United Nations
Environment Programme

UNEP

Ecosystem Management: Graduate Curriculum Development Sourcebook

United Nations Environment Programme

The Design and Development of this Sourcebook

This Sourcebook is designed to facilitate the access of universities to UNEP materials on ecosystem management that may be useful to their postgraduate programmes in the area and closely related fields. To this end, its original conceptualization by UNEP/EETU (Environmental Education Training Unit) was aligned with UNEP's Education for Sustainable Development (ESD) initiative and then discussed at a meeting of the Global Universities Partnership for Environment and Sustainability (GUPES) in Santiago Chile in September 2011. Consultative workshops on curriculum guidelines for ecosystem management and the green economy were held during February 2012 at UNEP headquarters in Nairobi with academic, civil society and other participants attending the workshops and contributing to an associated "Universities and Sustainability - Towards Rio+20" GUPES event. Following these consultations a draft of the sourcebook was circulated for review and comment to the participants and to selected experts in UNEP/DEPI (Department of Environmental Policy Implementation), UNEP/EMP (Ecosystem Management Programme) and UNEP/ETB (Economics and Trade Branch). Through further interactions involving EETU and the UNEP internal review process the content and format of the sourcebook was then finalized.

The present publication is to be considered as a living document and therefore suggestions for additional sources and any recommendations for improvement will be gratefully received. Such feedback will make a valuable contribution to our plans for adding to this document in the future. Please email any suggestions for improving the sourcebook to env.edu@unep.org.

Objectives of the Sourcebook

The primary objective of the sourcebook is to provide guidance on curriculum framework development for masters level postgraduate programmes in ecosystem management through reference to UNEP's approaches to the field and its extensive resources on the topic, together with links to certain other key materials. It is aimed at providing relevant information for university academics and curriculum designers looking into the potential for developing innovative new ecosystem management programmes as well as those who may wish to enhance their current graduate offerings in the discipline.

Expected Outcomes of the Sourcebook

Given that ecosystem management is presently offered in various forms at the postgraduate level in university programmes throughout the world there is an opportunity for contributing to the breadth and depth of the academic content and training in this discipline by providing additional information about UNEP's global commitment and experience in encouraging environmentally, socially and economically robust approaches to ecosystem protection in the context of human wellbeing. It can be anticipated that this sourcebook can be useful in helping universities to enhance and expand their existing ecosystem management programmes by facilitating access to relevant UNEP materials on the field and by enabling them to expedite the creation of new ecosystem management programmes that can draw on UNEP resources to improve learning experiences for postgraduate students who are to become professionally engaged in the diverse aspects of natural resource management. Moreover, recognizing the interest of universities in the developing world in strengthening the scope and scale of their ecosystem management programmes, the information in this sourcebook can be of particular relevance for academic institutions belonging to entities such as GUPES which share a common goal of providing advanced degrees in areas essential to environmental sustainability. The creation of innovative new ecosystem management postgraduate programmes in these universities as a result of the distribution of this sourcebook would thus become a very significant outcome.

How to Use this Sourcebook

This sourcebook is oriented towards addressing the interests of university teaching staff who may be considering the prospects for furthering graduate studies offerings at their institutions in areas related to ecosystem management. Consequently, it is intended to be useful to those already engaged in graduate teaching of the various disciplines often engaged in the field (forestry, fisheries, water management, land use, etc.) as well as those contemplating a dedicated new programme in ecosystem management. Each of these situations has its own context, but the sourcebook is structured around a series of chapters on topics which may be beneficial in providing perspective on how to develop a relevant graduate programme. These chapters are summarized in the following subsection of this text. Different users may want to look through them in varying order – for example, those seeking clarification on the conceptual framework of ecosystem management might first want to read through the introductory section while others, more interested in guidance on advancing a new programme through the university approval process, may instead wish to proceed immediately to the chapter with a section addressing that. By viewing the table of contents first, readers can decide in advance on those sections they may wish to view, and in what order. The text is not intended to be proscriptive and so it should possible to pick and choose the elements that may be most useful for a particular purpose with regard to curriculum development in the specific context of an institution working either towards launching a new programme or modifying an existing one. The users of the sourcebook should be comfortable in selecting those materials within it that best suit their goals in offering their students relevant learning opportunities that may be improved by use of the information within it. Bearing in mind the transdisciplinary nature of ecosystem management and UNEP's insights on this, and the sourcebook authors hope that it can provide useful guidance in advancing teaching and learning opportunities in the field.

Structure of the Sourcebook

This sourcebook is divided into four chapters, beginning with one containing an overview of ecosystem management, followed by a chapter dealing with suggestions on curriculum structure and implementation, and another on recommendations for the component courses or modules within the curriculum. It concludes with a chapter outlining examples of case studies, followed by relevant references and resources.

Chapter 1 explains the rationale for the sourcebook, introduces key ecosystem management concepts and methodologies, and describes current trends, issues and challenges for select global ecosystems.

Chapter 2 provides a curriculum development framework for an ecosystem management masters, including considerations on its positioning within the academic institution, links with UNEP and other agencies, and student profiling.

Chapter 3 focuses on the masters programme structure and curriculum components, offering suggestions for core courses and complementary courses and indicating alternative pathways for implementation.

Chapter 4 presents case studies of ecosystem management approaches and assessments in practice.

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Chapter 1 - Introduction

1.1 Background and Rationale

This document presents guidance information and source materials for universities which are developing or intend to develop new postgraduate masters programmes on ecosystem management and closely associated disciplines.

There are many reasons at this time for information and resources in support of an ecosystem management masters to be considered particularly useful, and these are primarily due to the current recognition that ecosystem management is a key discipline for assessing and offering solutions for many of the most critical problems involved in providing for environmentally and socially sustainable development that enhances human well-being today and in the future. As the premier international agency on the environment and with global reach and resources, UNEP encourages academic institutions worldwide to draw upon its data information resources, technical methodologies, analytical tools, and policy perspectives in such postgraduate programmes. To this end, this sourcebook provides relevant information and guidance for the development of UNEP oriented ecosystem management masters programme, guidelines for positioning it within the academic institution, suggestions for its curriculum components, and links to UNEP and other relevant knowledge resources.

The contents of this sourcebook have been compiled in support of an initiative of UNEP's Environmental Education and Training Unit (EETU), a Unit of the Division of Environmental Policy Implementation (DEPI) based in Nairobi. The material here is of particular relevance for universities within The Global Universities Partnership on Environmental and Sustainability (GUPES), a consultative and partnership body associated with EETU that provides a strategic platform for the mainstreaming of environment and sustainability concerns into university systems across the world, and that facilitates inter-university networking on sustainability issues for advancing sustainable development in the broader context of the United Nations Decade of Education for Sustainable Development (UNDESD, 2005-2014). Some additional information on the formation of GUPES is provided in the text box below.

The Global Universities Partnership on Environment and Sustainability (GUPES)

GUPES is a flagship networking programme of UNEP's Environmental Education and Training Unit (EETU) that was formed in November 2010.

***GUPES Overall* Goal:** To promote the integration of environment and sustainability concerns into teaching, research, community engagement, the management of universities, greening of university infrastructure/facilities/operations, as well as to enhance student engagement and participation in sustainability activities both within and beyond universities.

Developmental objective: To enhance the quality, policy, practice and relevance of university education globally in the context of sustainable development, taking into account the emerging paradigm of Green Economy.

GUPES Objectives

- To provide a strategic platform for the mainstreaming of environment and sustainability concerns into university systems across the world, and to facilitate inter-university networking on sustainability issues with emphasis on South-South and North-South tertiary partnerships;
- To build, through university education systems, a professional capacity and leadership needed for the prevention of and responses to environmental issues, risks and associated sustainable development challenges;
- To contribute to revitalizing the global higher education system and enabling it to address current sustainable development challenges with emphasis on UNEP's six thematic priorities;
- To contribute to the knowledge generation within UNEP's six priority thematic areas and other contemporary environmental and sustainability issues, risks and challenges;
- To optimize development opportunities provided by ecosystem services in a sustainable manner in line with the principles of "**Green Economy**" and in the context of sustainable development;
- To help prepare the world for the projected impacts of global *climate change, disasters and conflicts, harmful substances and hazardous wastes*, as well as to assist in reversing and mitigating these and other negative environmental and sustainability trends.

GUPES Pillars

The programmes, projects, activities and initiatives of GUPES are guided by the pillars of the Environmental Education and Training Unit (EETU) namely: *Education, Training and Networking.* The programmes, projects and activities of GUPES are also guided by the principles and objectives of the UN Decade of Education for Sustainable Development (UNDESD -2005 – 2014)

(Source: http://www.unep.org/training/downloads/GUPES%20Background%20Paper.pdf)

The development of a template for an innovative ecosystem management masters curriculum was discussed at the EETU/GUPES High Level Planning, Consultative, Sharing and Learning Meeting for University Leaders in Santiago,

Chile in September 2011. This was to link closely with the green economy masters curriculum template which was considered to be a closely linked and complementary subject area.

According to UNEP's Environmental Education and Training Unit, education for sustainable development in higher education has a critical role to play in the transition to a green economy specifically and in attaining sustainable development generally – all of which are heavily dependent on the *sustainable*, *acceptable*, *valued* and *efficient* management of ecosystems. In this regard, it is important that universities start positioning themselves strategically so as to respond appropriately to the expectations thereof in leading and contributing to sustainable development and the shift towards a green economy. Pursuant to this, EETU has conceptualized this sourcebook with the aim of inspiring, encouraging, informing, facilitating and supporting universities to develop appropriate graduate level curricula on ecosystems management so as to produce appropriately skilled and trained human resources that will drive the agenda of ecosystems management for sustainable development and a green economy

Given the role of universities in fostering and disseminating knowledge through teaching, research and community engagement on global sustainability, the focus here on a graduate level curricula for ecosystem management will provide support for UNEP's mandated activities in both ecosystem management and the associated concept of green economy. The importance of educational institutions at this critical point in addressing global issues of sustainability and ecosystem management cannot be overemphasized, a point clearly evident in a recent document by UNEP[1] in which *"Transforming human capabilities for the 21st century: meeting global environmental challenges and moving towards a green economy"* was given the second highest priority of the top 21 environmental issues determined and ranked by the UNEP foresight panel and some 400 distinguished scientists and experts worldwide during a consultative process lasting nearly one year. The present document has been developed in order to provide information targeted to ecosystem management as a discipline in which academic institutions are already engaged and where they can perhaps additionally enhance their programmes and courses offerings by taking advantage of the considerable knowledge resources on the topic within UNEP and affiliated organizations.

1.2 Ecosystem Management Perspectives on Marine, Coastal and Freshwater Ecosystems

To appreciate the present significance of ecosystem management in a global context it is worthwhile to provide perspectives here on exactly how it is used. The brief overview in this section provides an introduction to current trends, issues and challenges of two types of global ecosystems for which ecosystem management processes are being increasingly applied. The examples selected for this purpose are *marine and coastal ecosystems* and *freshwater ecosystems.*

Marine and coastal ecosystems are of obviously of enormous importance for humanity on a global scale, not only providing food through fisheries, but also serving as marine transportation corridors, and allowing for the offshore extraction of minerals, oil and natural gas, and for nearshore recreation and tourism. Covering 70% of the planet's surface, the oceans and seas furnish many critical ecosystem services to the biosphere, ranging from carbon fixation and nutrient cycling to climate regulation.

The UNEP Large Marine Ecosystems Report[2] identifies in detail the global and regional challenges existing today in marine ecosystems, the principal among which being the overexploitation of fish stocks, pollution, biodiversity losses, and the consequences of climate change. In concert with the GEF supported Global International Waters Assessment (GIWA) project, and NOAA's Large Marine Ecosystem Program, UNEP decided that the LME assessment framework would consist of five elements: 1) biological productivity, 2) fish and fisheries, 3) pollution and ecosystem health, 4) socioeconomics, and 5) governance. Its integrated ecosystem assessment approach is in accordance with what would be the normal components of an ecosystem management framework for measuring marine ecosystem conditions. Five elements were methodologically treated as module indicators to operationalize the assessment – i.e. productivity module indicators, fish and fisheries module indicators, pollution and ecosystem health module indicators, socioeconomics module indicators, and governance module indicators.

The UNEP/ Global Programme of Action for the Protection of the Marine Environment report *The State of the Marine Environment: Trends and processes*[3] provides a comprehensive review of the status of nine land-based threats to the marine environment, namely sewage, persistent organic pollutants, radioactive substances, heavy metals, oils (hydrocarbons), nutrients, sediment mobilization, marine litter and the physical alteration and destruction of habitats.

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[1] *21 Issues for the 21st Century": Results of the UNEP Foresight Process on Emerging Environmental Issues". Alcamo, J., Leonard, S.A. (Eds.). United Nations Environment Programme (UNEP), Nairobi, Kenya, 56pp.*

[2] UNEP (2008): *The UNEP Large Marine Ecosystem Report: A perspective on changing conditions in LMEs of the world's Regional Seas*. UNEP Regional Seas Report and Studies No. 182. United Nations Environment Programme. http://www.lme.noaa.gov/

[3] UNEP/GPA (2006). *The State of the Marine Environment: Trends and processes*. http://www.env-edu.gr/Documents/The%20State%20of%20the%20Marine%20Environment%20-%20Trends%20and%20processes.pdf

It provides a broad global perspective on the current state of the coastal and marine environment with respect to these threats and includes regional examples. The report concluded that good progress had been made on three areas (persistent organic pollutants, radioactive substances, oils (hydrocarbons), while conditions had deteriorated for four (sewage, nutrients, marine litter, physical alteration and destruction of habitats) and results were mixed for the remaining two (heavy metals and sediment mobilization).

Success in dealing with threats to the marine environment are predicated on strong commitments to regulatory systems, institutional structures, technology and funding, as well as having an informed and motivated public and the political will to make progress on priorities. The report concludes with the observation that it often takes 15 to 20 years to secure joint commitment for regional environmental initiatives (e.g. the Mediterranean Sea, North America's Great Lakes, the Mekong River Basin) and it can be even longer before the environment positively responds. The primary recommendations of the Global Programme of Action report were for international coordination in developing key indicators to better assess changes in the state of the marine environment, and for implementing integrated management approaches for river basins and coastal areas.

UNEP's Introductory Guide on Marine and Coastal Ecosystem-Based Management[4] is very helpful in explaining how to apply ecosystem management to marine environments and provides a framework for moving from the conceptual basis for EBM into its practical application in local, national and regional planning. With regard to the theoretical grounding of EBM, five core principles, and various tools and approaches utilized in each of the phases of EBM (visioning, planning, and implementation / adaptive management) are presented.

The marine and coastal management guide includes an informative explanation on how ecosystem-based management is distinguished from traditional forms of marine resource management:

> *"Ecosystem-based management is a holistic approach that takes into account the interactions within a given ecosystem. These interactions include those between different parts of an ecosystem; between land and sea; between humans and nature; and between uses of ocean resources and the ability of ecosystems to serve those uses. There are several core elements that must be put into practice at some point in an EBM process: 1) Recognizing connections within and across ecosystems; 2) Utilizing an ecosystem services perspective; 3) Addressing cumulative impacts; 4) Managing for multiple objectives; 5) Embracing change, learning, and adapting. Taken together, these core concepts set ecosystem-based management apart from traditional management."*

The authors clearly indicate how the geographic scope of marine and coastal ecosystem-based management relates to the other approaches commonly used in marine management – integrated coastal zone management, marine spatial planning, watershed management, fisheries management and marine protected areas management:

> *"The geographic scope of EBM can collectively cover that of all five of the main management strategies: 1) the coastal lands and nearshore environment of ICZM; 2) the marine environment of MSP; 3) the rivers and drainage basins in watersheds that drain into the sea; 4) the waters supporting exploited fish stocks; and 5) the coastal and marine environments encompassed by MPAs."*

For marine ecosystem management to precede successfully it is essential to have access to the necessary information and data on regional and subregional scales. Fortunately, there are many existing reports and databases available on coastal and marine environments through organizations such as UNEP, GEF, IUCN, NOAA and ICES as well in other national and international institutions. In addition, dedicated databases such as GRAMED provide a wealth of relevant information:

> *"The Global and Regional Assessments of the Marine Environment Database (GRAMED) has been developed at the request of UNEP and IOC/UNESCO, as the lead agencies responsible for taking forward the "Assessment of Assessments" through the implementation of UNGA Resolution 60/30. It was first developed to support the preparation of the 2007 report, Global Marine Assessments: A survey of global and regional assessments and related scientific activities of the marine environment and builds on the 2003 UNEP-WCMC/UNEP/ IOC-UNESCO report "Global Marine Assessments: A survey of global and regional marine environmental assessments and related scientific activities". The GRAMED Database is managed and hosted by UNEP-WCMC, Cambridge, UK". http://www.unep-wcmc-apps.org/gramed/*

Modeling is an important methodological component of marine ecosystem management that in recent years has also become more universally accessible to practitioners through online platforms. One of particular relevance is the

[4] UNEP (2011*): Taking Steps toward Marine and Coastal Ecosystem-Based Management - An Introductory Guide.* http://www.unep.org/pdf/EBM_Manual_r15_Final.pdf

Coastal-Marine Ecosystem-Based Management (EBM) Tools Network[5], which offers software, resources and web tools in support of interdisciplinary marine assessment planning. It also offers many links to other organizations involved in ecosystem-based management.

Freshwater ecosystems consist of the lakes, rivers and wetlands providing for much of humanity's water needs and serving as a global resource for agriculture, inland fisheries, hydropower, transportation and recreation. Of all the water in the Earth's hydrosphere[6] (the oceans, icecaps and glaciers, atmosphere, surface landwater and groundwater) only 0.26% is in lakes and rivers[7] . This precious resource circulates rapidly through the ocean-atmosphere system such that the amount discharged to the oceans annually is about equal to the total mass contained in lakes and rivers[7]. In addition to their critical importance as a water resource, freshwater ecosystems provide habitats for aquatic organisms and have a key supporting service role for nutrient cycling, primary production and ecosystem resilience on a global scale.

According to a recent report on the state of the world's freshwater ecosystems:

> *"Surface freshwaters—lakes, reservoirs, and rivers—are among the most extensively altered ecosystems on Earth. Transformations include changes in the morphology of rivers and lakes, hydrology, biogeochemistry of nutrients and toxic substances, ecosystem metabolism and the storage of carbon, loss of native species, expansion of invasive species, and disease emergence. Drivers are climate change, hydrologic flow modification, land-use change, chemical inputs, aquatic invasive species, and harvest." "Upper limits for human consumption of freshwaters have been proposed, and consumptive use may approach these limits by the mid-century."*[7]

This critical situation is reflected in findings of the third Global Biodiversity Outlook (CBD, 2010a) the fourth Global Environment Outlook (UNEP, 2007) and the statement of the 2012 UN World Water Development Report stating that *"…the loss and degradation of freshwater ecosystems remains the fastest of all the major biomes."* The second and third editions of the World Water Development Report (WWAP, 2006, 2009) had earlier reported that the principal pressures and impacts on freshwater ecosystems were habitat alteration (e.g. by drainage and conversion of wetlands), fragmentation and flow regulation (e.g. by dams and reservoirs), pollution, invasive species and climate change.

Given these circumstances, it is understandable that much attention over time has been directed towards working to protect and rehabilitate freshwater ecosystems, given that the scope of the problems is vast and the challenges are enormous. To this end a large number of entities are involved, including UNEP, FAO, WHO, IUCN and the World Water Council and the Global Water Partnership, as well as many other international and national agencies, NGOs and local community organizations. Instrumental in the approach to watershed ecosystem management has been the emergence of integrated water resource management:

> *"IWRM is a process which promotes the coordinated development and management of water, land and related resources in order to maximise the resultant economic and social welfare, paving the way towards sustainable development, in an equitable manner without compromising the sustainability of vital ecosystems.*[8]*" (Global Water Partnership, 2000).*

In addition to the regional, national and local databases maintained to support modeling for IWRM and other water management purposes, existing relevant data for ecosystem management can be accessed from a number sources. Information on water quality is available through UNEP's Global Environment Monitoring System Water Programme database (GEMStat)[9], which covers over 100 countries worldwide. UNEP's Global Environment Outlook (GEO) portal provides GPS referenced data on relevant freshwater variables such as the inland waters fish catch, and supports a global lakes and wetlands database.

Modeling for freshwater ecosystem management is much advanced, given the importance of water integrated water resource management in applied work on water basins in support of human health, agriculture and industry. The Coastal-Marine Ecosystem-Based Management Tools Network referenced above for the marine ecosystems serves as an equally useful gateway for freshwater ecosystem assessment and management. For example, a decision

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[5] *About the EBM Tools Network and Database* http://ebmtoolsdatabase.org/about

[6] http://www.britannica.com/EBchecked/topic/279025/hydrosphere

[7] *2011 State of the World's Freshwater Ecosystems: Physical, Chemical, and Biological Changes* http://limnology.wisc.edu/personnel/jakevz/pdf/2011_ARER_CarpenterStanleyVanderZanden_State-of-Freshwater.pdf

[8] *Integrated Water Resources Management (IWRM): A way to Sustainability* http://www.inforesources.ch/pdf/focus1_e.pdf

[9] http://www.gemswater.org

support toolkit incorporating and connecting to several models (e.g. ecoregional assessment, MARXTAN, Ecopath with Ecosim, and the Community Vulnerability and Assessment Tool) is to be found on the EBM network.

In summary, the overviews above on ecosystem management perspectives for marine and coastal ecosystems and for freshwater ecosystems show how there is a common approach in both instances focusing on: 1) identifying the intrinsic value of these ecosystems in providing a suite of regulating and supporting services for the functioning of the biosphere; 2) characterizing the importance of ecosystems in terms of providing food and other goods valued by humanity (including sociocultural benefits); 3) determining the pressures and impacts on ecosystems from human activities; and 4) devising plans for ecosystem protection and rehabilitation taking into account the wellbeing of the human populations which depend upon them. The discipline of ecosystem management is in turn reliant on networks of international and national agencies, NGOs and local community organizations that provide and continually contribute to the information databases needed for it to work, and the entire process is itself furthered by the intelligent application of the tools and modeling methodologies that will help governments, the public and its leaders to better understand the importance of ecosystems and how to make the right decisions on choices that will positively affect them and the wellbeing of the human populations they support.

1.3 Understanding Ecosystem Management: Key Concepts

Ecosystem management is one of the six priority thematic areas on which UNEP has been focusing its efforts towards delivering on its mandate for the period 2010-2013. The other priority thematic areas are: Climate change; Disasters and conflicts; Environmental governance; Harmful substances and hazardous waste; and Resource efficiency – sustainable consumption and production.

For the thematic priority of ecosystem management, UNEP's overarching objective is that countries utilize the ecosystem approach to enhance human well-being. This is based on the premise that human well-being ultimately depends on the health and function of natural infrastructure, i.e. the ecosystems which envelope and sustain us, and that the 'ecosystem approach' provides an effective management framework for ensuring that ecosystems are protected from cumulative degradation, today and in the future.

Ecosystem management is defined as "*an integrated process to conserve and improve ecosystem health that sustains ecosystem services for human well-being*" (UNEP 2009). UNEP's Ecosystem Management sub-programme has a focus on encouraging countries to use the ecosystem approach in their efforts to enhance human well-being. Its key goals are (1) to provide leadership in promoting the ecosystem management approach for development, (2) to develop and test tools and methodologies for national governments and regions to restore and manage ecosystems and biodiversity, and (3) to help national governments integrate ecosystem services into development planning and investment decisions. The principles of ecosystem management are also implicit in the mandates of other UNEP agencies dealing with global and regional environmental issues and challenges.

The first global attempt to codify the ecosystem approach concept occurred at the Fifth Ordinary Meeting of the Conference of the Parties (COP) to the Convention on Biological Diversity (CBD), in May 2000 in Nairobi, Kenya. The COP defined the ecosystem approach as *"a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way"*, and articulated 12 principles reflecting the then level of common understanding. The COP recognized that humans, with their cultural diversity, are an integral component of many ecosystems and that the ecosystem approach does not preclude other management" and conservation approaches, such as biosphere reserves, protected areas, and single-species conservation programmes, as well as other approaches carried out under existing national policy and legislative frameworks, but could, rather, integrate all these approaches and other methodologies to deal with complex situations.

Other Definitions of the Ecosystem Approach

1. The International Union for the Conservation of Nature (IUCN) defines it as *"a process that integrates ecological, socio-economic, and institutional factors into comprehensive analysis and action in order to sustain and enhance the quality of the ecosystem to meet current and future needs"*. http://www.iucn.org/about/union/commissions/cem/cem_about/
2. According to the UN Division of Ocean Affairs and Law of the Sea: *"While there is no single internationally agreed-upon ecosystem approach or definition of an "ecosystem approach", the concept is generally understood to encompass the management of human activities, based on the best understanding of the ecological interactions and processes, so as to ensure that ecosystems structure and functions are sustained for the benefit of present and future generations."* http://www.un.org/depts/los/ecosystem_approaches/ecosystem_approaches.htm
3. For the purpose of the OSPAR Convention, the ecosystem approach is defined as "*the comprehensive integrated management of human activities based on the best available scientific knowledge about the ecosystem and its dynamics, in order to identify and take action on influences which are critical to the health of marine ecosystems, thereby achieving sustainable use of ecosystem goods and services and maintenance of ecosystem integrity*". http://www.ospar.org/content/content.asp?menu=00430109150000_000000_000000
4. From Maltby (2000), the ecosystem approach is defined as *a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way, and which recognises that people with their cultural and varied social needs, are an integral part of ecosystems*. Haines-Young, R. and Potschin, M. (2007): The Ecosystem Concept and the Identification of Ecosystem Goods and Services in the English Policy Context. Review Paper to DEFRA Project Code NR0107, 21pp. http://www.ecosystemservices.org.uk/docs/NR0107_pos%20paper%20EA_D1.3.pdf

It is noteworthy that the ecosystem approach is not a prescriptive method. It offers flexible concepts to be adapted to the country or circumstance in which it is applied. Therefore, *"there is no single way to implement the ecosystem approach, as it depends on local, provincial, national, regional or global conditions."* The Conference encouraged further conceptual elaboration and practical verification of the ecosystem approach.

The ecosystem approach was further promoted by Millennium Ecosystem Assessment (MA) which highlighted the linkages between ecosystems and human wellbeing. An overview of the Millennium Assessment is provided in Appendix 1 of this document. Key to the ecosystem approach as it applied in the MA has been the consideration of ecosystem services – the benefits to humanity from the processes and resources provided by natural ecosystems. This explicit inclusion of ecosystem services as a feature of the ecosystem approach is therefore also a distinguishing feature of ecosystem management as it is presently viewed by UNEP.

Because ecosystem management from the perspective of UNEP is grounded in the ecosystem approach it is useful to provide additional details on the ecosystem approach in order to better understand what it is and how it inherently shapes the way ecosystem management activities are conducted, whether for specific local activities involving environmental protection or for large scale regional development projects. The essential features of the ecosystem approach as it is used for ecosystem management are indicated in the text box below

Description of the Ecosystem Approach

1. The ecosystem approach is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. Thus, the application of the ecosystem approach will help to reach a balance of the three objectives of the Convention on Biological Diversity: conservation; sustainable use; and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources.

2. An ecosystem approach is based on the application of appropriate scientific methodologies focused on levels of biological organization, which encompass the essential structure, processes, functions and interactions among organisms and their environment. It recognizes that humans, with their cultural diversity, are an integral component of many ecosystems.

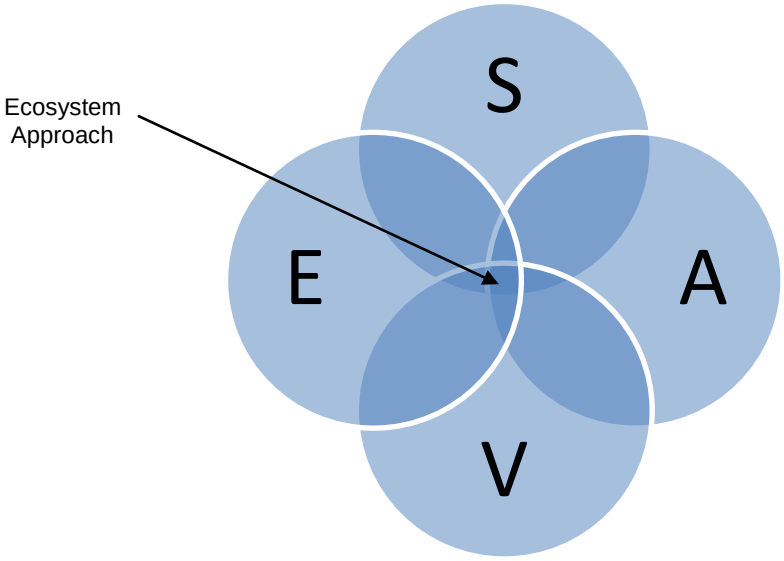
3. This focus on structure, processes, functions and interactions is consistent with the definition of "ecosystem" provided in Article 2 of the Convention. "'Ecosystem' means a dynamic complex of plant, animal and microorganism communities and their non-living environment interacting as a functional unit." This definition does not specify any particular spatial unit or scale, in contrast to the Convention definition of "habitat". Thus, the term "ecosystem" does not, necessarily, correspond to the terms "biome" or "ecological zone", but can refer to any functioning unit at any scale. Indeed, the scale of analysis and action should be determined by the problem being addressed. It could, for example, be a grain of soil, a pond, a forest, a biome or the entire biosphere.

4. The ecosystem approach requires adaptive management to deal with the complex and dynamic nature of ecosystems and the absence of complete knowledge or understanding of their functioning. Ecosystem processes are often non-linear, and the outcome of such processes often shows time-lags. The result is discontinuities, leading to surprise and uncertainty. Management must be adaptive in order to be able to respond to such uncertainties and contain elements of "learning-by-doing" or research feedback. Measures may need to be taken even when some cause-and effect relationships are not yet fully established scientifically.

5. The ecosystem approach does not preclude other management and conservation approaches, such as biosphere reserves, protected areas, and single-species conservation programmes, as well as other approaches carried out under existing national policy and legislative frameworks, but could, rather, integrate all these approaches and other methodologies to deal with complex situations. There is no single way to implement the ecosystem approach, as it depends on local, provincial, national, regional or global conditions. Indeed, there are many ways in which ecosystem approaches may be used as the framework for delivering the objectives of the

Source: Secretariat of the Convention on Biological Diversity (2004). The Ecosystem Approach, (CBD Guidelines). http://www.cbd.int/doc/publications/ea-text-en.pdf .
(Text extracted from section A of decision V/6, of the Conference of the Parties to the Convention on Biological Diversity. Paragraph numbering as in the original.)

Consistent with these developments of the concept, the ecosystem approach should be viewed as an iterative process that involves managing conservation, development and other human activities at a scale that reflects the dynamics of natural ecosystems in a manner that is concurrently Sustainable, Acceptable, Valued and Efficient (SAVE – see diagram below).



SAVE and the Ecosystem Approach

In reference to the SAVE approach as illustrated here; it is clear that achieving one of the four objectives in isolation does not constitute an ecosystem approach, but when all four SAVE objectives are considered, it can be said that the ecosystem approach is being applied.

A "SAVE the Planet" approach is currently being advocated by UNEP, based on the understanding that the proactive utilization of the ecosystem approach is vital to ensure the delivery of essential ecosystem services and must be mainstreamed into societal conscience, political thinking and economic processes. A detailed summary of the SAVE objectives in relation to the ecosystem approach is presented in Appendix 2.

In keeping with the considerations above it is evident that the present concept of ecosystem management is firmly based on the ecosystem approach and for UNEP this also entails inclusion of the SAVE objectives. These developments are in keeping with earlier definitions of ecosystem management, shown in the box on the following page. A key trend in the approach to ecosystem management since its conceptual origins has been to further strengthen it in the areas of sociopolitics and economics, and to work at improving its effectiveness as a management system[10]. Moreover, at least from the time of the UN Millennium Assessment, there has been an impetus towards explicitly providing for the inclusion of ecosystem service valuation as an essential component of ecosystem management. Taken together, these developments can be seen as signs that indicate ecosystem management, while continuing to evolve as a process, has a strong conceptual foundation and a well established suite of methodologies that can work in concert to address the serious global challenges for which it has been designed.

[10] *"Adaptive management has had mixed success in the field of ecosystem management (Gregory et al. 2006). This is because ecosystem managers may not be equipped with the decision-making skills needed to undertake an adaptive management methodology (Gregory et al. 2006). Additionally, economic, social and political priorities can interfere with adaptive management decisions (Gregory et al. 2006). For this reason, adaptive management should be a social process as well as scientific, focusing on institutional strategies while implementing experimental management techniques (Resilience Alliance 2010)." Source: Wikipedia –* http://en.wikipedia.org/wiki/Ecosystem_management#cite_note-3

Earlier Definitions of Ecosystem Management

1. Agee and Johnson, 1988. Ecosystem management is *"...regulating internal ecosystem structure and function, plus inputs and outputs, to achieve socially desirable conditions."* Ecosystem management for parks and wilderness. University of Washington Press, Seattle.

2. Overbay 1992. Ecosystem management is *"...the careful and skillful use of ecological, economic, social, and managerial principles in managing ecosystems to produce, restore, or sustain ecosystem integrity and desired conditions, uses, products, values, and services over the long term."* Taking an ecological approach to management. *In* Ecosystem management. Pages 3-15 in United States Department of Agriculture Forest Service Publication Wo.WSA-3.

3. Grumbine, 1994. Ecosystem management is *"...integrating scientific knowledge of ecological relationships within a complex sociopolitical and values framework toward the general goal of protecting native ecosystem integrity over the long term."* What is ecosystem management? Conservation Biology 8:27-38.et al. 1998.

4. Wood,1994. Ecosystem management is "*...the integration of ecological, economic, and social principles to manage biological and physical systems in a manner that safeguards the ecological sustainability, natural diversity, and productivity of the landscape."* Ecosystem management: achieving the new land ethic. Renewable Natural Resources Journal 12: 6-12.

5. Lackey, 1998. Ecosystem management is *"…'the application of ecological and social information, options, and constraints to achieve desired social benefits within a defined geographic area and over a specified period."* Seven pillars of ecosystem management. Landscape and Urban Planning 40: 21-30. http://www.sciencedirect.com/science/article/pii/S0169204697000959

6. Brussard et al., 1998 "*Ecosystem management is managing areas at various scales in such a way that ecological services and biological resources are conserved while appropriate human uses are sustained.".* Ecosystem Management: What is it really? Landscape and Urban Planning 40: 9-20. http://www.mendeley.com/research/ecosystem-management-it-really

Note: A source for the first four definitions on this list, together with much relevant historical information on ecosystem management is: C. Christensen et al. 1996. The report of the Ecological Society of America Committee on the Scientific Basis for Ecosystem Management. Ecological Applications. 6: 665-691. http://naldc.nal.usda.gov/download/63/PDF

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1.4 Ecosystem Management and the Green Economy

There is an exceptionally strong linkage between the green economy and ecosystem management in that ecosystem management is widely viewed as an essential methodological approach for enabling the green economy. This connection was recently highlighted in an issues paper prepared for the International Ecosystem Management Programme (IEMP) High-level Forum on Ecosystem Management and Green Economy which points to a "N*eed for improved synergies between ecosystem management and green economy in developing Rio+20 policy frameworks*"[11]. The importance of these synergies is similarly emphasized in another current UNEP report indicating "*Ecosystem management can halt and reverse the increasing degradation of ecosystems while also providing economic and job opportunities, particularly for developing countries. Hence ecosystem management plays a pivotal role in green economy development*"[12].

A "green economy" is defined by UNEP as an economy that results in '*improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities' (see box on the following page).* The UN General Assembly in 2009 declared the themes for the 2012 United Nations Conference on Sustainable Development ("Rio+20") to be "*A green economy in the context of sustainable development and poverty eradication and the institutional framework for sustainable development*"[13]. In 2011, UNEP's Green Economy Initiative released *"Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication",* a report which serves as a key document for Rio+20. In addition, at the end of that year an even more broadly representative document was launched by the UN Environment Management Group, comprising members of UN agencies, the Bretton Woods

[11] Securing *a Green Economy through Ecosystem Management (UNEP-IEMP 2011)*
[12] *Working towards a Balanced and Inclusive Green Economy (UNEP 2011)*
[13] "*The focus of the Conference will include the following themes to be discussed and refined during the preparatory process: a green economy in the context of sustainable development and poverty eradication and the institutional framework for sustainable development*" - paragraph 20(a) of the Resolution.

Institutions and other intergovernmental bodies: *"Working towards a Balanced and Inclusive Green Economy: A United Nations System-wide Perspective"*[14].

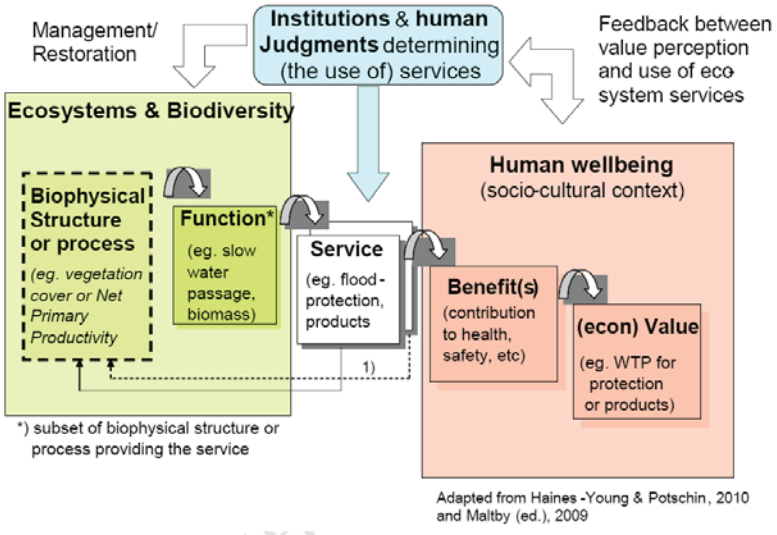
What is the Green Economy?

"For the purposes of the Green Economy Initiative, UNEP has developed a working definition of a green economy as one that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities**.** In its simplest expression, a green economy can be thought of as one which is low carbon**,** resource efficient and socially iclusive**."**

"Practically speaking, a green economy is one whose growth in income and employment is driven by public and private investments that reduce carbon emissions and pollution, enhances energy and resource efficiency, and prevents the loss of biodiversity and ecosystem services. These investments need to be catalyzed and supported by targeted public expenditure, policy reforms and regulation changes. This development path should maintain, enhance and, where necessary, rebuild natural capital as a critical economic asset and source of public benefits, especially for poor people whose livelihoods and security depend strongly on nature".

(Source: www.unep.org > Green Economy > About GEI > What is GEI?)

A UNEP/IEMP paper cited at the beginning of this section (*Securing a Green Economy through Ecosystem Management*) provides additional perspective on the connection between ecosystem management and the green economy, by illustrating on how ecosystems and biodiversity are interconnected with humanity's wellbeing through the institutions and human judgments which determine the use of ecosystem services, as shown in Figure 2 below.



The pathway from ecosystem structure and processes to human well-being[15]

[14] *"…the first-ever inter-agency report on the Green Economy"* – See announcement in http://www.unemg.org/Portals/27/Documents/IMG/GreenEconomy/report/GE_EMG_Final_PR.pdf

[15] *Source: Securing a Green Economy through Ecosystem Management (UNEP-IEMP 2011)* *http://www.unep.org/ecosystemmanagement/Portals/7/Documents/Issues%20paper%20for%20Hi-level%20Forum%20on%20Ecosystem%20Management%20and%20Green%20Economy.pdf*

The UNEP/IEMP paper also shows how key green economy issues are highly relevant to ecosystems management and indicates how actions taken within the ecosystem management framework support the green economy, as demonstrated in the table below[16].

Green Economy key issues to address	Relevance to Ecosystem Management	What can Ecosystem Management do?
Valuation and investments in Natural Capital	✓✓✓	When developing valuation schemes for ecosystem services and making investments. The current state of ecosystems and availability of its services will affect valuation.
Poverty Alleviation	✓✓✓	Community-based initiatives to restore ecosystems have a direct correlation to improved socio-economic standing of the community.
Create jobs and social equity	✓✓✓	Provides the natural capital for job creation and enhances social equity by providing provisioning services to the populace.
Promote renewable energy and low carbon technologies	✓✓	Ecosystems provide the raw material for renewable energy like biomass
Resource and energy efficiency	✓✓	The EM approach ensures resource availability and efficiency
Sustainable urban living	✓✓	Urban ecology promotes sustainable urban living.
Climate change	✓✓✓	Ecosystem-based adaptation (EBA) and REDD+

In summary, the close conceptual links between ecosystem management and the green economy are the basis for mutually advantageous connections between them and ensure that their aims and methodological approaches are complementary. For these reasons we can anticipate that ecosystem management and green economy initiatives are likely to increasingly become even more closely linked in the near future and beyond.

[16] *Source: Securing a Green Economy through Ecosystem Management (UNEP-IEMP 2011)* – selected information here is from columns 1-3 of the text table on pages 9-10.
http://www.unep.org/ecosystemmanagement/Portals/7/Documents/Issues%20paper%20for%20Hi-level%20Forum%20on%20Ecosystem%20Management%20and%20Green%20Economy.pdf

Chapter 2 – Curriculum Structure and Implementation Pathways

2.1 An Academic Framework for the Ecosystem Management Masters

It is within the framework for a postgraduate course of study that specific curricula are best placed within their contexts. In the case of developing a curriculum for ecosystem management there are a number of important considerations with regard to the objectives of the proposed course of study. These can be seen in terms of how the new programme is to be oriented and structured within the academic institution where it will be based. The academic administrative systems presently in place naturally have much bearing on this, but in broad terms proposed programmes may be seen as either research thesis oriented or as non-thesis professional programmes. Research masters programmes generally contain fewer required courses than professional programmes and as such offer fewer opportunities for directed study in the component courses typical of the professional programmes. Professional masters programmes, although not requiring submission of a thesis, normally require some form of substantive written documents (in the form of research reports and/or research articles) as an essential part of their curricula. The distinction between research masters programmes and professional masters programmes may not always seem to be clear because there can be much variability in their comparative requirements of research, coursework and the time required for completion. For these reasons, although a UNEP linked ecosystem management masters might normally be viewed as more easily placed in a professional masters framework, there are also potential prospects that it could fit within a research thesis masters programme within some institutions[17].

For the success of developing new masters programmes (or redeveloping existing ones) in ecosystem management linked with UNEP resources, it is useful to consider not only the content of the programme, but also the individuals who will be targeted for admission to it. Given the need for knowledgeable individuals who can work effectively in this field of endeavour, there are several options. Depending upon the orientation of the academic institution, it may be decided to concentrate upon admitting either recent university graduates who have suitable backgrounds in relevant disciplines but lack work experience or, alternatively, concentrating upon on early to mid-career professionals who already have appropriate work profiles in this area but need further training to achieve a higher level of success in the field. In general, similar to other fields where additional training is highly advantageous, it is likely that professional ecosystem management programmes may be mostly targeted towards recruiting individuals with at least 3-5 years of experience in appropriate disciplines and with backgrounds that indicate a real potential for enhancing their leadership qualities. Alternatively, it may be possible to achieve very good outcomes with recent graduates who have limited professional experience, the options for this can be explored as well as the prospects for their placements in more research based programmes or longer-term internships that can provide relevant working place knowledge.

Professional masters programmes from various fields tend have three components of their curricula in common. The first is are a set of courses in the beginning of the programme which provide the necessary information for an enhanced understanding of the knowledge base of the discipline and explicit training on how to apply this knowledge to real world situations; the second component is an element of applied experience, usually through an internship or supervised project that is situated in a suitable institutional or field setting where the student interacts with acknowledged experts in the discipline; the third component is usually some form of final product at the end of the programme – a paper or document on a completed project – alternately, some other form of evidence that a sufficient level of proficiency has been attained. Access of the masters candidates to additional courses during the final term of their studies while writing the final paper often provides for their being able to learn further at the graduate level about areas directly related to their special areas of expertise and interest, enabling them to attain information tailored to advancing their competencies for professional work. Another common feature of successful professional programmes is the provision of one-on-one mentoring throughout (i.e. during the courses, the internship and the final project reporting phase) such that, through continual interactions with mentors and peers, the masters candidates are provided with ongoing expert advice and guidance. For the launching of an ecosystem management masters, the creation of appropriate courses, a system for providing projects/internships, and some form of final project report document are likely to be needed, although the scope and contents of these complementary components may be differently offered by the various academic institutions involved.

[17] Although research thesis masters are generally longer in duration than professional or so-called “applied” masters programs and generally need about two years or more to complete, in some geographic areas (e.g. the UK) certain thesis masters may be completed within only two university terms – a period of about 9 months – and these contain a coursework component similar in size to that of professional masters programs.

2.2 Positioning the Ecosystem Management Masters within the Academic Institution

Because the nature of ecosystem management is transdisciplinary it is likely that the optimal base of a masters programme for this will be in a department and faculty which are oriented towards offering degrees in such broadly based areas of interest. While the masters could be seen to work within a faculty of science, it is equally probable that it could be founded within other areas of a university where the academic staff and administration are open to cross disciplinary programmes. Given that academic institutions are structured along faculty and departmental lines, provision for new cross-disciplinary programmes can be seen as particularly problematic. Nonetheless, at the higher administrative levels of many universities there is an increasing awareness of the need for developing more broadly based offerings that draw from academic staff in the natural sciences, social sciences and all those with the information, knowledge, experience and perspectives relevant to transdisciplinary fields such as ecosystem management. (Given that the use of terms such as "multidisciplinary" and "transdisciplinary" may require some explanation, a useful guide to these is provided in Appendix 3.)

Existing graduate programmes in fields such as forestry, fisheries, agriculture, regional planning and natural resource sciences are already in place at many universities which would possibly be amenable to offering the sort of programme generally described above and discussed in more detail in Chapter Three. There are many excellent masters programmes already in place which provide for a number of similar curriculum components, and these would be particularly suitable for adaptation. The primary changes that might need in many cases to be made would involve more explicit inclusion of the coursework related to the economic and social parameters of ecosystem management, particularly in topics and methodologies related to the green economy such as ecosystem service valuation, and for there to be sufficient opportunities for the masters candidates to gain relevant professional level experience.

Masters programmes such as the Yale University Master of Environmental Management (MEM), the University of Miami Masters of Professional Science Degree in Tropical Marine Ecosystem Management
and the De la Salle University MSc in Environmental Science and Ecosystem Management (Manila) have elements of their curricula which go beyond a strictly environmental science approach to ecosystem management to include related topics of social and economic relevance for practitioners in the field. Sometimes, as in the case of the Yale curriculum, there is also a specific professional development component to the programme. To exemplify what some such degrees have to offer in the fields of environmental and ecosystem management, some additional information on the Yale MEM is given in Chapter 4.

In general, there are comparatively few examples of truly transdisciplinary programmes in the area of ecosystem management and the existing structure and culture of universities is often regarded as a barrier to innovation when it comes to launching new academic offerings that encompass such a broad range of disciplines. In this context academic institutions have been depicted as slow to respond to the need for providing educational programmes that can serve the growing demand for relevant offerings that address critical real-world issues and contribute to their solutions. Critics have expressed this dilemma as: "*The world has problems, but universities have departments*"[18], a perspective summarized in the box on below.

Understanding the Structure and Culture of Universities
"*The world has problems, but universities have departments*."

"Much high-quality science illuminates environmental problems, but it is often poorly organized and incomplete. It often does not have an interdisciplinary integration and synthesis that permit problems to be seen in a larger context, especially in an ecologically sensitive and sensible one. It is often not geared to the scale needed to shed light on environmental problems of long-term importance to human well-being. In short, much essential knowledge is not capable of guiding the development of policy, heightening public awareness, or even informing and enlightening political debate (Brewer, 1995: p. 4)."

"Not a condemnation of conventional academic disciplines, which have obviously served well to build basic knowledge, these concerns actually argue for something more. In this case `more' means problem-oriented and interdisciplinary approaches, too."

"Universities and other knowledge institutions are obvious sources of creativity and innovation, and in truth these have provided some of both. Main concerns center on the small amount and slow rate of each, as reflected in the enormous and unresolved difficulties of achieving sustainable development, ecosystem management, integrated assessments of exceedingly complex bio-geo-chemical systems and processes, and clarity about human-intentional interventions on global and regional as well as local scales. In short, environmental problems require interdisciplinary treatment which the conventional knowledge institutions have been unable, unwilling or slow to provide. Or, as cynics have stated it: `The world has problems, but universities have departments.' "

Source: Brewer, G.D. 1999. The Challenges of Interdisciplinarity. Political Science 32, 327-337

A number of approaches may serve to address the challenge of dealing with what can be perceived as the seemingly intractable dilemma of putting in place innovative crossdisciplinary programmes at academic institutions. An initial point is to determine the flexibility of the university administrators towards developing new programmes that bridge several subject areas normally considered the domain of separate faculties and departments. A good indicator of this is the commitment of the administration to supporting multidisciplinary programmes that may already exist or are in active stages of planning. Given that the issue of precedence is commonly a major consideration for university decision makers, proposals for new masters curricula are more likely to be well received if there have already been broadly based programmes exhibiting a reasonable track record of success. Even when there has been no institutional experience with a truly transdisciplinary programme, it can be useful to put one forward by referring to well established academic areas already occupying positions of status within the academic community that involve multidisciplinary teams of professionals from within and outside of the university. Faculties of medicine, engineering, law and business management usually have multidisciplinary research teams and their curricula reflect this by explicitly including information and links to components which might formerly have been regarded as outside traditional boundaries. Universities that have existing programmes on environmental impact assessment may be particularly well placed for developing new offerings in areas such as ecosystem management because they already have experience in a field where natural scientists and social scientists work closely together.

Situating a new transdisciplinary academic programme within existing university structures may be seen as less problematic when looking at the various possible options. In some cases a solution involves establishing a new "home" for the masters through an interfaculty agreement. For environmental curricula of considerable scope, this has sometimes been done by forming an agreement for sharing joint responsibility and administration among several different faculties, to name only one viable possibility[19]. While this option can work well, it is likely best reserved for programmes that have the potential and resources to attract large numbers of students and can attract the commitment of senior university administrators and the deans of the faculties involved as well as department heads and the academics who will be teaching the component courses of the curriculum. There are many possible variations along the lines of what can be achieved by an interfaculty agreement, one of which would be alternate approaches at the level of departments and subdepartments within the university, assuming there would be no faculty level impediments to such arrangements. The nature of university governance however, is sometimes such that the time involved for approvals, even at departmental levels, may be too lengthy for such an approach to be particularly practicable. In such circumstances it will be necessary to seek other alternatives.

One alternative to seeking a broadly based interfaculty or interdepartmental agreement for establishing a new masters in ecosystem management is as a complementary programme to an already established area of study within a particular faculty or department. This can more quickly bring the proposed masters through a university approval process by building upon existing strengths of a cohesive academic unit. The new masters is then an option within an established curriculum it complements and expands. An example of this is provided by a programme at McGill University that, similar to the ecosystem management masters, was conceptualized in collaboration with UNEP prior to acceptance and implementation of its curriculum at the university. The new offering was designed as a non-thesis option within an established research thesis based masters degree programme. The box on the following page presents this masters and its curriculum[20].

[19] The McGill University School of Environment is a successful undergraduate program with its director and staff jointly administered by the Faculty of Science, the Faculty of Engineering and the Faculty of Agricultural and Environmental Sciences.
[20] McGill University Faculty of Agricultural & Environmental Sciences—2011-2012 (last updated Aug. 18, 2011)

Master of Science (M.Sc.); Renewable Resources (Non-Thesis) — Environmental Assessment

The Non-Thesis Masters in Renewable Resources: Environmental Assessment option is normally taken over a one year cycle beginning in the winter term and concluding in the fall term. It is comprised of three interrelated elements: graduate-level courses, primarily given in the winter term, a summer term internship, and a project-related research paper, which is completed in the fall term. The program is aimed at environmental assessment professionals and advanced environmental science scholars planning for careers in the public and private sector agencies which guide environmental impact assessment, integrated assessment, and sustainable development in Canada and internationally. McGill's non-thesis masters in Environmental Assessment is offered in conjunction with a Memorandum of Understanding (MOU) with the United Nations Environment Program (UNEP - 2003), which designates the Faculty of Agricultural and Environmental Sciences as a UNEP Collaborating Centre on Environmental Assessment. An important component of the MOU is that the Faculty advance teaching and training through the development of course offerings that enable students to prepare for contributing to sustainable development by utilizing the excellent materials provided by UNEP and other national and international agencies.

- **Required Courses (15 credits)**
  - NRSC 610 Advanced Environmental Assessment (3 credits)
  - NRSC 611 Environmental Assessment Knowledge Base (3 credits)
  - NRSC 612 Environmental Assessment and Sustainable Development (3 credits)
  - NRSC 613 Strategic and Sectoral Environmental Assessment (3 credits)
  - NRSC 614 Meeting Environmental Assessment Regulations (3 credits)
- **Required Internship (15 credits)**
  - NRSC 615 Environmental Assessment Internship (15 credits)
- **Complementary Courses (6 credits)**
  - 500- or 600-level relevant courses to be chosen in consultation with the Supervisor and Program Director
- **Research Project (9 credits)**
  - NRSC 616 Environmental Assessment Project Paper (9 credits)

There were several reasons supporting a favorable outcome to the original proposal to launch a new masters in environmental assessment at McGill, certain of which are also pertinent to developing and implementing ecosystem management masters in other universities. The link with UNEP was seen as positive in that UNEP's resources on the field environmental assessment were recognized as substantive and important[21]. Moreover, McGill already having a Memorandum of Understanding with the group responsible for the promotion of best practice in environmental assessment (UNEP-ETU in Geneva) was considered advantageous. Because of the research interests of some McGill staff there was considerable expertise in relevant areas, and a general perception that recruiting excellent candidates for such a programme could be done without a need for large investments of time and funding. Finally, it was appreciated that the link with UNEP and with other agencies having numerous experts with on the ground experience in environmental assessment would be a very important feature of the new masters. It was understood that, through those links, the content and relevance of the curriculum could be much enhanced beyond what might normally be expected of a programme based in a single university department.

A number of challenges that needed to be addressed in order to move the proposed UNEP-linked masters through the university approval process:. An approach to these challenges and their means of resolution is indicated here. (1) Initial responses at departmental and faculty levels primarily concerned dealing with the availability of personnel and other resources for the proposed programme and its possible effects on others already being offered. Anticipating that these matters will need to be discussed, it is best to consult in advance of formal meetings through communications with colleagues and administrators (deans, department heads) if any proposal is to advance through the early committee process (e.g. faculty planning committee, academic programme committee, curriculum committee). (2) higher level approval bodies with representation from most or all university faculties (e.g. a graduate faculty academic programme committee and/or a graduate faculty council) are potentially more contentious, given that this is where fundamental questions regarding the pedagogical merits of a proposed programme arise and issues relating to the sometimes competing interests of academic faculties and departments within the university may be brought to light. Some of these matters can effectively be dealt with in the course of document vetting by those representing the various disciplinary groups, provided the person championing the new masters is able to communicate directly with the individuals or groups to discuss their reservations. However, the larger issues need to be handled in meetings of the representative body and it is primarily there that these must be addressed in order for a

[21] Agenda 21 explicitly provides for UNEP's leadership in environmental assessment and through its outstanding track record of providing high quality reports and training manuals in the field UNEP has been recognized as a primary resource in its global implementation, working with developing countries to promote the use of environmental assessment as an important tool for sustainable development. The fact that all signatories to Agenda 21 have national legislation on environmental assessment in place provides jurisdictional legitimacy for this process.

new masters programme to be approved[22]. These issues can be resolved provided that a pedagogically sound curriculum has been developed, the target group for potential candidates has been clearly identified, academic staffing and financial resources have been secured and the proposed masters is regarded favorably by the university's senior academic administrators.

The most critical figure in moving proposed masters in ecosystem management through the processes described above is the member of academic staff responsible for seeing this through. Normally this will need to be a mid- or senior level individual among the teaching and research staff who is familiar with the university structure, has appropriate experience and credibility. Because the approval process is nuanced and can be very time-consuming, the individual involved must be prepared to meet with many colleagues and administrators to engage their interest. The person who takes on the task of promoting and implementing the ecosystem management masters will be viewed to be acting as its champion within the university and in interactions with UNEP.

Commentary on the curriculum framework can be concluded by providing a list of what can be considered as positive attributes for institutions which would be in a position to offer an ecosystem management masters in collaboration with UNEP. This list originates from one provided as "Eligibility requirements for academic institutions" for the Masters in Development Practice grant programme of the John D. and Catherine T. MacArthur Foundation[23] and has been adapted and altered in the box below. Items on the list are not given in order of importance.

Positive Attributes for Academic Institutions Offering
The Ecosystem Management Masters (EMM) Program

- **Strong Institutional endorsement**
  Endorsement for the establishment of the Ecosystem Management Masters from the senior university management
- **High academic standards**
  Reputable and well-established graduate-level academic programs in relevant core EMM disciplines (e.g. natural sciences, social sciences, policy, management) ensuring that students can receive an education across the entire range of EMM core competencies
- **Significant geographic representation**
  Potential of the academic institution to draw students from within the region and to serve as a regional EMM centre, and potential of the institution's location to contribute to an expanded geographic distribution of EMM programs globally
- **Supportive institutional home for the masters program**
  An identified institutional base for the EMM program within a particular academic department, school or university collaborative center
- **Sufficient institutional capacity**
  University administration and staff with experience administering masters degree programs and experience managing grants and budgets with transparency and efficiency
- **Established infrastructure**
  Basic infrastructure including available classrooms, labs, computer resource centers and internet connections that could provide students and faculty with regular access to a global EMM network
- **A dedicated faculty champion for the Ecosystem Management Masters**
  An appropriately positioned faculty member to guide and lead the institutional process for development and implementation of the EMM program
- **Substantive Ecosystem Management experience**
  Faculty members with experience working in focused projects or organizations locally as well as internationally
- **Dedicated personnel**
  Motivated faculty members and supportive staff, able to work across disciplines to support the EMM program
- **Practical training opportunities**
  International organizations, government agencies, and private sector partners working in the local area of the institution with demonstrated interest in engaging students in internships and field studies
- **EMM philosophy**
  A shared understanding of the philosophy on this innovative transdisciplinary program in support of sustainable development through ecosystem management

[22] Upon approval by a graduate faculty council or similar body a masters program will still be subject to final endorsement by the highest administrative level of a university (e.g. university senate) and it is possible at this point it may again be challenged but this is generally considered a less likely occurrence.
[23] www.macfound.org/mdp

2.3 Graduate Student Profiles

For the launch of an ecosystem management masters to be successful it is essential to clearly define the expected profiles for students targeted for registration in the programme. Given the level of knowledge expected of those who should be enrolled in an advanced programme of this nature, a normal requirement for admission would be for individuals already with professional work experience in a field relevant to advanced studies on the ecosystem management and with a bachelors degree in an appropriate discipline. Examples would be candidates having career experience in fields such as conservation, natural resource management, land use management, regional planning and the sectors of agriculture, forestry and fisheries. Prerequisite degrees of desirable candidates for the ecosystem management masters could be in environmental science, ecology, land management, planning, or other pertinent disciplines in faculties of the natural sciences humanities and social science, engineering, and management[24]. As a capstone programme providing in depth knowledge for advancing ecosystem management, it should be considered that those selected for admission already be considered already having expertise in an associated field, whether this be natural resource sciences, ecology, management or other relevant area. Because programme will be targeted towards individuals with an existing body of expertise upon which the ecosystem management conceptual framework and methodologies then be added, the masters would not be intended for "generalists", but rather as an advanced degree for individuals already having a considerable depth of knowledge in their specific area of expertise in a related discipline and with management skills or potential.

While there is room for alternate approaches to the ecosystem management masters, and in some cases it may be given at a different level for those without career experience, a focus on candidates with work experience in a relevant field can be particularly advantageous in that it better ensures job placements for those completing the degree. Following graduation, successful students would be expected to find employment in mainstream businesses supporting ecosystem management, financial institutions, governments and regulators, international organizations, nongovernmental agencies and consulting companies. Depending upon their specializations the graduates would be qualified in their chosen fields of specialization for mid-level placements as analysts, managers, and directors in the public or private sector.

Examples of ecosystem management jobs for graduates in fields related to disciplinary specializations and professional qualifications can be found at various websites devoted to careers in sustainable development and the green economy, for example the useful job sites at learningforsustainability.net, GreenBiz.com, and. ILO (International Labour Organization) Green jobs. UNEP in 2008 published a comprehensive report on the present and growing job market for the green economy entitled "*Green Jobs: Towards decent work in a sustainable, low-carbon world*"[25], which presents data on currently existing green jobs in various economic sectors and provides estimates on the future growth of such employment.

2.4 Expected Competencies of Graduates from the Ecosystem Management Masters Programme

Early consideration of the expected competencies of graduates from the ecosystem management masters should be an important part of planning for its implementation. The suggestions which follow have been developed in keeping with what would be considered relevant for students graduating from with a UNEP linked masters on ecosystem management, however the list of competencies given here may be of interest as well for academic institutions not prepared to launch a new masters on the discipline but nonetheless considering developments in allied subject areas within existing programmes. For the masters to be effective in educating individuals who can go on to leadership positions in the field and function at high levels of performance it is essential that the programme recruits and trains candidates who will not only have the knowledge to carry out their work but also have developed the critical skills and competencies to ensure their success. This means that beyond their educational experiences in the conceptual and practical aspects of ecosystem management the students must be provided with opportunities to build upon this core knowledge base through their developing the necessary abilities to function as managers in real world situations which demand the ability to work at all levels of developing and implementing ecosystem protection and restoration plans at local and regional scales.

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[24] It must be emphasized that an ecosystem management masters is not solely intended for candidates with backgrounds in the natural sciences but should also be open to individuals with degrees in the social sciences and management – the need is to provide advanced training and educational opportunities for those who will graduate and then work effectively in the field, and having management backgrounds in particular can be especially advantageous for this. Ecosystem management agencies presently can lack managerial capacity, as their scientists and other experts do originate from schools of management. This is to say *"… ecosystem managers may not be equipped with the decision-making skills needed to undertake an adaptive management methodology* (Gregory, et al. 2006. *Deconstructing adaptive management: criteria for applications to environmental management.* Ecological Applications. Vol. 16(6). pp. 2411–2425.).

[25] www.unep.org/labour.../Greenjobs/UNEP-Green-Jobs-Report.pdf *(UNEP/ILO/IOE/ITUC, September 2008)*

Given that it is to be a key goal for this ecosystem masters programme to produce graduates able to work effectively at the right levels in ecosystem management requiring their expertise, in keeping with growing career options in the discipline, the necessary skills and competencies can be readily defined. The key considerations in deciding upon these skill sets for success in the field would include:

1. *Core competencies* for ecosystem management – i.e. the personal skills, attributes, and behaviours which are considered important for all professionals in the field, regardless of their function or level.
2. *Managerial competencies* - i.e. the competencies which are considered essential for staff with managerial or supervisory responsibilities in the field of ecosystem management.
3. *Functional Competencies* - i.e. the specific technical competencies related to respective areas of work in the field of ecosystem management.

An example of competencies which could be expected of graduates of an ecosystem management masters is provided here[26].

Core Competencies	Managerial Competencies	Functional Competencies
Leadership qualities **Ethics and integrity** **Interpersonal skills** **Communication skills** **Critical analysis** **Strategic thinking** **Flexibility/adaptability** **Problem solving skills** **Cultural awareness** **Global perspective** **Political savvy**	**Leadership** **Team building** **Project management** **Strategic planning** **Decisionmaking** **Adaptive management** **Coalition facilitation** **Time management** **Negotiation** **Conflict management** **Financial planning**	**Ecosystem management** **Ecosystem assessment** **Ecosystem monitoring** **Ecosystem service valuation** **Applied statistics** **Environmental assessment** **+ Particular expertise in Fisheries, Forestry, Agriculture, Water management, Conservation, Regional Planning, Natural resource management, and/or other relevant fields.**

The complementary combination of core competencies, managerial competencies and functional competencies can be viewed as explicitly acknowledging what is to be anticipated as an appropriate set of attributes and skills for graduates from the masters programme. Equally important, the inclusion of such expectations in the planning process for the masters helps to more clearly designate the learning objectives of the programme for both its university developers and for its future students. The essential point is that a UNEP-linked masters in ecosystem management is to be seen by the host university and its potential graduates as a programme having both a targeted disciplinary content, consisting of courses and other elements containing information directly relevant to knowledge about ecosystem management, as well as a complementary component explicitly addressing the competency requirements to be expected of those who must work as effective managers to achieve real results. This emphasizes the importance that should be accorded to ensuring that those teaching in the masters and the graduate students enrolled will be entirely aware of the importance of understanding that the management component of the discipline is as important as the contents of its more technical sections on the specific methodologies involved in ecosystem assessment and monitoring. Core competencies like interpersonal skills, ethics and integrity, cultural awareness and political savvy are to be accorded equal importance with critical analysis and strategic thinking. These in turn can be seen as inherently important to the mastery of the suite of managerial competencies. The functional competencies, too often regarded as the "real work" of the discipline, are then appreciated in the context of their reliance on ecosystem management practitioners having the right personal attributes and managerial abilities to do them correctly.

[26] A number of the entries included in this table are sourced from Virginia Tech's Executive Master of Natural Resources (XMNR) program (http://cnre.vt.edu/xmnr/competencies/) and the linked XMNR Core Competencies pdf, together with materials provided later in this sourcebook. The XMNR Core Competencies list was compiled from reference to *"…issues identified by organizations such as the Association for the Advancement of Sustainability in Higher Education (AASHE), National Council for Science and the Environment (NCSE), Ecological Society of America (ESA), US Green Building Council (USGBC), and Environmental Protection Agency (EPA) and "… reflects core requirements for graduate programs such as Master of Business Administration (MBA), Master of Public Administration (MPA), and Master of Organizational Development (MOD)."* - see weblink citation.

2.5 Perspectives on Programme Delivery

Although programme delivery will vary among the academic institutions providing the ecosystem management masters, in keeping with most postgraduate programmes, the courses will usually be comprised of lectures, seminars, workshops, fieldwork/ field visits and tutorials, and student performance will be evaluated through assignments and examinations. Instructors are encouraged to provide active learning opportunities for students such that individually and in groups they are able to apply the course information and methodological tools to analysis and problem solving in appropriate real world case study exercises. While information will normally be provided in part through lectures and readings, an active learning approach would be expected to be prominently evident in course delivery such that opportunities for individual and group interactions with the instructor would be an inherent part of curriculum teaching. Collaborative teamwork by the students on selected exercises and assignments, monitored and evaluated by the instructors, should be regarded as a positive and distinguishing feature of the masters.

Given that the ecosystem management focuses on environmental sustainability and improved human wellbeing, and that "management is impossible without measurement" it is critically important that ecosystem management masters programmes consider measurement methodologies to be core to the curriculum and that these be clearly included in a manner that ensures the students be proficient in applying appropriate analytical and modeling methodologies. Explicit provision should be made for teaching the economic, scientific and statistical methods used by ecosystem management professionals. For example, courses or modules would be expected to include technical approaches such as scenario development, integrated assessment and ecosystem based management together with the statistical, modeling and analytical methodologies which are the basis for these. Through well designed exercises, assignments and case studies these and other important methods can be effectively taught to those in the programme. Clearly, the inclusion of such material means that students admitted to the masters possess an appropriate background enabling them to master these, and thus the methodological component of the curriculum is intended to build upon existing knowledge rather than containing basic information that should have been covered in previous coursework or training.

At the conclusion of the ecosystem management masters, those graduating would be expected to possess a high level of expertise in areas demonstrably important to professionals and expert practitioners in the field. This would include an in depth understanding of the principles and practice of ecosystem management, the ability to apply appropriate analytical methods and operational tools to the analysis of key datasets, and a demonstrated proficiency in communicating effectively with policymakers and specialist experts. The ideal graduate would have a strong understanding of the most important components of the field of ecosystem management, considerable managerial competence and an ability to effectively apply technical elements of his or her disciplinary specialization within the multidisciplinary teams working towards solving the most challenging problems addressed by the field.

2.6 Ecosystem Management Masters Programme Links with UNEP and other Agencies

The fundamental reason for linkages between UNEP and universities is the sharing of accumulated and emerging knowledge about the environment. As the world's premier environmental agency, UNEP provides global access to a wealth of environmentally related data and a vast array of reports and policy papers that are of great use to universities and other institutions concerned with the environment. By providing free and universal access to these via the internet, UNEP also serves as an information gateway to individuals and organizations active in all areas of environmental study, research and policy making. In turn, universities and their staff interact with UNEP in many ways, ranging from partnerships for gathering and analysing data, to research on environmental issues, and consultations in support of developing new ideas and policy positions. An example of this has been the role of universities in the Millennium Ecosystem Assessment, which was initiated in 2001 "...to assess the consequences of ecosystem change for human well-being and the scientific basis for action needed to enhance the conservation and sustainable use of those systems..."[27] Many of the over 1360 experts involved in the assessment were researchers and academic staff based in universities.

Despite these robust links between UNEP and universities through research and through the consultation process on its major initiatives and policy, UNEP has generally been less connected with universities in the area of environmental education, although this has is recently becoming more of a focus through the activities of divisions such as EETU and its initiatives – e.g. GUPES and MESA[28] which interact with university representatives to discuss and encourage

[27] www.maweb.org/
[28] Mainstreaming Environment and Sustainability in Africa (MESA) Universities Partnership toolkit website at http://www.unep.org/training/mesa/toolkit.asp

university teaching about sustainability. The direct impact of UNEP on environmental education in universities has to date been somewhat limited, a fact that is understandable given the impressive array of alternate providers and resources for university instructors to select from when teaching environmentally related courses. Relevant books and mainstream journals account for most materials referenced in university undergraduate and postgraduate courses and, given constraints on class time and the abundance of literature sources, e-journals and weblinks already available. Documents and reports from the UN and other environmental agencies less commonly appear in class offerings. Although those teaching university courses on the environment are generally aware of UNEP's role in global issues such as climate change and the protection of biodiversity, they are not often equally familiar with UNEP's recent and current activities in providing scientific reports, guideline documents, commentary and policy papers on many other relevant areas of environmental importance. Consequently, although UNEP materials are sometimes used as components of broadly based university environmental class courses and curricula, they receive less recognition than should be the case.

While UNEP's dissemination of knowledge on the environment can be considered valuable for university environmental education generally, it is actually for more applied areas of environmental knowledge such as ecosystem management that UNEP's relevance to university curricula is seen to be of the greatest importance. This is because, both globally and with its close connections to regional activities in developing countries, UNEP is able to provide well documented examples and case studies to show how data gathering, analysis and project planning can be linked together in solving real world environmental problems. These case studies, together with others from local and regional agencies, will provide core materials of considerable importance for ecosystem management curricula. Also, by explicitly acknowledging the importance of environmental, economic and social elements of ecosystem management and bringing these together within a transdisciplinary approach to the problem solving, as inspired by UNEP, those developing and implementing the masters curriculum for this field be able to further provide for their postgraduate students in keeping with past practice principles that are endorsed globally.

As well as connecting with UNEP, it is also useful to link the ecosystem management masters with additional partner organizations which can provide expert advice in relevant subject areas and can provide lecturers who add value to the academic programme by participating as guest speakers in its courses and seminars. However, besides this, the most important role for these institutional partners can be in providing projects or internships for the students and field study opportunities for the programme as a whole. Considering that the masters is oriented towards providing a sound practical background and experience in the field, it is critical that strong connections exist between the institutional base for the programme and outside actors which in the real world are on the front lines of work in areas of importance for ecosystem management. As indicated in information on page 7, partners may be international organizations, government agencies, or the private sector. It is advantageous to have a range of these from different sectors having various interests and involvements in ecosystem management. Organizations active in environmental planning and development, conservation, assessment, evaluation and reporting, government regulation and environmental policy are all potential partnership candidates, as are consulting companies and civil society organizations. By linking into a broad spectrum of partnership entities, the masters will have the capacity to provide its students with real world experience under the close supervision of seasoned professionals, ensuring that the masters candidates will be well prepared to move forward in their careers to make significant contributions to their chosen field and thus advance ecosystem sustainability.

Connecting with other universities and academic institutions is also to be regarded as a positive part of the development process for the ecosystem masters programme. Similar to the other partner organizations described above, academic institutions should also be seen in terms of their potential for providing valuable guest speakers for seminars and as places for locating appropriate outside advisors and peer reviewers for the masters during its formation and throughout the time the programme is underway. While many of these interactions with other academic institutions customarily can take place on a one to one basis, the overall process should be even further advanced through participation in multi-institutional meetings and through the international networks of academic organizations that promote education for sustainable development[29].

Robust links with UNEP and with other organizations and agencies outside of the university will distinguish the ecosystem management masters as an outstanding academic programme that produces graduates already exposed to the real world problems and how these are being resolved and who, based on their experiences within the programme, will be recognized to have the knowledge, professional attributes and managerial competencies to distinguish themselves in the field.

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[29] For example, the Association for the Advancement of Sustainability in Higher Education (AASHE) http://www.aashe.org/

Chapter 3 – Curriculum Components

Appearing here and in the following two subsections of this guidance document are specific suggestions for the base curriculum components of the ecosystem management masters. Subsection 3.1 provides information directly related to structuring an overall programme and course framework which can effectively deliver to the masters students the contextual knowledge, professional skills, on the job experience and management insights necessary to for them to perform at a high level of competency and effectiveness in their post-programme careers. Subsection 3.2 provides information on the contents of the curriculum components (courses, internship(s), etc.) to ensure that students enrolled in the masters will have access to the information and experiences needed to be offered a solid background of knowledge about ecosystem management in the context of its conceptual framework, and methodologies.

The information and materials presented in this description of curriculum components are provided only as a starting point for review and adaptation by academic institutions interested in taking steps to develop a new UNEP linked masters programme in ecosystem management. The eventual structure and content of a proposed masters programme in ecosystem management at a host university will likely differ in form and content from the model template prescribed here, as any such programme must be adapted to student needs, institutional norms and the capacities of academic staff and resources. However, in order to fulfill its objectives in training ecosystem management students at the level envisioned by this UNEP initiative, it is seems reasonable to expect that the essential elements of the ecosystem management masters as outlined below should remain fundamentally the same even though they may of course be adapted to a different form of delivery at any given academic institution.

3.1 Ecosystem Management Programme Structure and Course Framework

An applied masters programme such as ecosystem management often is organized to have a set of courses, an internship and a substantive final paper or report written to demonstrate student competency in the subject area. This form of the masters is normally regarded as a non-thesis programme because the final paper does not require the same level of in depth study as is the case for a thesis, and the programme and is characterized by more of a concentration on structured courses. Provided that this framework is compatible with university graduate faculty regulations and university statutes, it can to be recommended as appropriate for the ecosystem management masters.

Subject to institutional norms, the time frame for completing a non-thesis masters programme is usually from one year to 18 months. To ensure its availability for professionals who may be able to enroll during a leave of absence from their positions, and for others who can only complete a degree by intensive work over a comparatively limited time, the optimal duration could be regarded as one year, comprising full time attendance during the three 4-month semesters commonly offered over this period. Arrangements to take the masters on a part time basis (e.g. consecutive periods of one semester full time, one semester away) might be considered desirable to accommodate the needs of professionals in ongoing positions, and in this case creating curriculum schedules sufficiently flexible to allow for this would be necessary. An ecosystem management masters could also be made available part time for those already working in the field and requiring even more options with regard to scheduling. A number of additional alternatives for curriculum delivery are covered in Section 3.3 of this chapter.

Although it is evident that the ecosystem management masters is to be regarded as a programme that can be offered in a variety of different ways, to simplify its description here the following text will refer to a framework for a non-thesis masters taken over a comparatively short time period, with the understanding that interested institutions can readily adapt this model to other curriculum delivery patterns that will best suit their circumstances.

The first semester of a non-thesis programme should be devoted to courses that will provide all masters candidates with a strong grounding in base knowledge and advanced topics in ecosystem management plus any additional areas of importance considered essential to best practice standards of the discipline. The second semester (in a one year programme) can be devoted to internship placements and/or workplace –based research in appropriate partner organisations which provide for supervised assigned project work in areas of particular relevance to the objectives of the programme and specialized disciplinary orientations and technical background strengths of the individual candidates. The final semester entails additional coursework by the students in focus areas chosen to complement and expand their understanding and competencies in subjects most relevant to their developing expertise and levels

of professionalism in ecosystem management. Additionally, a project paper in a prescribed form on a topic of importance to the field is to be completed in this final phase of the programme and submitted at the conclusion of the semester. Suggestions for the internal structuring of these various elements of the masters programme are to be found in the following subsection on course contents.

From an administrative perspective, the necessary steps in the formation of the new programme will initially require work in organizing the syllabus, creating the new core courses, and guiding the proposed masters curriculum through the university approval process. Links with any key partner organisations must be secured also during this initial period if they are later to be effectively involved. Once the masters curriculum is approved and candidates recruited, the programme will need ongoing oversight by its director and other staff to ensure that it is functioning properly and any needs for adjustment are quickly recognized and addressed. Along with maintaining a close liaison with the programme course instructors and students, the most important management role involved will be the work of an internship coordinator. This individual, who in some circumstances might also be the programme director, will be responsible for guiding the internship process at all levels throughout its duration (e.g. contact with internship host organisations, evaluating potential internship positions, overseeing the internships, and receiving performance reports from supervisors and students). For the ecosystem management masters programme to be a success, the need for sufficient resources to support its administrative requirements must be recognized in advance and the necessary staff, infrastructure facilities and financing have to be in place.

The masters programme structure as described here is intended for prospective graduate students who have backgrounds in areas in or closely aligned to ecosystem management and who have worked professionally in such fields for at least several years. The demand for such a programme is high, given the present prominence of ecosystem management as a planning tool and the focus on it by organisations seeking to improve the outcomes of regional development at a variety of levels. Undergraduate programmes in the natural resource sciences and other academic sectors that already exist presently serve as entry point to work in the field, as do some research masters focusing on related topic areas, but there is a particular need for offering graduate programme opportunities of the type described above for individuals already involved in ecosystem management work and who are motivated to advance professionally. With the advanced training made possible through a masters such as this, those completing the programme will then become articulate problem solvers and leaders who can most effectively work with others to deal with issues of ecosystem protection, preservation and enhancement that are in the hallmarks of best practice in the field today.

3.2 Ecosystem Management Programme Courses/Modules

Course delivery approaches for the ecosystem management masters would be according to the decisions of the host institution and its instructors, and innovative methods are to be encouraged wherever practicable. The scheduling of classes may be throughout a semester or they can be delivered over shorter periods as modular units. The inclusion of guest speakers is particularly important when they are brought in to provide their expertise, and share their experiences with the class. Webconferencing can be very advantageously used to facilitate the sessions which involve guest lecturers who are not available locally, for example experts from UNEP and other organisations. Lectures, seminars, case-studies, in-class exercises, panel discussions and field sessions should all be considered as options for effectively delivering the learning objects of each course. The ecosystem management programme has as its primary objective the advanced training of professionals in a complex transdisciplinary field by providing them with an intensive exposure to the knowledge bases, skills and perspectives required of those who are to play a role in advancing sustainable development methodology. Knowledge integration is regarded as an overriding theme to be promoted throughout all courses and topic areas. Given that a major objective is to provide the candidates with opportunities to actively engage in discourse with their primary instructors and other knowledgeable individuals who come to share their technical expertise and perspectives, many instructors will probably decide to use a combination of teaching methods during class time. The most critical component of the classes is the level of intellectual engagement on important topics, and the opportunity for the students to be able to discuss with the presenters the nuances and complexities of dealing realistically with the challenges addressed in ecosystem management.

Because the modular approach has become a common form of delivery in university programmes, and because it can be particularly useful for presenting certain types of information (e.g. annotated readings, structured training in methods and their applications, etc), within applied disciplines such as ecosystem management, in the following outline of the curriculum the term “course” is to be taken to mean any of the following: a traditionally structured course, a multistage module or set of modules, or a combination of traditionally delivered course sections and related modules. Thus, the “courses” referred to below may consist of sections covering various topics that may actually be offered as a combination of modules and other teaching forms. Regardless of the extent to which modules may be involved in the masters programme, it can be appreciated that they can have particular advantages in certain circumstances because they enable particular subjects to be handled in a carefully prescribed manner and

sometimes these modules can be made available for students who are not enrolled in the entire programme but have a particular interest in some parts of it. It must nonetheless be acknowledged that the proper development of modules for course instruction purposes is often an arduous and time-consuming process although in the long run the modular approach can be extremely beneficial. The production of self-directed modules which allow students to work independently on some aspects of the learning process also can result in a more efficient use of instructor and class time, giving opportunities for the students to acquire information outside of the group class setting and then to return to the class for more advanced training, assignments and discussions among themselves and their instructors.

Within the framework described in section 3.1 above are a number of courses, some of which would need to be created as new courses and the remainder being existing graduate level courses that might be revised if necessary to be more compatible with the programme. Provisional working titles and sample contents for the core courses to be taken by students in the initial phase of masters are provided below. Following this are general descriptions of the internship and project paper courses and, finally, a generic list indicating examples of complementary graduate courses that could be added to complete the programme curriculum.

The curriculum as described in general here and in the following pages is presented simply as a template which may be of use in initiating discussions for an ecosystem management masters at an academic institution. Its format may be adapted as a whole or in part, but the particulars of an ecosystem management curriculum would necessarily have to be designed in keeping with the existing structures and policies of the university concerned. Thus, decisions about curriculum content and goals, specific courses within the curriculum (drawing from existing course offerings as well as any new ecosystem management courses) would be the responsibility of the host university. A new ecosystem management masters programme could consist of a course – internship – final paper format as indicated here, but could alternately be provided as a suitable combination of modules, assignments and active learning experiences that would equally well deliver the intended knowledge of and exposure to the field. The ultimate form and content of the masters would be determined by deliberations within the host university, which could be supported by consultations with outside collaborating bodies such as UNEP.

3.2.1 New courses/modules for the first term/semester

Three of the new courses, normally to be offered in the first semester of the masters, would be aimed at bringing together and documenting relevant information on the topic areas considered particularly necessary for the ecosystem management programme in the context of the needs of the students for applying such information to problem solving in their chosen fields. These courses are provisionally titled and provided with sample topic lists in the box on the following page.

The important matter for consideration is that in the first semester of the masters there be core courses that substantially cover the topic areas most relevant for the degree candidates in core areas of sustainable development, ecosystem management and the green economy. The specific topics to be covered should be carefully considered in the context of their value to the overall learning objectives of the programme and as such would be a mix of relevant theory, methodologies and analytical techniques together with examples of applications through relevant case studies.

The three courses provided here concern three elements of an appropriate masters curriculum for this field, specifically a course on ecosystem management, a course on sustainable development in relation to ecosystem management, and a professional development course. While only three courses are given here for the sake of simplifying this illustration of possibilities, the actual number and designations for the courses could of be different. Depending upon determinations of time for class contact hours with instructors, the times required for in class and external assignment and exercise activities, and the course credit weighting system for the academic institution concerned, more than three courses would quite possibly be offered to completely occupy the first semester of study. Or, as is discussed in later on in this document (Section 3.3 Alternative Pathways for Ecosystem Management Curricula) the coverage of core course topics could alternately be delivered through modules or at least in part through other graduate courses available at within the academic institution.

The topics listed within each of the three proposed courses are necessarily quite generic in order to provide a sense of the overall scope and range of topics which could be addressed within them. Depending upon the academic strengths of the host institution, these topics can then be revised to more precisely reflect the specific theoretical content, analytical approaches and technical methodologies most appropriate for developing core knowledge and competencies of the students in the institutional setting which is to deliver the relevant material for the ecosystem management masters.

Proposed new courses for the first semester of the ecosystem management masters are provided in the box on the following page.

Proposed New Courses/Modules for the First Semester of the Ecosystem Management Masters Programme[1]

- **Advanced Ecosystem Management**

  This core course would provide in depth information on the principles and practice of ecosystem management and insights into the most promising new developments in the field. Included among the subjects covered should be topics such as: *"The principles and practice of ecosystem management" (transdisciplinary overview), "Sectoral applications of ecosystems management (Fisheries/forestry/Agriculture)"; "Community-based natural resource management", "Integrated environmental assessment"; "Integrated water resource management"; "Ecosystem resilience and restoration", "Case studies in ecosystem management (terrestrial, marine and coastal, aquatic ecosystems)", "Scale and complexity in ecosystem management"; "Data collection, environmental auditing and environmental management systems"; "Biodiversity conservation"; "Ecological engineering", "Ecotechnology", "The social science of multistakeholder ecosystem management"; "Ecological Economics for ecosystem management", "Ecosystem management and the green economy"; "Multilateral agreements and ecosystem management"* and *"Environmental governance" .*

- **Ecosystem Management Methodologies and Tools**

  The objective of this core course would be to provide details on the methodologies and tools used in ecosystem management, with an emphasis on relevant practical methodological applications with reference to specific case study materials and datasets, plus training in effective management in real world situations. Appropriate subjects to include in such a course world be *"Applied statistics for ecosystem assessment and management", "Modeling and scenario building for ecosystem management", "Working with ecosystem management databases", "Ecosystem-based management toolkits", "Ecosystem service valuation methods", "The use of ecological indicators", "Adaptive ecosystem co-management", "Environmental audits", "Life cycle analysis", "Ecosystem management project operationalization and implementation"; and "Leadership in ecosystem management – strategic planning, time management, financial management, and team building for success".*

- **Managerial and Professional Development for Ecosystem Management Practitioners**[2]

  A core course in which the focus would be on providing training based on insights into the personal attributes, skills and capacities that are essential for ecosystem management professionals to function effectively in their work and to exemplify leadership in the field. Included as appropriate subjects for coverage could be topics such as: *"Problem solving and analytical skills", "Strategic planning", "Social sustainability and social responsibility", "Multicultural and gender perspectives", "Interpersonal skills and communication", "Consensus facilitation", "Negotiation and conflict ", "Process management", "Managing change within organisations", "Establishing priorities", "Team building, inspiring and motivating others", "Performance management", "Strategic planning", and "Managing social networks".*

[1] *Other topics may be placed within the courses depending upon the needs and orientations of the host academic institutions, graduate students and faculty in keeping with how such topics would best address programme learning objectives. UNEP resources would be favored for source materials and case-study examples wherever appropriate.*

[2] *Alternatively, the subject areas covered in this professional development course could be accommodated within the other two courses in appropriate subject areas, or offered as complementary modules and exercises.*

3.2.2 New courses/modules for the second and third semesters

In the second and third semesters of a three semester masters, practical experience in professional contexts would be made available for the candidates by means of carefully supervised internships and by closely directed work on a project papers related to the internships. The two courses which would provide for the internships and project papers are described in summary form in the text box on the following page.

Proposed New Courses for the
Ecosystem Management Masters Programme in
Its Second and Third Terms1

- **The Ecosystem Management Masters Internship**[2]

  The objective of the Ecosystem Management internship is to provide students with essential experience by enabling them to work with experienced environmental practitioners in a professional setting. It is a "non-course" that consists of an agreed minimum of work hours or work weeks (e.g.35 hours per week, 15 weeks) directly related to ecosystem management, within a private or public sector institution or organisation. Students will be expected to use the knowledge gained in coursework from the first semester and to apply it to project tasks throughout the internship. The actual work performed must be of a level appropriate to the learning objectives of the ecosystem management masters programme and, as such, it normally involves work on a research project focused on one of the following: 1) direct involvement in developing, planning and/or implementing ecosystem assessment or management; 2) conducting a field or desk study on a pertinent area of interest for ecosystem management, or 3) being directly involved in analyzing the effectiveness of a new or ongoing initiative in ecosystem management. Routine work for a host organisation not involving knowledge acquisition in keeping with the goals of the ecosystem management masters is not deemed suitable for this type of internship. Details of the tasks will be arranged in consultation with the student's faculty supervisor (an instructor within the institution administering the masters) and their on-site supervisor (an approved staff member within the agency). Information gathered during the internship will provide the basis for a project paper (see description in the following course below).

  Prior to placements in organisations, an internship coordinator affiliated with the ecosystem management programme office will work with students and agencies to ensure that the students are prepared and the each internship milieu and project is appropriate. Prior to, during, and after the internship, the student will prepare and submit a number of documents including a current c.v., an internship project description, and an internship report. The intern will also be required to complete background readings in advance of the internship, and to maintain a detailed learning log throughout the period of work.
  .

- **The Ecosystem Management Masters Project Paper**[3]

  The project paper is part of a separate course which is to be completed in the final term of the masters. The goal of this course is enable students to write an ecosystem management project paper, based on material gathered during the summer internship and clearly related to the subject area concentrated upon during that time. The course itself does not regularly scheduled class time except for participation in oral presentations on the project papers at the end of the term. However, meetings may be convened from time to time so that general discussions about the preparations for the paper and the oral presentation can be held with the class as a whole. Throughout the term students will be working with an assigned faculty supervisor who will review progress in preparing the final project paper document. Near the end of the term, students make an oral presentation on the paper topic which will be attended by the class and its faculty supervisors.

  1*Alternately, in an academic institution where the entire programme would extend beyond three terms, these courses would be given in the appropriate sequence following the three new core courses detailed previously.*
  [2] *Although not necessarily designated as a course in the normal meaning of the word, the internship is usually given course status in a graduate programme and assigned a course number and credit weighting.*
  [3]*Here the project paper is described to be a component of a course, although institutional arrangements may vary and it may be otherwise depicted in the university calendar.*

3.2.3 Complementary Courses/Modules for the Ecosystem Management Programme

To complete the curriculum for the ecosystem masters the students would be required to register for and satisfactorily complete a number of graduate courses in addition to the five above which comprise the core of the programme. These complementary courses would be selected for each student in a way to ensure their academic and professional development would be enhanced in keeping with the goals of the masters. The courses provide an opportunity for the masters candidates to focus on areas best suited to their needs and interests for further work in the field. The provision for complementary courses also adds some necessary flexibility to the ecosystem masters.

Listed in the box below are a number of relevant subject areas and topics. This generic list includes areas of interest to ecosystem masters education and training and, although most of these should also be covered to some degree in the core courses of the programme, their inclusion here provides an indication of topic areas particularly important

for individual students who can benefit from the opportunity to delve into them more deeply. In consultation with an academic advisor each candidate in the programme should be able to select appropriate complementary courses.

A List of Subject Areas and Topics for Complementary Courses/Modules[1]

Ecosystem management	Methodologies
Fisheries and wildlife management	Implementing the ecosystem approach
Integrated coastal zone management	Environmental auditing
Ecosystem management of parks and protected areas	Advanced GIS applications
Community-based natural resource management	Remote sensing
Scale and complexity in ecosystem mgmt	Statistics and modeling
Integrated water resource management	Environmental management systems (ISO)
Ecosystem management and conservation	Gap analysis
Adaptive ecosystem management	Collaborative management
Stakeholders in ecosystem management	Stakeholder analysis
Ecosystem management and climate change	Education and non-formal learning
Related areas of interest	Economics, finance and business
Landscaping and landscape ecology	Ecological economics
Urban and regional planning	Environmental economics
Natural resource management	Business management
Anthropology of development	Project management
Ecosystem response to climate change	Consulting for change
Water ethics, law and policy	Corporate social and environmental responsibility
environmental toxicology and management	Financial institution environmental risk management
Environmental law	Microfinance
Environmental justice framework	
Global environmental politics	Sectoral perspectives on ecosystem management
Environmental governance	
Poverty reduction and natural resource management	Agriculture
Resource use efficiency	Forestry
Ecosystem resilience and restoration	Fisheries
Food security and sustainability	Extractive industries
Sustainable rural development	Renewable energy
Public policy analysis and administration	Transportation
Political economy of environmental management	Tourism and ecotourism
Sustainable energy systems	
Environmental assessment and management	
Environmental impact assessment	
Strategic environmental assessment	
Integrated environmental assessment	
Environmental management issues and solutions	

[1]Subject areas in this list are only indicative of few among many relevant topics. Many others would be relevant depending upon the orientations of the ecosystem masters in a particular academic institution and the relevant courses and modules available.

3.2.4 Adapting Course Modules/Materials

Most academic programme developers often think that all course materials/modules are developed 'from scratch'. However, it may be a good idea to always look around what is available at the start of any course material/modules development process. In doing this, it is also important to look at copy right issues. In this regard, UNEP (and other agencies) have an abundance of resources, guides and manuals that could be used in an ecosystem management Masters Programme.

It may be useful to consider looking for course materials/modules that are similar in focus or style or materials that have been developed for a similar learner/student group. The masters programme developers could then adapt ideas from other materials and contextualize or adapt them in relation to the particular focus of their own masters programme. Sometimes, masters programme developers will adapt more than the ideas, using the original text as a basis for developing new course modules/materials.

However, it is useful to note that problems associated with the adaptation of course modules/materials arise when these are superficially adapted or simply 'adopted' with little thought given to the context in which the materials are likely to be used. Care should also be taken not to simply 'copy and paste' using computer technology while putting together course modules/materials. This is because; adapting course resources/modules/materials to different contexts requires more work than simply adopting a set of ideas/examples.

In adapting UNEP or other materials, it may be necessary to consider: Using an idea to open up new possibilities; and evaluating the resource materials for re-development.

Using an idea to open up new possibilities

A common example of drawing on existing materials is the design, development and adaptation of other course resources/modules/materials from existing ones (within the university) to suit the needs of different learners/students contexts. In this case, the use of existing information can enable material developers to open up different possibilities.

Evaluating Course Modules/Materials for re-development

Careful evaluation is extremely necessary when making decisions about adaptation of course modules/materials for different contexts. An important dimension of this is the checking of all the sources of information. It is also important to update postdated information and to provide more contextually relevant information.

3.3 Alternative Pathways for Ecosystem Management Curricula

The framework described in the previous pages for implementing an Ecosystem Management masters provides information for developing a full graduate programme on the field with provisions for the inclusion of new courses, an internship, and complementary existing courses. Some academic institutions do not presently have the capacity and resources to provide this form of an ecosystem management programme, although they may be in a position to move incrementally towards delivering it. Other institutions may choose to offer students a graduate degree with similar learning objectives and deliverables, but with a different form of curriculum framework. Here, these and other alternative pathways and possibilities are considered.

One alternative to a full scale adoption of the full course curriculum previously described would be to begin by offering certain of the courses within existing graduate programmes. This could be done either by using the course examples mentioned above or by creating new courses containing ecosystem management topics selected for students already enrolled in compatible programmes, with the courses adapted particularly to meet their needs and interests. Considerable flexibility could be exercised in the process of creating these courses, and their existence would provide for measuring student interest in the ecosystem management and faculty commitment to providing for it. Provided that responses are positive, this could open an opportunity for moving towards developing a new ecosystem management masters as an option and the courses created could be viewed as for their potential to be included in it.

Another alternative to the ecosystem management masters as depicted above would be to provide for a framework based on a modular approach. Modules containing ecosystem management topics could be developed in the beginning as stand-alone elements or as useful contributions to existing graduate study programmes. The modules could then be brought together to comprise the basis for an ecosystem management masters, with or without links to complementary courses already provided in university departments from compatible disciplines.

Chapter 4 – Case Studies

Essential to effective teaching of candidates enrolled in the ecosystem management masters is access to case studies that provide examples of best practice in the field, characterizing the manner in which the challenging assignments are typically addressed by the professionals who are directly involved.

This chapter provides an introduction to published and weblinked documentation on case studies and case study materials current available through UNEP and other organizations involved in ecosystem management projects. Such projects are by their nature large scale and involve many disciplines, and so the emphasis here is on informing the reader about the types of documentation available and certain sources which are useful as portals for gaining access to it. As well, a several brief summaries of ecosystem management and ecosystem-based management have been selected for presentation here to serve as examples. These can be further explored through the weblinks and references provided to access more detail on the nature of the information and data necessary for ecosystem assessment and management, the steps taken in determining relevant methodological approaches, the tools and computational methods utilized, determination of results, and examples of how findings are presented and conclusions reached and summarized.

4.1 Resources on Case Studies of Ecosystem Management in Practice

The most effective way to access appropriate case studies is by referring to key documents and weblinks which provide links to specific providing sound information on how ecosystem management is performed in field situations. The following three sources provide excellent examples of such resources.

1. UNEP's 2009 publication, Ecosystem Management Case Studies[30], a companion volume to Water security and ecosystem services: The critical connection, is a compendium of case studies focusing on the aspects ecosystem management approach as applied to water resources. These excerpts from its summary section provide an overview of its global range:

   > *"This fourth edition of the United Nations World Water Development Report (WWDR) features 15 case studies from different geographies of the world."…"This volume presents concise summaries of these 15 case study reports, the original versions of which represent approximately one thousand pages."…"The concise summaries provide a snapshot of reality. They present the current situation of water resources and their use in each area covered through a common framework that includes the state of the resource, how water resources are utilized, competition among sectors, legal and administrative frameworks, the status of ecosystems, impacts of climate change and climatic variations."*

   The each of the projects documented in UNEP's Ecosystem Management Case Studies provides details through subsections on: 1. Type and location of ecosystem; 2. Ecosystem Services provided by the ecosystem; 3. Ecosystem degradation, causes and impacts; 4. Management interventions undertaken to address ecosystem degradation and their outcomes; 5. Lessons learned; and 6. For further information. The "further information" sections for each case study are particularly useful in that they list primary literature sources and weblinks enabling readers to access primary reference materials for each case study.

   Three of the 15 case studies, describing ecosystem management projects for Chilika Lake in India, the Okvango Delta in South Africa, and the Aral Sea are provided in Appendix 4.

2. The 2012 UN World Water Development Report [31] offers ecosystem-based management case study summaries and includes links to key references providing relevant material. In this publication the information provided on specific field projects is less extensive and complete than that found in UNEP Ecosystem Management Case Studies, but by referring to the cited references and links it presents for individual projects it is possible in many instances to obtain full documentation on a particular case study.

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[30] *UNEP 2009. Ecosystem Management Case Studies - Water security and ecosystem services: The critical connection. http://www.unep.org/Themes/Freshwater/PDF/EMP_case%20studies_webR.pdf*

[31] *WWAP (World Water Assessment Programme). 2012. The United Nations World Water Development Report 4: Managing Water under Uncertainty and Risk. http://unesdoc.unesco.org/images/0021/002156/215644e.pdf*

A good example of the type of ecosystem-based management case studies which are can be located through the World Water Development Report is given in the box on the following page which outlines the main features of a project on the Komadugu Yobe river basin in Nigeria.

Ecosystem-based Management Integrated into the Management of the Komadugu Yobe basin, Nigeria

"The Komadugu Yobe River ecosystem, supplied by a subcatchment of the vast Lake Chad basin, is part of the natural infrastructure of northern Nigeria. In the semi-arid Sahel, rainfall variability is high and severe drought a frequent hazard. The great majority of the basin's human population – which has doubled in the past three decades to more than 23 million – live in poverty. Over the same time period, flow in the river fell by 35% due to construction of two dams since the 1970s, abstraction of water for large-scale irrigation and regional reduction in rainfall. A society already in social and economic crisis was thus confronted with ever-increasing pressure on vital water resources. The river's natural cycle of seasonal flooding and drying had been replaced by perennial low flows, causing loss of benefits (ecosystem services) that communities had historically relied on. Livelihoods dependent on fishing, farming and herding were devastated. Fish habitats were silted up, the loss of seasonal floods meant that cropland remained dry, and scarcity of water led to conflict. With growing impacts from climate change, the adaptive capacity of the Komadugu Yobe ecosystem and the communities it supports became even more fragile, just when resilience was needed most. The situation was not untypical of many river basins in Africa and elsewhere and its history typified by sector based approaches to water, lack of valuation of the full suite of benefits (services) available to be managed and the absence of any ecosystem level thinking. However, crisis stimulated change. Restoration of the river basin's natural infrastructure, alongside existing built infrastructure, has strengthened adaptive capacity and resilience to climate change. Beginning in 2006, the federal and state governments and other stakeholders, including dam operators and farming, fishing and herding communities, came together to negotiate a plan for coordinating and investing in restoration and management of the basin. In addition to agreeing on a Catchment Management Plan, they drafted a Water Charter, spelling out the agreed principles for sustainable development of the basin and the roles and responsibilities of each stakeholder. Reform of water governance is enabling transparent coordination of water resource development, including remediation of degraded ecosystems and, eventually, restoration of the river's flow regime. Dialogue has reduced the number of cases of conflict to just a handful per year, and governments have pledged millions of dollars in new investment for basin restoration. This progress offers, for once, a potentially more sustainable future. **Ecosystem-based management (EBM) was not a separate approach but integrated, or rather a framework for, more holistic and inclusive planning and management. Importantly, EBM delivered more sustainable water solutions and the ecosystem was not regarded as a 'user' (competing with other uses) but its management a means to deliver greater overall benefits from water.**" [Emphasis here was added to the text.]

Source of above excerpt: Mark Smith and Stefano Barchiesi 2009. Environment as infrastructure: Resilience to climate change impacts on water through investments in nature. In: IUCN Perspectives on Water and Climate Change Adaptation. http://www.preventionweb.net/files/12907_PersPap02.EnvironmentasInfrastructu.pdf

3. An IISD/UNEP 2011 review, Ecosystem Approaches in Integrated Water Resources Management (IWRM): A Review of Transboundary River Basins provides ecosystem management case study summaries for a number of projects located in different areas of the world. An added feature to this particular synopsis of case studies is that it has been written as an in depth review for the IWRM approach to ecosystem management as applied in each of the seven projects it covers. The significance of this is captured in the following excerpt from a section entitled Case Study Research (p 2):

> *"This research aimed to provide a detailed review of selected transboundary basins to ascertain the application of ecosystem-based approaches and draw specific lessons for effective integrated water resources management in international contexts. Basins were selected to represent Africa, Asia and the Pacific, Europe, Latin America and the Caribbean, North America, and West Asia. The case studies represent regional variables while attempting to showcase a range of stresses and ecosystem service vulnerabilities. They focus on ecosystem services relevant to basin management, including climate regulation, water regulation, natural hazard regulation, energy, freshwater nutrient cycling, water purification and waste treatment, disease regulation, primary production, fisheries and recreation, and ecotourism. They include an analysis of whether ecosystem management principles are explicitly or implicitly applied in IWRM processes and whether the approaches recognize and are oriented towards managing bundles of ecosystem services, such as uplands watershed management through afforestation, which addresses the combined services of climate regulation, water regulation, and water quality."*

In one of its final sections (Case Study Synthesis: IWRM Integration and Implementation – p 58), the authors indicate that IWRM is yet to be conducted in a manner that fully incorporates all components of ecosystem management. This conclusion is similarly alluded to in many other ecosystem management review papers

and case study compilations, and simply reflects the presently evolving state of development for ecosystem management as a discipline.

> *"This research on IWRM planning and implementation in transboundary case studies demonstrate the successes and challenges in applying such an integrated approach at the international level. The case studies demonstrate that while IWRM planning and implementation is generally stated as a priority at national and transboundary levels, IWRM implementation remains weak and marginalized from mainstream governance and resources. As a result, none of these case studies demonstrated an advanced level of IWRM implementation.*

4. The UNDP-UNEP PEI Knowledge Resource website and elibrary cab be accessed through the UNDP-UNEP Poverty-Environment Initiative website[32] for connections to a large number of potentially valuable project reports, methodological papers and policy studies, many of which pertain to ecosystem management. . Organized to include a very large scope of publications dealing with all aspects of environment, economics and policy issues, the PEI Knowledge Resource website and elibrary provides a particularly useful gateway for enabling instructors to locate materials for possible use as case studies.

   Information and links to the UNDP-UNEP PEI Knowledge Resource website and elibrary are to be found on the next page.

[32] *See weblinks on next page.*

Knowledge Resources and Services[34]

The production and provision of knowledge resources and services and its promotion including networking is one of the main roles of the Poverty-Environment Initiative.

Knowledge Resources

The regional and country teams of the Poverty-Environment Initiative (PEI) in close cooperation with governments, research institutions, international experts and other stakeholders generate country-specific original assessments, studies, methodologies, reports, policy briefs, guidelines, communication materials and more to inform and facilitate the poverty-environment mainstreaming process. Based on the PEI experiences at country level, the Poverty-Environment Facility (PEF) develops and collects knowledge materials including reviews, methodologies, tools, and examples from countries. It documents lessons learned and good-practices. Generic PEI guidance materials are available in form of Handbooks, Primers, Fact Sheets, Guidance Notes and country success stories. These knowledge materials are provided in return to support those engaged in country-level environmental mainstreaming. This process is carried out in partnership with UNDP and UNEP thematic/technical units, and with external partners including members of the Poverty-Environment Partnership (PEP).

- *PEI-PEP Publications*
- *Country success story archive*

Our generic elibrary offers selected external and PEI knowledge resources to inform each of the steps of the poverty-environment mainstreaming process. Based on experience to date, successful environmental mainstreaming requires a programmatic approach— adapted to national circumstances. The materials are organized according to the components and activities of the PEI programmatic three-phase approach.To access knowledge materials, please click on the relevant subject or section of the diagramme below.

Environmental mainstreaming is targeted at government processes for planning, budgeting, sector implementation, and local level implementation

Preparatory Phase: **Finding the entry points and making the case**	***Phase 1:*** **Integrating environment into national development processes**	***Phase 2:*** **Meeting the implementation challenge**
Preliminary assessments Understanding the governmental, political and institutional context	**Developing country-specific evidence** Integrated Ecosystem Assessment (IEA) Economic analysis	**Integrating Poverty-environment in the monitoring system** Indicators and data collection
Preliminary assessments Understanding the poverty-environment linkages	**Influencing policy processes** National (PRSP/MDG), sector and sub-national levels	**Budgeting and Financing forpoverty-environment** Budget processes and finance options
Raising awareness and building partnerships National consensus and commitment	**Developing and costing policy measures**	**Supporting policy measures** National, sectoral and sub-national levels
Strengthening institutions and capacities Needs assessment Working mechanisms	**Strengthening institutions and capacities** Learning by doing	**Strengthening institutions and capacities** Mainstreaming as usual practice

Engaging stakeholders and coordinating within the development community
Governmental, non-governmental and development actors

Addressing thematic poverty-environment issues
Climate change adaptation, resource efficiency, sound management of chemicals, sustainable land management, marine and coastal issues

[33] *http://www.unpei.depiweb.org/e-library.html*

[34] *http://www.unpei.depiweb.org/knowledge-resources/knowledge-resources-and-services.html*

4.2 Case Studies from the UNEP Millennium Ecosystem Assessment Sub-Global Assessments

A particularly useful website which has been developed by the Sub-global Assessments Working Group (http://www.maweb.org/en/Multiscale.aspx) provides detailed information, literature references and links to the sub-global assessments which comprise a key section of UNEP's original Millennium Ecosystem Assessment (MA) reports. As such, the website can be considered a valuable resource for case studies relevant to masters courses on ecosystem management. It is also particularly valuable as a guide on methodologies.

The sub-global assessments of the MA provide excellent examples of how the methodological approach of scenario development can effectively be used to provide critical information for ecosystem management. In particular, as indicated in its introductory section – *"The MA scenarios, unlike some earlier scenario efforts, were developed to integrate ecology into their design explicitly (Bennett et al. 2003; Peterson et al. 2003a). Ecosystems are not treated solely as passive recipients of impacts resulting from changes driven by socioeconomic systems, but are understood to play an active role in jointly determining the futures of humans and ecosystems. Changes in the flow of ecosystem services are seen as having the potential to alter future development pathways. This is a more integrated view of how human–environment systems unfold over time than is typically assumed in scenario exercises where the goal is to assess environmental changes. (See MA Scenarios, Chapters 2 and 3)".*

One issue of the online journal, Ecology and Society is completely devoted to providing an overview of the MA scenarios (http://www.ecologyandsociety.org/vol11/iss2/) and thus provides complementary material to the MA reports for ecosystem management case studies on the topic: *"This Special Feature was written to provide a synthetic overview of the MA Scenarios in an open-source format widely available to educators, decision makers, and the technical community. The synthesis presented in these papers summarizes selected lessons from the MA Scenarios, but does not provide an exhaustive account of the findings of the Scenarios Working Group. For a complete account, readers are referred to the underlying documents (see reference lists of these papers and http://www.MAweb.org)."*[35]

By opening the http://www.MAweb.org link and accessing the articles listed many projects can be found which can serve well as case studies.

An update to the sub-global assessments (*Follow-up to the Millennium Ecosystem Assessment – Sub-global Assessments)* from 2008 is available here: http://www.ramsar.org/pdf/wn/w.n.unu_subglobal.pdf.

[35] *Carpenter, S. R., E. M. Bennett, and G. D. Peterson. 2006. Editorial: special feature on scenarios for ecosystem services. Ecology and Society* ***11****(2): 32. [online] URL: http://www.ecologyandsociety.org/vol11/iss2/art32/*

4.3 Ecosystem Management Postgraduate Programme Case Studies.

Although there are no masters programmes in the exact configuration of the UNEP-linked ecosystem management masters as proposed and described earlier in this document, there are a number of excellent postgraduate study programmes relating to ecosystem management. Here reference is made to two of these which are notable in that they explicitly address the challenge of providing not only for coursework in the environmental sciences but also for management.

The following course plan curricula are provided to indicate some of the possible different approaches to postgraduate studies related to ecosystem management. In this context a further examination of their curricula may be informative for those developing innovative new ecosystem management masters programmes.

4.3.1. UNEP/UNESCO/BMU International Post Graduate Training Programme on Environmental Management for Developing and Emerging Countries[36]

A programme on integrated environmental management initiated in 1977 by the Centre for International Postgraduate Studies of Environmental Management (CIPSEM) of Dresden Technical University.

This 6-month course covers environmental management as an integrated interdisciplinary field. Therefore a broad range of topics is offered. The curriculum is organized in modules comprising issues of global sustainable development, environmental governance, environmental security, environmental economics and accounting, environmental awareness and public participation, applied ecology and ecosystem management, conservation of biodiversity, water management, recycling and waste management, energy for sustainable development, environmental assessment and environmental management systems, cleaner production and products and eco-efficiency, sustainable mobility, sustainable tourism as well as rural and urban land use planning.

- *Module 1 Conservation of Biodiversity and Nature Protection: - Ecosystems – Nature conservation – Sustainable tourism - Wildlife management*
- *Module 2 Water and Soil – Water resources - Water quality - Urban water – Wastewater treatment – Fisheries - Flood risk - Hydrology and climate - Soil productivity - Soil protection*
- *Module 3 Waste management and Cleaner production – Collection – Treatment and disposal – Recycling – Integrated product philosophy – Cleaner production - Life-cycle assessment*
- *Module 4 Energy efficiency and Renewable energy sources – Demand - Efficiency and conservation – Renewable energy sources*
    - *Transportation*
- *Module 5 Land-use and Impact Assessment - Land-use management – Planning standards - GIS & remote sensing – Risk assessment – Audit schemes*
- *Module 6 Governance and Sustainable Development – Sustainable consumption – Environmental education – Public participation – Economics – Law – International conventions*

A multitude of excursions to protected areas, industrial plants, public utilities for energy, water supply, waste water treatment, as well as waste recycling and disposal plants, environmental agencies and administrations etc. round off the course. They illustrate environmental problems and give ideas of successfully applied integrated environmental management practices. Participants are required to carry out a profound research on a specific environment related subject and present the results of this research in a symposium at the end of the course.

Participants acquire the ability to develop interdisciplinary strategies for sustainable development and to take appropriate measures for an environmental protection that takes ecological, socio-economic and cultural aspects into account. The course is particularly designed for decision-makers of public administration both at national and local level requiring an overall-competence in environmental matters. Participants having successfully completed this course are awarded a Diploma of Environmental Management.

[36] Sources of text excerpts: http://tu-dresden.de/die_tu_dresden/fakultaeten/fakultaet_forst_geo_und_hydrowissenschaften/cipsem/programme/em35 (primary website) and http://tu-dresden.de/die_tu_dresden/fakultaeten/fakultaet_forst_geo_und_hydrowissenschaften/cipsem/service/files/2012/Course_Programme_2012-2013.pdf (program overview).

In addition to the 6-month diploma course, each year CIPSEM offers "…several short courses of about 2 to 4 weeks on specific topics which are of special concern for developing countries (e.g. water, soil, waste, biodiversity, mobility, tourism, urbanization, land-use, energy…", for example: :

> *Short Course on Water Management and Climate Change Adaptation (SC56) Duration: 4 September - 28 September 2012*
> *Short Course on Urban Environmental Governance – Energy Management (SC57) Duration: 10 October - 2 November 2012*
> *Short Course on Remote Sensing and Land-use Change Management (SC58) Duration: 14 November - 14 December 2012*

Graduates from short courses are awarded a Certificate of Proficiency in the specialized field of study.

4.3.2 Yale University Master of Environmental Management (MEM),

Another relevant postgraduate programmes, earlier referenced in chapter two section 2.2 is the Yale University Master of Environmental Management (MEM).

The masters programme at Yale is of particular interest in that it is framed in a manner that takes into account the tiered
foundational structure of the environmental management within a conceptual framework that works well for closely related multidisciplinary fields such as ecosystems management. Also, the Yale masters has components that provide professional development courses for the graduate students. As a research masters, the Yale programme is necessarily organised in a different way than that of the model provided earlier here, but it has elements which are of relevance for both research masters and professional masters graduate study curricula.

The Yale Master of Environmental Management is profiled in the box below.

Yale University Master of Environmental Management (MEM),

Offered by the Yale School of Forestry and Environmental Studies.

"The Master of Environmental Management degree prepares students for careers in environmental policy and analysis, green business, design and planning, conservation and stewardship, education, consulting, and journalism. The program requires coursework from the diverse perspectives of the natural and social sciences, with a focus on the complex relationships among science, management, and policy. The purpose of the program is to provide students with a scientific understanding of ecological and social systems that can be applied in a policy or management context. Students are also expected to hone their capacities as leaders and managers through summer internships, professional skills courses, and other opportunities."

Curriculum Components

"Students pursuing the MEM degree complete courses in four major areas: Foundations, Integrative Frameworks, Electives, and the Capstone, for a total of 48 credits over four semesters:

1. *Foundations courses (9-15 credits)*
2. *Integrative Frameworks course (3 credits)*
3. *Capstone course or project (3 credits)*
4. *9 to 11 Electives, including Professional Skills Modules (27-33 credit"*

Curriculum Glossary

***"The Mountain** – the generic term for the new curriculum's overall structure*
***Foundations** – The basic knowledge courses that form the foundation both of the mountain and of our environmental education more broadly.*
***Integrative Frameworks** – Team-taught courses that examine topics from different perspectives and develop interdisciplinary frameworks for understanding environmental problems and solutions.*
***Specialization** – A coherent, deep focus of a student's elective course work.*
***Electives** – The great body of F&ES courses (those that are not a Capstone, Integrative Frameworks, Foundations courses).*
***Capstone** – A requirement for MEM graduation. Consists of either an individual project or a class focusing on the application of the student's knowledge, skills, and understanding to the solution of real-world problems.*
***Professional Skills Curriculum** – A series of four half-semester courses that teach the foundations of project and organizational management, negotiation and conflict resolution, communication, and financial management.*
***Technical Skills Modules** – Our program of student organized activities, focusing on particular technical skills and self-management. The Technical Skills Modules can also include environmental policy and analysis, green business, design and planning, conservation and stewardship, education, consulting, and journalism".*

Source of the above text excerpts: *http://environment.yale.edu/academics/degrees/mem/#mem-curriculum-glossary*

References, Links and Further Resources

The following pages provide examples of books, articles and websites that can be referenced in support of curriculum development for a masters programme in the green economy. The selections given are carefully selected for their use as resources for those working to design and plan suitable curricula with a strong connection to the advances of UNEP and other key organizations active in the field of the green economy.

Examples of books for potential use in ecosystem management curricula

Anderson, Jay Anthony. (2011). Ecosystem Service Valuation, Market-Based Instruments, and Sustainable Forest Management: A State Of Knowledge Primer. Edmonton, Alta: Sustainable Forest Management Network.

Barbier, E.B. (2005). Natural Resources and Economic Development. ,Cambridge UK: Cambridge University Press.

Batish, D. (2008). Ecological Basis of Agroforestry. Boca Raton, FL: CRC Press.

Berkes, Fikret, Carl Folke, and Johan Colding. (1998). Linking social and ecological systems: management practices and social mechanisms for building resilience. Cambridge, U.K.: Cambridge University Press.

Boyd, Emily, and Carl Folke. (2012). Adapting Institutions: Governance, Complexity, and Social-ecological Resilience. Cambridge: Cambridge University Press.

Chapin, F. Stuart, Gary P. Kofinas, Carl Folke, and Melissa C. Chapin. (2009). Principles of Ecosystem Stewardship Resilience-based Natural Resource Management in a Changing World. New York: Springer.

Christensen, V. and J. Maclean. (2011) Ecosystem Approaches to Fisheries: A Global Perspective. Cambridge University Press

Cortner, H., and Margaret A. Moote. (1999). The Politics of Ecosystem Management. Washington, D.C.: Island Press.

Daily, Gretchen C. (1997). Nature's Services: Societal Dependence on Natural Ecosystems. Washington, DC: Island Press.

Dalal-Clayton, B, B Sadler (2005). Strategic Environmental Assessment: A Sourcebook and Reference Guide to International Experience. Earthscan, London.

Eeten, Michel , and Emery Roe. (2002) Ecology, Engineering, and Management: Reconciling Ecosystem Rehabilitation and Service Reliability. Oxford: Oxford University Press,

Fowler, Charles W. (2009) Systemic Management: Sustainable Human Interactions with Ecosystems and the Biosphere. Oxford: Oxford University Press.

Gunderson, Lance H, and C S. Holling. (2002) Panarchy: Understanding Transformations in Human and Natural Systems. Washington, DC: Island Press.

Gunderson, Lance H., Craig R. Allen, and C. S. Holling. (2009). Foundations of Ecological Resilience. Washington, DC: Island Press.

Haas, Timothy C. (2011). Improving Natural Resource Management: Eological and Political Models. Chichester, West Sussex: Wiley.

Håkanson, Lars, and Andreas C. Bryhn. (2008) Tools and Criteria for Sustainable Coastal Ecosystem Management: Examples from the Baltic Sea and Other Aquatic Systems. Berlin: Springer.

Harper, David M., and Alastair J. D. Ferguson. (1995). The Ecological Basis for River Management. Chichester: J. Wiley.

Hein, Lars. (2010). Economics and Ecosystems: Efficiency, Sustainability and Equity in Ecosystem Management. Cheltenham, UK: Edward Elgar.

Hobbs, R. J., and Katharine N. Suding. (2009). New Models for Ecosystem Dynamics and Restoration. Washington: Island Press.

Holland, Daniel S. (2010). Economic Analysis for Ecosystem-based Management: Applications to Marine and Coastal Environments. Washington, DC: RFF Press.

International Society for Ecological Economics, and Marco Janssen. (2002). Complexity and Ecosystem Management: the Theory and Practice of Multi-agent Systems. Chelteham, UK: Edward Elgar Pub.Hein,

Jax, Kurt. (2010). Ecosystem Functioning. Cambridge: Cambridge University Press.

Jørgensen, Sven E, Fu-Liu Xu, and Robert Costanza. (2010) Handbook of Ecological Indicators for Assessment of Ecosystem Health. Boca Raton, FL: CRC Press/Taylor & Francis.

Jørgensen, Sven Erik, and Felix Müller. (2000). Handbook of Ecosystem Theories and Management. Boca Raton, Fla: Lewis Publishers

Kaiser, Harry M., and Kent D. Messer. (2011). Mathematical Programming for Agricultural, Environmental, and Resource Economics. Hoboken, N.J: Wiley.

Kareiva, Peter M. (2011). Natural Capital: Theory and Practice of Mapping Ecosystem Services. Oxford [England]: Oxford University Press.
Kellman, Martin C., and Rosanne Tackaberry. (1997). Tropical Environments: The Functioning and Management of Tropical Ecosystems. London: Routledge.
Koellner, Thomas. (2011). Ecosystem Services and Global Trade of Natural Resources: Ecology, Economics, and Policies. London: Routledge.
Kumagai, Michio, and Warwick F. Vincent. (2003). Freshwater Management: Global Versus Local Perspectives. Toyko: Springer
Kumar, P and M.D. Wood Eds. (2010). Valuation of Regulating Services of Ecosystems – Methodology and Applications.. Routledge Explorations in Environmental Economics.
Kumar, P. (2010). The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations. Earthscan, London; Washington, DC. Lal, R. (2000). Integrated Watershed Management in the Global Ecosystem. Boca Raton, FL: CRC Press.
Kumagai, Michio, and Warwick F. Vincent. (2003). Freshwater Management: Global Versus Local Perspectives. Toyko: Springer.
Layzer, Judith A. (2008). Natural Natural Experiments: Ecosystem-based Management and the Environment.. Cambridge, Mass: MIT Press.
Managi, Shunsuke. (2012). The Economics of Biodiversity and Ecosystem Services. New York, NY: Routledge.
McKitrick, Ross R. (2011). Economic Analysis of Environmental Policy. Toronto: University of Toronto Press.
McLeod, Karen, and Heather Leslie. (2009). Ecosystem-based Management for the Oceans. Washington, DC: Island Press.
McPherson, Guy R., and Stephen DeStefano. (2003). Applied Ecology and Natural Resource Management. Cambridge, UK: Cambridge University Press.
Meffe, Gary K. (2002). Ecosystem Management: Adaptive, Community-based Conservation. Washington, D.C.: Island Press.
Mitsch, W.J. and S.E. Jørgensen, Ecological Engineering and Ecosystem Restoration. (2004), New Jersey: John Wiley and Sons.
Neumayer, E. (2010). Weak versus Strong Sustainability — Exploring the Limits of Two Opposing Paradigms. Edward Elgar Publishing Limited, Cheltenham.
Norton, Bryan G. (2005). Sustainability: A Philosophy of Adaptive Ecosystem Management. Chicago: University of Chicago Press.
Peet, Richard, Paul Robbins, and Michael Watts. (2011). Global Political Ecology. Abingdon, Oxon: Routledge.
Perrings, Charles, Harold A. Mooney, and M H. Williamson. (2010) Bioinvasions and Globalization: Ecology, Economics, Management, and Policy. Oxford: Oxford University Press.
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Weblinks to some key websites and documents on ecosystem management

UNEP Ecosystem Management – *The gateway website to UNEP's ecosystem management framework and resources, including the UNEO's "Policy Series on Ecosystem Management".*

DEWA/GRID-Geneva - *is part of UNEP's global group of environmental information centres, known as the Global Resource Information Database (GRID) network. GRIDs-Geneva and Nairobi were the first centres to be launched in mid-1985. GRID centres not only facilitate access to but directly provide environmental data and information for decision-making and policy setting; underpin UNEP's ongoing review of environmental state and trends; and provide early warnings about emerging environmental problems and threats.*

Guidance Manual for the Valuation of Regulating Services - *The objectives of this manual are: to identify and evaluate different methodologies for valuing regulating services in economic terms; to provide guidance on the main issues that need to be considered and addressed when using these different valuation methodologies; [and] to demonstrate, through case studies, the application of these methodologies to the valuation of regulatingservices and the scope for incorporating these values into decision-making processes.*

Green Hills, Blue Cities – *"An Ecosystems Approach to Water Resources Management for African Cities" – This provides a good example of an excellent case study, based on UNEP ecosystem management best practice.*

Weblinks to some key documents and websites on the green economy

The UNEP Green Economy Report – *"Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication" - UNEP's key document on the topic, which "provides timely and practical guidance to policy makers on what reforms they need to unlock the productive and employment potential of a green economy".*

UNEP Green Economy Initiative – *The homepage of UNEP's key website on the green economy, containing links to its Green Growth Knowledge Platform, its Advisory Services to governments, Research Products, Partnerships, videos, success stories, information on news and events and more..*

Working towards a Balanced and Inclusive Green Economy: A United Nations System-wide Perspective *Launched in December 2011 by the UN Environment Management Group – this document offers a comprehensive perspective on the nature of the green economy and its implementation.*

The Economics of Ecosystems and Biodiversity – *The homepage of TEEB, with links to its important activities and publications. Provides access to many of the best websites on economics in relation to ecosystems and the green economy.*

Towards Green Growth - *The Green Growth Strategy (OECD) - The web portal to the OECD green growth strategy. "This strategy provides a practical framework for governments in developed and developing countries to seize opportunities that arise when the economy and the environment work together." It consists of: Towards Green Growth; Towards Green Growth - Monitoring Progress: OECD Indicators; Tools for Delivering Green Growth; Towards green growth: A summary for policy makers.*

UNEP Green Economy Research Products – *From a link within the UNEP Green Economy Initiative (see below) a number of important UNEP publications are listed including: Forests in a Green Economy: A Synthesis; Why a Green Economy Matters for Least Developed Countries; The Transition to a Green Economy: Benefits, Challenges and Risks from a Sustainable Development Perspective; Driving a Green Economy Through Public Finance and Fiscal Policy Reform; A Brief for Policymakers on the Green Economy and Millennium Development Goals, and others.*

A Compilation of Green Economy Policies, Programs, and Initiatives from Around the World. (World Resources Institute (WRI) - *"The purpose of this compilation is to highlight examples of "Green Economy" policies, programs, and initiatives taking place around the world…..The case examples in this compilation are organized first by sector and then by geographic location. Each example provides a brief description of the case study and identifies specific policy changes that made it possible. The compilation also discusses major economic, social, and environmental outcomes."*

Knowledge materials for developing country-specific evidence through integrated ecosystem assessments and economic analysis (UNDP/UNEP Poverty Environment Initiative (PEI)) - *"During the implementation of the PEI programme, country-specific evidence has been gathered to identify priorities and develop arguments to influence policy processes. Country-specific evidence is mainly developed through ecosystem assessments and economic analysis. A number of reviews, methodologies, tools and examples from countries can be used as reference. Under the headings of "Ecosystem Assessments" and "Economic analysis" links are given for the following: "Reviews and introductory documents"; "Methodologies and tools; and "Examples from countries"."*

Some further examples of key documents from UNEP and other institutions

FAO. (2009). State of World Fisheries and Aquaculture 2010. FAO, Rome
FAO. (2010). Global Forest Resources Assessment 2010: Main Report. FAO, Rome.
Millennium Ecosystem Assessment (2005). Ecosystems and Human Wellbeing: Synthesis. Island Press, Washington.
OECD (2006). Applying Strategic Environmental Assessment: Good Practice Guidance for Development Co-operation. Organisation for Economic Cooperation and Development, Paris.
OECD (2011). Towards Green Growth. Organisation for Economic Cooperation and

TEEB (2010). The Economics of Ecosystems and Biodiversity: Mainstreaming the Economics of Nature: A synthesis of the approach, conclusions and recommendations of TEEB. United Nations Environmental Programme, Geneva.
UNEP (2008). Green Jobs: Towards Decent Work in a Sustainable, Low Carbon World. United Nations Environment Programme, Nairobi.
UNEP (2009a). Rethinking the Economic Recovery: A Global Green New Deal. United Nations Environment Programme, Nairobi.
UNEP (2011). Green Economy Report. United Nations Environment Programme, Nairobi.
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World Bank (2011). The Changing Wealth of Nations. Measuring Sustainable Development inthe New Millennium. World Bank, Washington.
Worldwatch Institute (2012). State of the World 2012: Moving Toward Sustainable Prosperity: A Worldwatch Institute Report on Progress Toward a Sustainable Society. Washington, DC: Island Press.

Ecosystem management masters programmes *– Links to the curricula of some existing masters programmes having a focus on ecosystem management or a particular relevance to the subject area.*

Yale University Master of Environmental Management (MEM)

The University of Northern Iowa Professional Science Master's Degree Programmes in Ecosystem Management:

University of Miami Masters of Professional Science Degree in Tropical Marine Ecosystem Management

Texas A&M University masters in Ecosystem Science and Management

University of Montana Master of Environmental Management (MEM). in Ecosystem Management

University of Copenhagen MSc in Environmental and Natural Resource Economics

University of Southern Denmark MSc in Environmental and Resource Management

University of Wisconsin – Madison MSc in Conservation Biology and Sustainable Development

Other related masters programmes *– Additional links to related curricula*

Lund University International Master's Programme in Environmental Studies and Sustainability Science

MastersStudies.com *generates lists and links to programs offered at university institutions worldwide via a searchable database.*

See also masters degree listings from the Center for Sustainability at Aquinas College under
Masters Degrees Menu: » Sustainability in Education » Graduate Programs » Masters Degrees

Key education for sustainable development (ESD) websites

UNEP Environmental Education and Training (EET) - *The gateway to UNEP's Environmental Education and Training website, with information on programmes, meetings, newsletters, UNEP-partnered courses and training sessions. A key website provided by the Environmental Education and Training Unit, which is responsible for the implementation of environmental education and training activities in close collaboration with all UNEP Divisions.*

Education for Sustainable Development (ESD) *– In this UNESCO website and its sublinks are a definition of ESD and relevant information on its context and history with respect to UNESCO and UNEP initiatives. It*

includes reference to ESD's most important supporting documents - the Bruntland Report, Agenda 21, and the Bonn Declaration.

UN Division of Economic and Social Affairs Division for Sustainable Development (DSD) – *This is a UN website that "… promotes sustainable development as the substantive secretariat to the UN Commission on Sustainable Development (CSD) and through technical cooperation and capacity building at international, regional and national levels…". Linked with Agenda 21 and the Johannesburg Plan of Implementation.*

Other useful ESD websites

Earthscan Sustainability Curricula – *This is a useful website for publications on sustainability curricula hosted by Earthscan, publishes environmentally relevant information in association with international institutions such as UNEP and a wide range of governmental and civil society organizations. Earthscan's Sustainable Development Curriculum website contains "core textbooks" and "further reading" linked to an SD curriculum of 9 modules.*

Association for the Advancement of Sustainability in Higher Education (AASHE) – "*AASHE's mission is to empower higher education to lead the sustainability transformation. We do this by providing resources, professional development, and a network of support to enable institutions of higher education to model and advance sustainability in everything they do, from governance and operations to education and research." Based in the US, AASHE included member universities from other countries and has a wealth of useful links and resources.*

Global Higher Education for Sustainability Partnership (GHESP)
"Four international organisations with a strong commitment to making sustainability a major focus of higher education have formed the Global Higher Education for Sustainability Partnership (GHESP). The four founding partners of the initiative – the International Association of Universities, the University Leaders for a Sustainable Future, Copernicus Campus and UNESCO – combine forces in a unique effort to mobilise universities and higher education institutions to support sustainable development in response to Chapter 36 of Agenda 21."

Learning for Sustainability (LsF) – *An informative website independent from international organizations, hosted by learningforsustainability.net for "helping people collaborate and innovate".*

Link to Sustainability Masters Programmes – *Hosted by the Strategies for Sustainability website, this is a bloglink for web users contributing to the topic.*

Weblinks to key documents on ESD

Tomorrow Today: Learning to build a sustainable future – UNESCO on ESD – *This is the most comprehensive UNESCO document on Education for Sustainable Development.*

Environmental Education, Ethics, and Action: A Workbook to Get Started. (2006) – *An inspirational text on environmental education with interesting examples and thoughtful commentary, published by UNEP EETU for educators everywhere.*

EFA-ESD Dialogue: Educating for a sustainable world *A UNESCO policy paper highlighting the strategic role of ESD in achieving Millennium Development Goals and raising the profile of ESD in EFA (Education for All) Agendas.*

Sustainable Development in Higher Education: Current Practice and Future Developments
A report aimed at improving curricula to encourage "sustainability literate" graduates for the UK by embedding ESD in institutions of higher learning.

Weblinks to key documents on sustainable development

UNEP Millennium Ecosystem Assessment Guide to the Millennium Assessment Reports – *A website that provides information on and access to the millennium assessment reports, a key resource for green economy curricula in that the documents comprise a "…scientific appraisal of the condition and trends in the world's ecosystems and the services they provide, as well as the scientific basis for action to conserve and use them sustainably".*

UNEP Global Environmental Outlook (GEO) – *The gateway website to the Global Environment Outlook (GEO) "… a consultative, participatory process that builds capacity for conducting integrated environmental assessments for reporting on the state, trends and outlooks of the environment. GEO is also a series of products that informs environmental decision-making and aims to facilitate the interaction between science and policy". GEO datasets and the reports connected to the website are invaluable resources for the green economy.*

Global Reporting Initiative (GRI) - *The GRI website and its resource library contain information on environmental and economic data and provide detailed guidance for its consistent collection globally. Its main partnerships are with UNEP, the OECD and the UN Global Compact and also has connections with the International Finance Corporation (IFC) the International Organization for Standardization (ISO), the United Nations Conference on Trade and Development, and the Earth Charter Initiative.*

Appendix 1

Overview of the Millennium Ecosystem Assessment

What is the Millennium Ecosystem Assessment (MA)?
The Millennium Ecosystem Assessment (MA) was called for by the United Nations Secretary-General Kofi Annan in 2000. Initiated in 2001, the objective of the MA was to assess the consequences of ecosystem change for human well-being and the scientific basis for action needed to enhance the conservation and sustainable use of those systems and their contribution to human well-being. The MA has involved the work of more than 1,360 experts worldwide. Their findings, contained in five technical volumes and six synthesis reports, provide a state-of-the-art scientific appraisal of the condition and trends in the world's ecosystems and the services they provide (such as clean water, food, forest products, flood control, and natural resources) and the options to restore, conserve or enhance the sustainable use of ecosystems.

What were some of the innovations of the MA?
The MA was designed as an integrated assessment to cut across sectors, involving natural science and social science perspectives. The MA was also a multi-scale assessment, which included component assessments undertaken at multiple spatial scales – global, sub-global, regional, national, basin and local levels. Another important feature of the MA was the emphasis on including different knowledge systems, apart from "scientific knowledge". To explore this topic, the MA organized an international conference "Bridging Scales and Epistemologies" in March, 2004, in Alexandria, Egypt.
The MA also had an innovative governance structure that was representative of not only scientists and experts, but also UN conventions, civil society groups, and indigenous peoples. The MA Board, the Assessment Panel, and Working Groups were co-chaired by representatives of both developed and developing worlds.

What is new about the MA findings?
The MA, like the Intergovernmental Panel on Climate Change (IPCC), assessed current knowledge, scientific literature, and data. Thus, at the most basic level, assessments of this nature synthesize information that has previously been available, and do not present new research findings. Nevertheless, three aspects of the MA do represent important new contributions.

- First, the findings of this assessment are the consensus view of the largest body of social and natural scientists ever assembled to assess knowledge in this area. The availability of this broad consensus view of scientists is an important contribution to decision-making. The assessment identifies where broad consensus exists on findings but also where the information is insufficient to reach firm conclusions.
- Second, the focus of this assessment on ecosystem services and their link to human well-being and development needs is unique. By examining the environment through the framework of ecosystem services, it becomes much easier to identify how changes in ecosystems influence human well-being and to provide information in a form that decision-makers can weigh alongside other social and economic information.
- Third, the assessment identified a number of 'emergent' findings, conclusions that can only be reached when a large body of existing information is examined together.

What impact does the MA hope to have?
The overall aims of the MA were to contribute to improved decision-making concerning ecosystem management and human well-being, and to build capacity for scientific assessments of this kind. The ultimate impact of the MA will depend on the extent to which the MA findings are used by decision-makers, both at the global level (e.g., conventions) and at sub-global scales. Significant assessment capacity has already been built worldwide through participation in the MA. It is also expected that there will be substantial adoption of the MA conceptual framework, approaches, and methods in the ongoing initiatives and programs of the various institutions that have been partners in the MA process.

Source of the above text excerpts: http://www.maweb.org/en/About.aspx

Appendix 2

The SAVE Objectives and the Ecosystem Approach

The SAVE Objectives in Relation to the Convention on Biological Diversity (CBD) Principles:

Sustainable:

The first objective recognizes that the natural environment forms the foundation upon which all prosperity ultimately depends, and that management of an ecosystem must ultimately be ecologically sustainable. By utilizing an Ecosystem Approach, managers seek to ensure that decisions relating to development and other human activities do not impinge on the ability of the natural environment to function as a homeostatic system delivering essential 'life support' services, i.e. ecosystem services.

Importantly, prior to implementing management decisions, both the short-term and the long-term impact of those decisions on the natural environment are considered.

> CBD Principle 6: **Ecosystems must be managed within the limits of their functioning**. Rationale: In considering the likelihood or ease of attaining the management objectives, attention should be given to the environmental conditions that limit natural productivity, ecosystem structure, functioning and diversity. The limits to ecosystem functioning may be affected to different degrees by temporary, unpredictable or artificially maintained conditions and, accordingly, management should be appropriately cautious.
>
> CBD Principle 5: Conservation of ecosystem structure and functioning, in order to **maintain ecosystem services**, should be a priority target of the ecosystem approach. Rationale: Ecosystem functioning and resilience depends on a dynamic relationship within species, among species and between species and their abiotic environment, as well as the physical and chemical interactions within the environment. The conservation and, where appropriate, restoration of these interactions and processes is of greater significance for the long-term maintenance of biological diversity than simply protection of species.
>
> CBD Principle 3: Ecosystem managers should **consider the effects (actual or potential) of their activities on adjacent and other ecosystems**. Rationale: Management interventions in ecosystems often have unknown or unpredictable effects on other ecosystems; therefore, possible impacts need careful consideration and analysis. This may require new arrangements or ways of organization for institutions involved in decision-making to make, if necessary, appropriate compromises.
>
> CBD Principle 8: Recognizing the varying temporal scales and lag-effects that characterize ecosystem processes, **objectives for ecosystem management should be set for the long term**. Rationale: Ecosystem processes are characterized by varying temporal scales and lag-effects. This inherently conflicts with the tendency of humans to favour short-term gains and immediate benefits over future ones.

Acceptable:

The Ecosystem Approach places human well-being at its centre, and recognizes that communities and nations ultimately determine how "well-being" is both defined and achieved. It recognizes that the process of reaching agreement on how the natural environment should be conserved, used and valued should be a collaborative exercise. This process is often complex and frequently politically charged.

The Ecosystem Approach acknowledges that there are limits of acceptable change in any ecosystem, but also that attempts to 'push through' conservation measures without community support are likely to fail or prove counterproductive. Management decisions must therefore be acceptable to the communities they will affect and those charged with implementation.

The late Wangari Maathai stated *"You cannot protect the environment unless you empower people, you inform them, and you help them understand that these resources are their own, that they must protect them."*

> CBD Principle 1: The objectives of management of land, water and living resources are **a matter of societal choice**. Rationale: Different sectors of society view ecosystems in terms of their own economic, cultural and societal needs. Indigenous peoples and other local communities living on the land are important stakeholders and their rights and interests should be recognized. Both cultural and biological diversity are central components of the ecosystem approach, and management should take this into account. Societal choices should be expressed as clearly as possible. Ecosystems should be managed for their intrinsic values and for the tangible or intangible benefits for humans, in a fair and equitable way.
>
> CBD Principle 12: The ecosystem approach should **involve all relevant sectors of society and scientific disciplines**. Rationale: Most problems of biological-diversity management are complex, with many interactions, side-effects and implications, and therefore should involve the necessary expertise and stakeholders at the local, national, regional and international level, as appropriate.
>
> CBD Principle 10: The ecosystem approach should **seek the appropriate balance** between, and integration of, conservation and use of biological diversity. Rationale: Biological diversity is critical both for its intrinsic value and because of the key role it plays in providing the ecosystem and other services upon which we all ultimately depend. There has been a tendency in the past to manage components of biological diversity either as protected or non-protected. There is a need for a **shift to more flexible situations**, where conservation and use are seen in context and the full range of measures is applied in a continuum from strictly protected to human-made ecosystems.

The SAVE Objectives in Relation to the Convention on Biological Diversity (CBD) Principles (Continued):

Valued:

The Ecosystem Approach recognizes that communities, and humanity more broadly, value the natural environment in many different ways, but that the value of many ecosystem services is either understated or ignored because economic models and associated decision making processes are not designed to adequately capture externalities, including many of the services and benefits provided by ecosystems. Importantly, the Ecosystem Approach values the foundational role played by natural infrastructure in the long-term prosperity of humanity.

In this context, the Ecosystem Approach seeks to balance immediate or short-term financial benefits that might be gained by exploiting the natural resources or provisioning services of an ecosystem, against long-term expenses associated with replacing the supporting, regulating and cultural services, should those services no longer be available. This requires improving our understanding of ecosystem services and improving the way we value them so that informed 'trade-offs' can be made and 'wise use' planning frameworks adopted.

Consistent with the new economic paradigm of a green economy, natural ecosystems must be managed in such a way that short-term and inequitable wealth is not delivered at the expense of growing environmental risks, ecological scarcities and social disparities.

CBD Principle 4: Recognizing potential gains from management, there is usually a need to **understand and manage the ecosystem in an economic context**. Any such ecosystem-management programme should:

(a) Reduce those market distortions that adversely affect biological diversity;
(b) Align incentives to promote biodiversity conservation and sustainable use;
(c) Internalize costs and benefits in the given ecosystem to the extent feasible.

Rationale: The greatest threat to biological diversity lies in its replacement by alternative systems of land use. This often arises through market distortions, which undervalue natural systems and populations and provide perverse incentives and subsidies to favour the conversion of land to less diverse systems. Often those who benefit from conservation do not pay the costs associated with conservation and, similarly, those who generate environmental costs (e.g. pollution) escape responsibility. Alignment of incentives allows those who control the resource to benefit and ensures that those who generate environmental costs will pay

Efficient:

The Ecosystem Approach recognizes that it is not sufficient for the management of the natural environment to be ecologically Sustainable, locally and politically Acceptable, or to make good Financial sense over the long-term. Management must also be Efficient. This involves considering all forms of relevant information, decentralizing management as much as possible and managing ecosystems at efficient scales, both spatially and temporally.

Management frameworks must be developed to enable adaptive responses and management actions in a climate of uncertainty and an ever changing world.

CBD Principle 11: The ecosystem approach should **consider all forms of relevant information**, including scientific and indigenous and local knowledge, innovations and practices. Rationale: Information from all sources is critical to arriving at effective ecosystem management strategies. A much better knowledge of ecosystem functions and the impact of human use is desirable. All relevant information from any concerned area should be shared with all stakeholders and actors, taking into account, inter alia, any decision to be taken under Article 8(j) of the Convention on Biological Diversity. Assumptions behind proposed management decisions should be made explicit and checked against available knowledge and views of stakeholders.

CBD Principle 2: Management should be **decentralized to the lowest appropriate level**. Rationale: Decentralized systems may lead to greater efficiency, effectiveness and equity. Management should involve all stakeholders and balance local interests with the wider public interest. The closer management is to the ecosystem, the greater the responsibility, ownership, accountability, participation, and use of local knowledge.

CBD Principle 7: The ecosystem approach should be undertaken at the **appropriate spatial and temporal scales**. Rationale: The approach should be bounded by spatial and temporal scales that are appropriate to the objectives. Boundaries for management will be defined operationally by users, managers, scientists and indigenous and local peoples. Connectivity between areas should be promoted where necessary. The ecosystem approach is based upon the hierarchical nature of biological diversity characterized by the interaction and integration of genes, species and ecosystems.

CBD Principle 9: Management must recognize that **change is inevitable**. Rationale: Ecosystems change, including species composition and population abundance. Hence, management should adapt to the changes. Apart from their inherent dynamics of change, ecosystems are beset by a complex of uncertainties and potential "surprises" in the human, biological and environmental realms. Traditional disturbance regimes may be important for ecosystem structure and functioning, and may need to be maintained or restored. The ecosystem approach must **utilize adaptive management** in order to anticipate and cater for such changes and events and should be cautious in making any decision that may foreclose options, but, at the same time, consider mitigating actions to cope with long-term changes such as climate change

Appendix 3

Understanding the Nature of Transdisciplinary Studies

Useful definitions from Kronin 2008 *Transdisciplinary Research (TDR) and Sustainability:*
http://www.learningforsustainability.net/pubs/Transdisciplinary_Research_and_Sustainability.pdf

"Disciplinary studies: projects that take place within the bounds of a single, currently recognized academic discipline.

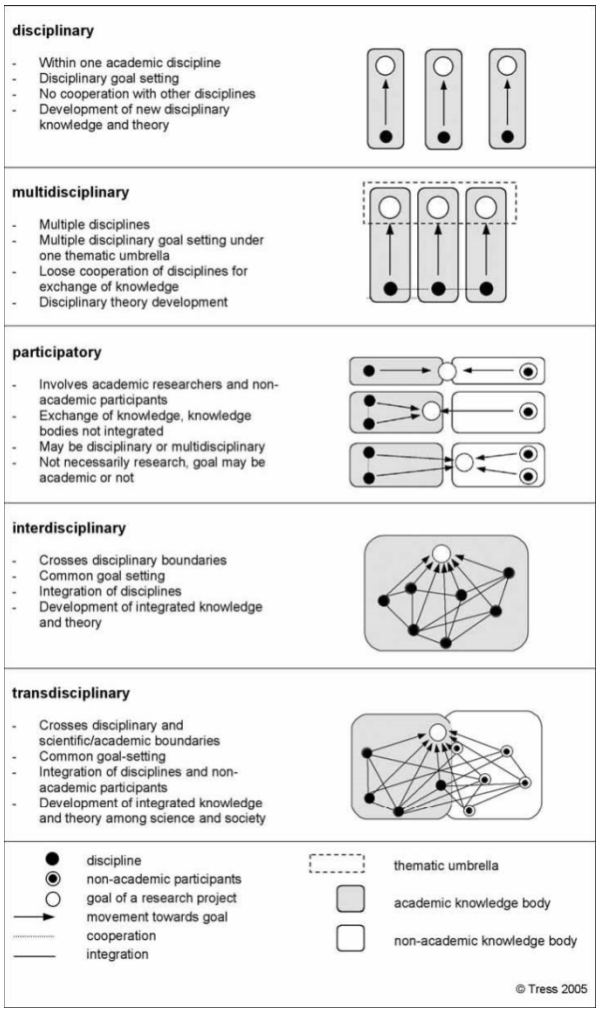
Multidisciplinary studies: several different academic disciplines researching one theme or problem but with multiple disciplinary goals. Participants exchange knowledge, but do not aim to cross subject boundaries to create new knowledge and theory. The research process progresses as parallel disciplinary efforts without integration but usually with the aim to compare results.

Participatory studies: academic researchers and non-academic participants working together to solve a problem. The participants exchange knowledge, but the focus is not on the integration of the different knowledge cultures to create new knowledge.

Interdisciplinary studies: several unrelated academic disciplines [involved] in a way that forces them to cross subject boundaries to create new knowledge and theory and solve a common research goal.

Transdisciplinary studies: projects that both integrate academic researchers from different unrelated disciplines and non-academic participants, such as land managers and the public, to research a common goal and create new knowledge and theory. Transdisciplinarity combines interdisciplinarity with a participatory approach."

The relationships between these are illustrated below. Source: *Defining concepts and the process of knowledge production in integrative research* *http://library.wur.nl/frontis/landscape_research/02_tress.pdf*



Appendix 4A

CHILIKA LAKE (INDIA)

AN ECOSYSTEM MANAGEMENT CASE STUDY

Author:Mohan Kodarkar, Indian Association of Aquatic Biologists, Hyderabad, India In: UNEP 2009. Water security and ecosystem services: The critical connection: Ecosystem Management Case Studies.http://www.unep.org/Themes/Freshwater/PDF/EMP_case%20studies_webR.pdf

1. Type and location of ecosystem

Chilika Lake is the largest coastal brackish water lagoon in India, situated along its eastern coast (Figure 3) between latitude 190 28' and 190 54' N and longitude 850 38' E. This fragile ecosystem is known for its amazing biodiversity, being a designated Ramsar site. It is an avian paradise and wintering ground for more than one million migratory birds. The rich fishery resources of this highly-productive lake ecosystem sustain the livelihood of more than 200,000 strong fishermen community. Apart from its fishery, the ecosystem and its basin resources also are important for the large agrarian community around the lake.

2. Ecosystem Services Provided by Ecosystem

(a) Fishery resources: The Chilika Lake environment is a cradle of lake-based civilization, where traditional lake dependent fishermen communities have utilized the ecosystem resources for generations on a sustainable basis.

(b) Vegetation-based resources: A variety of aquatic weeds are traditionally used for manufacturing handicrafts and things for daily use.

(c) Ecotourism: The rich biodiversity of the lake, including its flagship species of Irrawadi dolphins (Orcaella brevirastris) has made Chilika Lake a major tourist attraction and eco-tourism site.

(d) Recreational, socio-economic and religious values: The lake environment has great social and religious significance. The local communities have a number of traditions and customs that have sustained a very cordial relation between the lake's ecosystems and its surrounding communities.

3. Ecosystem degradation, causes and impacts

(a) Lake hydrology: Chilika Lake is influenced hydrologically by 3 sub-systems: (i) the distributaries of the Mahanadi River in the north; (ii) minor rivers flowing into the lake from the western catchment; and (iii) the tidal outlet to the Bay of Bengal in the south. Construction of major hydraulic structures upstream in the recent past, however, has altered the flow and sedimentation pattern in the lake. Similarly, sediment transport along the shore bordering the sea was influencing and shifting the mouth of the lake, thereby affecting tidal water flows in and out of the lake, with profound influences on the water quality and biodiversity.

(b) Loss of biodiversity: The spatial and temporal salinity gradient produced by freshwater inflows from the lake drainage basin, and the seawater influx from mouth of the lake, makes Chilika Lake a unique ecosystem with fresh, brackish and marine water zones supporting productivity and characteristic biodiversity. Excessive freshwater inflows, and reduced influxes in seawater resulting from the shifting and reduction of the cross-section of the lake mouth, however, had extremely adverse environmental impacts on the lake. Further, because of altered hydrodynamics, and degradation of the lake basin has resulted in serious consequences, leading to changes in the ecological character of the lake, to the extent that it was placed in the Montreux Record (threatened list of Ramsar sites) in 1993.

(c) Siltation: Increased siltation resulting from changed land use patterns and land degradation in the lake basin, as well as partial closure of the outlet channel connected to the sea, caused severe siltation and sedimentation problems in different zones of the lake. The impact was manifested in the form of increased turbidity, decreased salinity, proliferation of invasive species, and resultant shrinkage of the lake surface area.

(d) Depletion of fish resources: Overall loss of biodiversity and disruptions of food chains and webs, obstruction of the migratory route and recruitment from the sea due to partial closure of the inlet mouth, had direct impacts on the fishery potential and output. The degraded state of the lake ecosystem facilitated excessive growths of invasive freshwater weeds and proliferation of pollution-resistant fish species lacking any commercial value, with a direct loss to the fishermen communities.

(e) Commercial aquaculture and over-exploitation of lake resources: The illegal culture of shrimp along the shoreline of the lake by outside operators, and juvenile poaching to seed these shrimp ponds, had adverse impact on the lake fishery. This resulted in stiff resistance by the local fishermen, with bloodshed and loss of life. The apex court (supreme court) subsequently intervened in the matter, and shrimp culture is now banned in the lake.

4. Management Interventions Undertaken to Address Ecosystem Degradation and Their Outcomes

(a) Development of Chilika Development Authority (CDA): The establishment of the CDA by the Government of Orissa was an important first step for pursuing sustainable management of the lake ecosystem, based on an ecosystem approach.

Outcome: Inter-departmental cooperation and coordination crucial for the success of Chilika Lake conservation and restoration programs could be carried out. The agency's innovative approach, with an ecosystem approach, in involving local communities in conservation efforts ensured strong participation of stakeholders.

(b) Opening of the new mouth and channel through barrier beach (at Satpara): The numerical model studies of the Central Water and Power Research Station (CWPRS) revealed that, due to littoral drift along the shore, shoal formation and reduction of the cross-section, the inlet has been shifting continuously away from the lake, resulting in poor tidal influx into the lake. This has, in turn, resulted in a significant hydraulic head loss and poor flushing of sediments. Opening of a new outlet closer to the lake was recommended as a major hydrologic intervention to improve the lake's hydrology and restoring its ecology. The strategy was to opt for a more ecologically-beneficial hydrologic regime to: (i) improve water quality; (ii) restore micro- and macro-habitats for important species; (iii) enhance fishery resources; and (iv) control invasive species.

Outcome: The opening of the new lake mouth to the sea on 23 September 2000 led to massive ecological regeneration and restoration of the lake ecosystem. It also reduced the inlet channel length by 18 km, with its de-siltation ensuring proper exchange of marine and brackish waters.

A significant improvement in the salinity, from earlier lower values ranging between 0.5 – 2.5 parts per thousand (ppt), to a more desirable average level of 15 ppt, had positive impacts on the lake's fishery. The fish yield improved from 1,745.75 metric tons (MT) prior to opening of the new lake mouth to the sea, to 4,982.75 MT in 2000 – 2001, increasing further to 11,988.88 MT in 2001-2002. The output of three basic fishery components viz.

prawns, crabs and fish significantly improved after the intervention. This improvement catch is largely attributed to the process of auto-recruitment of prawn, crab and fish juveniles from the sea and, more importantly, free breeding migration from the lake into the sea and vice versa, with the opening of the new lake mouth. It also facilitated recovery of 6 threatened species of fish and 2 species of prawns.

The hydrologic intervention also helped restore the ecosystem, including expanding the expanded seagrass meadows, which are the nurseries for many commercial species. There also was a significant reduction in invasive species. Prior to opening of the new lake mouth to the seas, for example, the declining salinity had triggered proliferation of freshwater weeds from a surface area of 20 km2 in 1972, to 523 km2 by 2000, leaving a bare 334 km2 of the lake surface area free of weeds. The situation changed dramatically after the opening of the new lake mouth, with the weed-free surface area increasing to 506 km2.

(c) Community based management of the drainage basin: The Lake Chilika drainage basin was adopted as the logical starting point for management interventions. The environmental flow assessment provided necessary clues regarding the significance of the freshwater inflows from the drainage basin to maintain the lake's ecological integrity. The large-scale silt flow (0.365 million m3) was due to land degradation in the drainage basin, leading to loss of productive soil and siltation of the lake, as well as being one of the main reasons for the failure of rain-fed agriculture and the resultant hunger and poverty. The major challenge was that the lake basin community did not derive any direct benefits from the lake. Most of the micro-watersheds contributing maximum silt loads to the lake were in a severely-degraded condition. The lake basin communities mostly depend on the rainfed agriculture. Land degradation in the drainage basin resulted in an enhanced silt flow into the lagoon and low agriculture production. Depletion of natural resources, and loss of their productive capacity, had previously resulted in huge costs to the lake basin communities.

Outcome: An innovative participatory micro-watershed management concept was adopted with a "sustainable rural livelihood" approach for holistic management of natural resources in the lake basin. The focus was on restoration and conservation of the degraded soil system within the micro-watersheds. The watershed associations and the user groups were able to efficiently implement the micro-plan, thereby significantly reducing the loss of top soil and siltation pressures on the lake.

(d) Biodiversity conservation and community-based eco-tourism: The CDA facilitated community based eco-tourism as an alternate income source for the unemployed youth of communities around the lake. The population of Irrawaddy dolphin increased after the hydrological intervention. The lake also is the wintering ground for more than 1 million migratory birds, and CDA initiated training of unemployed youths as nature guides to conduct the tourists to the bird congregation and dolphin-watching areas. Support was provided for this purpose for the development of minimum infrastructures like watch towers, nature trails and boat landing facilities. This community-supported initiative was one of the most successful actions executed by CDA.

Outcome: Restored lake ecosystem enhanced the return of the Irrawaddy dolphins, with more than 0.2 million tourists visiting Chilika for dolphin watching in recent years. The members of Boatmen Association have become the ambassadors of this conservation, celebrating dolphin conservation day each year on September 8.

(e) Outreach programme:

(i) A network of NGOs and CBOs working at the grassroots level is already established and active as "Campaign for Conservation of Chilika Lake." A quarterly newsletter in the local language is published to disseminate information about the ecosystem and update stakeholders about the various CDA initiatives. A section of the newsletter also is dedicated to articles on wise use and good practices regarding natural resources management.

(ii) A visitor center is also developed to highlight the ecosystem resources of Lake Chilika.

(iii) Self-Help Groups (SHG), with women also integrated into the mainstream through empowerment by capacity building and organizing Self Help Groups (SHG), thereby adopting income-generating activities to supplement family incomes, both in the wetlands and the lake basin.

5. Lessons learned

• An ecosystem approach to manage ecosystems can restore the ecological health of an ecosystem;

• Ecological imbalances can result from both anthropogenic (unsustainable agriculture, pollution, siltation) and natural factors (closure of lagoon mouth to sea);

• Ecosystems can exhibit dramatic improvements if the stresses on them are relieved by management interventions, particularly if the interventions involve stabilization of energy and matter cycles;

• An ecosystem-based management approach can restore both macro- and micro-niches (habitats; reeds), dramatically improving ecosystem productivity upon which ecosystem services depend;

• Activities in the drainage basin of a lake can have profound impacts on the ecosystem, and an integrated basin management approach is key to sustaining the benefits to be derived from it;

• Integration of traditional wisdom and involvement of ecosystem-based communities into modern ecosystem management is a key to a successful ecosystem-based management approach;

• An empowered institutional framework (i.e., Chilika Development Authority), continuous assessment of ecosystem health, awareness campaigns, and involvement of all lake basin stakeholders can go far to ensure the sustainability of an ecosystem and its goods and services;

• If practiced within the ecological limits of an ecosystem ecotourism has significant potential for generating economic benefits to ecosystem-oriented communities.

In summary, the success of the Chilika Lake restoration project is a dramatic case of a large-scale ecosystem intervention, and its beneficial outcomes, in terms of improved goods and services. This effort also received global-scale recognition when the CDA received the prestigious Indira Gandhi Paryavaran Purashkar (Indira Gandhi Environment Award) and Ramsar Wetland Award in 2002. Chilika lake was also removed from the Montreux Record (threatened list of Ramsar site) in the year 2002 because of its successful restoration.

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Appendix 4B

RIVER BASIN MANAGEMENT IN SOUTHERN AFRICA: OKAVANGO DELTA MANAGEMENT PLAN (ODMP):

AN ECOSYSTEM MANAGEMENT CASE STUDY

Author: Hillary Masundire, University of Botswana In: UNEP 2009. Water security and ecosystem services: The critical connection: Ecosystem Management Case Studies.http://www.unep.org/Themes/Freshwater/PDF/EMP_case%20studies_webR.pdf

Type and location of ecosystem

The Okavango River forms an endorheic inland delta in the middle of the Kalahari Desert in northwest Botswana (Figures 15, 16). The delta lies between 18° 20′ S and 20° 00′ S, and 21° 50′ E and 23° 55′ E. The delta covers an area that varies seasonally and temporally between years, as dictated by hydrology; namely water inflows (through the river) and water losses (mainly evapotranspiration). There are perennial channels, pools and lagoons, seasonal channels, pools and lagoons, and permanent and seasonal swamps, all interspaced with high dry ground. The delta covers an area fluctuating between 6,000 - 15,000 km2 at no flood and high flood periods, respectively (Alosno and Nordin, 2003).

2. Ecosystem services provided by ecosystem

The Okavango Delta, located in the middle of the Kalahari Desert, provides habitat for a large and diverse range of flora and fauna. For one high-water, rapid sampling event, more than 150 species of aquatic and semi-aquatic plants, about 116 species of invertebrates, 66 species of fish, and 63 species of water birds, were observed. Smith (1976) recorded 50 species of trees, 106 species of aquatic herbs and ferns, and more than 100 species of grasses. Elery and Tacheba (2203) recorded a total of 1,259 plant species in the delta, including 20 on the IUCN Red Data List of Threatened BotswanaPlant Species. Invasive alien species include Salvinia molesta (an aquatic weed) and Cenchrus biflorus (a dryland grass species). There are 444 confirmed bird species (ODMP, 2008), including 8 globally-threatened or near-threatened species. Including herbivores and carnivores, there are about 122 mammal species in the delta.

The delta also is home to about 150,000 people, most subsisting on fishing, crop production and livestock rearing. The abundance and diversity of wildlife makes the delta a tourist paradise. The National Tourism Policy advocates for high-cost, low-volume tourism, in order to minimize the numbers of visitors. Tourism revenue generally exceeds US $4 million per year. The delta vegetation is used for construction (poles, reeds and grass), energy (firewood), crafts (carving and basketry), dugout canoes, and medicinal purposes.

3. Ecosystem degradation, causes and impacts

Some ecosystem uses for the delta are mutually conflicting. Commercial fishing, for example, conflicts with subsistence and sport fishing. Water abstractions may conflict with maintenance of the wetland ecosystem. Other problems include land use changes from increased urbanization, water quality impacts from tourist campsite waste disposal, fuels and lubricants, and land degradation leading to soil erosion and siltation, and uncontrolled and/or over-exploited natural resources,. There also are increasing conflicts between local communities and tour operators, since their activities often can clash. Uncontrolled wildfires have increased in frequency in recent years. The resurgence of the tsetse fly in early-2000 resulted in spraying of the insects with chemical insecticides, raising concerns about their impacts on the wider ecosystem.

Botswana became a contracting party to the Ramsar Convention on Wetlands in 1997. An area of approximately 68,640 km2, including the Okavango Delta, was designated as a Ramsar site, obligating Botswana to use, manage, conserve and protect the site, consistent with the Convention guidelines and provisions. Other threats to the delta are external to Botswana, including the developmental aspirations of the upstream states of Angola and Namibia.

4. Interventions undertaken to address ecosystem degradation

To curb potential conflicts from the various uses and users of the delta ecosystems, and to meet the obligations of the Ramsar Convention, Botswana embarked on a project to develop the Okavango Delta Management Plan (ODMP). It was decided at the outset to apply an ecosystem approach (www.cbd.int) in formulating this plan (ODMP, 2008). The main objectives of the ODMP project (Table 3) were:

• "to develop a comprehensive, integrated management plan for the conservation and sustainable use of the Okavango Delta and surrounding areas" with the long-term goal of the ODMP;

• to integrate resource management for the Okavango Delta that will ensure its long-term conservation and that will provide benefits for the present and future well being of the people, through sustainable use of its natural resources."

This long-term goal was further refined into strategic goals each with several strategic objectives, as follows:

One of the key aspects in the development of the plan was to engage as many stakeholders as possible, with the stakeholders classified as:

• Primary – Those directly dependent for their livelihoods on the delta, and possessing little option for survival apart from the delta, and including an estimated 120,000 delta residents;

• Secondary – Those dependent on the delta to a large measure for their livelihoods, but also having other viable options should the delta cease to support their livelihoods; these stakeholders include business people exploiting the delta resources to varying degrees, as well as upstream states whose actions have a significant effect on the delta's wellbeing;

• Tertiary – Those groups or individuals with interest in the delta, but whose livelihoods are not intimately connected with the delta, including tourists who will go elsewhere should the delta cease to be attractive.

5. Results of interventions

One achievement of the Okavango delta management effort was to get sectors of government who normally do not communicate with each other to work collectively toward the same goal over 5 years. Another milestone was regular meetings and discussions between government officers, local communities and the private sector.

The project involved extensive consultation with all stakeholders to identify what each category perceived as major issues that required addressing in the plan. The draft plan was reviewed by the stakeholders, and the final Plan being launched on 2 February 2008, as part of the commemoration of World Wetlands Day. It also was widely distributed in hard copy, on CDs, and on the Internet.

Several research projects are currently being conducted in the delta as part of ODMP implementation, including the following:

• Darwin Initiative Project – This project will enable simulation of aquatic biological diversity responses to future change scenarios

involving basin climate and hydrology, which are crucial to informing policy decisions for biodiversity protection and conservation within the Okavango Delta Management Plan. In its 4th year of implementation, this plan has produced much information on macro-invertebrates in the delta;

• BIOKAVANGO Project (www.orc.ub.be/biokavango/) – Created as a means of implementing the ODMP component on biodiversity conservation, this project is funded jointly by the GEF, Government of Botswana, International Union for the Conservation of Nature (IUCN), UNDP, DANIDA, SIDA, Kalahari Conservation Society (KCS), University of Western Virginia and several private sector partners. Some project highlights including the following:

- Safari camps will use constructed wetlands for wastewater treatment and disposal; currently being incorporated into district council bylaws, some camps are already implementing this plan;
- Water quality monitoring is underway with community participation; some safari tour operators make simple water quality measurements and collect water samples that subsequently analyzed at the University of Botswana Harry Oppenheimer Okavango Research Centre (HOORC). Some pollution hotspots have already been identified and corrective measures undertaken;
- A study on tourists' willingness-to-pay for conservation efforts in the delta concluded that most are willing to pay about US $235.00 into a fund to be used for such conservation work. The funds will be used inter alia, to fund community projects to reduce conflict between tourist service providers and local communities;
- Aquaculture guidelines for the delta area have been finalized, and are being incorporated into fishing regulations and the EIA Act (2005) of Botswana

6. Lessons learned

• The ODMP project, aligned with the OKACOM from the beginning, could be used as a model for national planning for those parts of the Okavango River Basin in other OKACOM states.

Although application of an ecosystem approach can produce products that all stakeholders can claim ownership of, the process can be physically, financially and emotionally exhausting.

• Although working at the grassroots level can achieve a great deal, there also is a need to have higher government levels in the process from the beginning.

• Effective ecosystem management will benefit from mainstreaming the ecosystem approach in all sectors involved in development planning and implementation; this was demonstrated at the district level by the ODMP by pulling together government departments, private sector and civil society.

• Applying the ecosystem approach enables sectors that do not normally work together to actively seek to set out and work to achieve common goals.

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Appendix 4C

SYR DARYA RIVER CONTRIBUTION TO HABITAT REHABILITATION IN THE NORTHERN ARAL SEA (SOUTHCENTRAL ASIA)

AN ECOSYSTEM MANAGEMENT CASE STUDY

Author: Gunilla Björklund, GeWa Consulting, Uppsala, Sweden. In: UNEP 2009. Water security and ecosystem services: The critical connection: Ecosystem Management Case Studies.http://www.unep.org/Themes/Freshwater/PDF/EMP_case%20studies_webR.pdf

1. Type and location of ecosystem

The Aral Sea, former the world's fourth largest inland sea, is situated in the former Soviet republics Kazakhstan and Uzbekistan in Central Asia. Both haline (salt) and freshwater ecosystems existed in the sea prıor to the 1960s. And although the species diversity was relatively low, the Amu Darya, dıschargıng to the lake in the south, and the Syr Darya, dıschargıng to the lake in the north, kept the water and the salt balance relatively stable. The annual rainfall at the lake is 90-120 mm, a high evaporatıon rate of 58-65 km3 per year from the lake water surface (equal to around 900 mm!) (Roll et al. 2004), and a minor exchange by groundwater and infiltration and separation in lagoons made the freshwater contributions by the rivers absolutely necessary for the survival of the Aral Sea.

The Northern Aral Sea became a separate water body in 1989, although it was still connected to the Southern Large Aral Sea (Björklund, 2005).

2. Ecosystem goods/services provided

The Syr Darya River, discharging into the Northern Aral, supports freshwater ecosystems, both natural and crop production ecosystems. Cotton (>55%), wheat and rice are the main crops grown in the river basin. The ecosystem services provided with the growth of these crops are to a very large extent strengthened by irrigation. Thus, water allocation schemes existing early during the 1900s were already driven by economic tradeoffs. From an economic perspective, because cotton was worth more than fisheries, the influent river water that would have contributed ecosystem services that supported the Aral Sea aquatic ecosystems were, to an increasing extent, allocated to cotton production.

Although the Aral Sea ecosystems were not particularly species-rich, they nevertheless contained such fish species as sturgeon, pike perch and silver carp. Commercial fisheries caught 40 million tons of fish in the Aral Sea in 1960. The main fishing ports were Aralsk in the northern part, and Muynac in the southern part. Fish was an important export commodity, making up an important part of the economy to both Uzbekistan and Kazakstan, although it was not as important as cotton production. Being at the downstream end of this water system, the aquatic ecosystems were the primary systems being impacted by these practices.

3. Ecosystem degradation, causes and impacts

As a result of the above agricultural activities, particularly diversion of the influent waters of the Amu Darya and Syr Darya, the surface area of the Aral Sea decreased to 10% of its former size between 1960 and 2007. As a result, it divided into four different, highly salinized water bodies. This emergence of four much smaller water bodies from the original Aral Sea was the result of a management system wherein water diversion for irrigation of central Asian cotton fields was considered to be of highest priority. The extent of irrigated area increased by more than 2% per year, mainly because the economic revenue from cotton production far surpassed that possible from fish production. The quantity of influent water diverted for irrigation of cotton fields along the rivers doubled during the period 1965 - 1986. As a result, the 1989 the Aral Sea water level declined until the water body essentially split into a Small Northern Aral Sea in the territory of Kazakhstan, and a Large Southern Aral Sea in Kazakhstan and Uzbekistan. Further, the Southern Aral Sea further split into a deeper Western part and a shallower Eastern part by 2003, both water systems being extremely and increasingly salinized.

The desiccation of the Sea resulted in serious economic, social, and environmental damage. Salinity and pollution levels increased dramatically, dust and salt storms occurred frequently, and local climatic changes (with hotter summers and colder winters), were occurring around the Sea as a result of the decreasing water body surface area and volume. Drinking water supplies became polluted and human health problems increased sharply. Both the aquatic ecosystems in the two Southern, severely-desiccated Aral Sea units and the Northern Small Aral, as well as the terrestrial ecosystems along the downstream river stretches and the shorelines (including the former sea bed) have become heavily degraded. The salinity of the Southern Aral rose from about 14 g/L to more than 100 g/L by 2007, making the water unfit for almost all purposes (Micklin and Aladin, 2008). Increasing irrigated cotton production is resulting in an unhealthy spiral of increasing salinization and the spread of toxic substances. With few exceptions, for example, the Southern parts of the Aral Sea are considered essentially doomed. During such water-scarce years as 2008, practically no water reached these parts, and the Eastern Aral Sea is rapidly disappearing. The only part considered feasible for restoration is the Northern, Small Aral Sea Aral Sea sub-unit.

4. Interventions undertaken to address ecosystem degradation

Several interventions to address ecosystem degradation in the Aral Sea Basin as a whole have been undertaken, including the GEF Project, "Aral Sea Basin Program: Water and Environmental Management Project," initiated in 1998 and closed in 2003 without having completed the project objectives.

The situation in the Northern Small Aral is fortunately easier to control. In early 1990, Kazakstan began construction of an earthern dam to control the water flow from the Small Aral to the Southern parts. That dam, however, collapsed in 1999. A subsequent World Bank loan for a "Syr Darya Control and Northern Aral Sea Project" was approved in June 2001, with Phase 1 expected to be completed by the end of 2008. A second project phase is expected to be agreed in 2009 (World Bank Project P093825). The Project goal is to secure the continued existence of the Northern Aral Sea, and to improve ecological conditions in the area; as well as sustain and increase agriculture and fish production in the Syr Darya basin in Kazakhstan.

(a) Construction of the 13-km Kokaral Dike, which separates the Small Northern Aral from the Large Southern Aral Sea, and which would allow the Small Aral Sea to recover, was completed in August 2005, with the Southern Aral having divided into a deeper Western, and an Eastern shallower and even more salty Aral Sea sub-unit. In addition to the dam, several new hydraulic structures were constructed on the Syr Darya to increase its flow capacity and safely bring much more water than before to the Aral Sea. Some of these construction works are still ongoing, with their still being a large quantity of water in the basin lost for productive and environmental purposes. Nevertheless, the project is so far considered a success.
(b) A competition on water saving among water users of Syr Darya water was also announced under this project. The goal was to estimate possibilities for water savings but also to spur to such saving, which should ensure more water for the Northern Aral Sea.

5. Results of interventions

Since the commencement of the World Bank-funded "Syr Darya Control and Northern Aral Sea Project," the water table of the Small Aral has risen from 37 m.a.s. to 42 m.a.s and should continue to increase The Small Aral surface area has increased by 18%, and its salinity has dropped steadily from roughly 20 g/L to about 10 g/L at the present time. This increased water should also facilitate the rehabilitation of several delta lakes. The ecosystem also has been enriched with several species having returned in substantial numbers — particularly the highly-prized pike perch (a type of carp). Continued construction works, and current replenishment of water to the Sea and its delta lakes to keep salinity and oxygen levels at a biological-adequate level, are resulting in a larger water body, an increasing water table, and decreasing salinity (calculated to remain between 3 – 14 g/L, varying over the sea, depending on circumstances. These habitat enhancements should facilitate breeding possibilities for many of the indigenous species, with reed thickets already having cropped up along banks in the delta area as a result of the increased water table. These reeds are also used by people for fodder and house construction which, although the basis for potential conflicts, are mainly seen as parts of a wider win-win ecological system.
The costs of the management interventions are mainly financial costs, including the cost of all constructions needed to completely stop the flow of water from the Northern Aral Sea into the Southern Aral Seas. This restriction will, of course, result in no water contributions from the Northern Aral Sea into the Southern Aral Seas, thereby possibly increasing the rate at which the Southern Seas continue to shrink and desiccate.
The Kazak government also has socioeconomic objectives for further enlarging the Northern Aral Sea, including increasing its fisheries potential, and enhancing a water return to the city of Aralsk, previously the most important fishing port. This will not only enrich the ecosystems, but also give large commercial fishing vessels access to the sea, which may provide for healthier food supplies and improved incomes at a later date.
The results of the Water Use Competition introduced under the World Bank project indicate the upper areas in the Syr Darya basin should become more water efficient, thereby enhancing water conservation in this area. At the same time, there is a risk that the conserved water might simply be used to increase the irrigated areas. If this should happen, agricultural production will increase because water is being used more effectively. However, it will not result in water savings that can be transferred to the Aral Sea. The risk to the Syr Darya basin, therefore, is that upstream water savings will merely mean more water available for downstream irrigators, rather than for the overall betterment of the Aral Sea.
The long-term perspectives of these interventions are very dependent upon the sustainability of these activities. The GEF-project contains components of enhance capacity, both technical capacity and institutional capacity to improve water resources management. Although these components do not specifically include ecosystem management aspects, sustaining ecosystems in the Aral Sea would not be feasible from a long-term perspective if not done within the framework of integrated water resources management.

6. Lessons learned

- Minimum environmental flows are necessary to rehabilitate the Northern Aral Sea and ensure its ecosystem services;
- Adequate quantities of water reaching the downstream parts of the Syr Darya are necessary to ensure the continuity of ecosystem services of the river, as well as its downstream lake;
- On the evidence of the results to date, management interventions for the Northern Aral Sea must be based on maintenance of a range of long-term ecosystem services, rather than the relatively short-term economic benefits associated with the focused production of cotton in this arid region;
- Attempting to achieve sustainable habitat rehabilitation with a focus resting solely on economic benefits, and disregarding the social and economic aspects, is counter-productive, mainly because needed ecosystem services do not only secure habitat rehabilitation, but also serve as a basis for sustainable economic outcome;
- Ecosystem rehabilitation measures can be very costly in both environmental and economic terms; prevention continues to be cheaper over the long-term than rehabilitation.

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