DESERTIFICATION AND INDICATORS

**Should the UNCCD definition of desertification and the particulars of the Mediterranean Annex be on the inside of the front cover of each booklet?

Desertification in the Mediterranean

The Mediterranean climate is semi-arid and prone to seasonal droughts and great variability in annual rainfall. Intense sudden storms are typical. Since the northern Mediterranean region has been settled and cultivated for thousands of years, the term “desert” is here mostly related to sparse population, isolation and wilderness.

Apart from the semi-arid climate there are other features recognised as predisposing the region to desertification. These include poor and highly erodible soils; uneven relief and steep slopes; extensive forest loss caused by wildfires; abandonment of traditional agriculture with deterioration of soil and water conservation structures; unsustainable exploitation of water resources; and concentration of economic activity in coastal areas. Soils become salinized, dry, sterile, and unproductive in response to a combination of natural hazards - droughts, floods, forest fires - and unsustainable farming activities such as excessive tilling and overgrazing. The health of soils is also at risk from over-use of fertilisers and pesticides that can make soils more susceptible to erosion. In addition, land quality may be affected by redistribution of water resources through the building of reservoirs and canals. The widespread decline in groundwater levels is a subject of particular concern, especially along the coasts where there are demands for tourism as well as intensive irrigated agriculture, and industry.
All these features have been studied in the context of providing indicators of the current extent of desertification and potential desertification risk.

What is a desertification indicator?

Indicators are used to indicate something, to be a sign of something, but they do not always suggest trouble. A desertification indicator suggests that there **may** be a desertification problem, but it is not definite. A shallow SOIL DEPTH can be an indicator of desertification, but it does not say that there will definitely be any risk of desertification without taking account of other factors (indicators) such as annual RAINFALL, VEGETATION COVER, or SLOPE GRADIENT.

The European Environment Agency [1] defines an indicator as "a parameter or value derived from parameters, which provides information about a phenomenon. Indicators are quantified information that helps to explain how things are changing over time and how they vary spatially. Indicators generally simplify the reality in order to make complex phenomena quantifiable, so that information can be communicated."

It is often advantageous to aggregate several indicators into an **index** allowing different factors to be taken into account at the same time. ARIDITY INDEX is an example of an index in which annual RAINFALL and POTENTIAL EVAPOTRANSPIRATION rates are combined. This booklet contains an example of a tool for calculating an Environmental Sensitivity Index, combining 16 separate indicators. However, this level of aggregation is rarely possible, and considerable effort has to be put into ensuring the scientific validity of the index and in helping the user to interpret it.

WHY ARE INDICATORS NEEDED AND WHY DO YOU NEED TO KNOW ABOUT THEM?

Because they are required by the UNCCD …

Desertification has not been studied across Europe in the same detail that it has for Africa but there is now greater emphasis on identification and monitoring of all forms of land degradation. The UNCCD [2] provides an international framework for these activities. It aims to coordinate the collection, analysis, and exchange of data, and identify firstly indicators that help to assess the current situation and the potential impacts of changing climate and changing land uses and agricultural practices, and secondly indicators to measure progress in the implementation of the Convention. Clarification of indicators and benchmarks continues to be a priority for the UNCCD. The use of desertification indicators as benchmarks can be either as "a representative site where detailed studies are conducted and results extrapolated to a larger area that is represented by that site"; or as "a set of data, referred to as a baseline that serves as the starting point for evaluating subsequent trends in an indicator or an issue".

In these ways areas at risk of degradation can be identified and designated for protection. Synergies with indicators from other treaties, such as those on climate change and biodiversity, reinforce the promotion of technologies that are environmentally, economically and socially acceptable.

… and can be used in regional, national and local action plans

National action and cooperation are essential for combating desertification in the affected countries of the northern Mediterranean. As a sub regional group of the UNCCD, Portugal, Spain, Italy and Greece have set up thematic networks and workshops to share scientific knowledge and training, both within the group and with the neighbouring sub regions of central and Eastern Europe, and North Africa. Italy, Greece, Portugal and Turkey adopted their National Action Programmes (NAPs) in August 2005 and other affected countries are following suit. In this context indicators are used particularly for monitoring compliance with the UNCCD processes and for mapping and monitoring, communication and education. At the local level indicators provide the evidence for the state of health of agro-ecosystems, suggesting whether action is required to make changes to promote sustainablility.

Properties of a good indicator

To qualify as useful, an indicator should conform to certain criteria, ideally being Specific, Measurable, Achievable, Relevant, and Time-bound [3]. The European Environment Agency suggests that indicators should demonstrate policy relevance and utility for users, and analytical soundness as well as measurability [4]. It should be cost effective to compile the necessary data. For example, annual RAINFALL is indispensable in the suite of desertification indicators as is PARENT MATERIAL (rock type) and POPULATION DENSITY. The data for these are widely available, easily understood, measured and monitored. Data availability problems may be overcome by providing a choice of measurements or parameters that can be made for the same indicator. For example it is possible to determine the value of the indicator VEGETATION COVER by taking measurements from field surveys, aerial photographs or from satellite images. Indicators should also be understandable, easy to interpret and suitable for indicating changes over time.

A threshold is a breakpoint between two regimes of a system, or a starting point for a new state, e.g. between arid and semi-arid. Threshold values for an indicator are given where possible, providing definite boundary information about whether desertification processes are likely to be a problem or not.

For many reasons it can be very difficult to assign definite values to individual indicator benchmarks [5] or thresholds. More often it is possible to suggest classes or ranges of values. Some classes may have specific limits: soil depth, vegetation cover, fire protection. Other classes may simply be low, medium or high, for indicators such as land use intensity, or drainage.

HOW ARE INDICATORS IDENTIFIED?

By national focal points, research and by local people

The Commission on Sustainable Development [6] started working some years ahead of the UNCCD. It took a top-down approach to the identification and use of indicators for sustainable development. A working list of indicators was identified and then their testing and use in individual countries was centrally co-ordinated. In contrast to this the UNCCD's Committee on Science and Technology issued more general guidelines [7] to the countries and organisations within each annex who then collaborated in developing their own indicators. Particular emphasis has been placed on identifying and using indicators which are relevant to the concerns of local people, rather than solely to the strategies of national government.

Over recent years a number of groups have been working on the identification of desertification indicators. Firstly indicators have come from the National Action Plans for each affected country in which they have been used to identify desertification-affected areas. These indicators tend to be those for which data is available at the national scale (such as LAND USE INDEX** check indicator name). Secondly they have come from over a decade of European research. These indicators range from the Mediterranean-wide scale (VEGETATION COVER FROM REMOTE SENSING, REGIONAL DEGRADATION INDEX) to the sub-national (EMPLOYMENT INDEX, DEFORESTED AREA, EFFECTIVE PRECIPITATION) to the plot scale (SOIL DEPTH, TILLAGE OPERATIONS). Thirdly they have come from the people themselves who live in those desertification-affected areas. Some of these indicators are more pragmatic: LAND ABANDONED FROM AGRICULTURE, FRAGMENTATION OF LAND PARCELS, GROUNDWATER EXPLOITATION and NET FARM INCOME.

Sources of indicators

DIS4ME (Desertification Indicator System for Mediterranean Eropue) has collated a list of some 140 desertification indicators. drawn from ths following sources

Environmental indicator systems:
- Commission on Sustainable Development (CSD)
- Organisation for Economic Cooperation and Development (OECD)
- European Environment Agency (EEA)
- Indicator Report on the Integrated Environmental Concerns into Agricultural policy (IRENA)
- Towards European Pressure Indicators (TEPI)
- Land Degradation Assessment of Drylands (FAO-LADA)
- Agri-environmental indicators for sustainable development in Europe (ELISA)
- Proposal on agri-environmental indicators (PAIS)
- International Institute for Sustainable Development (iisd)

Recent and contemporary research projects :
- MEDALUS III, MEDACTION, GEORANGE, INDEX, DISMED, DESERTNET, RIADE, SURMODES

National Action Programmes for Portugal, Spain, Italy and Greece.

Suggestions from Focal Point and National Committee representatives, within and beyond Annex IV.

Suggestions from stakeholder workshops and activities.

Why are there so many desertification indicators?

It is easy to become over-enthusiastic in the search for a single desertification indicator or index that is universally applicable. However the likelihood of finding such a holy grail is low. This is because even within Europe the causes and consequences of desertification and land degradation are manifold, with wide-ranging local variability. For example, a particular issue associated with desertification in the Alentejo region of southern Portugal is rural depopulation. This is driven by the search by younger people for better incomes and standards of living in the cities, and results in an ageing rural population. In the Guadalentín basin of SE Spain the main issues relate to changing land uses in response to available EU subsidies. This results in large-scale contouring of hillslopes and planting of almond trees. The land degradation in these two situations has different causes and consequences. A different set of indicators is required to understand the bigger picture in each.

Indicators are used as substitute measures for issues that are not directly observable or measurable. Consider, for example, the issue of local capacity to combat desertification. Relevant indicators include the NUMBER OF FARMER COOPERATIVES, average FARMER'S AGE and LITERACY RATE. Because of the imperfect fit between indicators and issues, it is better to make use of several indicators rather than just one.

Frameworks for organising indicators

The best frameworks for organising indicators are those that provide direct answers to the questions being asked by indicator users. Some users need information at a national scale and some at the local scale. Some users are interested only in the success or failure of agricultural practices and others are interested in the broader implications in terms of, for example the economic impact.

Examination of reports and documents from the National Action Programmes highlight many of the desertification issues for which indicators are required. These documents also provide indicators and indexes already in common use at the national scale. Workshop consultations with groups of local stakeholders have provided lists of potential indicators at the local scale. It is useful to classify indicators under the classes: physical/ecological, economic, social and institutional. This classification encourages the user to think beyond the more common physical/ecological approach.

An organisation system often referred to in the literature is the DPSIR (Driving force, Pressure, State, Impact, Response) framework [8]. This was developed by organisations such as the European Environment Agency to organise environmental information and supply causal links for decision-makers. The framework helps to explain the relationships between the current state of a landscape and the factors that could exacerbate or reduce the risk of desertification. Driving force and pressure indicators, such as climatic conditions and land use changes, may be developed to provide early warning systems.

DPSIR is a useful concept to the scientist, but to the stakeholder it can sometimes be confusing. It is not always easy to decide which DPSIR category an indicator should be part of. It can depend on the context or the scale of operation. For example, declining population density or yields of agricultural crops can be both a driving force and a response.

140 indicators of desertification

Physical and ecological indicators

Climate	Air temperature Aridity index (1) Aridity index (2) Climate quality index Drought Drought index Effective precipitation Potential evapotranspiration Rainfall Rainfall erosivity Rainfall seasonality Wind speed
Water	Groundwater depth (change in) Water quality
Runoff	Dam sedimentation Drainage density Erosivity (RDI) Flooding frequency Floodplain and channel morphology Impervious surface area Rainfall-runoff relationship Runoff threshold (RDI) Soil permeability
Soils	Acidified area Drainage Erosion risk (RDI) Infiltration capacity Organic matter in surface soil rs Organic matter in surface soil Organic matter mixing with depth Parent material Rock fragments Salinization potential Slope aspect Slope gradient Soil crusting Soil depth Soil erosion (USLE) Soil erosion (measured) Soil loss index Soil quality index Soil stability index Soil structure Soil surface stability Soil texture Soil type Water storage capacity
Vegetation	Area of matorral Biodiversity conservation Deforested area Drought resistance Ecosystem resilience Erosion protection Forest fragmentation Vegetation cover Vegetation cover rs Vegetation cover type Vegetation quality index
Fire	Burned Area Fire Frequency Fire Risk Forest and wild fires Fuel models Wild fire incidence

Economic indicators

Agriculture	Expenditure on water Family size Farmer's age Farm ownership Farm size Forest productivity Fragmentation of land parcels Gross margin index Traditional agricultural products Net farm income Parallel employment
Land management	Agri-enviromental management Fire Protection Forest management quality Management quality index Organic farming Reclamation of affected soils Reclamation of mining areas Soil erosion control measures Soil water conservation measures Sustainable farming Terraces (presence of)
Land use	Area of cultivated & semi-natural vegetation (rs) Area of marginal soil used Land abandoned from agriculture Land use evolution Land use intensity Land use type Natural vegetation Period of existing land use type Shannon's diversity index Urban sprawl
Cultivation	Area of hillslope cultivated Fertilizer application Mechanisation index Tillage direction Tillage depth Tillage operations
Husbandry	Grazing Grazing control Grazing impact Grazing intensity Husbandry intensity
Water use	Aquifer over exploitation External water resources Groundwater exploitation Hydrological regulation (artificial) Irrigated area Irrigation intensity and seawater intrusion Irrigation percentage of arable land Irrigation potential realised Runoff water storage Water consumption by sector Water leakage Wastewater recycling Water scarcity Water availability
Tourism	Penetration of tourist eco-labels Tourism contribution to local GDP Tourism change Tourism intensity
Macro economics	Employment index GDP per capita Accessibility Unemployment rate Value added by sector

Social indicators

- Adult education level
- Depopulation caused by degradation
- Gini index
- Human poverty index
- Number of technicians with a knowledge of desertification
- Old age index
- Population density
- Population growth rate
- Public perception of desertification

Institutional indicators

- EU production subsidies
- Hydrological and forestry plans
- Internal resources mobilisation
- Local agenda 21
- NGO contribution
- Policy enforcement
- Protected areas
- Recycled waste
- R & D expenditure
- River basin management plan
- Water use policy/law

Describing indicators

The standardised format for describing indicators used by the CSD (Commission on Sustainable Development) has been adopted for use with desertification indicators by the Italian Environment Protection Agency [9] and subsequently by the EU-funded DESERTLINKS project [10] for the Indicator system DIS4ME [11].

**I want to put in here an example description

HOW DO YOU CHOOSE THE RIGHT INDICATOR FOR YOU?

To use desertification indicators successfully requires some preliminary thought about the issues you are interested in, the specific questions you are asking and the spatial scale at which these questions are best answered. Systems and lists such as the DESERTLINKS project indicator information system (DIS4ME) can help you to:

- Review background information about indicators
- View and consider a complete list of possible indicators (e.g. grouped according to their relevance to ecophysical, economic, social and institutional aspects of desertification, to spatial scale of operation, and to specific users such as National Action Programmes).
- View and consider indicators relating to specific desertification issues.

** should this section be here?

You can also look at indicators combined in different ways:

- Headline indicators are single indicators integrating several aspects of a more complex system. The European Environment Agency [13] uses the term for broad summaries of lists of specific problems, e.g. soil degradation, climate change. In DIS4ME key headline indicators were defined and measured in the same way in adjacent areas or countries to provide a credible basis for comparison and monitoring change. Headline indicators are often calculated from a collection of indicators as an index, e.g. soil quality index, climate index.

Identifying the desertification issues

These are the principal issues which have been associated with desertification by the UNCCD's Focal Points in Portugal, Spain, Italy and Greece [12], and by local stakeholders in the Alentejo, Guadalentín basin, Agri basin and the island of Lesvos.

- Land abandonment
- Increase in intensive irrigation
- Littoralisation (concentration of economic activity in the coastal zone)
- Deforestation
- Overgrazing
- Inappropriate agricultural techniques
- Changes in the economic activities in desertification-affected areas
- Degradation of the physical environment (including soil erosion, salinisation, fire)
- Changes in the availability of water resources
- Changes in the social structure
- Institutional organisation to combat desertification

Land abandonment

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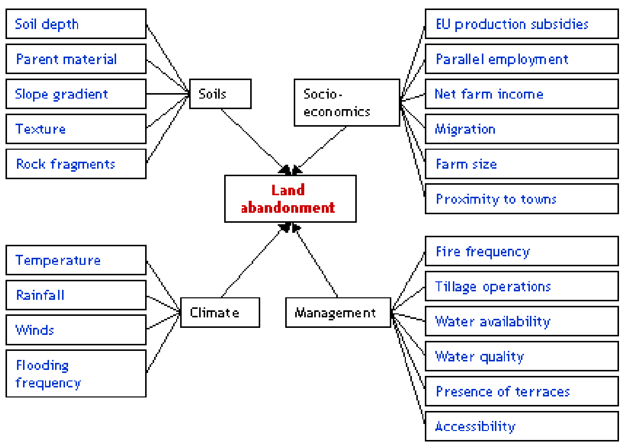
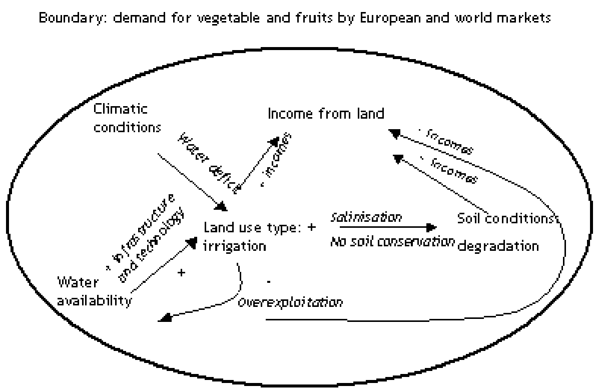
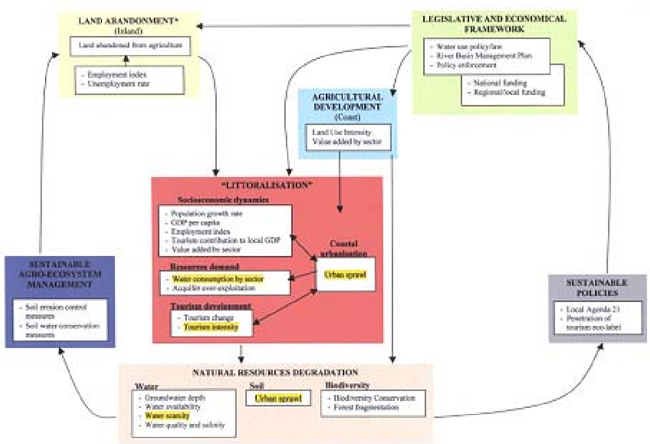


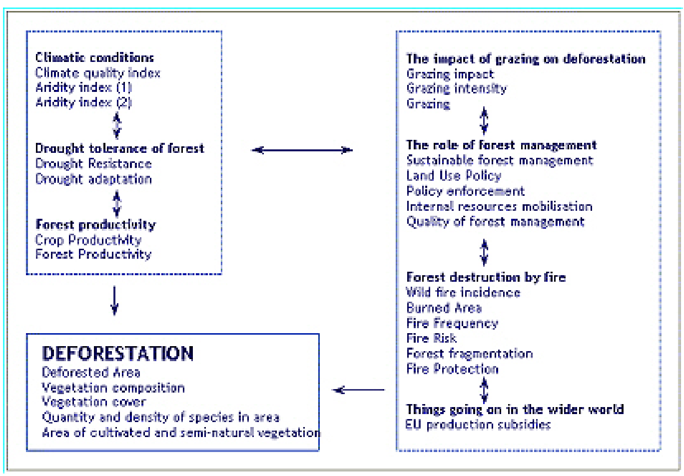
Increase in intensive irrigated farming



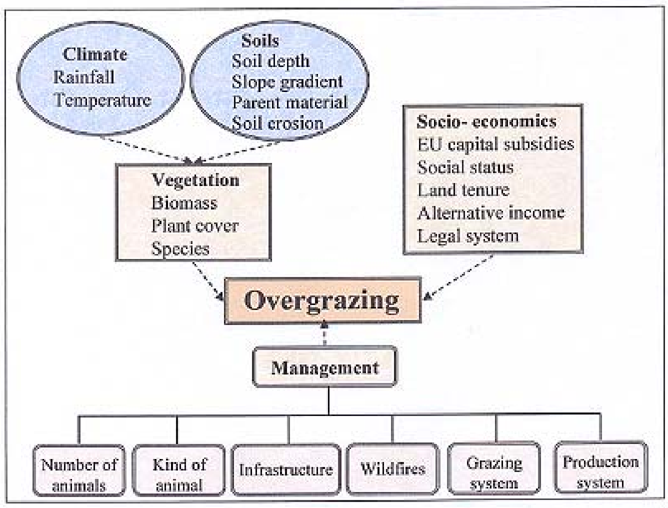
Littoralisation (concentration of economic and social activity in coastal



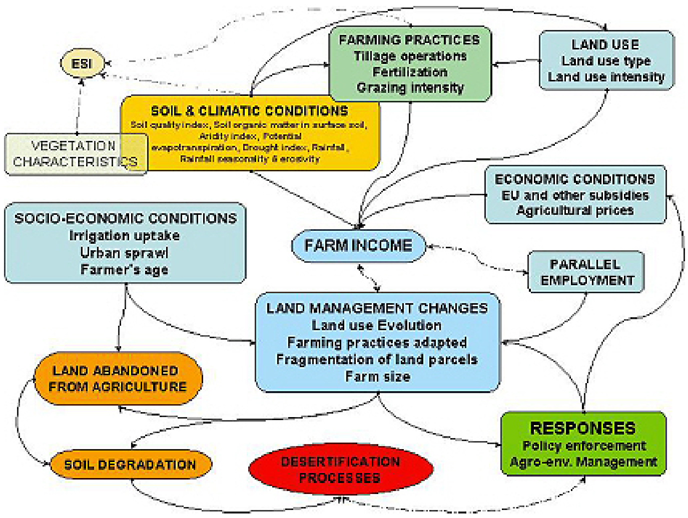
Deforestation



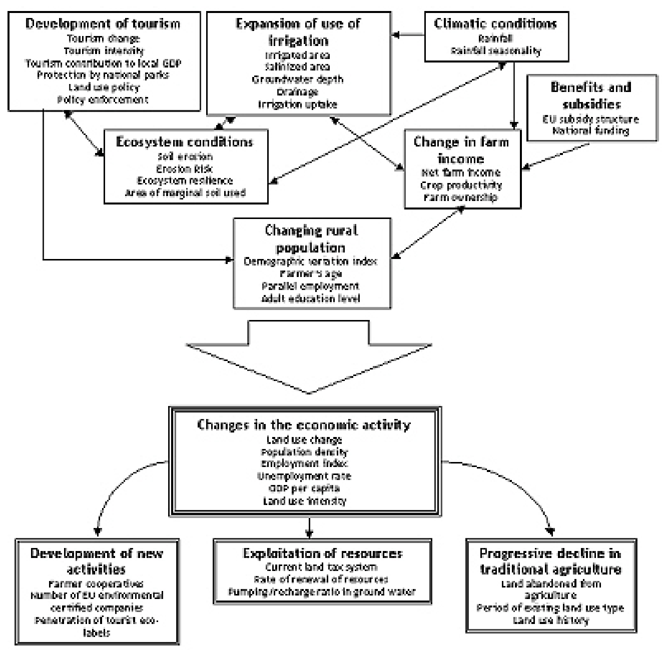
Overgrazing



Inappropriate dry farming agricultural



Changes in the economic activity in desertification-affected areas

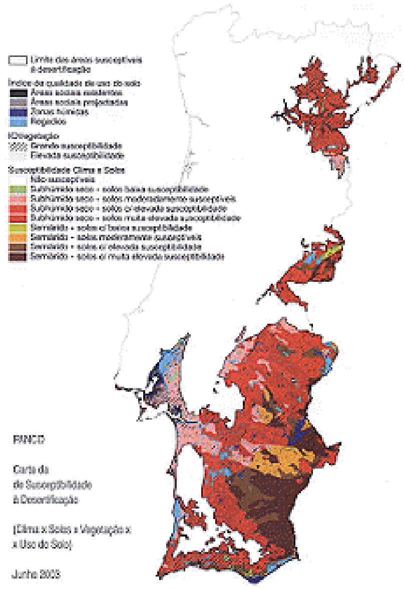


INDICATORS THAT HAVE BEEN CHOSEN AT THE NATIONAL AND INTERNATIONAL SCALES

Not all indicators are appropriate for use at all scales. Some are more suitable for local or landscape situations, others for regional, national and Mediterranean-wide levels. The choice of which indicators to use over such larger areas is determined by several factors. The first, as we saw for the local situation, is the nation-wide assessment of the main desertification-causing processes, and this varies from country to country. Spain, Portugal, Italy and Greece all identify aspects of aridity and soil and vegetation vulnerability as important processes; some countries also include fire, groundwater usage or population change. A second important determinant in the identification of these indicators is the availability of routinely-collected, widespread and long-term data sets. Hence such information as can be extracted from meteorological data, soil and land use maps is most commonly used. There are several reasons for choosing and using indicators at the national and international scales. Most obviously, they can be mapped to show which areas are most affected by desertification, and where actions to combat it should be focussed. If the same indicators are mapped over the entire Mediterranean regions, the relative severity of desertification in different areas can be easily seen. However there is another reason which is also important. The act of identifying the main issues, choosing the indicators and collating the necessary data sets to map them promotes capacity building and exchange of data between different institutions both nationally and internationally.

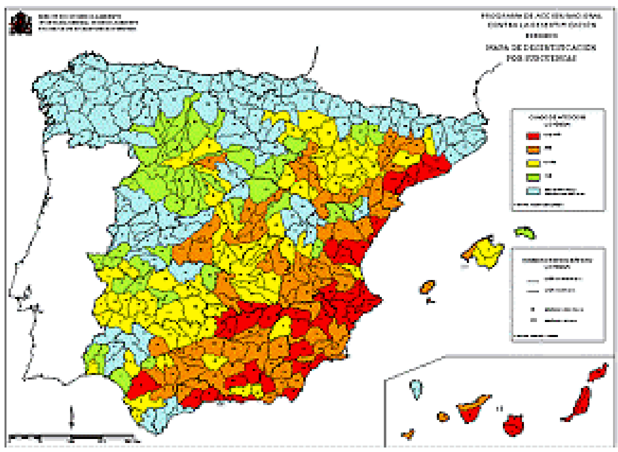
When assessing desertification threatened areas and the extent for their National Action Programmes, the Annex IV sub-region Focal Points each used 3 or 4 indexes which they mapped nationally. Most of them also mapped a further set of indicators at the regional scale.

Portugal



The Portuguese map of Index of Susceptibility to Desertification is derived from three other indices:
Aridity index (mean annual precipitation and mean annual potential evapotranspiration)
Soil susceptibility index (Soil depth, Soil permeability, Soil structural stability, Stoniness, Drainage, Slope gradient.)
Vegetation susceptibility index:= (Fire risk, Erosion protection, Drought resistance, Vegetation cover, Structural cover, Proximity to climax)

Spain



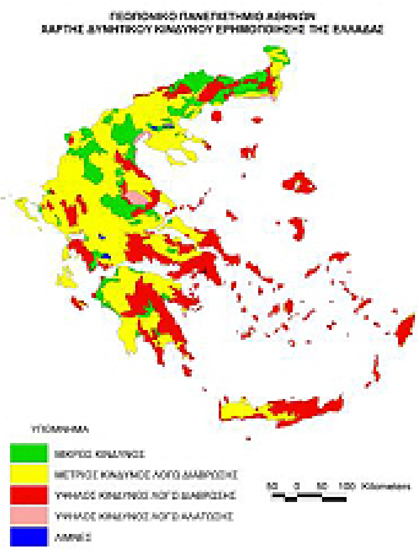
The Spanish map of desertification-affected areas is derived from three indices:
Aridity (mean annual rainfall and mean annual potential evapotranspiration)
Soil erosive state (median annual soil loss)
Fire intensity (percentage surface area affected by fire over 10 years)
Aquifer overexploitation (groundwater extraction, groundwater recharge)

Italy

The Italian map of areas sensitive to desertification is derived from four indices

Aridity index (mean annual precipitation, mean annual evapotranspiration;)
Soil characteristics index (pedo-climatic classification dependent on soil and biotic cover)
Land use index (Corine Land Cover classes)
Demographic variation index (percentage population variation between 1981 and 1991)

Greece



The Greek map of desertification vulnerability was derived from four indices

Soil mapping units (indicate erosion extent, erosion risk, soil depth, soil drought risk)
Slope gradient (indicates potential erosion risk)
Bioclimatic zone (aridity level used to estimate soil drought, salinity and vegetation resilience)
Irrigation and saltwater intrusion (indicate salinization risk of irrigated soils)

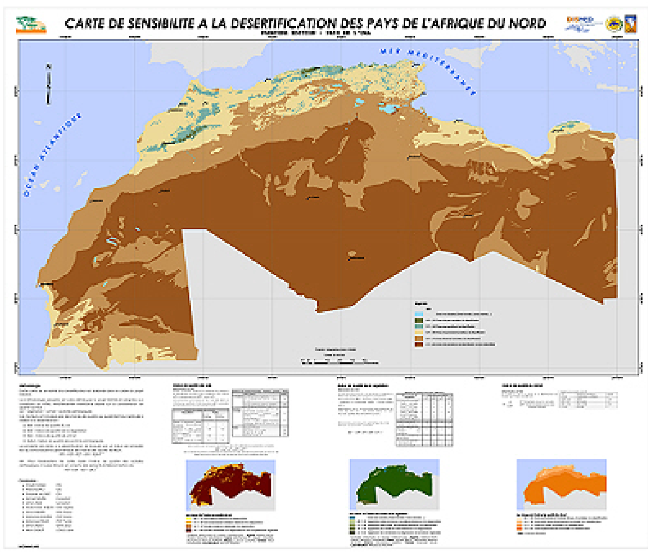
DISMED

Using indicators at even larger scales requires trans-national collaboration, agreement on which indices are to be used, and even greater degrees of capacity building.

The DISMED project was an successful example of such an effort. Its objectives were to improve the capacity of national administrations of Mediterranean countries to effectively program measures and policies to combat desertification and the effects of drought. This aim has been pursued by reinforcing the communication amongst them, facilitating the exchange of information and establishing a common information system to monitor the physical and socio-economic conditions of areas at risk, assess the extent, severity and the trend of land degradation.

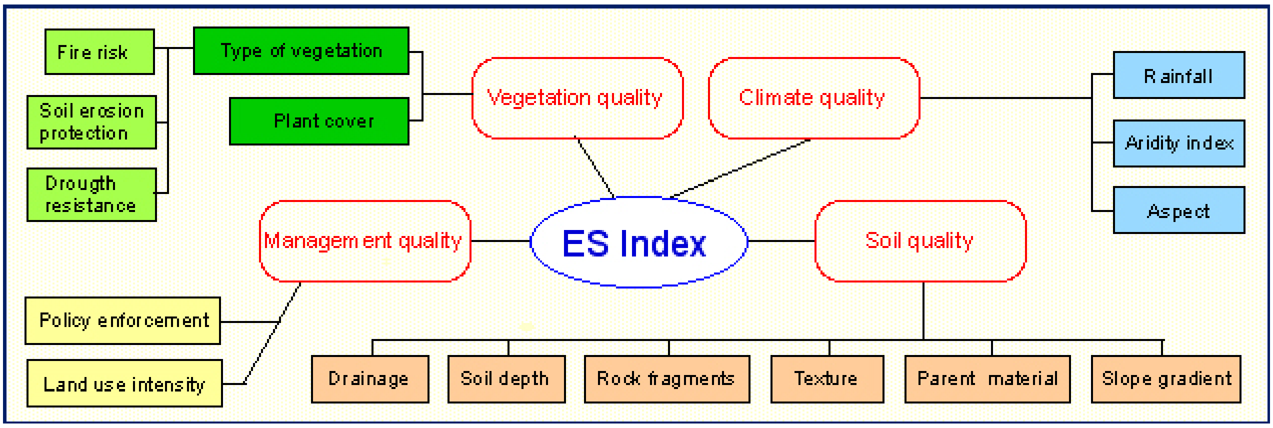
Desertification sensitivity maps for the northern Mediterranean and north Africa were derived from three indices

Climate quality index (mean monthly rainfall mean monthly evapotranspiration).
Soil quality index (parent material, soil depth, soil texture, slope gradient)
Vegetation quality index (erosion protection, drought resistance, vegetation cover, fire resistance).



THE ENVIRONMENTAL SENSITIVITY INDEX—A COMPOSITE INDEX FOR USE AT A LOCAL SCALE

Environmental Sensitivity is a composite index (ESI) which can be used to gain an understanding of factors causing desertification risk within a land unit. Developed by the MEDALUS and DESERTLINKS project, can be used online at http://www.kcl.ac.uk/projects/desertlinks/indicator_system/introduction.htm). It has also been used in Italy, Crete, Iran (among other areas).
A combination of poor management quality and critical environmental factors such as soil, climate, and vegetation can result in severe, irreversible environmental degradation. The ESI enables the characterisation and identification of the factors which produce such critical situations in order that informed decisions can be taken about land management. The ESI also establishes the inter-relationships between these, rarely independent, factors so that their relative importance can be determined. The ESI provides decision-makers with a functional summary highlighting major issues; the straightforward identification of sensitive areas; and the ability to determine the effect of remedial actions without having to have detailed knowledge of the underlying science.



Methodology and data requirements

The Environmental Sensitivity Index (ESI) of degradation or desertification of an area is a single index calculated from 15 different indicators which have been shown to be closely correlated with degradation phenomena or critical environmental states (Basso et al., 1998). An additional requirement was that data for all the indicators used should be widely available and easily obtainable.
The calculation is made in the following way.

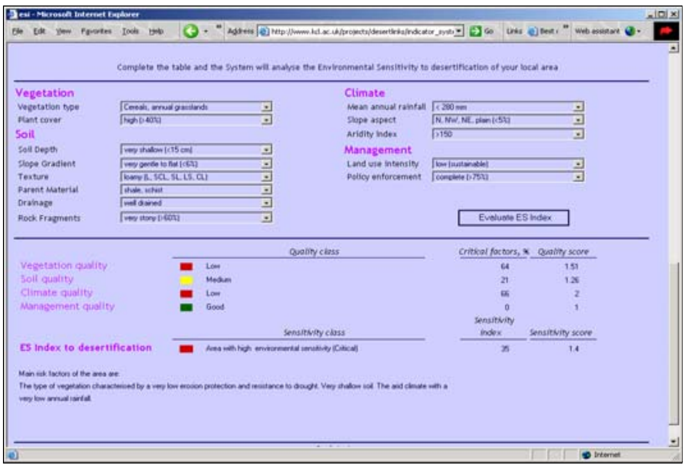
1. According to its value, each indicator is given a weighting of between 1 and 2. For example vegetation types associated with high levels of erosion protection (such as mixed Mediterranean macchia) are given a weighting of 1, those with associated with low levels of protection (such as vines and annual crops) are given a weighting of 2. All weightings are the result of extensive empirical studies ** insert refs
2. Between 2 and 6 indicators are combined into one of four quality indexes:
   Vegetation quality = (FIRE RISK * SOIL EROSION PROTECTION * DROUGHT RESISTANCE * VEGETATION COVER)$^{1/4}$
   Climate quality = (RAINFALL * ARIDITY INDEX * ASPECT)$^{1/3}$
   Soil quality = (DRAINAGE * SOIL DEPTH * ROCK FRAGMENTS * TEXTURE * PARENT MATERIAL * SLOPE GRADIENT)$^{1/6}$
   Management quality = (POLICY ENFORCEMENT * LAND USE INTENSITY)$^{1/2}$
3. The four quality indexes are combined into the single ESI.

   ESI = (Vegetation Quality * Climate Quality * Soil Quality * Management Quality)$^{1/4}$

The method permits the easy addition or removal of individual indicators. Additional indicators can be added when there is a requirement to study specific aspects or areas in greater detail, or can be removed when a first approximation of an ESI estimate is required and all the desired information is not available

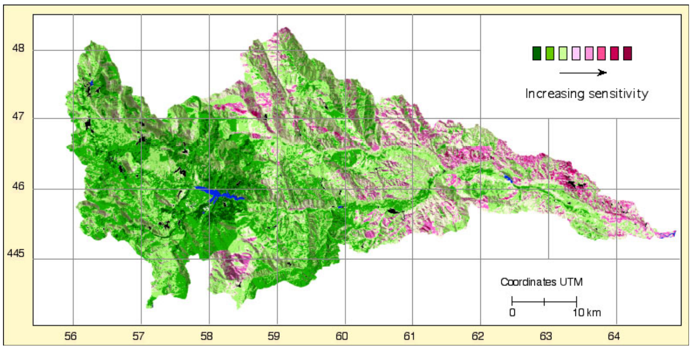
At a point calculation of ESI

DIS4ME contains a tool for calculating the value of ESI at a point. Values for each parameter are selected from pull down lists, and the index is calculated, giving additional feedback on the particular factors to note.

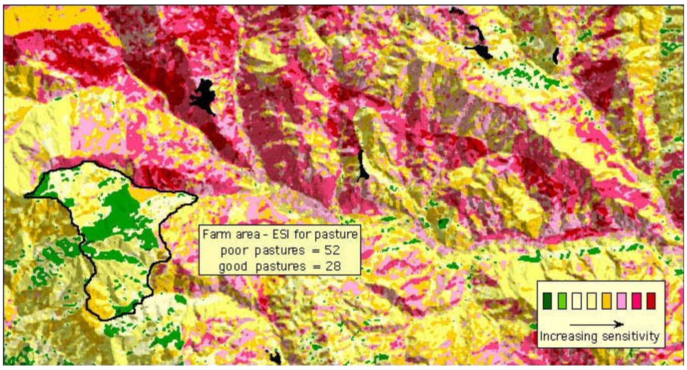


Using the ESI to map desertification over larger areas

By using a geographical information system to calculate the ESI for a large number of land units, it is possible to generate a map of desertification-affected areas. The example shown is the Agri Basin in southern Italy which covers about 1700 km^2. Each individual land unit was 900 m^2. The map shows that central and eastern parts of the basin are more affected than the western.



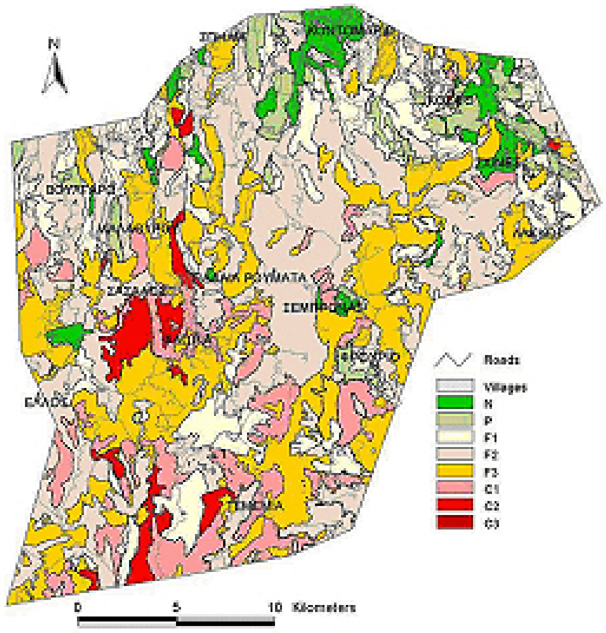
Analysis need not be restricted to the individual land units; it is also possible to obtain overall scores for any portion of land or any land use. In this example, the system has been used to analyse different cultivation types on a farm. Using this approach, it is possible to compare two or more farms, or cultivation types, or to examine the effects of different intervention measures.



** Could do with a photo here showing a picture of a critical landscape.

Example of the type of analysis that can be carried out using the ESI

The area of Chania in Crete area is primarily covered by olive groves, but there are also vines, citrus, annual crops, nut trees, and natural vegetation (shrubs, pine forest, oak forest).



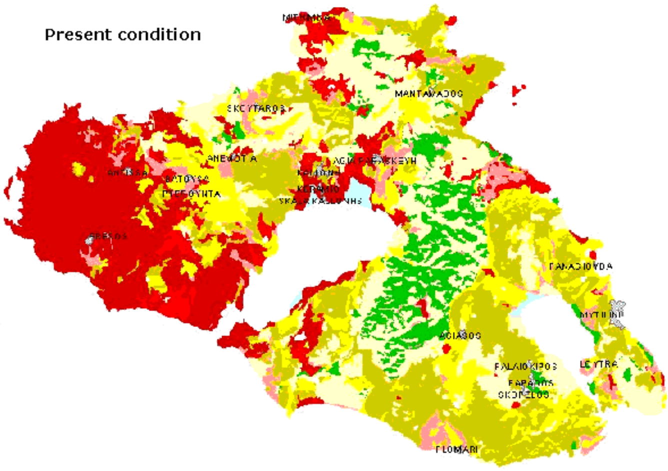
Analysis summary

Fragile areas (78% of the area - F1, F2, F3) are located mainly in the north and central part of the area. Currently, the soils are moderate to deep, well vegetated with olive trees or shrubs and slightly to moderately eroded. However the area is sensitive to degradation should there be (a) slight climate change and (b) changes to the existing land use of olives.
The **critical areas** (14 % of the area - C1, C2, and C3), are located mainly in the central and south part of the area. Currently they have shallow, severely eroded and poorly vegetated soils formed on limestone or shale. The dominant land use is pasture but burning and overgrazing of these marginal areas causes further deterioration. This area is very sensitive to low rainfall and extreme events.
The **potential areas** (4% of the area) are mainly located in the northern part of the area. Slopes are low and soils deep and well drained. Dominant vegetation is olives with some vines or citrus which afford high erosion protection, high drought resistance and low fire risk. Land use intensity is moderate with complete enforcement of environmental protection policies.
Non-threatened areas (4% of the area) are confined to valleys with very deep soils formed on alluvial deposits. dominant vegetation, land use intensity and policy enforcement are the same as in potential areas.

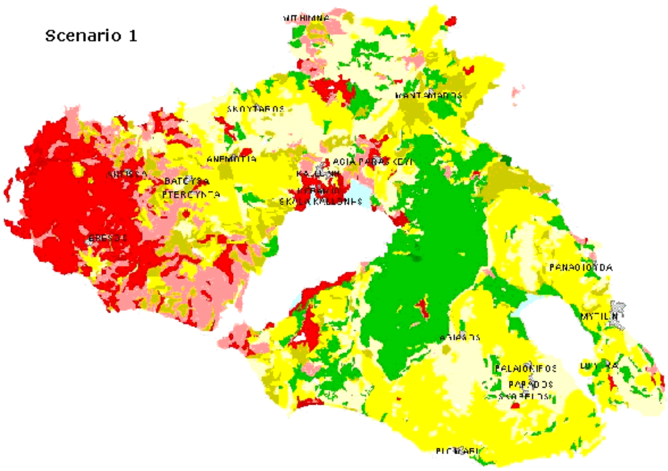
This analysis using the ESI shows that almost 80% of the area is currently productive and in good condition but is vulnerable to degradation should there be ill-considered changes to the well-adapted land use of olive groves.

Using the ESI to demonstrate the effects of changes in land use

The ESA methodology can also be used as Decision Support System to evaluate the effects that different management strategies would have on have on the sensitivity levels.



This is an ESI map of the Greek Island of Lesvos. It shows that under present conditions the western part of the island (** characterised by ….), shown in red, is severely degraded, while the unthreatened areas, shown in green, are fragmented.



Here the ESI values have been recalculated for a different scenario a) the number of animals grazing the pastures has been reduced to a sustainable level, (b) terraces in olive groves are receiving protection from collapse and (c) adequate fire protection policies are enforced in pine and oak forests. Such a demonstration could be a powerful tool in arguing for a change in land use practices.(** or some such rousing conclusion)

USING INDICATORS TO CALCULATE DESERTIFICATION RISK UNDER DIFFERENT LAND USES

The concept of desertification risk summarises the vulnerability or sensitivity of the land to further degradation and desertification according to existing land, socio-economic, and management characteristics. The assessment of risk is a pre-requisite of any early warning system. In addition to calculating the ESI, indicators can be used to calculate salinisation risk and erosion risk for a given location. DIS4ME contains a tool to calculate erosion risk under these land uses: pine forest, cereals, olives, pasture, vines and oaks.

High degraded hilly area covered with oak trees and subject to **high desertification risk**. The area is characterized by relatively shallow soil, steep slopes, moderate rainfall, animal grazing density of 3.5 with moderate grazing control, and low policy enforcement of existing regulations for environmental protection. (** insert ack.above photo by C. Kosmas)

Oak forested area in N. Peloponnesus at **no desertification risk**. The area is characterised by deep soils formed on conglomerates, with annual rainfall 870 mm and aridity index exceeding 135, slightly sloping. Animal grazing is strictly controlled since land is publicly owned, fire protection is adequate, and there is adequate policy enforcement of existing regulations for environmental protection. (photo by C. Kosmas)

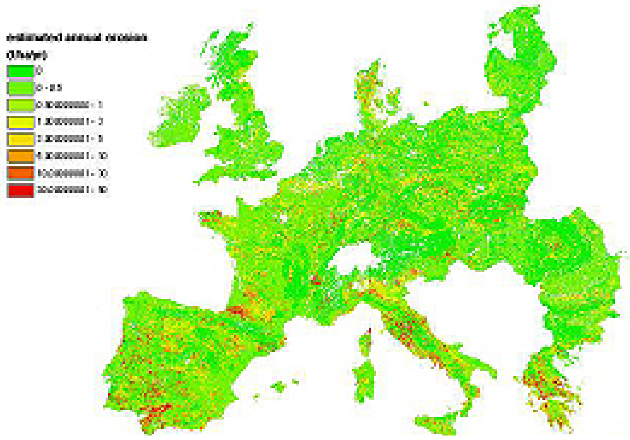
More complex methods for combining simple indicators into composite indices at a regional scale

** far more complex methods have been developed for combining indicators into indices that take into account knowledge about how the physical processes interact. These can also take account of data sets such as current or predicted climate, and satellite images. Currently research tool. Potential for giving access to much more sophisticated data sources, and to producing maps under different scenatios.

Since many of the processes and factors which influence the rate of erosion are well known, as outlined above, it is possible to rank individual factors for susceptibility to erosion, providing a series of erosion indicators. For example, climatic indices may be based on the frequency of high intensity precipitation, and on the extent of aridity or rainfall seasonality. Soil indicators may reflect the tendency to crusting and the experimental erodibility of soil particles or aggregates. Similar rank indicators may be developed for parent materials, topographic gradient and other factors. Clearly a high susceptibility for all factors indicates a high erosion risk, and a low susceptibility for all factors indicates a low erosion risk.

Individual indicators may be mapped separately, but it is more problematic to combine the factors into a single scale, by adding or multiplying suitably weighted indicators for each individual factor. There are difficulties both about the individual weightings and about the assumed linearity and statistical independence of the separate factors. The method should therefore be most effective for identifying the extremes of high and low erosion, but less satisfactory in identifying the gradation between the extremes.

Despite these theoretical limitations, factor or indicator mapping has the considerable advantage that it can be widely applied using data which is available in Europe-wide GIS for topography and soils at 1 km resolution, and for climate at 50 km resolution. Kosmas et al (1999) provides one example of this approach, applied at a regional scale to areas in Greece, Italy and Portugal. Factor mapping can also take account of a wider range of factors, as illustrated by the Environmental Sensitivity Index (ESI) within DIS4ME, which also considers sensitivity to salinisation and other desertification hazards.

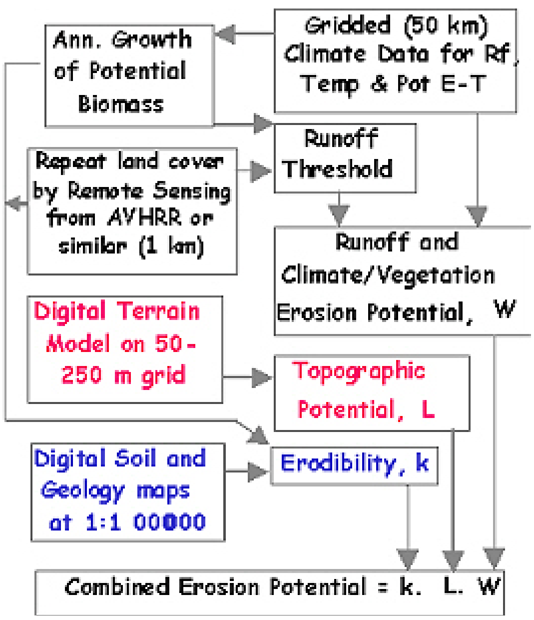


** these data descriptions need synthesising. The MARS database, assembled by JRC-Ispra , provides daily time series of rainfall, temperature and potential evapotranspiration, interpolated to a 30 second (approximately 50 km) grid for Europe .

The European Soils database, prepared by JRC-Ispra and INRA-Orleans, has been used to provide a consistent level of soils data at 1 km resolution across Europe. In conjunction with a

Land cover may be derived from remote sensing, or from land use maps in combination with a vegetation growth model. Remote sensing methods use data from AVHRR or LANDSAT imagery. AVHRR provides a 20-year monthly

Topography A 30 second (1 km) DEM has been available from EROS for some years, and has been the basis for work on PESERA, and for the erosion map. The critical



USING THE SAME INDICATOR DATA TO INFORM AGRICULTURAL DECISION MAKING

ManPrAs is a tool for Agricultural Management Practices Assessment set up within DESERTLINKS project. The objective is to suggest a method, based on the indicators list in DIS4ME, to assess the sustainability of agricultural practices through its soil conservation index (SCI) and economic results (Gross Margin-GM), and to simulate the impact on soil degradation, farm profitability and socio-economic features of alternative crops in a specific context. The tool is strongly user-orientated, and allows assessment of the environmental and economic aspects of agricultural practice, giving a powerful simulation tool to farmers and stakeholders involved in land management.

** need an example photo of the workshop where farmers discussed the farm operations.

The first part of the tool allows the calculation of a (SCI), a ·dynamic· indicator of soil quality combining the interaction between the physical-chemical and climatic site characteristics and the single agricultural operations. SCI considers the effects of 1. the physical-chemical-climatic characteristics and 2. the agricultural operations on 3. the principal threats to soil. Each interaction between these three groups has been established taking into consideration both the literature review and stakeholder consultations. For each parameter value classes have been derived taking account of the same information.

The second part of the tool is designed for the economic evaluation of agricultural practices. Through an algorithm it is possible to obtain the gross margin (GM) for each practice.

** some sort of summary from this Together, SCI and GM, provide the possibility of checking the degree of soil conservation on a farm, the tradeoff options to switch towards more or less sustainable practices, and the economic impact. The environmental and economic assessment of the identified agricultural practices reported in the ManData database and the stakeholders comments gathered during the workshops have represented the first validation of the tool. ManPrAs is intended both as a review of environmental impacts of common types of land management in the four Target Areas of the DESERTLINKS project (Agri Basin · Italy; Alentejo · Portugal; Guadalentín · Spain; Lesvos · Greece), specifically for agricultural techniques, and as an interactive tool that allows an individual assessment of land management in a specific context.

Using indicators as a tool for education and information

Who are the stakeholders?

As a socio-environmental issue, desertification cuts across many scientific disciplines (including soil science, ecology, agronomy, economics, social sciences, and rural studies) and governmental sectors (environment, agriculture, economics, regional and rural development). The responsibility for addressing desertification often lies with many groups and involves both governmental and non-governmental organizations, agri-businesses, local communities, individual farmers and other users of land, scientists, professional and social organizations.

Discussion of indicators in workshops

Experience in the DESERTLINKS project has shown that the concept of desertification indicators can be used as an effective tool to engage and motivate stakeholders at all levels in discussions about how processes of desertification are affecting their area, and how it should be managed.

Group of people from the Alentejo in Southern Portugal discussing their perceptions of desertification.

Through the use of sketches the workshop further refined their statement of the problem.

A drawing by a school child from the Municipality of Mértola depicting desertification and its causes.

Indicators identified by local stakeholders

Local stakeholders are very knowledgeable about their environment. Their understanding of their situation yields many suggestions for appropriate indicators for their area.

- Depopulation—continuous exit and gradual ageing of the population
- Soil erosion (mainly due to the action of human activities and climate, wild fires, poor immediate restoration and cultivation of crops unsuited to soil types.
- Lack of investment
- Agricultural techniques unsuitable for soil type
- Scarcity of water, bad use of existing water supplies
- Geo-Agro-Environmental imbalance (lack of trees and dry weather)
- information about intensification of agriculture: expenditures on energy and water, use of fertilizers, plastics...
- diversification of land use
- demand for jobs (since more a stable agricultural system has a higher demands for jobs)
- disappearance of water springs (as a measurement of the overexploitation of the water tables)
- cultivated area under subsidies
- lack of traditional knowledge about collecting and exploiting water and prevention of floods
- area of sloping soil cultivated

(** although they would need further work to make them operational)

Incorporation of such information is essential in Local Action Plans to combat desertification (** is this true? Need some sort of statement about how this information is used.)

FURTHER SOURCES OF INFORMATION

** not yet completed

[1] Gentile, A.R. From national monitoring to European reporting: the EEA framework for policy relevant environmental indicators. http://www.desertification.it/asv/ASINARA%20WEB/04gentile.htm

[2] UNCCD http://www.unccd.int/

[3] Environmental Indicators for Agriculture, Volume 3: Methods and Results, OECD, Paris March 2001. www.oecd.org/agr/env/indicators.htm

[4] Gentile, A.R. From national monitoring to European reporting: the EEA framework for policy relevant environmental indicators. http://www.desertification.it/asv/ASINARA%20WEB/04gentile.htm

[5] http://www.unccd.int/cop/officialdocs/cop1/pdf/cst3add1eng.pdf

[6] http://www.un.org/esa/sustdev/natlinfo/indicators/isd.htm

[7] Intergovernmental Negotiation Committee for the Convention to Combat Desertification. 1997. Report on ongoing work being done on benchmarks and indicators1997 (A/AC.241/INF.4) http://www.unccd.int/cop/officialdocs/incd10/doclist.php

[8] Gentile, A.R. From national monitoring to European reporting: the EEA framework for policy relevant environmental indicators. http://www.desertification.it/asv/ASINARA%20WEB/04gentile.htm

[9] Enne, G. and Zucca, C. 2000. Desertification indicators for the European Mediterranean region: state of the art and possible methodological approaches. ANPA, Roma and NRD, Sassari, 261 pp

[10] DESERTLINKS project http://www.kcl.ac.uk/projects/desertlinks/

[11] DESERTLINKS indicator system: DIS4ME http://www.kcl.ac.uk/projects/desertlinks/accessdis4me.htm

[12] UNCCD website: Action programmes, Northern Mediterranean, Greece, Italy, Portugal, Turkey http://www.unccd.int/

[13] Gentile, A.R. From national monitoring to European reporting: the EEA framework for policy relevant environmental indicators. http://www.desertification.it/asv/ASINARA%20WEB/04gentile.htm