systems highlight several challenges, including high transaction costs, inadequate consideration of power dynamics, and the potential for undesirable outcomes [121,122], it appears that the relatively well-developed institutional attributes of adaptive governance could potentially serve as a framework for the operationalization of the ethical principles of deep ecology.

6. Case Study: Management of Protected Areas

The establishment of protected areas has been gaining increased recognition as a key component of global conservation strategies aimed at addressing the loss of biodiversity [123-125]. Protected areas refer to "clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values" [125] (p. 5). The conventional approach to managing protected areas, known as the "Yellowstone model," has been characterized by the reliance on government representatives as resource owners and decision-makers. This model of protected areas management typically employs expert-driven rational-comprehensive planning processes aimed at achieving a narrow range of goals, particularly nature preservation and provision of opportunities for recreation and tourism [126,127]. While this conventional approach has been largely successful in the United States [128], its application in the developing world has received several criticisms, including the separation of humans from nature, neglect of local socio-economic concerns, abuse of human rights through forced displacement, and failure to achieve biodiversity goals [124,129-132]. In recent decades, alternative approaches to protected areas management, such as co-management and community-based conservation have emerged in response to the shortfalls of the conventional model [126,131,133,134]. Nonetheless, the conventional approach to protected areas management continues to receive support [135]. Ongoing work on principles for good governance of protected areas suggest the need for governance mechanisms for promoting integrative goals and inclusive decision-making processes as well as addressing uncertainties and ethical considerations [125,136,137]. Here, we offer a brief overview of the history and key features of the conventional Yellowstone model of protected areas management, following which we identify its key shortfalls and discuss how they could be addressed using ideas from adaptive governance and deep ecology.

The establishment of Yellowstone National Park in the USA in 1872 as the world's first national park ushered in the role of national governments in the ownership and management of protected areas [138]. Yellowstone National Park was established to be managed as a "public park or

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pleasuring ground for the benefit and enjoyment of the people" [139] (p. 37). Following the establishment of Yellowstone National Park, the role of national parks as places for the recreational enjoyment of the American public became entrenched in early US national park policy, notably the National Park Service Organic Act of 1916 which states the purpose of the parks as "to conserve the scenery and the natural and historic objects and the wild life therein … unimpaired for the enjoyment of future generations" [140] (p. 12). Early preservationists, notably John Muir, supported the promotion of mass tourism in US national parks as it was seen as an important strategy to create awareness and political support for the National Park System [139,141]. Under the first director of the National Park Service, Stephen Mather, recreation and tourism became entrenched as the primary focus of national parks in the US [142]. However, far from being a benign land use, the adverse impacts of mass tourism on ecosystems and recreational experience became clearer over time. Through the works of Aldo Leopold, Arthur Carhart and Robert Marshall among others, the wilderness values of national parks gained popularity and policy attention over the years, eventually culminating in the adoption of The Wilderness Act of 1964 that provided a legal mandate for the designation of wilderness areas on public lands managed by federal land management agencies [139]. The Wilderness Act states that "A wilderness, in contrast with those areas where man and his own works dominate the landscape, is hereby recognized as an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain" [139] (p. 4). What has come to be commonly known as the Yellowstone model of protected areas management represents the management of protected areas by government representatives for ecosystem preservation and provision of opportunities for nature-based recreation and tourism [126]. In this model, the resource is typically owned by a government agency that also has the authority and responsibility for managing the resource to achieve specific goals [125,143]. Over the years, several criticisms have been levelled against the application of the Yellowstone model in the management of protected areas in the developing world.

First, the Yellowstone model has been critiqued for its flawed ecological assumptions. The primary management approach of drawing legal boundaries around parks and protecting them from natural and anthropogenic disturbances as a means of preserving their naturalness [144] has been linked to the outdated balance of nature paradigm and its associated climax theory [140]. The balance of nature paradigm depicted ecosystems as closed, self-regulating systems, separate from nature, and possessing a single equilibrium state that was reached through a linear, predictable development trajectory [145,146]. Based on these assumptions, climax theory posited that "all vegetation was at, or was returning to, a fully developed climax stage of succession that was natural and characteristic of the region" [140] (p. 15). However, the emergence of new ecological insights on the dynamic and complex nature of ecosystems has challenged the assumption of stable ecosystems fluctuating predictably around a single equilibrium [127,147,148]. Also, new evidence on the role of Native Americans in shaping the landscape prior to European settlement has challenged the idea of naturalness [129,140,149].

In view of these insights, building the resilience of park ecosystems to uncertainties and change is beginning to receive attention as a useful goal in the management of protected areas [147,150]. Although these emerging perspectives offer promise for the sustainable management of protected areas, much of the discussion has largely focused on the ecological component of protected areas [144]. An application of deep ecology and adaptive governance to protected areas management promises to advance a truly holistic perspective on the complex and evolving relationships between social and ecological systems across space and time. Such a holistic approach broadens the aspirations of protected areas managers from building the resilience of park ecosystems against uncertainties, to building social-ecological resilience in protected areas as integrated systems of humans and nature [148] using adaptive management and other planning approaches for managing uncertainty [65].

Second, the Yellowstone model of protected areas has also been critiqued for its narrow focus on nature preservation and nature-based tourism [126]. As has been noted previously, the establishment of Yellowstone National Park in the US began the tradition of managing protected

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areas for the purpose of recreation and tourism [138,139]. Following the adoption of the Wilderness Act in 1964, the management of protected areas shifted from its previous anthropocentric focus on recreational enjoyment toward an ecocentric or biocentric focus that emphasized managing to preserve naturalness and solitude in protected areas [139]. In spite of the changing management philosophies, a common feature of the Yellowstone model of protected areas is its focus on park ecosystems to the neglect of local socio-cultural concerns [132]. The increased adoption of this model of protected areas management in the developing world has generated major adverse consequences. [151] have argued that tropical regions in the developing world that are considered as biodiversity hotspots where protected areas are needed are also social hotbeds, characterized by various socio-economic and political challenges that are neglected in the management of protected areas. The establishment of protected areas in these regions is often characterized by forced evictions that lead to physical, economic and cultural displacement [124,152-154]. This authoritarian approach to managing protected areas also leads to social conflicts that threaten biodiversity conservation [126,130,155]. Finally, established protected areas in the developing world tend to be poorly managed, with most of them existing as paper parks [135].

In view of these shortfalls, people-centered conservation approaches, such as Community-based Conservation (CBC) and Integrated Conservation and Development Projects (ICDPs) have emerged to address the need for community involvement and access to conservation benefits [124,151,156]. ICDPs aim at reducing local pressures on protected areas by providing various incentives through the integration of local development needs into park management goals, particularly in the buffer zones of protected areas [124,157]. While ICDPs and CBC are often treated synonymously in the literature, [124] note that CBC goes beyond ICDPs by emphasizing local community involvement in park management as a means of achieving conservation and local development goals. In all, the implementation of people-centered conservation initiatives has been critiqued for promoting socio-economic goals, such as sustainable livelihoods and poverty reduction, at the expense of biodiversity conservation [130,133,157]. The focus of ICDPs on the buffer zones of individual protected areas has been critiqued for failing to account for external forces stemming from the broader political economy [151]. Other shortfalls associated with people-centered conservation initiatives include a lack of recognition of community complexity [158], and poor design and implementation mechanisms [157,159]. In view of these shortfalls, a resurgence of interest in the protectionist Yellowstone model of protected areas has been occurring [130,135,156,160]. This pattern of narrow sectoral approaches to protected areas management highlights the need for ethical guidelines covering the social and ecological dimensions of protected areas [156,161].

Managing protected areas to achieve long term sustainability and resilience requires consideration of ecological, economic, cultural and community issues in a broader regional context [148]. This goal could be realized using the focus of adaptive governance on the integration of multiple values [63,67] and the ethical guidelines of deep ecology on the promotion of biological and cultural diversity [19,101]. The deep ecology principles also provide ethical foundations in support of the call for greater social justice, human dignity and cultural integrity in protected areas management [131,156,162].

Third, a defining feature of the Yellowstone model of protected areas management is its reliance on government representatives as owners and managers of protected areas [126,143]. Consistent with its reliance on centralized institutions, decision-making also follows the rational-comprehensive model [127], a planning approach that aims at choosing the best means for maximizing the common interest based on the assumption of the availability of comprehensive data on planning problems and societal values [163]. The reliance on centralized institutions and expert-driven planning processes in the Yellowstone model offers limited opportunities for community participation [162], and often leads to the marginalization of local knowledge and local institutions in protected areas management [128]. For instance, decisions on the legal designation of protected areas often occur without the input of the communities that will be impacted by these decisions [131,162]. The widespread existence of paper parks in the developing world also reflects

the limited capacity and interest of governments in the developing world in the implementation of the Yellowstone model [135,164]. The legitimacy of conservation decisions based on the authoritarian approach of the Yellowstone model has also been questioned [124,156].

In response to the shortfalls of the Yellowstone model, a shift has been occurring from an emphasis on the role of government to a focus on the governance requirements for protected areas management [123,127,137]. Governance refers to the interactions among the structures, processes and traditions that shape how power is exercised, how collective decisions are made, and how stakeholders have a say in the decision-making process [165]. There appears to be a growing consensus on the principles for the good governance of protected areas and they include legitimacy, transparency, accountability, inclusiveness, fairness, policy connectivity within and across sectors, and resilience to uncertainties [137]. Of particular interest is the need for governance mechanisms that advance human dignity and social justice by safeguarding the right to self-determination, local autonomy, and the right to participate as equal partners in all levels of decision-making [156]. To address these governance concerns, alternative governance mechanisms for protected areas that have been receiving attention include co-managed protected areas, private protected areas, and community conserved areas [124,125,143]. Of all the alternative institutional arrangements, co-management which refers to the sharing of rights and responsibilities between government representatives and local resource users [166], appears to offer the most promise for meeting these governance requirements [126]. However, neither co-management nor the other institutional mechanisms explicitly address the need for building resilience to change in protected areas management [167,168].

More recently, the search for appropriate institutions for protected areas management has broadened to include adaptive co-management [127,169,170], and adaptive governance [171]. The key features of adaptive governance, such as analytic deliberation, nesting, and institutional variety provide mechanisms for meeting the attributes of good governance, including building resilience against surprises [71]. Protected areas policies based on the integration of deep ecology and adaptive governance could advance an agenda for social and ecological justice 161] by promoting decentralization, local autonomy, and diversity of institutions across levels, as well as enhancing opportunities for the utilization of local ecological knowledge in protected areas management.

7. Conclusion

In recent decades, the idea of sustainable development has received significant attention from scientists and policy-makers as a framework for enhancing harmonious human-environment interactions. However, in response to the social and ecological threats presented by climate change and other grand sustainability challenges, recent years have seen a turn toward resilience and adaptive governance of social-ecological systems as more useful frameworks. Yet, the ethical implications of these emerging concepts have not received adequate attention. In this paper, we have argued for the integration of deep ecology and adaptive governance as a means of addressing the institutional and ethical challenges entailed in the promotion of sustainable development in the Anthropocene era. Using the management of protected areas a case study, we have illustrated that the integration of deep ecology and adaptive governance could inform the assumptions, goals, knowledge, and institutional mechanisms that underpin conservation and development efforts. We conclude that deep ecology provides a strong ethical justification for the pursuit of a resilience-based approach to sustainable development. Other researchers are invited to interrogate this proposed integrative agenda and to explore its implications for the management of various resource systems in various parts of the world.

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