2.1.1 Basics of Ecosystem Analysis

**Human Environmental System Management**

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Life on Earth began about 4 billion years ago.
Humans are of relatively recent origin.
Homo sapiens evolved about 200,000 years ago.
Development of humans into a cultural species (usage of tools, weapons, burial of death…) about 60,000 years ago.
First domestication of plant and animals dates back only 12,000 years.
Throughout its **relatively short history**, the human species has **constantly extended its influence and control**. Humans have “conquered” a wide range of environments and have used, changed or even displaced ecosystems for their purposes.

![Map of Converted Areas Span the Globe](image)

*Figure 2: Global Map of Converted Areas

Source: Based on data from Global Land Cover Characteristics Database Version 1.2 (Loveland et al. 2000); NOAA-NGDC (1998); WWF (1999).
As with demographic and economic transitions, societies appear also to follow a sequence of different land-use regimes:

Source: SCIENCE VOL 309 22 JULY 2005: Global consequences of land use; land use transitions
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3 Management of human environmental systems
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There is a never-ending process of mutual adjustment (adaptation) and change between human social systems and the environment.
Ecosystems and human social systems are complex adaptive systems (Marten, 2001):

- Complex because ecosystems and social systems have many parts and many connections between these parts.
- Adaptive because they have feedback structures that promote survival in a constantly changing environment.
The Drivers-Pressures-State-Impact-Response (DPSIR) model

- The DPSIR model was originally developed by the European Environmental Agency (EEA) and is used to **assess and manage** environmental problems.

- Variations of DPSIR model include PSR (e.g. OECD 1994), DSR (e.g. UNCSD 1996) and many others.

- It identifies the various **causal loops** between human activities and environmental change.
Modelling human environmental systems

DPSIR model

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Driving forces
Human “activities” that cause pressures:
Total industrial production, GDP, road traffic…

Pressures
Direct stresses from the human social system on the natural environment:
Emissions (toxic, CO₂), noise due to road traffic...

State
Current state of atmosphere, land and water:
Air, water and soil quality, global mean temperature, acidity of forest soils...

Impact
Effects on the human social system due to environmental change:
Human health, economic loss, floods...

Responses
Human society tries to solve problems and adapt to changed situations:
Policies, technological progress...

modify, remove
generate
reduce, prevent
restore
compensate, mitigate
stimulate

modify
modify
provoke, cause
Driving force indicators:

are not very responsive ("elastic") because driven by powerful economic forces.

**Driving force indicators** are useful to:

a) derive important pressure indicators

b) help decision-makers to plan **measures** ("responses") to mitigate or avoid future problems ("pressures").

c) can be used as a basis for **scenario development** and **long-term planning**.
Pressure indicators:

These indicators show the direct stresses (e.g. CO² emissions) on the environment.

Pressure indicators are generally responsive. **Decision-makers** should be able to reduce the pressure by introducing appropriate actions.

Furthermore pressure indicators demonstrate the effectiveness of political action.
State indicators:

These indicators are often **rather slow**.

A state indicator showing the acidity of forest soils refers to the **NO$_x$ and SO$_2$ emissions** of about the last ten years.

State indicators are very useful to make a **first assessment of the situation** (what is the current state of the forest soils? where could corrective measures be applied?).

Furthermore they can be **appropriate tools** to plan **habitat restoration and similar activities**.
Impact indicators:

react even slower than state indicators. When the impacts are felt, it is usually too late for action.

It is hardly possible to demonstrate solid statistical correlations between pressures, state, and impacts due to the enormous delays and the influence of non-environmental factors.

Nevertheless Impact indicators demonstrate the cause-effect chains and help searching for adequate measures to prevent negative impacts in future. In this sense, they are not statistical "indicators", but scientific "decision models".
Response indicators:

_These indicators are very fast._ They monitor the _measures_ that have been launched to solve the problems.

Examples:

1. The introduction of an _energy tax_.

\[\text{Energy tax} = \text{response} \rightarrow \text{Rising energy prices} \rightarrow \text{Decreasing CO}_2 \text{ emissions}\]
The United Nations Convention on Biological Diversity (1992) approach to **ecosystem-based management** is that:

*Ecosystem and natural habitats management seeks to meet human requirements to use natural resources, whilst maintaining the biological richness and ecological processes necessary to sustain the composition, structure and function of the habitats or ecosystems concerned. Important within this process is the setting of explicit goals and practices, regularly updated in the light of the results of monitoring and research activities.*
“The overall aim of ecosystem management is to use ecosystems, but not to lose them” (Pirot, J.-Y., Meynell P.J. and Elder D. (2000).

Humans have always been major causes of disturbance and degradation of natural systems. Problems are caused by intensive land-use, fisheries, deforestation, the establishment of urban areas and many more.

Therefore human environmental systems management should focus on the role of people and their interactions with environment.
**Environmental assessment**

Assessment tools may be used both in the **planning stage** and for **monitoring**. One possible tool to assess human environmental issues is the **DPSIR model**.

![DPSIR Model Diagram](image)
Information management

- in ecosystem management you usually have many sources of information.
- it is important to establish a network of contacts and experts
- too much information or details on some subjects that do not contribute to management decisions should be avoided.

Important thematic issues:

a) The ecosystem and its boundary
b) socio-economics, politics and local communities
c) Uses and impacts of stakeholders on the ecosystem
d) Legal and administrative boundaries
e) Monitoring indicators
Participatory process

The views of all stakeholders shall be considered. Usually stakeholders participate in various consultative meetings. A big challenge is to have a broad representation of stakeholders without including so many individuals that the meetings become ineffective.

Tools to assist in the participatory approach
A number of methods have been developed that focus on the participatory approach. Some of techniques and methods useful for ecosystem-based management projects include:

- Participatory assessment;
- Planning, negotiation and conflict management;
- Participatory monitoring and evaluation
**Communications strategy**

Communication and public education are very important for the success of any ecosystem management initiative. To implement a certain communications strategy managers can use different tools.

Among these tools are:
- publications, newsletters and newspaper articles;
- round tables, seminars etc.
- working with opinion leaders and local groups;

The long-term sustainability of any conservation initiative will depend on changing young people’s attitudes through education.
There are some fundamental principles when dealing with human environmental systems:

- human society is constantly changing, and so is the environment. Therefore sustainable ecosystem management must be very flexible in order to adapt to continually changing situations and conditions.

- ecosystem management is only partly about ecological sciences. It has to take into consideration all the economic, social and cultural factors affecting the communities concerned with an ecosystem management project.

- public and community participation – at all stages of project development and implementation – is extremely important for success.
References:

Books:

Reports/Journals:

Internet:
http://esl.jrc.it/envind/theory/handb_01.htm: Information on the DPSIR model and its indicators
Thank you for your attention!

“So what's this? I asked for a hammer!
A hammer! This is a crescent wrench! ...
Well, maybe it's a hammer. ... Damn these stone tools.”