DESERTLINKS

COMBATING DESERTIFICATION IN MEDITERRANEAN EUROPE
LINKING SCIENCE WITH STAKEHOLDERS

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Classification framework for desertification indicators

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Classification framework for desertification indicators
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A framework composed of five hierarchical levels is proposed, corresponding to as many indicator classification criteria. They provide an answer to the questions "what is it for", "at what scale does it apply", "what kind of data is it based on".
The classification scheme serves to facilitate the placement of available indicators into a rational framework.

The five classification criteria are, in hierarchical order:

1. *Operational objectives;*
2. *Position within the DPSIR framework;*
3. *Spatial scale and time scale;*
4. *Component of the environmental or socio-economic system involved*
5. *Type of data and acquisition platform*

For each of these criteria few classes are indicated, identified by a capital letter in bold type. An indicator can thus be codified by a sequence of capital letters referring to the five sub-classes they belong to (see also the recapitulative table of the class codes, pag 8). For example an indicator of type (P,S,L,V,R) is an indicator for Prevention, of State, applicable on a Local scale, referring to Vegetation, measurable by means of remote-sensed data: if the indicator also requires data collected directly from the Field, then it will not be R, but R/F and so on.

1. *Operational objectives*;
By "operational objectives", reference is made to prevention (**P**), monitoring (**Mo**), mitigation (**Mi**).

Indicators targeting *prevention* should be based on an understanding of the degradation processes and of their causes: those detecting how human activities degrade the environment are mostly of a socio-economic and cultural nature (the importance of cultural aspects in this context is now recognised): while those linked to concepts of *vulnerability*, *sensitivity*, intrinsic *resilience* of natural systems with respect to processes causing degradation are mainly of a biophysical nature. They are both socio-economic and biophysical when the question of prevention is tackled from the point of view of *sustainability* of land use management.

Monitoring indicators should describe the state of natural resources or of the socio-economic systems that interact with them, and inform on the dynamics of evolution at different scales of temporal observation. These indicators must also assign a value to such dynamics, so they are linked to concepts such as *quality* or level of degradation which in turn may be linked to an evaluation either of the functional or absolute kind (i.e. referring to an ideal model of a perfect ecosystem) of the value of ecosystems. There are a great many indicators of this type, of very different origin (depending on the "what" and the "how" being monitored).

Indicators designed for *mitigation* may be regarded as indicators of the impact of activities implemented by man to alleviate the effects of Desertification and drought (they will therefore serve to decide on the necessity and efficiency of mitigation measures). A whole range of problems may be posed by this type of evaluation depending on the case and spatial scale: it is not always easy, except in well localised and controlled cases, to ascertain whether a degree of progress achieved is due to human intervention or to natural causes (for example, the relationship between CO_2 emissions reduction and the greenhouse effect). Moreover a common understanding of what is meant by mitigation is far from having been reached. Sometimes the objectives of actions are so specific that they can only be assessed by means of specific indicators that cannot be applied elsewhere.

This family of indicators must be closely linked to the notion of *functions of an ecosystem*, in as far as it is assumed that every mitigation measure is aimed at reviving one or more of the environmental functions to which society attaches a value and which have to some extent been compromised. It may be possible in future to determine common sets of mitigation indicators once agreement is reached concerning what functions of natural ecosystems should receive priority attention and to the extent to which these functions are controlled by a limited number of universally valid factors (for example if the scope of a reforestation measure is only to reduce erosion risk, the evolution over time of the vegetation cover percentage is a simple but universally valid indicator).

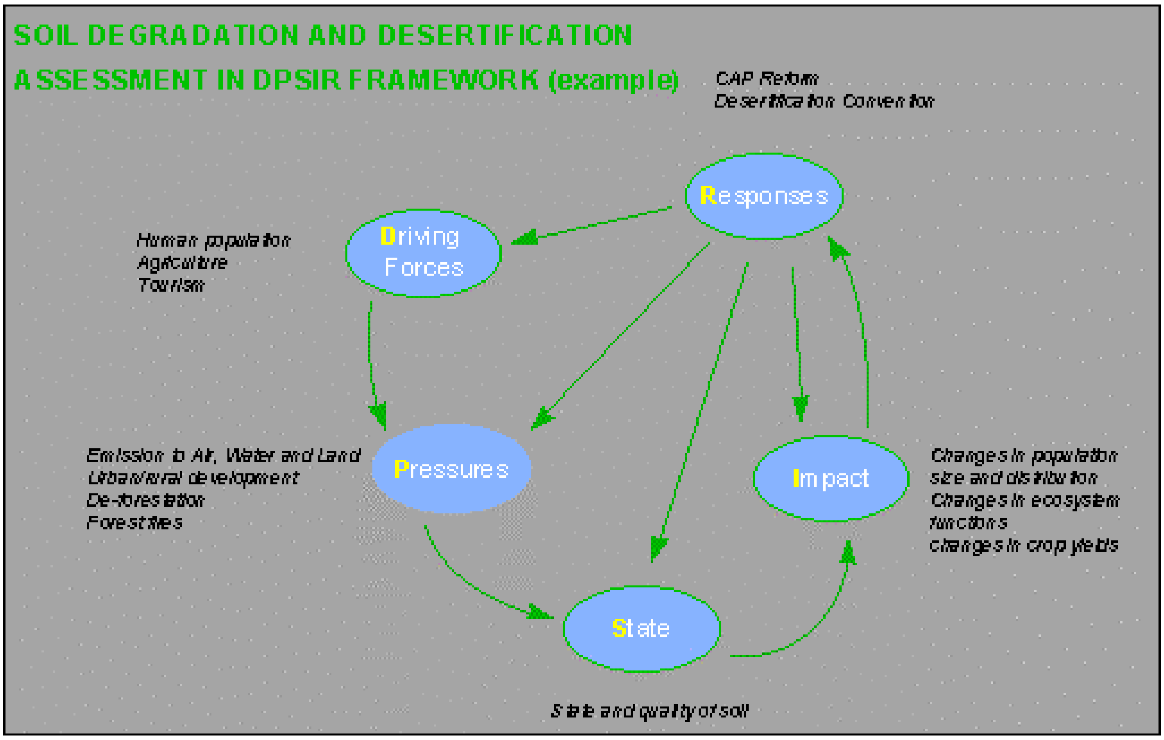
Obviously certain parameters can be indicators for each of the three objectives, but the manner in which they will be considered, the methods of measure, the benchmarks, etc. may be different.

2. *Position within the DPSIR (D,P,S,I,R,).*

The DPSIR framework was chosen because it seemed to be the most comprehensive amongst those designed to describe interactions existing between the components of the natural and socio-economic system.

It is very important that the indicator be characterised in this way, because it presupposes a knowledge of the context (the physical and socio-economic system) within which the indicator was developed, its components, the interactions between them, the mechanisms causing degradation: i.e. it is an encouragement to adopt a comprehensive, multidisciplinary and integrated vision of the issues at stake, in keeping with the provisions of the Convention. Resorting to this model also implies acknowledging the importance of analysing political and socio-economic type of driving forces. Obviously, the assessment should be carried out by whoever proposes the indicator. However, apart from indicators developed by Agencies such as FAO or EEA, or those devised more recently, indicators are not generally placed into a logical framework and when they are, it does not always coincide with the one determined in the present case. The one most frequently used is the PSR, from which it is possible to pass onto the DPSIR, even if not always easy.

Figure 1:Example of the DPSIR framework applied to soil degradation (EEA)



3. Spatial scale and time scale

Spatial scale

One of the major problems in this respect is to determine intervals of scale able to represent both geopolitical processes (scale / geopolitical spatial levels) and physical ones (physical, regional divisions), especially as there are no universally accepted classifications either for one or the other. In recent years problems of scaling have become increasingly important in modelling the effects of phenomena such as Global Climate Change at different spatial scales and it has now been acknowledged by the scientific community that the problems of defining an optimal working scale and the passage from one scale to the other present non negligible difficulties. For example, in the case of Desertification indicators, Imeson (2000) proposes a framework to facilitate identification of land degradation indicators at different scales, based on the following levels: plot; slope; primary catchment area; secondary catchment area; region. This framework seems designed to describe physical degradation processes and in particular, soil erosion, and disregards needs in terms of socio-economic data.

In the present proposal, for physical regional sub-divisions, the framework proposed by Mitchell, 1991 (figure 2) was used as a reference, for the geo-political sub-division reference is made to certain administrative units, which, at various levels, occupy relatively similar areas in different Mediterranean countries.

The scales proposed are the following:
Station, Local, Sub-region, Region, European Mediterranean Region.

An indicator may be assigned to a given scale on the basis of the following criteria:

a) the indicator “functions” only for specific contexts that can be identified or delimited only at a certain level of detail;

b) the indicator needs data with a level of accuracy such as to require measurements and surveys above a certain level of detail.

- Station (**S**): indicators designed for studying extremely localised processes, for example, soil contamination by heavy metals in the proximity of a point source of pollution; their applicability can be linked to a specific context (for example to assess the behaviour of a certain type of contaminant in a certain type of soil, in well-determined microclimatic conditions; they require accurate and specific data, the validity of which is generally confined to the narrow field of the area under study. They are essentially indicators of state of a biophysical nature. The metric scale of reference can vary from very large scale of detail of the cadastral type, to large scale in the order of 1:5000.
  The physical units recognisable at this scale (Mitchell, 1991): land element; land sub-facet.
  Corresponding administrative unit: cadastral plot.

- Local (**L**): Indicators designed to provide a detailed description of the mechanisms of Desertification processes in local contexts, (possibly in areas characterised by a high level of internal homogeneity), with particular reference to pressure factors, to the dynamics of the state of resources, to impacts on local populations. Often the local system cannot take the driving forces and response into consideration, nor the indirect impacts and the off-site impacts. Their applicability can be linked to a specific context (for example the study of “erosive processes on marly soils destined for extensive pasture”), or they can have a more general validity (for example a generic indicator of soil erodibility), but require a level of spatial detail such as to require measures and surveys with a level of detail of the local type. The metric scale of reference can vary from the large, in the order of 1:5000, to medium scale (1:50000).
  Physical units recognisable at this scale (Mitchell, 1991): Land clump; land facet.
  Corresponding administrative unit: municipal

- Sub-region (**Sr**): Indicators to describe the mechanisms of Desertification processes on a broader geographical scale than the local, characterised by a lesser degree of internal homogeneity (for example, indicators for a process at work on the scale of a catchment area which includes various

kinds of landscapes) but which call for data with a level of accuracy that could not rationally be managed at a scale of lesser detail. Generally at this scale, which is the most important for land use planning, all the system of causes (DPSIR) determining Desertification processes can be described and each of the components, both bio-physical and socio-economic are manifested with equal importance, just as all the disciplines and data sources make a potentially equal contribution (figure 3 presents a model of the optimal relationship between working scale and the data acquisition platform). The metric scale of reference can vary from medium scale in the order of 1:50000 small (1:200000).
Physical unit recognised at this level (Mitchell, 1991): land clump: land facet, land catena.
Corresponding administrative unit: district or province.

- Region (**R**): these indicators are less appropriate for describing processes in all their complexity because the description of the natural components, in particular, at this scale becomes very simplified but it is a scale at which many indicators are defined for monitoring by means of remote sensing. The socio-economic component acquires increasing weight at this level, so this scale is suitable for indicators of driving forces, impact and response. The metric scale of reference is small included between 1:200000 and 1:1000000.
  Physical units recognised at this scale (Mitchell, 1999): land system (simple); Land region.
  Corresponding administrative unit: region.

- European Mediterranean region (**M**): At this scale considerations regarding the regional scale also apply, with an even greater importance given to economic factors of the structural type. Moreover, at this scale it becomes possible to take into account global processes, whether globalisation of markets or global climate change. The metric scale of reference is very small, below 1:1000000.
  Physical units recognised at this scale (Mitchell, 1991): land region; land Province.
  Corresponding administrative unit: national or supra national.

Figure 2 Hierarchical classification of terrain, soil, and ecological units.

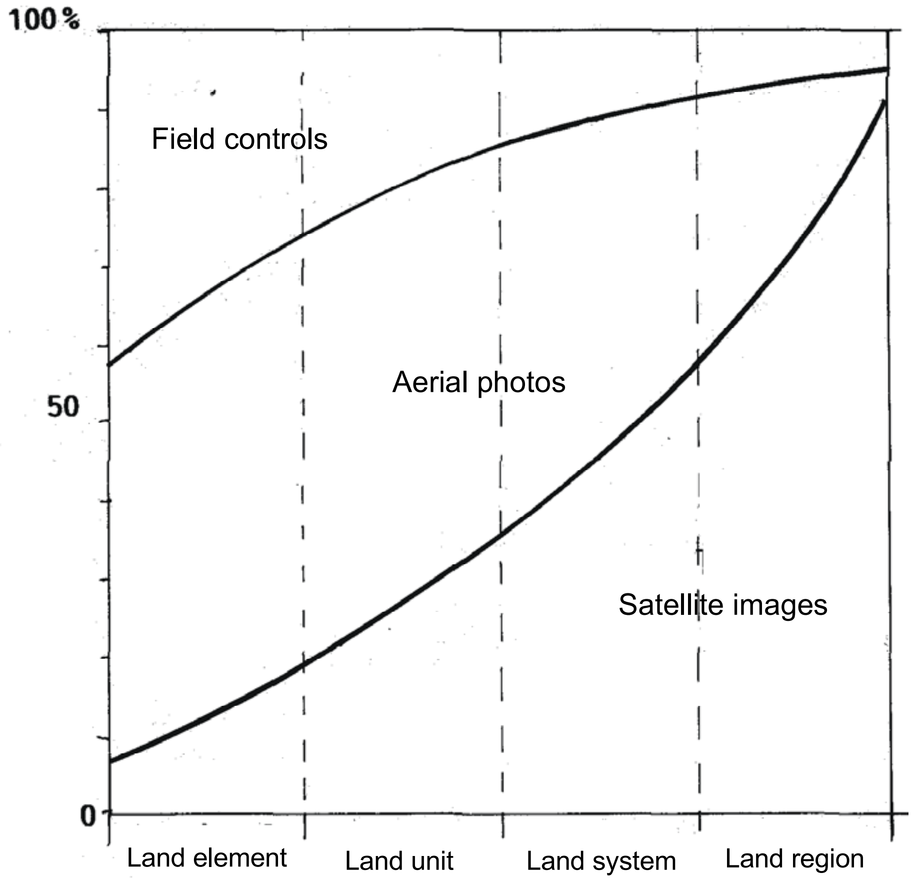
Hierarchical classification of terrain, soil, and ecological units

Terrain unit	*Definition*	*Soil unit*	*Vegetation unit*	*Mapping scale (approx.)*	*Optimal remote sensing platform*
Land zone	Major climatic region	Order	—	<1:50 000 000	
Land division	Gross continental structure	Suborder	Plant pan-formation; *zone écolo-gique*	1:20 000 000 –1:50 000 000	Meteorological satellites
Land province	Second-order structure or large lithological association	Great group		1:5 000 000 –1:20 000 000	
Land region	Lithological unit or association having undergone comparable geomorphic evolution	Subgroup	Sub-province	1:1 000 000 –1:5 000 000	Landsat SPOT ERS
Land system (simple) *	Recurrent pattern of genetically linked land facets	Family	*Région écologique*	1:200 000 1:1000 000	Landsat SPOT, ERS, and small-scale aerial photographs
Land catena	Major repetitive com ponent of a land system	Association	*Secteur écologique*	1:80 000–1:200 000	
Land facet	Reasonably homo geneous tract of landscape distinct from surrounding areas and containing a practical grouping of land elements	Series	Sub-formation; *station écologique*	1:10 000–1:80 000	Medium-scale aerial photographs, occasionally SPOT and Landsat
Land clump	A patterned repetition of two or more land elements too contrasting to be a land facet	Complex	Sub-formation: *station écologique*	1:10 000–1:80 000	
Land subfacet	Constituent part of a land facet where the main formative pro-cesses give material or form subdivisions	Type		Not mapped	Large-scale aerial photographs
Land element	Simplest homogeneous part of the landscape, indivisible in form	Pedon	*Elément de station écologique*	Not mapped	

* A land system can be complex if it represents a combination of two or more geomorphogenetically related simple land systems, or compound if the combination is not geomorphogenetic. Complex and compound land systems are appropriate to the mapping scale of the land region.

Sources: soil units, USDA (1976); vegetation units, Howard (1970c), Long (1974).

Figure 3. Working scale and contribution of different data acquisition platform. From Giordano, 1999 (modified).



Time scale
At least two pieces of information are required to characterise an indicator in terms of time-scale:

a) The lapse of time required for the indicator to provide the expected information.
Some indicators are designed to describe properties of a system under study that can reasonably be considered constant in time, like a slope, so the measurement can be made once and for all, while others measure properties whose averages are constant in time, so the final value of the indicator will be a mean value taken over a more or less long period of time (for example the climatic characterisation of a station requires a series over a thirty years period): others measure properties that vary in time and at different speeds and the purpose of the measurement may be to compare the present value with a reference threshold or to determine the trend: these objectives can require very different time-spans. Imeson (2000) underlines, for example that some degradation processes are very slow and must be assessed over a lapse of time in the order of about 20 years, while the average time required to evaluate the success of a reforestation measure is of approximately 10^2 years. The time required for the regeneration of highly eroded soils in dry climates can be in the order of 10^3years.

b) The frequency of measurements required to obtain information.
In addition to the total time required to obtain the final data, the frequency with which measurements have to be repeated is sometimes quite different, and can be hourly or more (for example to measure the instantaneous energy of precipitation), daily, seasonal, annual, etc. according to the specific requirements of individual indicators.

Obviously, for a classification designed to be practical there is no point in taking all possible cases into consideration and therefore we have restricted ourselves to a very much simplified classification, based exclusively on the frequency of measure, so as to give the user an immediate idea of the magnitude of the indicator’s needs in terms of data sampling. The classes identified, designated this time by a lower case letter, are the following:

*Very frequent, daily or more (**d**); monthly or seasonally (**m**); annual (**a**); less than annual (**b**); single measure (**s**).*

4. Component of the environmental or socio-economic system involved;

Here the traditional classification of indicators into the following categories is used:

Climate (**C**); soil (**S**); water resources (**W**); vegetation (**V**); socio-economic aspects (**SE**).

5. Type of data and acquisition platform;

The types of data are grouped into three major categories to help the user to immediately identify the type of data required by the indicator and consequently, to see at once whether it is available or not and at what cost:

- From data banks (**B**); data commonly found in the data banks of many governmental agencies or research institutes, such as data on climate, demography, socio-economic data and also other types, for example from mapping data banks, like the FAO Map of the Soils of the World, in case work is being done on a very small scale and that direct acquisition of data is totally out of the question.
- Field (**F**): data to be gathered by special data collection campaigns, either of the punctual or mapping type, when it is not already available.
- Remote sensing data (**RS**): with reference only to aerial photographs and satellite images.

Synthetic presentation of the proposed classification framework

Rapid classification of the indicator =
=(operational objective; position in the logical framework; spatial scale - time scale; component; type of data)

Recapitulative table of the class codes:

Criteria		**Classes and relative codes**				
Operational Objective		prevention	monitoring	mitigation		
		P	**Mo**	**Mi**		
Position in the DPSIR framework		driving force	pressure	state	impact	response
		D	**P**	**S**	**I**	**R**
Scale	*space*	punctual	local	sub-region	region	European Mediterr. region
		P	**L**	**Sr**	**R**	**M**
	time	daily or more	monthly or seasonal	annual	less than annual	single measure
		g	**m**	**a**	**b**	**s**
Component of the system under consideration		soil	water resources	vegetation	climate	socio-economic aspects
		S	**W**	**V**	**C**	**SE**
Nature of data		data banks	direct gathering	remote sensing		
		B	**F**	**RS**		

Example:
Indicator for prevention, state, spatial scale from sub-region to region, time scale seasonal, referring to vegetation cover, remote sensing data;

P	S	Sr/R - m	V	RS