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An Appraisal of Integrated Ecosystem

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ABSTRACT

Integrated ecosystem provides the use of biodiversity and ecosystem services into an overall strategy for helping people adapt to climate change. To date, insights into these approaches have often been based on reports from isolated anecdotal case studies. Though, these are informative, and provide evidence that people are using ecosystems to adapt, they provide rather limited insight in terms of measuring and evaluating the effectiveness of integrated ecosystem, especially when compared with technical or structural adaptation interventions. The body of scientific evidence indicating how effective such approaches are is lacking in some aspects. Where evidence does exist, it is often dispersed across a range of related fields, such as natural resource management, disaster risk reduction and agroecology. To date, there has been little attempt to systematically assemble and analyze this evidence. Therefore, evidence in respect of the merits or otherwise of integrated ecosystem is unknown and it has not been possible to identify prevailing knowledge gaps to inform further research and analysis, which will enable policymakers to compare integrated ecosystem with other adaptation options. Hence, this paper is emphasizing the identified gaps for further research purposes.

Introduction

Integrated ecosystem assessment is an environmental management approach that recognizes the bridge between science and policy by providing scientific information on the consequences of ecosystem change for the wellness of human being. Assessment findings, when presented in a readily digestible form, can respond to decision makers' needs for credible information. It can also highlight trade-offs between decision options, and model future prospects for the avoidance of unforeseen long-term consequences (Berbés-Blázquez, Oestreicher, Mertens, and Saint-Charles 2014)

The Integrated Ecosystem Assessment offers a framework for demonstrating connections between ecosystem services to sustain people's livelihoods and national economies, and to quantify their values in monetary terms where possible. An ecosystem assessment provides the connection between environmental issues and people, where ecosystem services include: provisioning services such as provision of food, water, timber and fibre; regulating services such as the regulation of climate, floods, disease, wastes and water quality; cultural services such as offering of recreational, aesthetic and spiritual benefits; and, supporting services such as soil formation, photosynthesis and nutrient cycling (Ash et al 2010)

Over the last decade, marine and maritime policies have embraced the ecosystem approach to manage human impacts on marine ecosystems. These policies recognize the need to implement approaches that address ecological, economic, and social needs. Using the ecosystem approach, ICES strengthens the link between science, policy developments, and advisory needs. In this way, we can inform society about the ecological, economic, and social trade-offs between different policy options (Aberley 1993)

Objectives of the Research Paper

The paper is meant to appraise integrated ecosystem by achieving the following objectives:

i) review of works related to integrated ecosystem;
ii) identification of knowledge gaps; and
iii) recommendations for further research.

Review of Related Works

According to MacKinnon (2008), the Land and Resource Management Planning (LRMP) was implemented by the British Columbia Government (Canada) in the mid-1990s in the Great Bear Rainforest in order to establish a multiparty land-use planning system. He further posits that the aim was to "maintain the ecological integrity of terrestrial, marine and freshwater ecosystems and achieve high levels of human well-being". The steps described in the programme included: protection of old-growth forests, maintenance of forest structure at the stand level, protection of threatened and endangered species and ecosystems, protection of wetlands and application of adaptive management. It was also highlighted that the main limitation of this program was the social and economic aspects related to the lack of orientation to improve human well-being.

The article of Hartig et al (1998), discusses A Remedial Action Plan (RAP), which was created during the Great Lakes Water Quality Agreement that implemented ecosystem-based management. The transition, according to the authors, from "a narrow to a broader approach" was not easy because it required the cooperation of both the Canadian and American governments. This meant different cultural, political and regulatory perspectives were involved with regards to the lakes. Hartig et al. (1998) described eight principles required to make the implementation of ecosystem-based management efficacious which are: "broad-based stakeholder involvement; commitment of top leaders; agreement on information needs and interpretation; action planning within a strategic framework; human resource development; results and indicators to measure progress; systematic review and feedback; and stakeholder satisfaction".

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In 1979, the importance of ecosystem-based management resurfaced in ecology from two biologists: John and Frank Craighead. The Craigheads found that grizzly bears of Yellowstone National Park could not sustain a population if only allowed to live within park boundaries. This reinforced the idea that a broader definition of what defines an ecosystem needed to be created, suggesting that it be based on the biotic requirements of the largest mammal present (Grumbine 1994).

In Thailand, National Planning Unit of the Ministry of Interior, as part of the Prince Edward Island Thailand country programme, conducted an integrated assessment in three sites at different watershed locations (upper, middle and lower) in Nan, Khon Kaen and Samut Songhan Provinces respectively. The assessments aimed to inform decision-makers in coming up with community and provincial development options that will bring about economic improvement with minimum negative impact on the environment and natural resource base. An integral component is also to strengthen capacity of national institutions in carrying out assessments and to make use of findings to inform decision makers. As a result of the assessment, provincial and local administrations now make better use of area-based development planning tools (spatial planning, community based research, and payments for ecosystem services). For example, in Nan province, the Provincial Administration has been supported to better manage corn-based livestock farming through investments in watershed management and more secure land tenure (PRODOC 2009).

Also, in Guatemala, the Ecosystem Assessment is looking at the "corredor seco" (Dry corridor) in eastern Guatemala, particularly, the key watersheds emanating from the Sierra de la Minas that support key agricultural subsistence and export production systems. The assessment aims to inform provincial and municipal development plans through scenario analysis and response options that aim to bring about inclusive economic improvement for all people with minimum negative impact on the natural resource base.

Mali is not left out as an integrated ecosystem assessment was completed in the Mopti region, eastern Mali, in 2009. This was championed by the Ministry of Environment and Sanitation. The assessment highlighted the importance of ecosystem services in particular wetlands for agriculture production and the effects of degradation. The report was presented to local authorities to inform local development plants and training of trainers was undertaken. Legal arrangements for institutionalizing the use of a Strategic Environmental Assessment approach to green policy documents has been put in place.

In other countries like Mauritania, Rwanda, Tanzania and Uganda, Integrated ecosystem assessments were undertaken between 2005 and 2011 in specific locations, all bothered on water catchments and wetlands, to inform sub-national and national development processes, each with varying degrees of success. A rapid independent evaluation of the ecosystem assessments in Rwanda, Tanzania and Uganda (December 2008) was conducted in 2008 by the World Resources Institute. The evaluation findings concentrated on how the ecosystem assessment methodologies could be better tailored to provide information relevant to the policy processes that are the object of PEI's P-E mainstreaming efforts, especially reviewing capacity building and knowledge transfer, the assessment process and the methodology.

Ecosystem Assessments

Poverty Initiative Environment(PEI) has provided support to integrated assessments through regional training of practitioners and technical support to PEI country programmes to undertake an integrated ecosystem assessment. In all cases, focus has been on grounding the ecosystem assessments with a known need identified by decision makers, involving the best available scientists from a range of disciplines, subjecting the assessment findings to rigorous review, and applying the generic methodological steps of 1) assessment of conditions and trends in ecosystems and their services (according to social, economic and environmental variables), 2) development of future scenarios as a consequence of plausible changes in driving forces, ecosystem services and human well-being, 3) formulation of response options for improved management of ecosystems for human well-being and pro-poor economic growth(PRODOC 2009).

Increasingly PEI is Emphasising the economic valuation of ecosystem services as an important tool within the integrated assessment process to enable monetary analysis as requested by decision-makers. Similarly, participatory processes enabling effective participation of all stakeholders including vulnerable groups as well as private sector operators are being applied. Lastly, PEI supports more rapid application of the process which does not compromise on the credibility, relevance and legitimacy of the assessment (UNDP-UNEP 2013).

Making the economic case of the importance of sustainable management of the environment and natural resources for pro-poor economic growth, and achievement of the Millennium Development Goals (MDGs) are important components of the Poverty-Environment (P-E) mainstreaming approach.

Economic-based analysis and argumentation for environmental investment can be the most effective in convincing decision-makers on the importance of environmental sustainability for achieving development goals. It requires one to understand and be able communicate on the environment and associated systems in economic terms, and how the environment sector can be explained as a productive sector that can be managed to generate pro-poor and inclusive economic growth.

In response to country demand, PEI has piloted a number of economic valuation studies at country level that aimed to inform and influence economic development policy and planning. These studies touch on key aspects of the PEI publication "Making the Economic Case: A Primer on the Economic Arguments for Mainstreaming Poverty-Environment Linkages into Development Planning" according to UNDP/UNEP PEI (2014) which include:

- Treating the environment base as an economic asset where environmental resources and ecosystem services are seen as productive natural capital having economic values, and where trade-offs exist between investing in sustaining the natural capital and converting it to other uses or allowing for degradation.
- Emphasizing the economic returns from environmental investment and the economic costs of environmental degradation. This can be expressed through a number of variables including among others employment, returns on investment related to rehabilitation of ecosystems, human health affected by pollution and degradation, effects from climate change, improved or lost agricultural productivity and food security, etc.
- Understanding human and economic well-being outcomes and linking environmental goods and services with national economic and social indicators used to measure progress towards poverty reduction, equality and inclusive economic growth.

Goals of Ecosystem-based Management

Defining clear and concise goals for ecosystem-based management is one of the most important steps in effective ecosystem-based management implementation. Goals must move beyond science-based or science-defined objectives to include social and cultural purposes. Experts also call for the creation of "suites" of goals. A single, end-all goal cannot be the solution, but instead a combination of goals and their relationships with each other should be the focus (Slocombe 1998a).

As discussed by Slocombe (1998a), goals should be broadly applicable, measurable and readily observable, and ideally be collectively supported in order to be achievable. The idea is to provide direction for both thinking and action, and should try to minimize managing ecosystems in a static state. Goals should also be flexible enough to incorporate a measure of uncertainty and be able to evolve as conditions and knowledge change. This may involve focusing on specific threatening processes, such as habitat loss or introduced invasive species, occurring within an ecosystem. Overall, the goals should be integrative, to include the structure, organization and processes of the management of an area. Correct ecosystem-based management should be based on goals that are both "substantive", to explain the aims and importance of protecting an area, and "procedural", to explain how substantive goals will be met.

As described by Tallis et al. (2010), some steps of ecosystem-based management may include

Scoping: This step involves the acquisition of data and knowledge from various sources in order to provide a thorough understanding of critical ecosystem components. Sources may include literature, informal sources such as aboriginal residents, resource users, and/or environmental experts. Data may also be gained through statistical analyses, simulation models, or conceptual models.

Defining Indicators: Ecological indicators are useful for tracking or monitoring an ecosystem's status and can provide feedback on management progress (Slocombe 1998a). Examples may include the population size of species or the levels of toxin present in a body of water. Social indicators may also be used such as the number or types of jobs within the environmental sector or the livelihood of specific social groups such as indigenous peoples.

Setting Thresholds: Tallis et al.(2010) suggest setting thresholds for each indicator and setting targets that would represent a desired level of health for the ecosystem. Examples may include species composition within an ecosystem or the state of habitat conditions based on local observations or stakeholder interviews. Thresholds can be used to help guide management, particularly for species by looking at the conservation status criteria established by either state or federal agencies and using models such as the minimum viable population size.

Risk analysis: A range of threats and disturbances, both natural and human, often can affect indicators. Risk is defined as the sensitivity of an indicator to an ecological disturbance. Several models can be used to assess risk such as population viability analysis.

Monitoring and Evaluation: Evaluating the effectiveness of the implemented management strategies is very important in determining how management actions are affecting the ecosystem indicators. This final step involves monitoring and assessing data to see how well the management strategies chosen are performing relative to the initial objectives stated. The use of simulation models or multi-stakeholder groups can help to assess management.

It is important to note that many of these steps for implementing ecosystem-based management are limited by the governance in place for each region, the data available for assessing ecosystem status and reflecting on the changes occurring, and the time frame available for operation.

Ecosystem Based Fisheries

According to Marine Ecologist Chris Frid, the fishing industry points to pollution and global warming as the causes of unprecedentedly low fish stocks in recent years, he posits that, "Everybody would like to see the rebuilding of fish stocks and this can only be achieved if we understand all of the influences, human and natural, on fish dynamics." Overfishing has also had an effect. Frid adds, "Fish communities can be altered in a number of ways, for example they can decrease if particular sized individuals of a species are targeted, as this affects predator and prey dynamics. Fishing, however, is not the sole perpetrator of changes to marine life - pollution is another example. No one factor operates in isolation and components of the ecosystem respond differently to each individual factor."

In contrast to the traditional approach of focusing on a single species, the ecosystem-based approach is organized in terms of ecosystem services. Ecosystem-based fishery concepts have been implemented in some regions. In 2007, a group of scientists offered the following ten commandments as cited in Francis et al (2007).

- Keep a perspective that is holistic, risk-adverse and adaptive.
- Maintain an "old growth" structure in fish populations, since big, old and fat female fish have been shown to be the best spawners, but are also susceptible to overfishing.
- Characterize and maintain the natural spatial structure of fish stocks, so that management boundaries match natural boundaries in the sea.
- Monitor and maintain seafloor habitats to make sure fish have food and shelter.
- Maintain resilient ecosystems that are able to withstand occasional shocks.
- Identify and maintain critical food-web connections, including predators and forage species.
- Adapt to ecosystem changes through time, both short-term and on longer cycles of decades or centuries, including global climate change.
- Account for evolutionary changes caused by fishing, which tends to remove large, older fish.
- Include the actions of humans and their social and economic systems in all ecological equations

Findings

- **Connections:** At its core, ecosystem-based management is about acknowledging connections, including the linkages between marine ecosystems and human societies, economies and institutional systems, as well as those among various species within an ecosystem and among ocean places that are linked by the movement of species, materials, and ocean currents (McLeod and Leslie 2009). The more information we can gather about an ecosystem and all of the interconnected factors which affect it, the more capable we will be of better managing that system (Guerry 2005).
- **Cumulative Impacts**: Ecosystem-based management focuses on how individual actions affect the ecosystem services that flow from coupled social-ecological systems in an integrated fashion, rather than considering these impacts in a piecemeal manner (McLeod and Leslie 2009). Loss of biodiversity in marine ecosystems is an example of how cumulative effects

from different sectors can impact on an ecosystem in a compounding way. Overfishing, coastal development, filling and dredging, mining and other human activities all contribute to the loss of biodiversity and therefore, degradation of the ecosystem (Leslie et al. 2008).

• **Interactions between Sectors**: The only way to deal with the cumulative effects of human influences on marine ecosystems is for various contributing sectors to set common goals for the protection or management of ecosystems (Leslie et al. 2008). While some policies may only affect a single sector, others may affect multiple sectors. A policy for the protection of endangered marine species, for example, could affect recreational and commercial fisheries, mining, shipping and tourism sectors to name a few (Leslie et al. 2008). More effective ecosystem management would result from the collective adoption of policies by all sectors, rather than each sector creating their own isolated policies.

• **Changing Public Perceptions**: Not all members of the public will be properly informed, or be fully aware, of current threats to marine ecosystems and it is therefore important to change public perceptions by informing people about these issues. It is important to consider the interest of the public when making decisions about ocean management and not just those who have a material interest (Leslie and McLeod 2007) because community support is needed by management agencies in order to make decisions. The Great Barrier Reef Marine Park Authority (GBRMPA) faced the issue of poor public awareness in their proposed management strategy which included no-take fishing zones (Olsson et al. 2008). They addressed this problem by starting a 'reef under pressure' information campaign to prove to the public that the Great Barrier Reef is under threat from human disturbances, and in doing so were successful in gaining public support (Olsson et al. 2008).

• **Bridging Science and Policy**: To ensure that all key players are on the same page, it is important to have communication between managers, resource users, scientists, government bodies and other stakeholders (Leslie and McLeod 2007). Proper engagement between these groups will enable the development of management initiatives that are realistic and enforceable (Leslie and McLeod 2007) as well as effective for ecosystem management.

• **Embracing Change**: Coupled social-ecological systems are constantly changing in ways that cannot be fully predicted or controlled. Understanding the resilience of ecosystems, i.e. the extent to which they can maintain structure, function, and identity in the face of disturbance, can enable better prediction of how ecosystems will respond to both natural and anthropogenic perturbations, and to changes in environmental management (McLeod and Leslie 2009).

• **Multiple Objectives**: Ecosystem-based management focuses on the diverse benefits provided by marine systems, rather than on single ecosystem services. Such benefits or services include vibrant commercial and recreational fisheries, biodiversity conservation, renewable energy from wind or waves and coastal protection (McLeod and Leslie 2009).

• **Learning and Adaptation**: As a result of the lack of control and predictability of coupled social-ecological systems, an adaptive management approach is recommended.

Conclusion and Recommendations

Worldwide population and economic growth put an increasing pressure on fresh water, coastal and marine environments. Concurrently, the benefits humans derive from these ecosystems are recognized and need to be maintained. Integrated Ecosystem Analysis aims to develop and assess methods to sustainably embed human activities in a healthy (i.e. well functioning) ecosystem, while protecting and strengthening ecosystem services. This can be achieved through an integral, interdisciplinary approach. Based on our appraisal of the integrated ecosystem, the following are hereby recommended:

i) Research should focus on the cultural and social importance of integrated ecosystem. More so, it has been observed that Modeling to understand the dynamics of natural capital, ecosystem services and human wellbeing will play a key role

ii) Stakeholders and researchers should employ Economic-based analysis and argumentation for environmental investment in convincing decision-makers for sustainable environment.

iii) The steps of Tallis et al. (2010), which include scoping, defining indicators, Setting thresholds, risk analysis, and monitoring and evaluation should be followed for effective eco-system based management.

iv) Partner Education Connection (PEC) will promote the development of a new generation of trans disciplinary and intersectoral models for assessing movements toward and away from sustainability.

Further researches should beam their search light on the recommended approaches Though, it is acknowledged that the suggestions here are by no means exhaustive, but they will go a long way to improve the integrated ecosystem if taken into considerations.

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