ECOSYSTEM SERVICES IN COASTAL AREAS – SCIENTIFIC STATE OF THE ART AND POSSIBILITIES FOR FUTURE RESEARCH

P. Michael Link, Leonard Borchert

Forschungsgruppe Klimawandel und Sicherheit (CLISEC), Institut für Geographie, Centrum für Erdsystemforschung und Nachhaltigkeit, Universität Hamburg

michael.link@uni-hamburg.de
leonard.borchert@uni-hamburg.de

Introduction

Ecosystem services (ES) play an increasingly important role in modern coastal research as they are a fundamental concept that can be well used to couple natural and social sciences aspects of Environmental Sciences. Assigning a value to functions of an ecosystem is the logical connection between the given environmental conditions and the wellbeing of the human inhabitants of the assessed region. ES are not only useful with regard to the provision of resources but also when it comes to the regulation of environmental quality and the evaluation of the cultural value of coastal zones. Originally applicable to any kind of ecosystem, they have become the focus of many coastal researchers in recent years since many current assessments include the human-environment interaction in their considerations. Also, ES have become increasingly complex, encompassing more and more possible functions of coastal and marine areas that are of value to humans.
This poster provides an overview of the development of the use of ES in coastal research, looking at how the kinds of applications have evolved over time leading up to the current state of the art. On the basis of the current understanding of coastal ES, possible pathways for further development of this concept are outlined.

History of Ecosystem Services

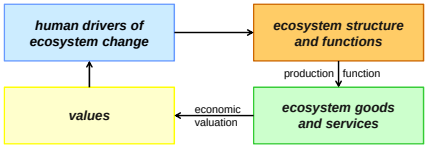
ES such as the provision of potable water or food have always been indispensable to humankind and they have been addressed in research implicitly for decades. However, in recent years the framing of ES as such has come up, being brought to broader attention by the Millennium Ecosystem Assessment carried out by the United Nations Environment Programme (UNEP) between 2001 and 2005. It was called for by United Nations Secretary-General Kofi Annan in 2000 and had the objective to not only assess the impacts of environmental changes on human wellbeing. It was also supposed to provide the fundamental scientific understanding that is necessary to improve the sustainability of human use of ecosystems. Examples for ES given in the report are clean water, food, forest products, flood control, and natural resources.
The Millennium Ecosystem Assessment found major anthropogenic changes of ecosystems since 1950, mainly due to rapidly growing demands for food, fresh water, timber, fiber, and fuel. As a result, a largely irreversible loss in biodiversity was identified. Despite substantial net gains in terms of economic development following the exploitation of ecosystems, a significant progress of ecosystem degradation is predicted for the first half of the 21st century. Avoiding such degradation is crucial for meeting the UN Millennium Development Goals:

(1) eradicate extreme poverty and hunger,
(2) achieve universal primary education,
(3) promote gender equality and empower women,
(4) reduce child mortality,
(5) improve maternal health,
(6) combat HIV/AIDS, malaria, and other diseases,
(7) ensure environmental sustainability,
(8) develop a global partnership for development.

At least five of these goals are directly influenced by a degradation of ES, although potentially all of them could be indirectly affected. The rather bleak prognosis regarding the fate of ecosystems and their fundamental importance for so many aspects of human wellbeing sparked a considerable increase in scientific interest and publications on ES and their influences on livelihood, as well as on their degradation and protection potentials from 2005 onwards. Particularly, in research on coastal management and protection this concept was applied very frequently.

Coastal and Estuarine Ecosystem Services

In order to be able to evaluate the impact of human activities on coastal ecosystems, it is necessary to quantify the value that the ecosystems provide to human wellbeing and how this value is affected by anthropogenic changes. This valuation allows the quantitative assessment of different options of coastal zone management by making market and non-market goods and services comparable.



The quantification of ecosystem services (Barbier, 2013)

Coastal and Estuarine Ecosystem Services (CEES) can be divided into four fundamental categories based on their function for humans: regulating services, provisioning services, cultural services, and supporting services. CEES have been found to provide a multitude of direct and indirect gains to humankind.

Regulating Services

The regulating ES are the benefits that are obtained from key regulatory processes in the ecosystems. In coastal zones this can refer to the regulation of the spread of diseases through waste treatment, the buffering of natural hazards, and the regulation of climate effects.
In marine ecosystems, waste can be diluted and detoxified by being removed from land and subsequently buried or recycled. Organic waste can be broken down by microbial communities, reducing eutrophication. Representing the interface between land and sea, coasts play an important role in these processes that help averting the spread of diseases.
There are numerous natural hazards to shoreline areas from the open ocean such as storm surges, floods, and storms. In many cases, ecosystems such as mangrove communities or, in case of the German Bight, the Wadden Sea protect coasts from these hazards, acting as buffer zones. Modern flood defense combines human engineering and the protective capacities of coastal ecosystems for an effective protection of coastal areas.

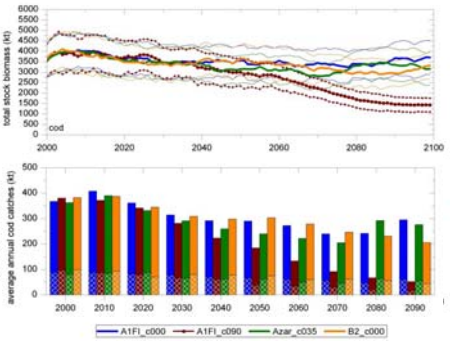
Ecosystem-based flood defense (Temmerman et al., 2013)

Water masses and coastal marine ecosystems physically and biogenically take up and store greenhouse gases. Furthermore, oceans act as buffers for atmospheric temperature increases.

Provisioning Services

Marine ecosystems also provide a variety of products to humans, most of which are retrieved in coastal areas. In addition to seafood and fuel, the filtration of sea water has become increasingly important, particularly in arid coastal regions that do not have other adequate sources to meet their water demand.

Many areas on Earth, particularly island states, small islands, and developing countries, rely on marine products for meeting daily dietary needs. A considerable share of the global population relies on fish as its primary source of protein. Intensive harvesting of marine resources in conjunction with changing environmental conditions can have massive implications for the development of fish stocks as well as the associated fisheries.



Development of Northeast Arctic cod stock and catches for different scenarios of thermohaline circulation weakening (Link & Tol, 2009)

Cultural Services

The use of coastal areas for recreational purposes has a long history. In recent years, marine sports have become more and more popular causing a further intensification of coastal tourism, which in many coastal areas already constitutes the main source of income. Furthermore, coastal areas offer substantial potential for scientific exploration and educational use. The ocean with its many complex process chains has sparked human curiosity for already many centuries and it still offers ample opportunities for further discoveries.

Supporting Services

These ES are not only fundamental themselves, they are also those CEES that are prerequisites for the other three ES of the other three categories. They represent an important part of ES but only affect human beings marginally, generally over long periods of time.
Biologically mediated habitats are natural habitats that are located within another living organism. They do not have to be designed as such but can develop accordingly while growing naturally. Common examples are mangrove forests or coral reefs. These communities complement other CEES in multiple ways, usually combining several types of ES in one area.
The oceans and coastal zones are also a major storage pool for nutrients, offering essential feeding services to a variety of organisms. Key nutrients are usually used up by phytoplankton through photosynthesis, which then progress through the food chain by being consumed by zooplankton and progressively larger organisms, eventually reaching the top predation level. Since the oceans and coastal areas represent a quasi-closed system with regard to nutrients, they are recycled efficiently with very little losses. This positive effect on primary productivity is a valuable asset of coastal areas in assessments of CEES.

Pathways for further research on CEES

Recent research on the valuation of non-market services by coastal areas has significantly increased the awareness that long-term sustainable coastal zone management only functions if ES are adequately considered. The difficulty is to determine what “adequate” means in this context as assumptions of assessments are often quite subjective. To further increase the usefulness for policymakers, the means of determining the values of ES should be standardized, e.g. by use of proxies for indirect measurement where necessary.