Developing a system of reference for ecological evaluation in the frame of landscape and restoration planning processes

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Anylandscape assessment process consists of four phases:

- selection of landscape functions,
- data management and parameter derivation,
- landscape analysis
- landscape evaluation

This last phase poses critical methodological issues because any evaluation implies the need of having a stable replicable reference system in relation to which the evaluation can be made.

This replicability is critical for the soundness and applicability of the evaluation results

Therefore, a working tool is necessary that is able to:

- build a coherent characterization and evaluation framework for landscape ecological studies.
- allow, within this framework, all types of expert knowledge or models to be operated on a coherent working background.

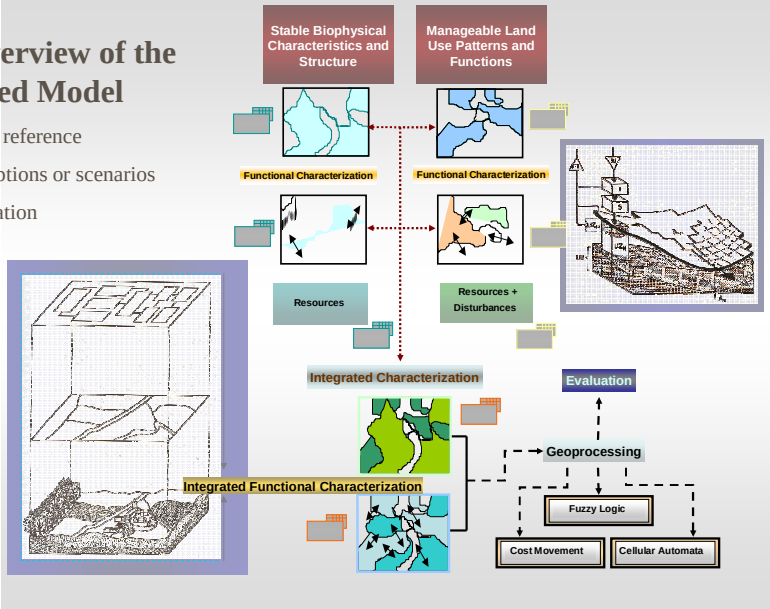
Basic ideas on witch such a tool must be based:

- Each landscape is determined and can be characterized by two types of environmental factors:
  - stable biophysical characteristics and related functions and processes, and
  - manageable land use or land cover patterns and related functions and processes;
- It is possible to identify and characterise reference system to which every possible land use pattern can be compared using common evaluation algorithms

- it is therefore possible to build a large to very large scale characterisation and evaluation model, providing that the same amount of evaluation data can be available for both levels of characterisation.
- This is done trough the creation of a common base of reference (the stable biophysical environmental structure) that can be describe by the same set of evaluation descriptors as every other object of evaluation (land use system or scenario).

General overview of the proposed Model

- Stable system of reference
- Land Use descriptions or scenarios
- Integrated evaluation



Main advantages

- The use of a stable system of reference allows the comparative simulation of different land use scenarios, but also the permanent availability of the same reference system independently from the intensity of land use changes throughout the years.

- It allows the use of different evaluation algorithms according to different evaluation contexts, without having to repeat or adapt the characterization process.
- Trough the independent consideration of the land use scenarios, it allows those scenarios to be the object of economical comparative analysis or evaluations, without any interference with the nature or quality of the environmental information.

Aplication to conservation and restoration processes

- It allows the consideration of different evaluation criteria for the same area or sets of landscape objects (e.g. naturalness vs. promotion of a disturbed habitat essential to the survival of a given endangered species – e.g. great bustard in the Iberian Peninsula).
- It allows the comparison of different sets of scenarios and conservation targets

The use of the model at the structural and functional level allows the use of a large variety of tools like:

- Comparison of landscape metrics between the reference and the circumstantial characterisation layers.
- Qualitative evaluation of the stable or circumstantial character of landscape elements like (matrix, patches, corridors) or characteristics like fragmentation or connectivity.
- Modelation of landscape or habitat connectivity as well as target animal movements (using for example percolation or cost-distance models)

Implementation

- Data requirements
  - **it is a framework for data and evaluation processes**. Therefore, the only requirement of the method is the **availability of a stable geographical reference base that can be qualified with the same set of indicators or descriptors as the system to be evaluated**.

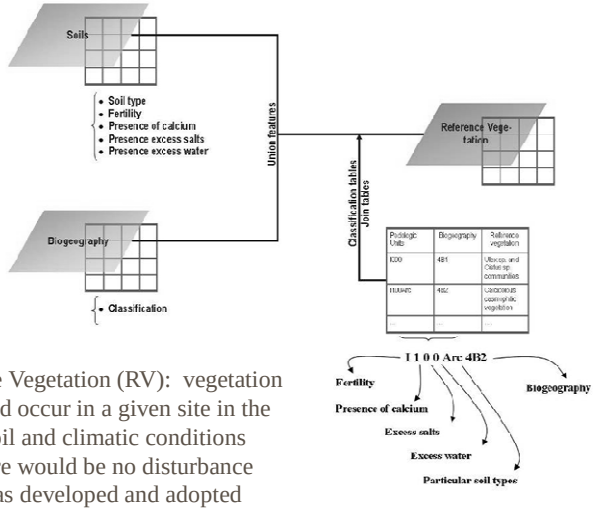
- This imply that every geographical land use/habitat or ecological/biological structural arrangement can be described by a set of indicators or other evaluation tools that can be applied, at the same time to a given stable geographical/ecological system of reference in order to determine the variation (+/-) of those indicators or evaluations descriptors.

- The evaluation process is carried trough the comparison of the "conceptual situation" – the reference system, with the present situation, according to the system of values chosen.
- The scale, evaluation framework (value structure), variables considered, depend only on data availability.
- The method is independent from the evaluation procedures (e.g. indicators).

Ecological indicators used in the model implementation

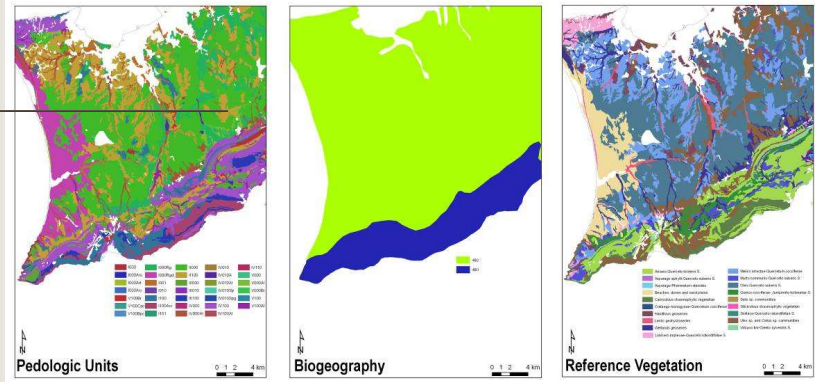
Structural diversity (vegetation) – StD	Number of vegetation strata, relativized to the nature of the potential vegetation formation
Specific diversity (vegetation) – SpD	Specific diversity according with the biogeographic region
Maturity of the vegetation communities – M	Evolution degree throughout the succession process
Disturbance intensity – DI	Degree of anthropic disturbance of the vegetation formation (Leser, 1997)
Productivity – P	Equivalent to the soils fertility (Grilo CEEM, 1996)
Complementarity – CM	Complement other vegetation formations, concerning to its use as habitat by the most important faunistic species
Connectivity – CN	Guarantee the functional continuity of the land units, for the most important faunistic species
Rarity of the vegetation communities – R	Estimated according to the existing bibliographical references and taking into account regional and supra-regional nature of the related vegetation formations
Degree of threat of the phytocenoses – DT	Population dynamics of the vegetation formation at local and global scales
Degree of correspondence with the potential natural vegetation – CPNV	Degree of correspondence between the vegetation formation and the potential natural vegetation, at local scales (Appendix A)
Resilience – RC	Response capability of the vegetation formation to disturbances
Presence of rare species (vegetation) – RS	Number of species included on the red lists and your biogenetic significance
Functionality as a refuge habitat – FRfH	Functionality as refuge habitat for the most important faunistic species
Functionality as a reproduction habitat – FRpH	Functionality as reproduction habitat for the most important faunistic species
Functionality as a food habitat – FFH	Functionality as food habitat to the most important faunistic species
Classification and protection status of the vegetation formation – CPS	Normative laws and traditional and consensual practices of the populations and landowners

The selected object of reference: Reference Vegetation



Reference Vegetation (RV): vegetation that should occur in a given site in the present soil and climatic conditions when there would be no disturbance factors was developed and adopted

Bioclimatic/pedological units and corresponding "Reference Vegetation" in the area of Setúbal Peninsula (Portugal)



Selected evaluation algorithms (evaluation criteria: naturalness)

Ecotope Formation Value (EFV) – Capacity of the vegetation communities to originate viable ecotopes. This value refers essentially to variables related to vegetation

$$EFV = \frac{(StD + SpD)}{2} + M + DI + P + CM + CN$$

Natural Potential Value (NPV) – Interest of the vegetation communities and particular species of the originated ecotope

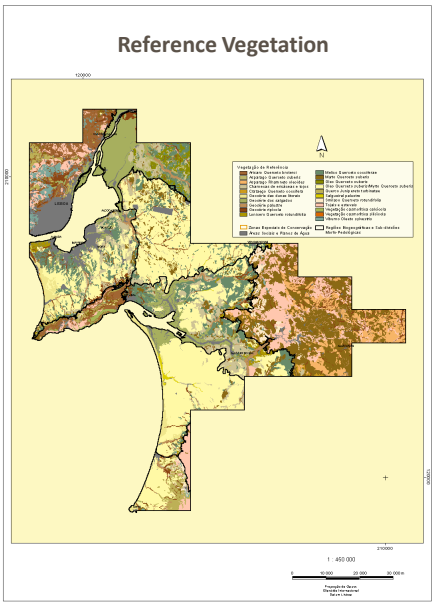
$$NPV = EFV + R + DT + CPNV + RC + RS$$

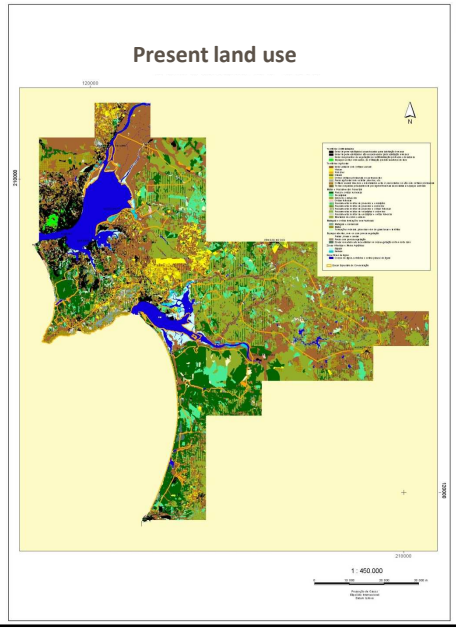
Nature Conservation Value (NCV) – Value of the vegetation communities in terms of the nature conservation proposes, integrating the criteria represented in previous values with strictly faunistic criteria (determined for each target species)

$$NCV = NPV + FRfH + FRpH + FFH + CPS$$

Results

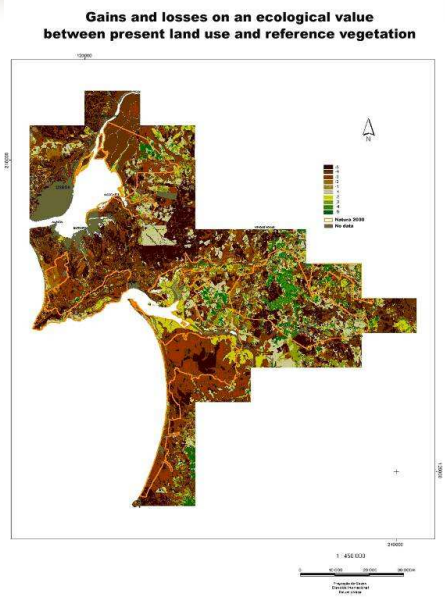
Land units vs land use units



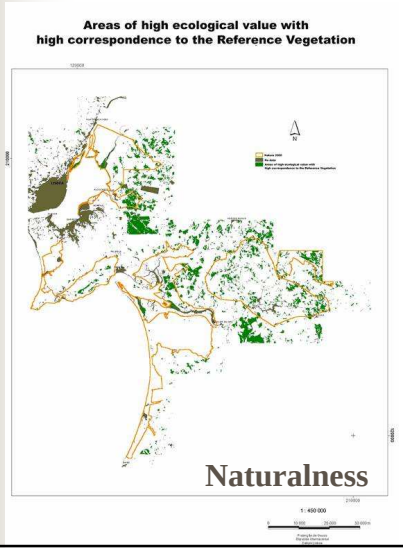


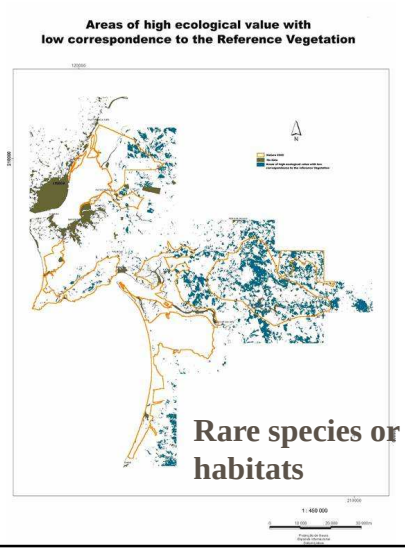
Ecotope formation value – reference vs present

Variation of the calculated values (example)

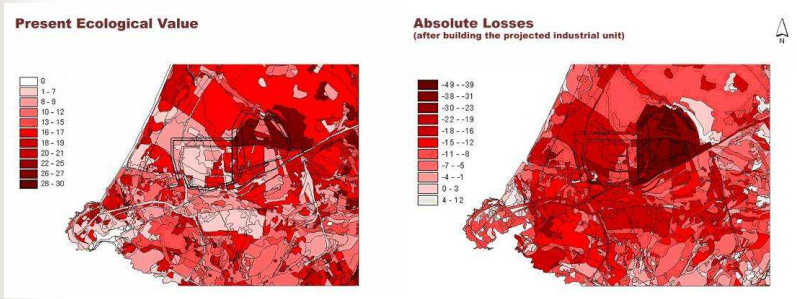


Comparing values according to different evaluation paradigms

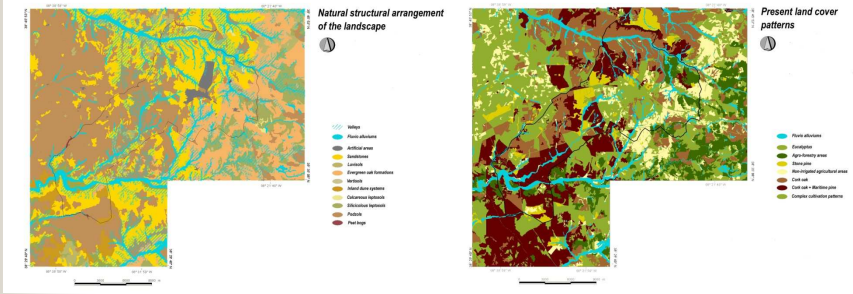




Use as an EIA tool



Use as tool for the characterisation of structural changes in a given landscape



Comparison between the reference and the present spatial structure of the area of Vendas Novas (Portugal)

Practical advantages for ecological studies as well as evaluation and planning processes

- **Development of simulation models for the evaluation of alternative land use scenarios**;
- **Evaluation of the present situation and of prospective alternative land use scenarios** using habitat suitability analyses for spatial indicators;
- **Assessing the sensitivity of biodiversity indicators** within different alternative land use scenarios, allowing the comparative evaluation of biodiversity gains in relation to economical costs and benefits;
- **Integrated evaluation of the effects of different land use scenarios on biodiversity, economy and cultural aspects**. Assessing synergetic and incompatible effects in achieving ecological and economical targets;

- **Spatial framework for target species dispersal simulation processes** according to alternative development scenarios and particular infrastructural developments (highways, railroads, irrigation, etc.);
- **Evaluation of alternative allocations of different land use systems**;
- Assessment of capability of different premium schemes in agriculture, forestry and conservation systems;
- **Analysis of structural changes** and their degree of disturbance in relation to the structural arrangement of natural resources. Assessment of the relative degree of disturbance or naturalness of fragmentation or coalescence processes in the landscape.

- **Assessment of the effects of different management, incentive or policy measures can have in different regions by building a common reference base where many different ecological and economical models can be used** as, for example:
  - Nutritional models allowing the identification of different grazing or feeding scenarios and correlated costs and profits;
  - Ecological models simulating the resource allocation of each land use distribution in a characteristic region, as well as the spatial constraints in terms of continuity, complementarity regarding target species, indicator species or other particular important groups of species;
  - Economical models simulating the variation of economical income according to different sets of economical, institutional or ecological restrictions;
  - Management system (enterprise, farm, shepherd, or other) models to identify the restrictions to the farming systems that constrain the profits of each scenario.

Thank you for your attention