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Environmental Analysis and Impact Assessment

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COURSE INFORMATION

Program of studies	Faculty of Urbanism
Type of course	Required course and studio
Level of course module/unit	Master's / 5th year
Number of ECTS credits	4/3 ECTS (theoretical workload for student: 120/90 hrs)
Hours / week	4/3c
Competences to be developed	1) Understanding main concepts of ecology and environmental analysis 2) Understanding systemic organization of live matter and holistic approach to environmental issues 3) Knowledge of the methods (including computer-assisted) used in environmental analysis 4) Application of environmental analysis methods to urban ecosystems 5) Using statistical and environmental information in urban, spatial and landscape planning 6) Interpretation of final results of analyses from the standpoint of their relevance to urban or landscape planning 7) Correct use of the technical jargon and specific concepts
Objectives	Placed among informative disciplines, the course and studio do not aim to train specialist in their curriculum, but instead to familiarize students with the environmental deterioration phenomena, underlining the need for assessing the environmental impact of anthropic activities and for ecological restoration, and presenting their specific methods. Studios focus on environmental impact assessment. The assignments and essays will allow for a presentation of the application of methods and use information specific to environmental analysis in urban, spatial and landscape planning, accenting the interpretation of final results and their relevance for an urban or landscape planner.
Teaching methods	Lectures, PowerPoint presentations, computer demonstration (ArcView), discussions based on real or hypothetic problems
Evaluation	Students who chose to study during the semester will be evaluated according to ***Method 2*** described below. Students who prefer to study during the examination session will be evaluated according to ***Method 1***. Students who make a partial effort during the semester can use points obtained by ***Method 2*** as credit for some of the demands based on ***Method 1***. In both cases, assessment is based on two criteria: minimal: knowledge of concepts and methods, maximal: use of concepts and methods. **Granting bonuses depends on the attitude of the entire series to the course, indiscipline resulting into total cancellation**. ***Method 1***: **10** p. essay/presentation. *The essay* or *presentation* will consist of developing or exemplifying in a short form one of the following topics based on the course note, other references and/or personal opinions based on arguments. Each student can opt out for writing an essay (max. 4 A4 pages) or delivering an oral presentation. ***Method 2***: Students receive a continuous learning score, reflecting their activity during the semester (max. 10 p. accumulated from bonuses). Students who obtain a passing grade can pass the class with the respective score without taking an exam, writing homework, or delivering a presentation/writing an essay. The final grade will be the points for the essay/presentation + bonuses.
Bibliography	1) Negrei C. C. (1996), *Bazele economiei mediului (Foundations of Environmental Economy)* [in Romanian], Editura Didactică şi Pedagogică R. A., Bucharest, ISBN 973-3059013, 169 pp. 2) Petrişor A.-I. (2007), *Analiză de mediu cu aplicaţii în urbanism şi peisagistică (Environmental analysis with applications in urban and landscape planning)* [in Romanian], Editura Universitară „Ion Mincu”, Bucharest, ISBN 978-973-7999-85-6, 89 pp. 3) Petrişor A.-I. (2008), *Ecologie urbană, dezvoltare spaţială durabilă şi legislaţie (Urban Ecology, Sustainable Spatial Development and Legislation)* [in Romanian], Editura Fundaţiei România de

	mâine, Bucharest, ISBN 978-973-163-305-3, 272 pp. 4) Petrişor A.-I. (2010), *Mediul urban: o abordare ecologică (Urban environment: an ecological approach)* [in Romanian], Urbanistique, http://www.urbanistique.ro/mediul-urban-o-abordare-ecologica-dr-alexandru-ionut-petrisor/#more-127 5) Petrişor A.-I. (2011), *Systemic theory applied to ecology, geography and spatial planning*, Lambert Academic Publishing GmbH & Co. KG, Saarbrücken, Germany, ISBN 978-3-8465-0260-0, 172 pp. 6) Vădineanu A. (1998), *Dezvoltarea durabilă (Sustainable Development)*, Vol. I. *Bazele teoretice ale dezvoltării durabile (Theoretical Foundations of Sustainable Development)* [in Romanian], Editura Universității din Bucureşti, Bucharest, ISBN 973-975-256-5, 248 pp. 7) Vădineanu A., Negrei C., Lisievici P. (*coordinators*) (1999), *Dezvoltarea durabilă (Sustainable Development)*, Vol. al II-lea. *Mecanisme şi instrumente (Mechanisms and instruments)* [in Romanian], Editura Universității din Bucureşti, Bucharest, ISBN 973-575-333-2, 348 pp.
Topics for the essays (the list includes all topics from similar cross-listed courses; course-specific lists can be found in corresponding curricula)	1) Anthropic impact assessment in mountain resorts using Leopold or Sorensen methods 2) Assessment of the impact of developing tourism in the coastal areas or Danube Delta using Leopold or Sorensen methods 3) Assessment of the impact of infrastructure development on lakes around Bucharest using Leopold or Sorensen methods 4) Assessment of the impact of urban sprawl around Bucharest 5) Cost-benefit analysis of extending tourism infrastructure over forested areas 6) Cost-benefit analysis of moving the urban traffic (highways, beltline) 7) Cost-benefit analysis of the option for landscaped instead of natural green spaces 8) Cost-benefit analysis of the projects for the thermal (energy) rehabilitation of buildings 9) Cost-benefit analysis of the restoration of lakes around the floodplain of Danube 10) Cost-benefit analysis of the thermal rehabilitation of buildings 11) Cost-benefit analysis of using alternative energy in residential buildings 12) Cost-benefit analysis of water course infrastructure in large cities 13) Ecologist and environmentalist approaches to energy issues 14) Ecologist and environmentalist approaches to human settlements 15) Energy in ecological systems: anthropocentric and holistic approaches 16) Energy in natural and artificial (man-dominated) ecosystems: differences 17) Energy in protected areas 18) Energy, diversity, entropy and stability of ecological systems: relationships and examples 19) Environmental deterioration processes affecting energy flows in ecological systems 20) Environmental impact assessment of intra and extra-urban migration 21) Environmental impact assessment of urban traffic 22) Fishbone diagram of deforestations after 1990 23) Fishbone diagram of environmental taxes (application of the principle "polluter pays") 24) Fishbone diagram of urban heat islands 25) Fishbone diagram of urban sprawl 26) Fishbone diagram of urban traffic in Bucharest 27) Food pyramid and chains and energy in ecological systems: relationships, consequences 28) Implications of the loss of biodiversity on energy 29) Indigenous populations, biodiversity and energy-related sustainability 30) Natural and artificial energy in man-dominated systems 31) Pollution of the atmosphere: energy-related consequences in natural and artificial ecosystems 32) Social physiology / Social ethology / Social energy 33) Sustainable use of energy: principles, good practices 34) SWOT analysis of extra-urban migration (to/from satellite cities) 35) SWOT analysis of intra-urban migration (center-fringes) 36) SWOT analysis of landscaping water courses within the large cities 37) SWOT analysis of moving the urban traffic (highways, beltline) 38) SWOT analysis of the metropolitan area 39) Use of Geographical Systems for a sustainable development with respect to energy

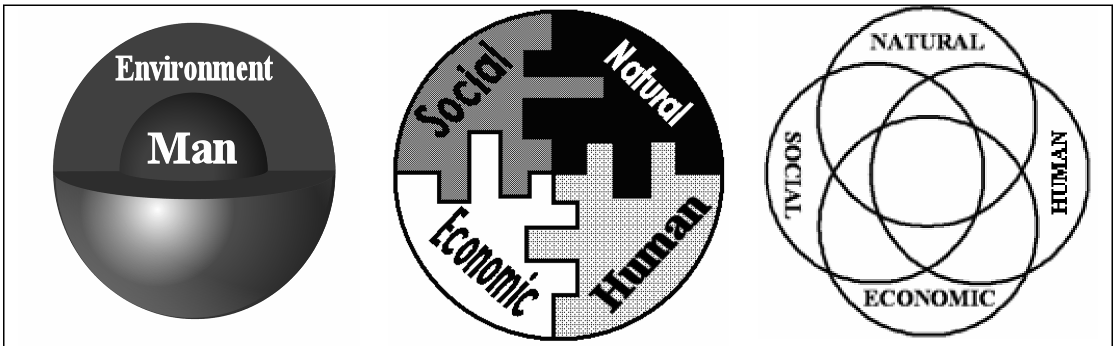
Notes on an introductory course on Ecology

Note: The text represents a synthesis of core concepts taught in the courses *Urban Statistics and Environmental Analysis*, *Data Analysis Studio*, *Environmental Analysis and Impact Assessment*, and *Urban Ecology and Impact Environmental Assessment* designed for ERASMUS students. For any other uses, please request the permission of the author.

The Environment

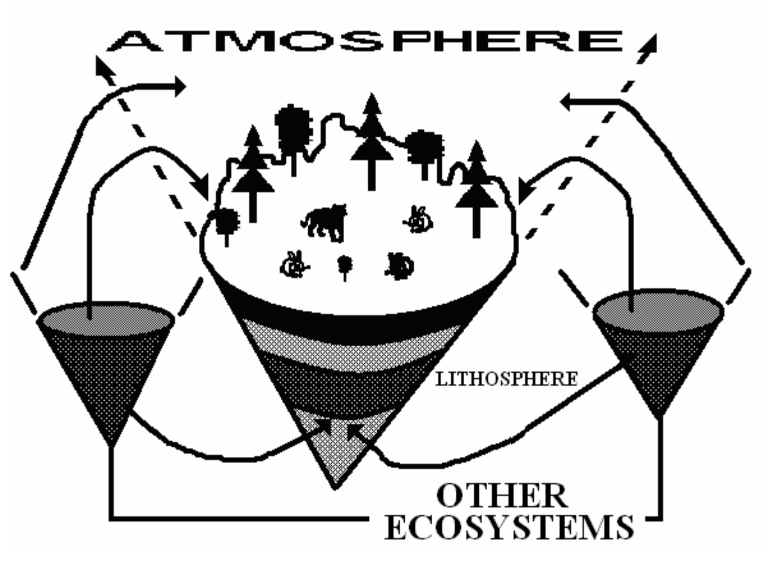
Views on the environment could be classified as either anthropocentric (man-focused) or holistic (no focus) - *Fig. 1*. Anthropocentric views (*Fig. 1A*) are sectoral (the so-called natural environment is divided into *environmental factors*: water, air, soil, flora and fauna) or un-sectoral. The holistic approach does not make any distinction between the natural and man-made (man-dominated) systems. All the following concepts rely on the holistic approach (*Fig. 1B*).

Holistic definition of the environment: the environment is the hierarchy of organized ecological systems.



A. Anthropocentric approach B. Holistic approach

Fig. 1. Approaches to the environment



An ecological system (*Fig. 2*) consists of a lifeless (***abiotic***) component, *i.e.*, all geological, geographical, climatic etc. factors, and a live (***biotic***), component, *i.e.*, all vegetal and animal species. The two are tightly connected and form a whole. Ecological systems depend on exchanges with other similar systems. The transit area between two ecosystems is called *ecoton*.

The main functions of ecological systems are ***biogeochemical circuits*** and ***self-regulation***; the later provides for the continuity of structure in time and space in a dynamic equilibrium, as ecological systems evolve continuously through ***ecological succession***. The first function is carried via food chains and webs (*Fig. 3*). Matter circulates via metabolism (organisms eat each other, substances are decomposed and used to build own constituents), while energy is embedded in chemical links and spent in metabolic processes. Since the numbers and biomass decrease across food chains, a better representation is the food pyramid (*Fig. 4*).

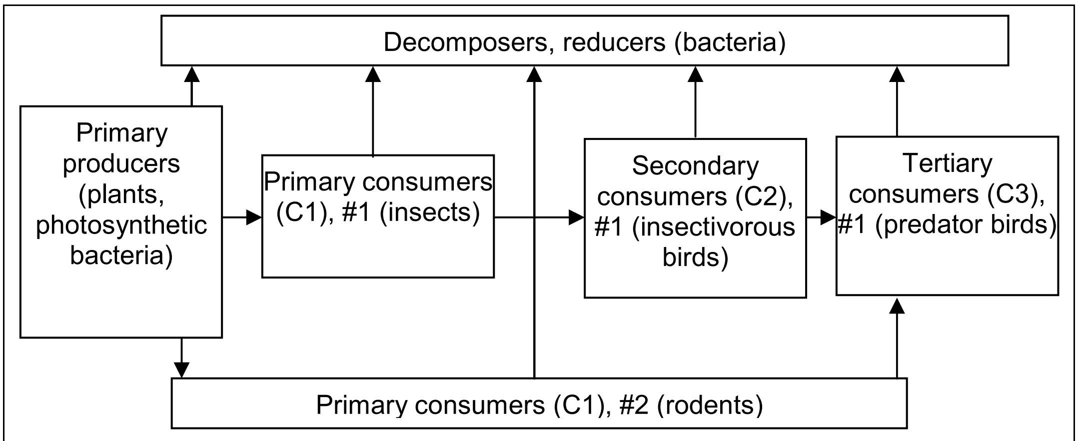


Fig. 3. Food chains and webs

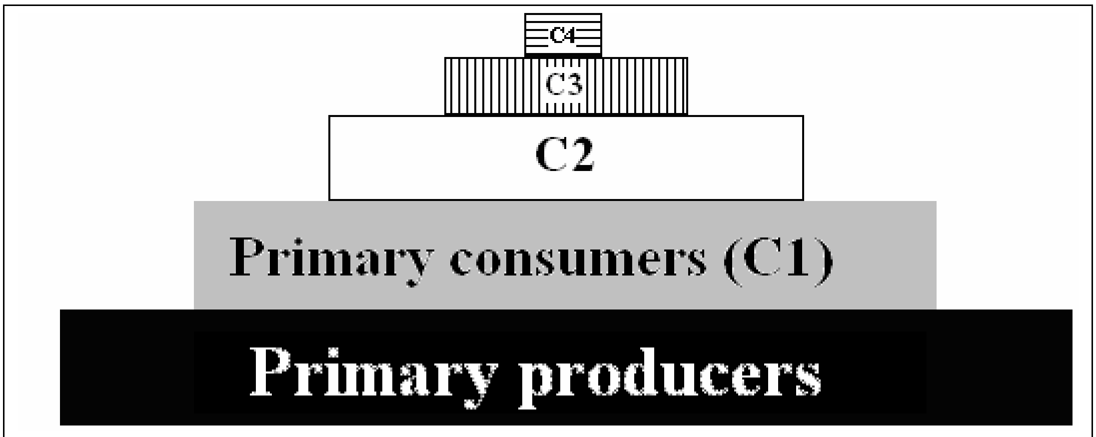


Fig. 4. Food pyramids

Ecological systems suffer transformations in time, maintaining their stability through self-regulation under dynamic equilibrium conditions. These transformations are called generically *succession*. Primary succession occurs after catastrophic events that destroy the biocoenose completely. Secondary succession represents the gradual transformation of a biocoenose into a new one (*Fig. 5*).

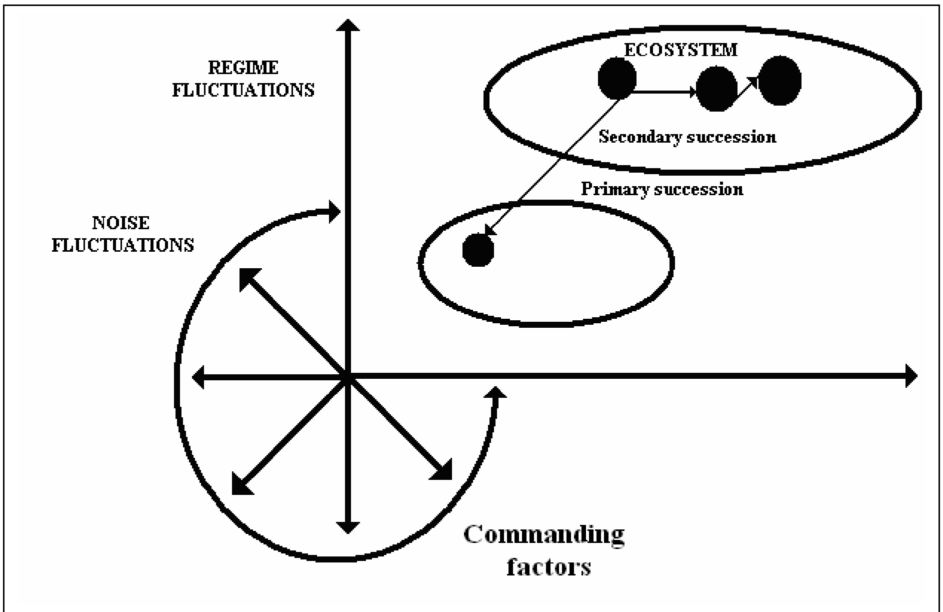


Fig. 5. Self-regulation under the influence of different factors

Interpreting the stability of ecological systems (Vădineanu, 1998);

– ***Resilience*** – speed of the return of variables to equilibrium after impact – large for stable systems

- ***Persistence*** – conservationism to impacts – measured by duration of stability under impact – large for stable systems
- ***Resistance*** – amplitude of changes under impact – small for stable systems
- ***Variability*** – frequency of changes under impact – small for stable systems.

Ecological systems form a hierarchy (*Fig. 6*).

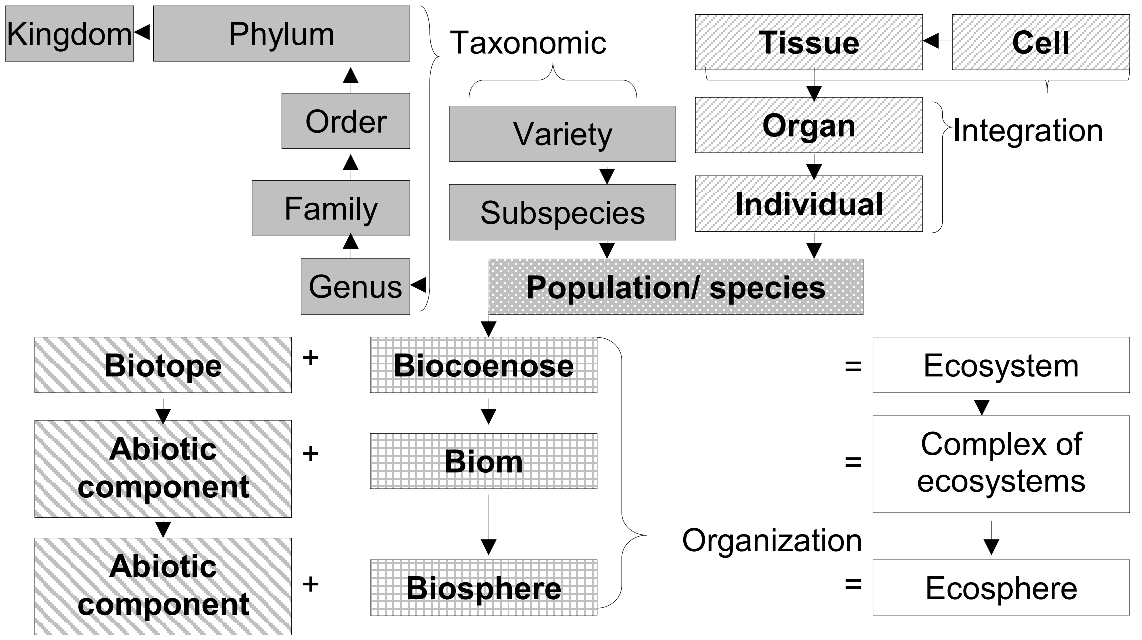


Fig. 6. The hierarchy of ecological systems

Deterioration of the Environment

The concept is an "umbrella" covering negative environmental effects of human activities: pollution – linearization of food and energy circuits, loss of biodiversity, fragmentation of habitats, introduction of alien species, genetic manipulation, construction of dams and other water works etc.

The leading causes are the growth of human population and its needs. Abraham Maslow has proposed a pyramid of needs: (1) physiological, (2) safety, (3) social acceptance, (4) self-esteem, prestige and success, and (5) self-realization.

Responses to the Deterioration of the Environment

1. "Zero-growth" solution – Club of Rome, 1972
2. Sustainable development: equally meet present and future needs (1987 – Brundtland Report, 1992 – Rio de Janeiro). Sustainable development equally implies a sustainable (wise) use of natural resources within the limits of the carrying capacity, conservation of biodiversity (via natural and cultural protected areas), ecological restoration of deteriorated systems and preventive actions embedded in sectoral development strategies, including the internalization of environmental costs and environmental impact assessment. The main components of sustainable development are displayed in *Fig. 7*. The carrying capacity represents the ability of a system to maintain its structure and function, producing a certain amount goods and services for a given human population.

Conservation: the "zero-growth" model promotes strict conservation called *preservation*; in sustainable development, conservation means to bring a system to a condition where it can self-regulate (within the limits of its carrying capacity).

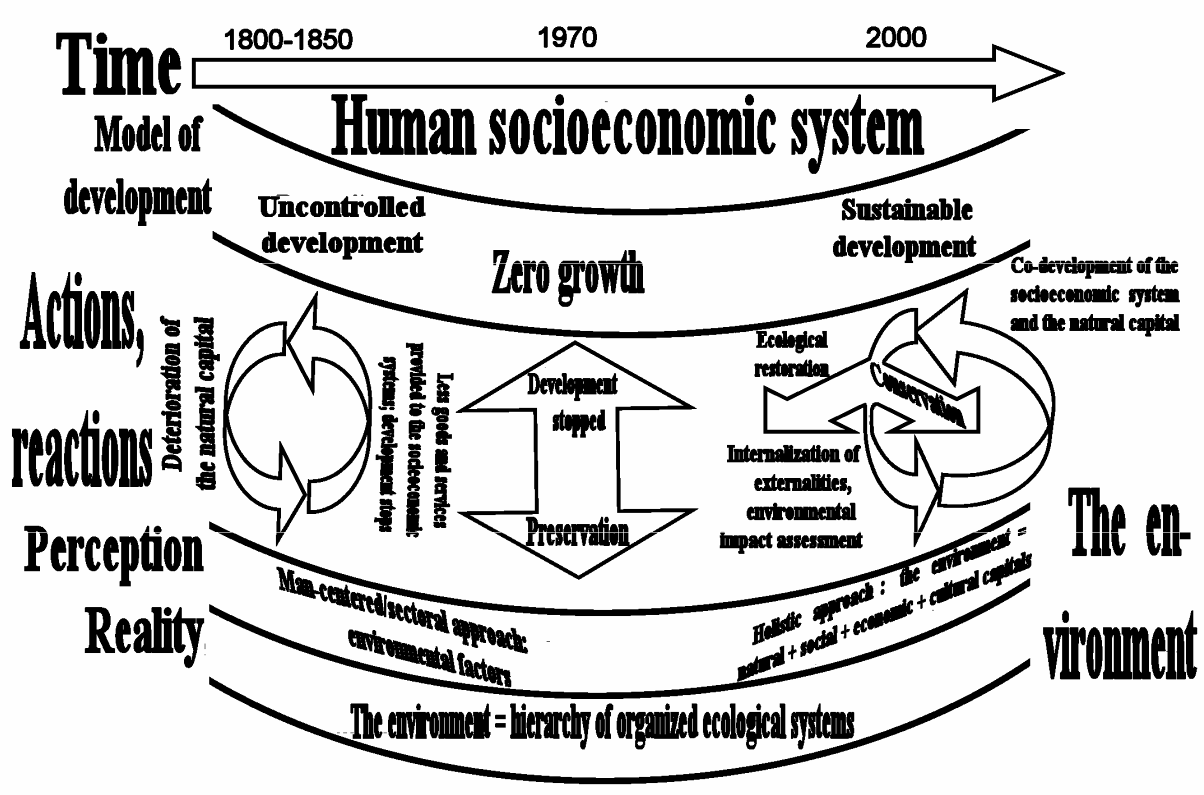


Fig. 7. Sustainable development: timeline

Techniques used by Ecological Engineering to Reconstruct Deteriorated Ecological Systems

- ***Restoration***: bring the system to a previous state/condition
- ***Mitigation***: diminish or compensate functional loss
- ***Creation***: convert a system to another one that did not exist on site in the last 100-200 years (otherwise refer to restoration). Such systems can either survive naturally or helped by man.
- ***Enhancement***: improve some values of parts or the whole – others may decrease
- ***Rehabilitation***: sometimes synonym with restoration or a component of it; represents a return to a system that did not exist on site; however, the reference is that the final goal is not the previous state, but some situation better than the current one.
- ***Amelioration / regeneration***: similar to rehabilitation, start from parts remained from the previous system.
- ***Bio-manipulation***: use fauna or flora to recreate or enhance deteriorated systems.

Biodiversity

Rio de Janeiro convention on biological diversity: variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.
What means: diversity of biocoenoses, biotopes; of complexes of ecosystems (including ecosystems), of human population and artificial ecological systems.
Components:
- Ecological diversity, at several levels: complexes of ecosystems, species and ecological niches
- Diversity of organisms – taxonomical hierarchy
- Genetic diversity – genotypes, frequency in populations
- Cultural diversity – interaction of man at all levels, traditional lifestyles

Notes on an Environmental Analysis and Environmental Impact Assessment course

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Environmental Analysis

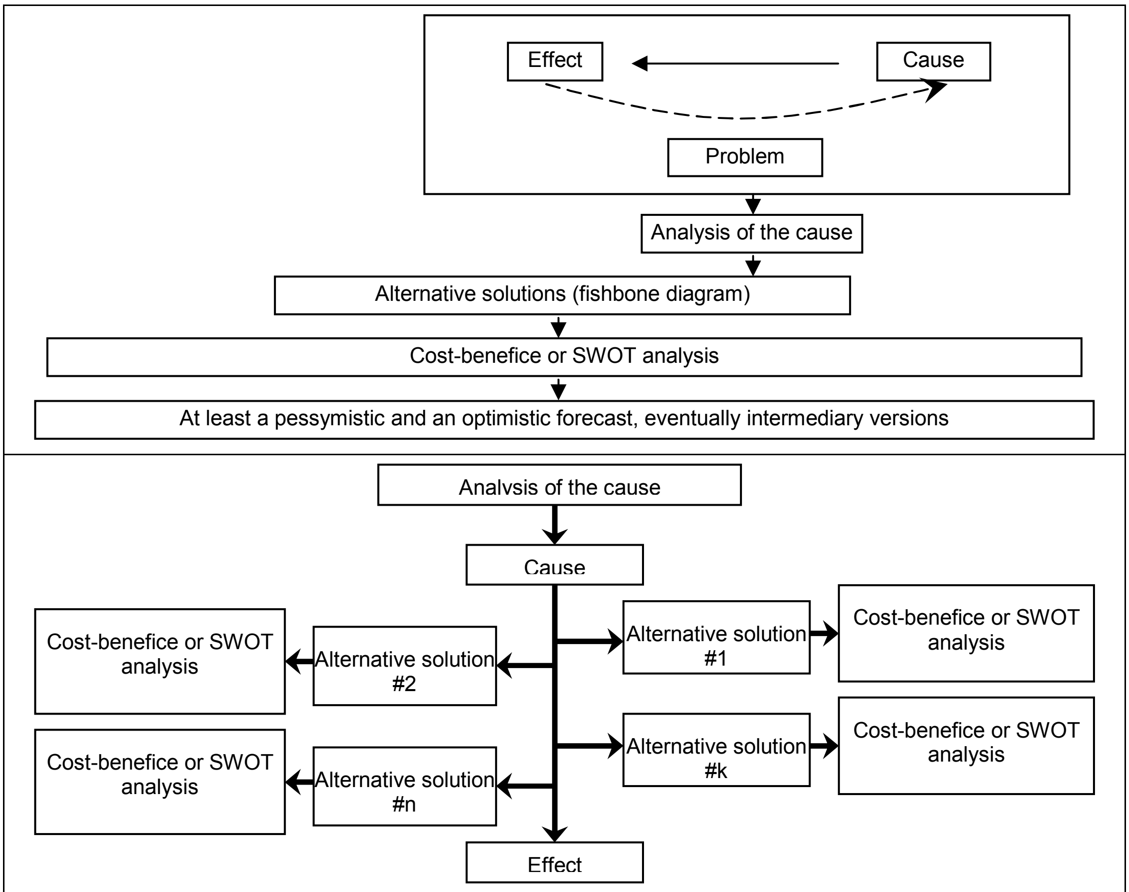


Fig. 1. Analysis and diagnosis of environmental problems (above) using the fishbone diagram (below)

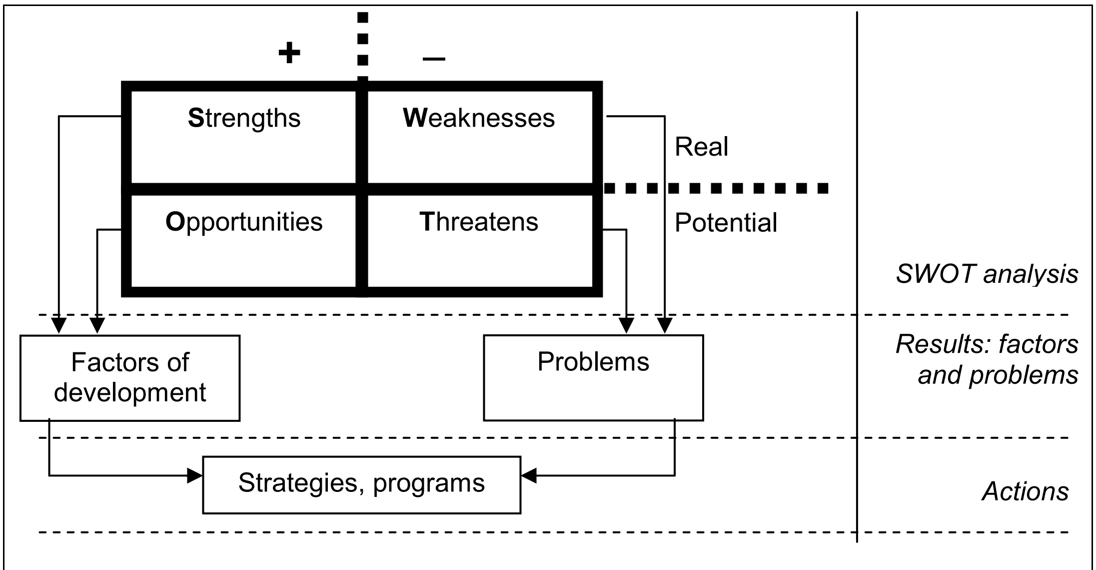


Fig. 2. SWOT analysis

Costs	Benefits
– ...	– ...
– ...	– ...
– ...	– ...

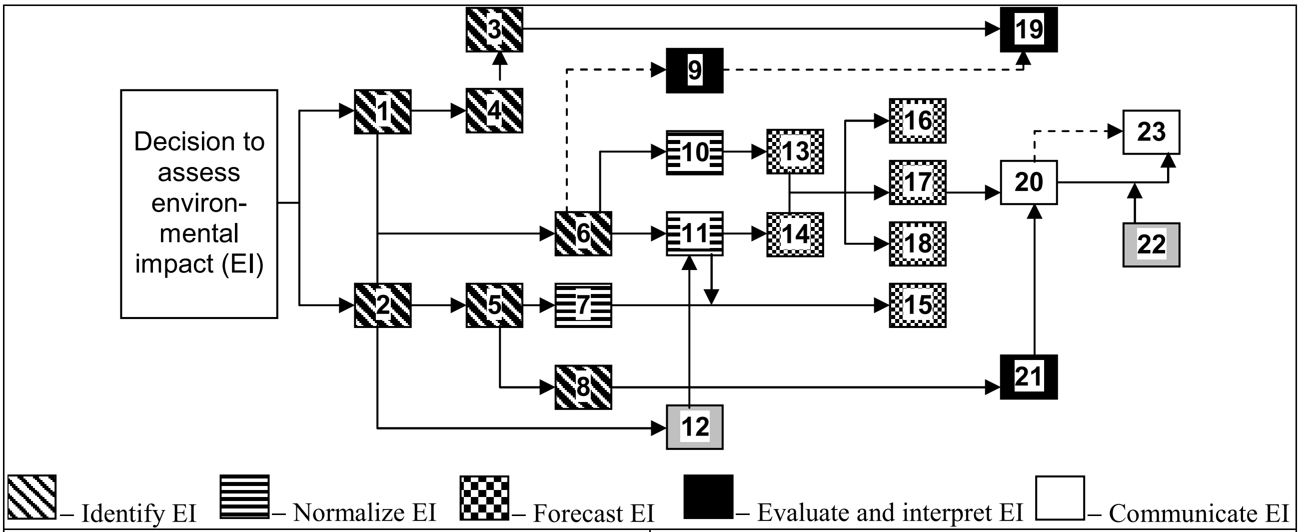
Fig. 3. Cost-benefit analysis

Determining the market value of environmental goods and services

- ***Method of substitution markets***
  - **<u>Environmental protection expenses technique</u>** – individuals would prefer prevention until costs equal availability to pay for decreasing health risks
  - **<u>Hedonistic prices technique</u>** – explain price variations using information on attributes, use statistical regression to estimate price based on the correlation between price and observable attributes
  - **<u>Travel cost technique</u>** – improved environmental quality could increase recreational opportunities in a region – substitute additional satisfaction with value granted to it (money, time)
- ***Hypothetical markets method***
  - **<u>Surveys</u>** – ask people how much would pay for a benefit or to avoid damage cost.
- ***Indirect methods***
  - **<u>“Dose response” or “dose-effect”</u>** – based on the correlation between environmental changes and qualitative/quantitative/financial changes of production.

<u>Table 1</u>. Life cycle of a product

Stage	Idea of product	Design	Technological design	Production	Market	Use – current, capital repairs	Post-use
Time	t_0	t_1	t_2	t_3 $t_{3_1} \rightarrow t_{3_2}$	t_4	t_5	t_6



1 – analyze project and alternatives
2 – analyze and diagnose area of implementation
3 – identify potential corrective actions
4 – identify elements and actions causing EI
5 – identify environmental components to be affected
6 – identify impact: cause-effect relationships
7 – select appropriate indices and units
8 – identify corrective actions in the area
9 – qualitative EIA
10 – characterize EI: place, time, manner
11 – forecast EI size if the project is not applied
12 – assess area before implementation
13 – reduce impacts
14 – assess EI in comparable units
15 – transform units
16 – assess area if project is applied
17 – assess gross impact
18 – assess area if project is not applied
19 – corrective actions
20 – final report on EI and communication to the population
21 – corrective actions
22 – participation of population
23 – declaration of EI

Fig. 4. Sequences in Environmental Impact Assessment (*apud* Negrei, 1997)

Methods used in Environmental Impact Assessment (EIA)

– 1. **Checklist (Westman, 1985)** – table containing impacts in the lines and phases of the project in columns; mark intersection with X or record value of EI (size, importance)

Example. Checklist (Westman, 1985) applied to a transport project – construction phase

Project	Construction phases
I. Acoustic impact A. Population health B. Land use	**x**
II. Air quality A. Population health B. Land use	**x**
III. Water quality impact A. Underground waters 1. Diffuse surface and underground sources 2. Effects of filling and dragging 3. Characteristics of flooding and draining B. Runoff 1. Effects on effluent loading 2. Other actions: a) Disturb benthos b) Alter currents c) Change flow regime d) Underground salt infiltration 3. Population health 4. Land use	**x**
IV. Soil erosion A. Land use and economy B. Pollution and alluvial deposits	**x**
V. Ecological impacts A. Flora B. Fauna	**x**

– *2. **Cause-effect matrix (Leopold, 1971)** – two-entry table: structure/functions of ecosystem and actions generating impacts*

Example. Phosphate mine construction. First number indicates size, and the second estimates the importance of EI.

	Industrial objectives	Highways, bridges	Communication	Mining	Ground digging	Treatment of minerals	Truck transport	Waste deposits	Runoff, infiltration
Water quality					2/2	1/1		2/2	1/4
Air quality						2/3			
Erosion		2/2			1/1			2/2	
Deposits and sediment						2/2		2/2	
Shrubs						1/1			
Grass						1/1			
Water plants						2/2		2/3	1/4
Fish						2/2		2/2	1/4
Tourism						2/4			
Landscape	2/3	2/1	2/3		3/3		2/1	3/3	
Wildlife quality	4/4	4/4	2/2	1/1	3/3	2/5	3/5	3/5	
Rare species		2/5		5/10	2/4	5/10			
Health and security									

– *3. **Matrix of large dams** – two-entry table similar to the previous, but "inversed", used in conjunction with the **method of networks (Sorensen, 1971)***

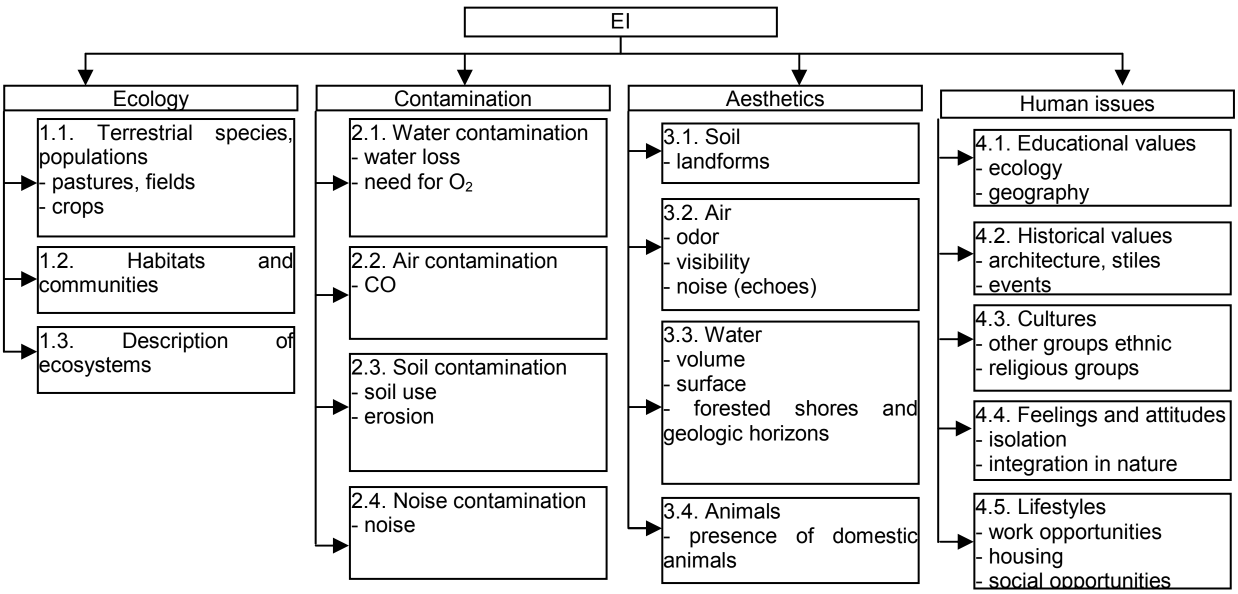
Example. Use of arrows to indicate chain reactions and closed loops

	Agriculture and husbandry	Recreational utilities	Erosion	Sediments	Solid alluvia	Physical and chemical quality of water	Aquatic flora	Aquatic fauna
Irrigation								
Fishing								
Dam								
Anti-erosion curtains								
Artificial lake								
Top layer (live)								
Dragging								
Erosion control								
Leveling pool								

Interpretation. Irrigations favor development of agriculture and husbandry, leading to accented soil erosion and sedimentation, altering physical and chemical quality of water. For this reason, proposed anti-erosion curtains could control the process. Sedimentation is accented close to the dam, but also in the artificial lake, requiring dragging. An alternative solution is a leveling pool. Dragging intensifies alluvial process, and aquatic flora and fauna. Dragging leads to a decrease of the fishing harvest.

– *4. **Battelle-Columbus method**: tree structure of the impact area – categories, components, units, data*

Example.



– *5. **Delphi method** – qualitative method based on input from specialists, data processed using: (1) sorting by branches, (2) scale-based classification or (3) pair comparison.*