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Agenzia Nazionale per
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Indicatori di Desertificazione per il Mediterraneo Europeo

Stato dell'arte e proposte di metodo

Nucleo Ricerca Desertificazione
Università di Sassari

Desertification Indicators for the European Mediterranean Region

State of the art and possible methodological approaches

UNCCD

Ministero dell'Ambiente

Desertification indicators for the european mediterranean region

State of the art and possible methodological approaches

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The Mediterranean is one of the most beautiful and richest seas of the world, but it is also one of the most fragile and vulnerable ecosystems. It is a unique and divided, biodiverse, geographic and historical place, a combination of climatic and demographic components, a common space of regulated and irregular mobility, a transportation and pollution passageway, an assemblage of species and waste, an opportunity of production and consumption, a multi-usage dimensions, a North-South axis....The Mediterranean Basin is a "small" sea subjected to intense anthropic pressure. The key factor for fostering collaboration among the states stretched along the Mediterranean coastlines, is sustainable development, meaning global social development, european co-operation to African development, peaceful resolution of conflicts (both terrestrial and militar) over water, regulation of people's multi-generational migration and movement of goods, research, innovation and reclamation on a basin scale and not on a national scale.

In the whole Mediterranean Basin, "greenhouse effect" and "desertification" identify themselves, since they are specular effects triggered by multiple causes linked to energy production and consumption, and to the unsustainable exploitation of natural resources.

Italy and European Mediterranean countries are not only donors of assistance to developing countries; they are also affected by an environmental crisis due to climatic variations that generate prolonged drought periods, soils characterized by high erodibility, a high frequency of forest fires causing destruction of forestrey resources, the condition of crisis of traditional agriculture whose consequence is the abandonment of vast areas that become marginal, the excessive exploitation of water resources, the massive concentration of economic activities along coastlines, the aggregation of urban areas, the intensive touristic and rural activities generating negative consequences that affect the whole Mediterranean ecosystem, that is in the meantime subjected to progressive "tropicalization". It is very likely that, during this century, worldwide average temperature will rise 4 °C, sea-surface temperature will rise 2 °C or more, and "our" extreme events will increase: intensive rains and coastal floodings, rough seas and melting of alpine glaciers. Health, tourism and agriculture will be strongly affected. In the last 20 years, average yearly temperature has risen 2.8°C, and the percentage of carbon dioxide in the atmosphere has increased by 20% in the last 38 years.
Also in Italy, 27% of the territory is threatened by processes of soil parching. Erosive phenomena, hydrogeological events and slope instabilities, impermeabilization, salinization, pollution due to heavy metals are some of the factors causing a strong decrease in the productivity of soils.

Therefore, it is necessary to develop a tighter collaboration between governments, institutions, scientific bodies, local communities and non-govermental organizations, in order to establish joint programs aimed at harmonizing not only policies, but also instruments, norms and indicators suitable for identifying areas at risk within the territory, for safeguarding coasts and smaller islands, protecting fragile ecosystems, enhancing the knowledge and improving the management of processes related to climatic changes.

I believe that this book, by indicating paths that have already been walked in other qualified situation, may provide a very useful starting point for individuating and laying new paths we will have a chance to walk together.

Valerio Calzolaio
State Undersecretary for the Environment
Chairman, Committee to Combat Drought and Desertification

The Mediterranean basin has been a crossroad of multiform stories and cultures for centuries, and is characterized by a dense array of connections and exchanges in a both complex and homogeneous, physical, geographic and biological environment.
This is a region of the Earth that is particularly sensitive to major global changes, such as loss of biodiversity, desertification, climate changes which are here highly evident and interrelated.
The Report recently compiled by the European Environment Agency, in co-operation with the United Nations Environment Programme (UNEP), shows that the open waters of the Mediterranean Sea are generally in good condition; however, particular pollution problems occur in coastal areas, semi-closed gulfs and bays and in the vicinity of major harbours, large cities and industrial areas. Only a small percentage of the coastal area is still in its original condition, and an even smaller percentage of areas is protected.
The most important pressures on the natural assets of the Mediterranean and the major threats to the Basin's capacity to preserve and regenerate itself are: the fast population growth along the southern coastlines of the Mediterranean basin, where legal tools and investments in environmental infrastructures are lacking; the mass migration of the population toward major urban centers of the Basin, caused by unsustainable living conditions; touristic flow which will double in the next 20 years; the intense rural activity that, especially in the narrow litoral plains, consumes and degrades water resources; fishing activities and, finally, chemical, petrolchemical and metallurgic industrial activities, and marine transportations.
Knowledge and understanding of the desertification phenomenon has progressively evolved during the last years, in terms of the necessity to define a process that, although characterized by local causes, is increasingly assuming a global and integrated connotation, both with regard to its causes and its effects.
The United Nation Conference on Desertification, held in Nairobi in 1977, adopted a definition of desertification which was based on biologic productivity criteria, and did not take into consideration the geographic position and climatic features of the areas affected, as well as the causes and processes originating the degradation of the soil's biologic potential.
The United Nations Convention to Combat Desertification, which stemmed from the Rio de Janeiro Conference (1992) takes into due account the complexity of a multi-faceted phenomenon that reflects physical, biologic and climatic issues, as well as social, economic and strategic evaluations. And, according to the Sustainable Development perspective, it aims at dynamically combining actions at the local and global levels.
As a matter of fact, the Convention chose to adopt a definition of desertification ("land degradation in arid, semiarid and dry subhumid areas resulting from various factors, including climatic variations and human activities") that outlines its sphere of intervention, while highlighting the often adverse consequences of an economic development that disregards the effects of the consumption of natural resources and the damages inflicted to the quality and availability of natural assets.
It is therefore evident that social-economic and environmental indicators deserve a special position, since they can play a key role in evaluating the aspects and evolution

over time of desertification processes, and the effects of actions taken to combat desertification.
The Italian Environment Protection Agency (ANPA), and the Desertification Research Centre at the University of Sassary have worked jointly to provide decision-makers with an in-depth analysis of the state of the art and methodologies applicable to the evaluation of the desertification phenomenon.
ANPA has promoted this important research activity, within the wider and more dynamic framework of actions it conducts in the Italian National Committee, providing its support to the definition and start up of the National Plan to Combat Desertification and Drought.
The complexity of the phenomena and their causes leads to the individuation of a plurality of "actors" who might take the responsibility to carry out actions aimed at combating Desertification and Drought.
Indicators represent a crucial link in the chain that, from knowledge, leads to taking decisions and promoting responsible behaviours: starting from an evaluation of the various, physical, biologic, socio-economic processes that contribute to land degradation and desertification, the goal is to individuate indicators that might prove useful in territorial planning and public information activities, and that might be a suitable answer to the request for direct knowledge of the status and evolution of the phenomenon, as well as the opportunity to take actions aimed at mitigating and, above all, preventing the occurrence of the phenomenon.
It is evident that, in order to be effective, indicators have to be based on solid data. The above mentioned EEA-UNEP Report shows how crucial it is, especially in this sensitive area of the Earth, to further develop and implement procedures for collecting data, as well as checking and validating their quality in order to ensure the reliability and effectiveness of information.

I would like to thank for their collaboration:

Sonia Cantoni, Anna Luise, Stefanina Viti - ANPA
Giuseppe Enne, Massimo D'Angelo, Chiara Zanolla,
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Rome, November 2000

Walter Ganapini
President
Italian Environment Protection Agency

Summary

Most research on the subject of Desertification was undertaken before the recent guidelines on research and application of useful indicators were issued by the CST-UNCCD, the Committee on Science and Technology of the United Nations Convention to Combat Desertification.

Consequently, it is not surprising that international bibliography on the subject often seems to lack uniformity and is frequently conditioned by the specificities of individual disciplines, generally ill-suited to the extrapolation of elements that could be applied to more general and complex situations. The international Scientific Community has moreover understood that it is impossible to determine a set of universal indicators, but on the contrary it is more important to devise a method of identifying context driven indicators able to effectively represent the different aspects of Desertification.

The present report constitutes a major step in this direction. It is the result of a critical appraisal of the state of the art in the field of Desertification, starting from the Rio de Janeiro conference up to the present day, setting out a methodological approach in line with the CCD[1] mandate and inspired from the recommendations and decisions of the CST-UNCCD and of the first three COP held in Rome, Dakar and Recife.

This report will provide even the unprepared reader with, not only a comprehensive vision of the approach adopted by international organizations to the problem of Desertification, but also and above all, important methodological indications for the identification and selection of the different types of indicators and for their use within the NAPs[2] and RAPs[3].

Indications as to the method and the course to follow, overriding the hierarchical and relational confusion that often exists when different disciplinary fields are at play. Thus we are laying the ground, without bias, for an unequivocal and objective interpretation of indicators and their application.

The NRD-UNISS[4], is pleased to offer ANPA, the Asinara National Observatory on Desertification and the Scientific Community, an awaited and significant contribution which, because of its didactical, academic leaning, will also facilitate the understanding of problems, the study and the implementation of proper tools for combating drought and Desertification. For this I wish to express my thanks to all NRD-UNISS colleagues and staff and in particular to Doctor Claudio Zucca, Doctor Massimo d'Angelo and Doctor Chiara Zanolla.

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[1] CCD: Convention to Combat Desertification

[2] NAP: National Action Programme

[3] RAP: Regional Action Programme

[4] NRD-UNISS: Nucleo di Ricerca sulla Desertificazione dell'Università di Sassari

The United Nations Conference on Environment and Development held in Rio de Janeiro in 1992 (UNCED 1992) marked an important step in the history of environmental and Development policies.
Indeed, from Rio emerged Agenda 21, containing new development strategies for the twenty-first century and the major international Conventions for the protection of the environment (Desertification, Climate change, Biodiversity), based on the concept of sustainable development and on an approach affirming the importance of public participation in solving major social and environmental problems.
Amongst these, the United Nations Convention to Combat Desertification (UNCCD[5]) is considered by many to be the most important, with the most far-reaching implications and above all with the greatest challenge for party countries, for it places in the forefront the issues of international cooperation, social justice and the eradication of poverty, as constituting the necessary conditions for containing Desertification processes.

After a first period of "reaction" and of negotiations following its entry into force, on 26 December 1996, the CCD too, like its "sister" Conventions, entered its phase of implementation.
The main instruments for the implementation of the Convention are the National and Regional Action Programmes that the party countries are under the obligation to draw up. According to the Convention, such programmes should contain "long term strategies for combating Desertification and mitigating the effects of drought in the affected areas, in the context of an integrated approach and in conformity with the Agenda 21 principles and by means of concrete actions at all levels...". Action Programmes must therefore incorporate operational means of preventing, monitoring and mitigating Desertification processes.
It was in this context that the international community affirmed the urgent need for elaborating specific sets of indicators for assessing Desertification, which will be the subject of this piece of work.

Research on indicators will certainly require that Italy make a particular effort, in so far as it has decided to play a guiding role in this process. Italy had in fact offered to host the First Conference of Parties (COP-1), held in Rome in September 1997 and subsequently took responsibility for coordinating the action of countries belonging to Annex IV for the northern Mediterranean (Greece, Italy, Portugal, Spain and Turkey)[6].
The National Observatory on Desertification, promptly established by decree from the Ministry of the Environment on 31/12/1997, was assigned the task, amongst others, of promoting study and discussion precisely on indicators at the international level. The first such activity was the International Seminar on indicators to assess Desertification in the Mediterranean[7], the first such international meeting to be held in the Mediterranean devoted specifically to the issue.

A year and a half after the Porto Torres meeting, and now only a few months from the Fourth Conference of Parties (COP-4), where Italy will have to present a preliminary progress report on action undertaken, this report seeks to provide a summary of the state of the art with respect to research and application of Desertification indicators, contributing in this manner to making the efforts the

[5] The Convention's full title is: United Nations Convention to Combat Desertification in Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa.

[6] France is cooperating with observer status at present, as officially it is a non affected country

[7] "Indicators for assessing Desertification in the Mediterranean", Porto Torres, 18-20 September 1998

scientific community has made and is making, widely known,at a time when an increasing number of initiatives are being taken to encourage meetings and confrontations, and to draw up action plans both on the national and international levels.
Moreover, only a few months ago, the COP-3, held in Recife in November 1999, pointed to the urgent need of drawing up a synthesis of work accomplished in the sphere of indicators to then proceed as soon as possible to the next phase of testing these indicators.
It is important to underline that the work accomplished during the negotiations that took place after ratification of the CCD and in the formal and informal meetings of the Committee on Science and Technology (CST) of the Conference of Parties (COP) did not lead to the adoption of any set of indicators, although the need to define appropriate methods for identifying effective indicators was recognised and work has started in this direction.
Most research undertaken so far on the subject of Desertification indicators was obviously done prior to the recent dissemination of the CST guidelines and therefore a process of verification and harmonisation will be necessary to ensure that all the proposed indicators conform to the reference model.

Furthermore, only in certain cases do the considered contributions in this report stem from studies directly targeted on Desertification, in other cases they result from research on various related topics (biodiversity, global climate change, environmental impact assessment, sustainable development, processes of land degradation, social sciences....) hence, the report also constitutes an attempt at determining the most suitable methodological approach for encompassing such heterogeneous contributions into the organic framework of indicators to assess Desertification.
Indeed, by presenting the "state of the art" in respect to Desertification indicators, the aim is both to clarify the method proposed by the COP by illustrating its guiding principles and objectives, and to mark the starting point of a systematic attempt to bring together all available scientific results (without hope of being exhaustive in view of the extensive subject matter), and thus stimulate a constructive discussion on the efficiency of the proposed indicators and on the gaps that remain to be filled.

Finally, the CCD does not only refer to Desertification indicators in the traditional sense of the term, as instruments for measuring the state and the extent of Desertification or its processes, but also to indicators for the monitoring of prevention and mitigation measures (indicators of implementation and impact of the Action Programmes). In fact it puts forward National and Regional Action Programmes as operational and open instruments, through which all bodies, institutions, associations, communities involved, will look for and test solutions, examining and assessing them all at once to see their effect over time. These particular indicators will be given special attention in our presentation of the "state of the art".

The report is divided into three parts, as follows.

- The first part will deal with the background of the Desertification indicator concept, with a summary of scientific progress made from Rio onwards by the Conference of Parties technical and scientific bodies on the subject of indicators and a brief analysis will be made of the environmental and socio-economic specificities that justify the northern Mediterranean having a specific annex of the CCD devoted to it.
- In part two, a synthesis of the most recent achievements in the field of Desertification indicators for the European countries of the Mediterranean will be made and some suggested methods will be described with reference to the identification and management of indicators.
- The third and last part contains useful information for those wishing to undertake further research on the subject of indicators to assess Desertification (bibliographical references, organizations and research and experimental programmes under way, addresses and web sites devoted to indicators).

To voice the hopes expressed during the course of COP-3, we look forward to moving on as soon as possible from the research phase to the experimental phase and we hope that the present survey will open the way to further study and to the identification of pilot areas where the effectiveness of the available indicators can be put to test. For its part, the Nucleo Ricerca Desertificazione, intends to promote the process of devising indicators based to a large extent on participation and based on the methodology proposed by the Conference of Parties (illustrated in chapter 4), in which organizations with relevant knowledge, starting with scientific ones at all levels, will undertake to organise their experience in a systematic manner with the specific aim of producing simple indicators that can be interpreted clearly and unequivocally and be made available to the largest possible number of users.

Part one

Within the last two decades, Desertification has become one of the most debated environmental issues: some dramatic events, such as the drought in the Sahel (1968-73) brought the perception of Desertification as something closely linked to scarcity, famine and poverty and, more generally to development, to the attention of the world at large. In the wake of this new awareness, UNEP organised the first World Conference on Desertification, in 1977. From then on, terms such as combating Desertification and land degradation were brought into common use, as well as being placed on the political agenda of many countries, even if their meaning has undergone constant evolution. Fact sheet number 1 gives a detailed description of the principal institutional stages of the struggle against Desertification.

Data on the global occurrence of Desertification is unequal and in some cases has been criticised with respect to the methods of collection and interpretation (Thomas and Middleton, 1994).

Table 1 figures the official data provided by UNEP to the 1977 Conference and the two successive assessments (GAP and GAP II).

	1977: UNCOD[1]	1984: GAP[2]	1992: GAP II[2]
Arid land risking Desertification (millions of hectares)	5.281	4.409	5.172
Ardi land affected by Desertification (millions of hectares)	3.970	3.475	3.562
% of arid land used for agriculture affected by Desertification	75	79	70

[1] UNCOD: United Nations Conference On Desertification
[2] GAP: Global Assessment Progress

Other institutions have come up with different estimates. An assessment carried out simultaneously by FAO based on data collected during the "Global Assessment of Soil Degradation - GLASOD" (Oldeman, 1988; Oldeman et al., 1990) showed that 19,5% of drylands were affected by soil degradation. A subsequent study (Dregne, 1991), carried out by the International Centre for Arid and Semi-Arid Land studies - ICASALS, Texas, revealed that approximately 70% of arid lands show more or less intense signs of Desertification (data is shown in table 1.2).

Data (relative to GAP II) presented at the Rio de Janeiro Conference on Environment and Development in 1992 sum up the figures pertaining to Desertification. More than a third of surface land is affected to a greater or lesser extent by Desertification. Areas at risk are to be found in as many as 110 countries situated also on the European and North American continents, which are populated by a billion inhabitants. More than 250 million people, mainly in the poorest and least developed regions of the planet, are already directly affected by the problem.

Such alarming data have confirmed the global nature of the issue. Moreover, agricultural land proves to be the most at risk, approximately 70% of which may already be degraded.

If the estimates according to which before the year 2015 an increase of 27% in agricultural land will be necessary to meet increasing food needs, this data take on all its dramatic significance.

Table 1.2. Agricultural land affected by land degradation (from Dregne et al., 1991)

Continent	Irrigated land			Rainfred			Rangeland			Tot. agricultural areas in arid lands		
	Total	Degraded		Total	Degraded		Total	Degraded		Total	Degraded	
	m.ha	m.ha	%	m.ha	m.ha	%	m.ha	m.ha	%	m.ha	m.ha	%
Africa	10,4	1,9	18	78,8	48,8	62	1342,3	995,0	74	1431,59	1045,8	73
Asia	92,0	31,8	35	218,1	122,2	56	1571,2	1187,6	76	1881,4	1341,7	71
Australia	1,8	0,2	13	42,1	14,3	34	657,2	361,3	55	701,2	375,9	54
Europa	11,9	1,9	16	22,1	11,8	54	111,5	80,5	72	145,5	94,2	65
N. America	20,8	5,8	28	74,1	11,6	16	483,1	411,1	85	578,1	428,6	74
S. America	8,4	1,4	17	21,3	6,6	31	390,9	297,7	76	420,6	305,8	73
TOTAL	145,5	43,1	30	457,7	215,6	47	4556,4	3333,5	73	5159,6	3562,2	69

The United Nations has for the first time also provided estimates of the global economic cost of Desertification which attains about 42 billion dollars annually.

It must also be stressed that the connection between Desertification and social and environmental imbalances, armed conflicts affecting many developing regions and migratory flows towards Developed countries and Europe in particular, have now become more and more obvious and clearly demonstrate that combating Desertification is in the direct interest of the Countries of the Northern world as well.

With respect to Italy, these aspects were highlighted in the address given by the Secretary of the Convention, H.A. Diallo during the international seminar[8] held in Rome in October 1997. According to Diallo, Italy is involved both directly and indirectly: on the one hand as an affected Country, especially in the southern regions and islands, and on the other hand because of the repercussions it suffers from the aggravation of socio-economic imbalances in developing Countries.

In view of the severity of the problem, the International Community thought it necessary to review and reassess international cooperation strategies which in the past have not lived up to expectations, often because the action undertaken was improvised and lacked coordination as well as common objectives and approaches.

The CCD represents a major response to the need for a new global and integrated approach, based on the participation of the affected populations and on the concept of sustainable development. Combating Desertification, in the words of the CCD implies combating poverty, the too unequal distribution of wealth, and promoting a sustainable long term use of land resources.

The problem is the sustainable management of resources and development, and this is considered to be the main challenge facing the 21st century.

So far, 161 countries[9] have ratified their accession to the Convention. Italy did so on 6 June 1997. Subsequently, by DPCM of 26 September 1997, the National Committee to combat Desertification was set up and in 1999 it drew up the first "National Communication on the struggle against drought and Desertification". This document constituted the basis of the subsequent National Action Programme, officially presented by Italy on 17 February 2000.

[8] "The Fight Against Desertification: What Action at National and International Level", Rome, 7 October 1997.

[9] Data updated in February 2000

As mentioned in the introduction, estimates as to the state and extent of Desertification have been and are still controversial. In the early years this was largely due to the lack of a common understanding of "what to measure" and "how to measure it". In fact, as soon as the issue came to the attention of world public opinion, it immediately became necessary, for political rather than scientific purposes at first, to make an assessment of the global occurrence of the problem, to identify the causes, quantify the impacts and justify the cost of intervention. In other words, the need to identify adequate indicators emerged so as to estimate and even map the scale of Desertification as well as provide guidance and justification for decision-making.

However, research on indicators necessarily progressed in parallel to discussion on the causes, the dynamics and on the very concept of Desertification, discussion which particularly in the 70's and 80's were still very open. In fact, identification of adequate indicators on which to base concrete action cannot proceed without an in depth knowledge of the relationships between cause and effect controlling degradation processes: in order to prevent, it is necessary to understand the causes and driving forces; in order to mitigate, it is necessary to analyse the consequences and impacts of human action (including the mitigation measures themselves) on natural resources.

If at the end of the 70's Desertification was understood as a "reduction and destruction of the biological potential of land which can lead to desert-like conditions" (UNEP,1977), today the concept embraces all the processes of "land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors, amongst which climatic variations and human activity" (UNEP,1994). In this light, Desertification includes all the processes, largely due to human impact, that contribute to the reduction of biological and economic potential of drylands[10] and to their increasing vulnerability.

At the outset, focus was on the processes leading to the appearance of desert-like conditions and the most studied regions were the pre-desert regions, such as the Sahel. The indicators sought were those able to measure the advance of the desert, hence the displacement or progression of the climatic and vegetation boundaries, using both biophysical and socio-economic parameters, such as lack of food, population movements, etc..

It soon became clear to the international scientific community that Desertification had to be considered more generally as a series of processes of decline in land potential, not necessarily in the form of an expansion of desert-like landscapes ("desertisation" as it were), but rather due, in the many parts of the world where it occurred, to a whole set of very different processes, linked in turn to complex systems of causes, amongst which a highly arid climate is an essential determining factor but not the main triggering cause. Hence we saw a gradual transition towards definitions of "Desertification" that gave increasing consideration to interaction with human activity (this transition is only summarily presented in Table 2.1, but is well documented in the works of Thomas and Middleton, 1994 and Perez Trejo, 1994, which can be referred to for greater detail).

[10] The term drylands includes areas with an arid, semi-arid and dry sub-humid climate; the aridity index, the ratio between annual precipitation and potential evapotranspiration, is between 0.05 and 0.65.

Thus, during the 80's the need for a both general and flexible approach to combating Desertification became more keenly felt: the definition had to be general enough to encompass phenomena that sometimes appear under very different forms in the various regions of the world and at the same time conceptual and operational tools had to be devised which were flexible enough to be effectively adapted to regional and local specificities.

From this process emerged the definition of Desertification adopted by the United Nations and included in the CCD, as well as the very structure of the CCD itself, based, precisely, on a definition and general principles and on 4 specific regional implementation protocols (concerning Africa, Asia, Latin America, the Northern Mediterranean). Fact sheet Number 2 deals with the principles and structure of the Convention in more detail.

Table 2.1: Some of the stages in the evolving concept of Desertification are given in the box below

Desertification

"The creation of desert-like conditions resulting from erosion processes " (Aubreville, 1949).

"The reduction or destruction of the biological potential of land that can lead to desert-like situations. It is an aspect of ecosystem degradation following a consistent reduction in their biological potential..." (UNEP, 1977)

"The impoverishment of terrestrial ecosystems under the effect of human impact, that can be measured by reduced productivity of useful plant species, reduced biomass and lesser diversity of micro and macro-fauna and flora, accelerated soil degradation and increased risks due to the presence of man" (Dregne, 1983).

"All encompassing expression to indicate socio-economic,natural and anthropic processes causing a modification in the soil,vegetation,atmospheric and water balance of regions characterised by aridity induced by edaphic and climatic factors" (FAO/UNEP, 1984).

"Land degradation in arid, semi-arid and dry/sub-humid areas, due principally to negative human impacts". The term land in this context includes soil and local water resources, land surface areas and natural vegetation" (UNEP, 1991).

"Land degradation in arid, semi arid and dry/sub-humid areas, resulting from various factors, including climatic variations and human impact" (UNEP, 1994).

Regarding the causes of Desertification, if the present definition only refers to them in general terms, the general introduction to the body of the Convention states that "Desertification is caused by complex interactions among physical, biological, political, social, cultural and economic factors", that "sustainable economic growth, social development and poverty eradication... are essential to meeting sustainability objectives; that in turn "Desertification and drought affect sustainable development through their interrelationships with important social problems such as poverty, poor health and nutrition, lack of food security and those arising from migration, displacement of persons and demographic dynamics".

Obviously, the great complexity of the system of interactions renders the task of identifying unequivocal and efficient indicators an arduous one.

It should be underlined that precisely because Desertification mechanisms are still not altogether understood, the implementation of effective indicators, facilitating the collection and analysis of information, will provide for a better understanding of the issues and a broadening of knowledge which in turn will enable a better definition of

the indicators themselves. The search for the most efficient indicators is therefore highly pertinent in the context of combating Desertification, in as far as it will constitute a long-term iterative process, in a virtual circle, to improve available knowledge. This concept is at the very basis of the methodological proposals made by the Committee for Science and Technology (CST) of the Conference of Parties (COP).

An important consequence of the wealth of implications contained in the concept of combating Desertification, is the fact that many international organizations, within the scope of very different programmes broadly addressing sustainable management of natural resources, are in fact already contributing to the advancement of knowledge.

To this effect, the CCD has set up mechanisms to ensure the harmonisation and use, even in the field on research on indicators, of all contributions made in different contexts and/or for different ends (other international Conventions, programmes of the main UN agencies on environmental sustainability, international and national research, etc....).

In the meantime, action which, following ratification, individual Country Parties will begin to undertake to draw up their respective National and Regional Action Programmes (PAN and RAP), will also contribute to identifying sets of local and regional indicators based also on the results of operational experience. So the picture becomes more complete day by day.

The alarm concerning the risk of Desertification in the countries on the northern shore of the Mediterranean was sounded some time ago and on various occasions by the EEC (Fantechi and Margaris, 1986: Perez Trejo, 1994; EC, 1997) and for more than a decade the European Commission has identified Desertification as one of the major problems facing southern Europe. Specifically, DGXII launched large scale projects such as MEDALUS (Thornes, 1997)[11] aimed at improving understanding of the phenomenon. Such projects were certainly inspired, amongst other factors, by a new awareness of the inadequacy of community policies i) with respect to the risks and uncertainty connected to global climate change ii) with respect to the necessity of realigning agricultural policy on criteria of environmental sustainability.

Many other projects and reports financed by the EU have contributed to identifying and describing the main Desertification processes at work in the region, the causes, the driving forces. The Perez-Trejo report (1994) provides a synthetic and organic picture of the Desertification problem from the European perspective. The ARCHAEOMEDES project (van der Leeuw, 1998) delved into the historical, social and cultural aspects; the DeMon project (Lacaze et al., 1996) developed satellite monitoring techniques; REDMED (Vallejo et al., 1998) devised techniques for the restoration of degraded environments, etc. Particularly within the IVth Framework Programme (1994-1998) projects connected to this topic were numerous, as pointed out by Burke and Thornes (1998). The Vth Framework Programme (1998-2002) contains an objective specifically devoted to the subject ("key action 2.3.3: Fighting land degradation and Desertification) within which many projects have already been submitted for appraisal by the European Commission.

The outcome of these projects constitutes the state of the art on the subject and therefore the starting point for defining indicators. Amongst the most thorough studies on the matter is the publication "Atlas of Mediterranean environments in Europe - The Desertification Context" (Mairota et al., 1998) which recapitulates the results of the two first phases of MEDALUS.

According to the emerging picture, Desertification in the European Mediterranean countries is linked to the following general characteristics of the region:

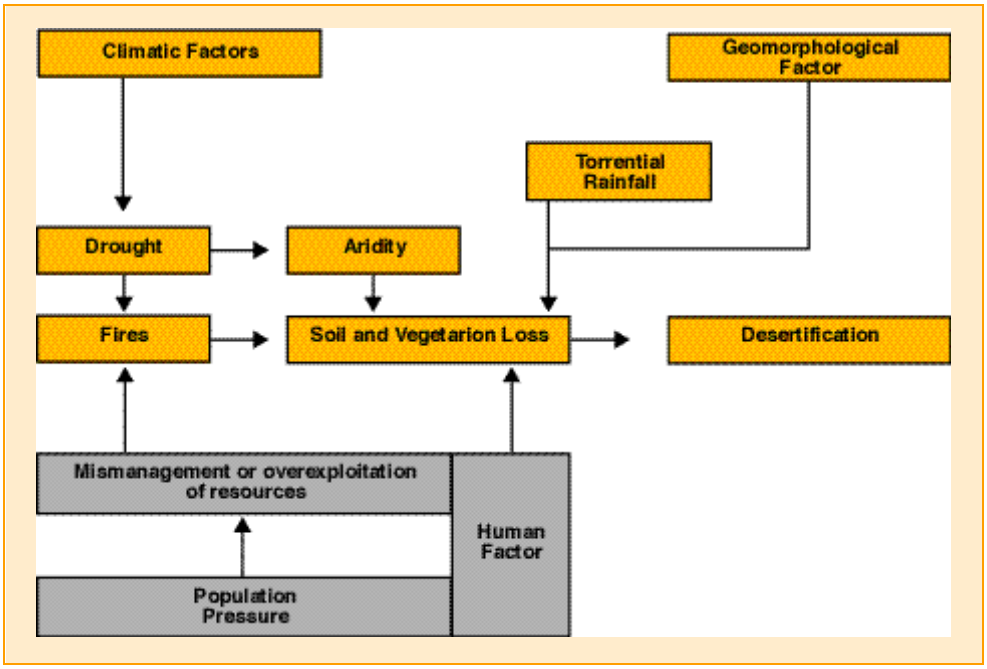
- particular climatic and geomorphological characteristics which combined with often poorly adapted use of land, have resulted in a highly vulnerable environment.
- Strong human pressure due to agricultural and pastoral activities rooted in the region for at least four thousand years, having decisively contributed to the formation of present day landscapes and having caused extensive Desertification several times in the course of history, often in conjunction with phases of demographic growth and rapid economic development.
- Enormous increase in this pressure recorded from the 50's onwards following major economic transformations, accompanied by the intensification and mechanisation of agro-pastoral practices, the strong increase in water demand also linked to urban and tourist development, the appearance of soil and water pollution;
- A growing concern with respect to the effects of what is known as the Global Climate Change on the region; it now seems clear that the most advanced models agree in forecasting a non insignificant increase in the aridity of the climate for the

[11] Mediterranean Desertification and Land Use. MEDALUS I, (1991-1992); MEDALUS II (1993-1995); MEDALUS III (1996-1998).

next decades, in particular in the centre-eastern part of the northern Mediterranean.

The "International Conference on Mediterranean Desertification: Research results and policy implications" (Balabanis et al., 1999) was held in 1996, on the island of Crete (Sissi, 29 October - I November). Organised under the auspices of the European Union, the event represented a fundamental step on the path to a global, integrated and multidisciplinary vision of the problem, and its fundamental components were outlined. Figure 3.I below represents the schematic results of the synthesis.

Figure 3.I "The nature of the Problem". From the report of the Crete Conference (Balabanis et al., 1999).



The CCD Annex IV (figuring in extenso in fact sheet number 3) summarises the particularly vulnerable characteristics of the European Mediterranean region in the following manner:

a) Semi arid climatic conditions affecting large areas, seasonal, droughts, very high interannual rainfall variability causing periods of particularly long drought and sudden and high-intensity rainfall;
b) poor and highly erodible soils, prone to develop surface crusts.
c) uneven relief with steep slopes and very diversified landscapes;
d) extensive forest coverage losses due to frequent wildfires;
e) crisis conditions in traditional agriculture with associated land abandonment and deterioration of soil and water conservation structures;
f) unsustainable exploitation of water resources leading to serious environmental damage, including chemical pollution, salinisation and exhaustion of aquifers;
g) excessive concentration of economic activity in costal areas as a result of urban growth, industrial activities, tourism and intensive irrigated agriculture.

3.1. Actions undertaken at the level of Regional Annex IV

An up to date report on measures adopted by individual countries belonging to Annex IV, within the context of the implementation of the Convention can be found in Burke and Thornes (1998): this document constitutes the first report on the Concerted Action financed by the EU and it describes not only the action undertaken by Governments, but also by non-governmental organizations.

Other initiatives fall within the definition of implementation strategies on the regional level (Regional Action Programmes). These initiatives are in part an extension of the concertation instigated in Rome[1] by the Italian government during the course of the First Conference of Parties, when Italy, Spain, Portugal, Greece and Turkey prepared a joint document. The joint action was crystallised in a series of meetings and formal and informal exchanges amongst the "focal points" of the various Countries. Recently, in Rome on the occasion of the formal presentation of the National Action Programme (on 17 February 2000), an important series of meetings took place, devoted to participation[2] and to the synergies between the major Conventions[3].

Besides these initiatives more directly linked to the institutional aspects of the implementation of the CCD, others were aimed at exchanging and increasing scientific and technical knowledge both on the regional level (Annex IV), and on the interregional level (in particular between the northern and the southern shore of the Mediterranean).

Amongst the most important:

- the Porto Torres international meeting (Enne et al., 1988)[4] which gathered together all the knowledge acquired during the course of more than a decade of research in the EU on the subject of indicators to assess Desertification in the northern Mediterranean.
- the international Marrakech workshop[5] devoted to the role of information systems to combat Desertification;
- the Paris international workshop (OSS-CILSS, 1999)[6], on the subject of methodology for identifying indicators of impact of the implementation of the Convention.
- The Alghero[7] international workshop on requirements in terms of data for research on Desertification.

[1] International seminar on "The Fight Against Desertification: What Action at National and International Level", Rome, 7 October 1997

[2] International workshop "Social participation to combat Desertification" Rome, 16 February 2000

[3] International workshop "Desertification, climate change, biodiversity and forests: synergies for an inter-regional agenda between northern and southern Mediterranean Countries, Rome, 18 February 2000

[4] Indicators for assessing Desertification in the Mediterranean", Porto Torres, 18-20 September 1998

[5] "Desertification Information Systems for planning needs in the Mediterranean region", Marrakech, 9-13 November 1998

[6] "Les indicateurs d'impact de la CCD", Paris, 29 juin - 2 juillet 1999.

[7] "Desertification Convention: data and information requirements for interdisciplinary research", Alghero, 9-11 October 1999

Main institutional steps in the struggle against Desertification

Combating Desertification has constituted the main activity of many international organizations. In this regard UNEP (United Nations Environmental Programme), has played a fundamental role in convening the Conferences on Desertification (United Nations Conference On Desertification - UNCOD), held in Nairobi in 1977, and on the Environment and Development (United Nations Conference on Environment and Development - UNCED) held in Rio de Janeiro in 1992.

The following paragraphs will review the main steps leading to the adoption of the Convention to combat Desertification, illustrating the guiding principles; this document constitutes the main institutional reference for the future Action Programmes to combat Desertification.

From the United Nations Conference on Desertification (UNCOD) to the United Nations Conference on Environment and Development (UNCED).

The United Nations Conference on Desertification constitutes a milestone in the history of the struggle against Desertification. Although, UNESCO had already recognised the importance of land degradation through its Programme for Arid Zones, it was only with the United Nations resolution No.3337 of 1974, envisaging the organization of the Conference, that the global nature of the problem was officially acknowledged.

Besides creating an awareness amongst the international community, the Conference's primary objectives were the systematic collection of data on the occurrence of the problem and the promotion of a programme to combat Desertification. The United Nations Plan of Action to Combat Desertification - UNPACD) stemming from UNCOD, in its conclusions identified as immediate objectives "the prevention of land degradation and the rehabilitation of affected areas for productive use" in order to "improve the living conditions of local populations".

Once approved by the United Nations in 1977, the Desertification Control ¨Programme Activity Centre (DC/PAC) was set up within UNEP, based in Nairobi and in the following decade became the coordination centre of activities to combat Desertification on the international level.

The efficiency of the Action Plan was moreover to be monitored by periodical assessment intended to evaluate the extension and trends of Desertification as well as the effectiveness of programmes to combat the problem.

The document referring to the first assessment (Global Assessment Progress - GAP) was presented in 1984 and constituted the first true attempt at the systematic collection of data on land degradation in all continents. Despite the lack of reliability of the data presented, due to the absence of a standardised method of collection and interpretation (Thomas and Middleton, 1994), they contributed substantially to the concept promoted by UNEP of the close link between Desertification and socio-economic development. In other words, it confirmed that all activities to combat Desertification had to be part of a broader programme for social and economic development aimed at improving the quality of life and the basic needs of all peoples, especially in developing countries.

Despite the existence of an Action plan, the following years were marked by a series of failures in

terms of actions to combat the problem, largely due to a lack of coherency between the nature of the measures proposed and the real socio-economic context.
The United Nations Conference on Environment and Development, held in Rio in 1992, marked a turning point in the struggle against Desertification for it was recognised that Desertification and sustainable development were intimately linked; Chapter 12 of Agenda XXI, the most important programme document to emerge from the summit, is entirely devoted to the management of fragile ecosystems and to combating Desertification. In confirming the scale of Desertification, the document identified the following priorities:

a) acquiring greater knowledge on land degradation processes and the development of monitoring systems;
b) undertaking forestation activities as a direct means of combating Desertification
c) elaborating and implementing integrated development programmes aimed at eradicating poverty and promoting alternative livelihoods in areas affected by Desertification;
d) implementing programmes for combating Desertification integrated into development plans and, more generally, into environmental planning.
e) encouraging public participation in activities and promotion of environmental education programmes.

The United Nations Convention to Combat Desertification (1994)

On the basis of indications and recommendations issued by the Rio Conference, the United Nations General Assembly adopted Resolution 47/188 in December 1992, setting up the Intergovernmental Negotiation Committee (INCD) to draw up the Convention to combat Desertification. The Convention was presented in its final form in June 1994 and entered into force in December 1996. At present, the Convention constitutes an institutional frame of reference for combating Desertification for all affected countries; this includes the four regional implementation annexes, respectively for Africa, Asia, Latin America/Caribbean and the Northern Mediterranean. Some of the fundamental principles of the Convention are described below.

i. Desertification is land degradation in arid, semi-arid and dry/sub-humid areas due to climatic variations and human impacts.

This definition clarifies once and for all the concept the international scientific community has amply debated and has now accepted. Land degradation means the loss of biological and/or economic productivity and complexity in croplands, pastures, forests and woodlands due to soil use, to a process or a combination of several processes amongst which: water and wind erosion, modification of the physical, chemical and biological properties of soils; destruction or modification of the vegetation cover. Amongst the causes of degradation linked to human activities, the cultivation of inappropriate areas, overgrazing, deforestation and inadequate irrigation practices. The intensification of these activities has resulted in the loss of resilience in arid land ecosystems.
The Convention's principal objective is to combat Desertification and this will be done by 1) preven-

tion in areas at risk ii) mitigation in partially degraded areas and iii) the restoration of affected areas.

ii. The Convention to combat Desertification will be implemented through the National Action Programmes.

These programmes constitute the core of the Convention. Their aim is to elaborate a general strategy for the prevention of degradation processes and the mitigation of their effects.
The participatory approach constitutes one of the keys to the success of the action programmes. Traditionally, local communities have played a passive role in development projects. It has now been fully acknowledged within institutional spheres, that the failure of actions to combat Desertification were primarily due to the local communities' low level of involvement. The participatory approach, both in the elaboration of national action programmes and in local development plans of all kinds, enhances culture and local traditions in the execution of projects.
Furthermore, the Convention focuses on the fundamental role of research in the struggle against Desertification in order to foster a better understanding of the causes and impacts of Desertification; this knowledge will constitute the scientific basis on which the action programmes will be constructed. In order to facilitate the dissemination of scientific knowledge, as well as international cooperation, the Convention seeks to achieve an ever greater integration between research and organizations involved in land management.

iii. Combating Desertification must be undertaken within the general framework of action to promote sustainable development.

Desertification, like almost all environmental problems, is a complex process involving the interaction of various components: the socio-economic issues, such as food security, migratory flows and political stability, and different environmental issues, such as climate change, biodiversity and water supply, are intimately linked to land degradation. The Convention emphasises the need to coordinate all efforts towards sustainable and long lasting development.

Some of the fundamental stages in the struggle against Desertification

1968-73 The "great drought" in the Sahel. The Sahel drought brought Desertification as a global problem to the attention of public opinion.

1974 UN Resolution 3337. The United Nations General Assembly approved resolution 3337 on the organization of an international conference of Desertification.

1977 UNCOD (United Nations Conference on Desertification).At the Conference held in Nairobi,the Plan of Action to combat Desertification was presented.

1977 PACD (Plan of action to Combat Desertification). The Plan of action was approved by the United Nations General Assembly.

1984 GAP (General Assessment Progress of the Plan of Action to Combat Desertification).

1992 GAP II (General Assessment Progress of the Plan of Action to Combat Desertification II).

1992 UNCED (United Nations Conference on Environment and Development). The Conference was held in Rio where the importance of combating Desertification as a precondition to sustainable development was confirmed.

1992 INCD (Intergovernmental Negotiating Committee). The Rio conference proposed the setting up of this committee to prepare the Convention to combat Desertification. The United Nations General Assembly approved the creation of the Committee in Resolution 47/188 in December 1992.

1994 CCD (Convention to Combat Desertification). The Convention was adopted in Paris on 17 June and in December it was signed by more than 100 countries.

1996 The Convention to Combat Desertification entered into force on 26 December, three months after the fiftieth ratification. The phase of implementation began.

1997 The First Conference of Parties was held from 29 September to 15 October in Rome. At the opening, 113 Countries had ratified the Convention. 161 countries (cfr ref.9 page 9) have now ratified the Convention.

1999 During the third Conference of Parties (Recife, 15-26 November) the African countries presented the first progress report on the design and application of National, Sub-Regional and Regional Action Programmes.

The CCD: Objectives and General Principles: The implementation mechanism; the regional annexes.

A) Objectives and General Principles

The objectives, principles and general obligations are stipulated in the first articles of the Convention. Schematically, they may be summarised as follows:

Objectives: To combat Desertification and the effects of Drought with an approach that is:

- integrated in the long term;
- aimed at achieving sustainable development;
- focussed on the concrete improvement in living conditions of affected populations.

General principles:

- Participation of all actors of the communities involved.
- Promotion of international cooperation, with particular attention to the problems of developing countries.

Fundamental obligations of Country Parties:

- undertake to reduce the negative effects of global trade on the less developed economies and to promote debt relief for developing countries;
- engage in the fight to eradicate poverty as it is a primary cause of Desertification;
- promote cooperation at all institutional levels;
- provide technical and financial assistance to developing countries.

General obligations of affected Countries;

- allocate adequate resources;
- establish priorities and strategies;
- give due attention to socio-economic aspects;
- create an awareness and involve local populations and associations;
- create an enabling institutional context.

B) The implementation mechanism

The Convention entered into force on 26 December 1996, 90 days after the fiftieth ratification. In ratifying the Convention, Country Parties became legally responsible for the obligations contained in the document.

The text of the Convention provides that implementation of the treaty be ensured by certain specifically created bodies and mechanisms: the Conference of Parties, the Secretariat, the Committee on Science and Technology, the Global Mechanism.

The Conference of Parties (COP) oversees the implementation of the Convention. It is the supreme decision-making body and is composed of all the ratifying governments, as well as regional economic integration organizations, such as the European Union. Other organizations are admitted

and encouraged to participate, in particular international and national agencies and NGOs. It is planned that the first four sessions will be organised on an annual basis and that afterwards they will be held every two years. One of its main functions is to make a periodical assessment of the progress made in the different countries in implementing the Convention, and to provide guidelines and recommendations to this effect. It also has the authority to introduce amendments to the text of the treaty and initiate the necessary negotiations.

The COP is assisted by a permanent Secretariat, with the task of organising the sessions of the Conference, collecting the reports of Country Parties, preparing documents, transmitting information, facilitating consultations and other activities, providing technical support in particular to developing countries. The headquarters of the Secretariat are in Bonn.

The Committee for Science and Technology advises the COP on scientific and technological matters and meets during regular COP sessions. It identifies priorities for research and stimulates cooperation between researchers, even by proposing joint research programmes for the development of new technologies. The COP can also be assisted by a broad group of experts from all the scientific disciplines involved in combating Desertification, and it can set up, from amongst them, ad hoc working groups on specific and particularly relevant issues

A Global Mechanism is mandated to help the COP promote funding for Convention related activities and programmes. The Mechanism does not raise or administer funds, but encourages and assists all possible donors in order to mobilise available funds and direct them where they are most needed. It also promotes greater coordination and greater efficiency in the use of funds. The Global Mechanism is based in the IFAD, in Rome.

C) The Regional Annexes

The Convention is made up of a central body and of four regional implementation annexes:

I) Africa
II) Asia
III) Latin America and the Caribbean
IV) The Northern Mediterranean

The introduction of a fifth annex for Central and Eastern Europe is under discussion.

The Regional Annexes contain a description of the physical and Socio-economic specificities distinguishing the main affected areas in each of the four regions. Each annex also identifies priorities and sets out specific guidelines for the implementation of the National and Regional Action Programmes. Annex IV countries, being economically advantaged, are not eligible to receive financial assistance for activities to combat Desertification.

Text of Annex IV for the Northern Mediterranean

United nations conventions to combat deesertification to combat desertification in those countries experiencing serious drought and/or desertification particularly in africa.

Annex IV regional implementation annex for the northern mediterranean

Art. 1: Purpose

The purpose of this Annex is to provide guidelines and arrangements necessary for the effective implementation of the Convention in affected country Parties of the northern Mediterranean region in the light of its particular conditions.

Art. 2: Particular conditions of the Northern Mediterranean region

The particular conditions of the northern Mediterranean region referred to in article 1 include:

a) semi-arid climatic conditions affecting large areas, seasonal droughts, very high rainfall variability and sudden and high-intensity rainfall;
b) poor and highly erodible soils, prone to develop surface crusts;
c) uneven relief with steep slopes and very diversified landscapes;
d) extensive forest coverage losses due to frequent wildfires;
e) crisis conditions in traditional agriculture with associated land abandonment and deterioration of soil and water conservation structures;
f) unsustainable exploitation of water resources leading to serious environmental damage, including chemical pollution, salinisation and exhaustion of aquifers; and
g) concentration of economic activity in coastal areas as a result of urban growth, industrial activities, tourism and irrigated agriculture.

Art. 3: Framework di pianificazione strategica per uno sviluppo sostenibile.

1. National action programmes shall be a central and integral part of the strategic planning framework for sustainable development of the affected country Parties of the northern Mediterranean.
2. A consultative and participatory process, involving appropriate levels of government, local communities and non-governmental organizations, shall be undertaken to provide guidance on a strategy with flexible planning to allow maximum local participation, pursuant to article 10, paragraph 2 (f) of the Convention.

Art. 4: Obligation to prepare national action programmes and timetable

Affected country Parties of the northern Mediterranean region shall prepare national action programmes and, as appropriate, subregional, regional or joint action programmes. The preparation of such programmes shall be finalised as soon as practicable.

Art.5: Preparation and implementation of national action programmes

In preparing and implementing national action programmes pursuant to articles 9 and 10 of the Convention, each affected country Party of the region shall, as appropriate:

a) designate appropriate bodies responsible for the preparation, coordination and implementation of its programme;
b) involve affected populations, including local communities, in the elaboration, coordination and implementation of the programme through a locally driven consultative process, with the cooperation of local authorities and relevant non-governmental organizations;
c) survey the state of the environment in affected areas to assess the causes and consequences of Desertification and to determine priority areas for action;
d) evaluate, with the participation of affected populations, past and current programmes in order to design a strategy and elaborate activities in the action programme;
e) prepare technical and financial programmes based on the information gained through the activities in sub-paragrphs a) to d); and
f) develop and utilise procedures and benchmarks for monitoring and evaluating the implementation of the programme

Art.6: Content of national action programmes

Affected country Parties of the region may include, in their national action programmes, measures relating to:

a) legislative, institutional and administrative areas;
b) land use patterns, management of water resources, soil conservation, forestry, agricultural activities and pasture and range management;
c) management and conservation of wildlife and other forms of biological diversity;
d) protection against forest fires;
e) promotion of alternative livelihoods; and
f) research, training and public awareness.

Art.7: Subregional, regional and joint action programmes

1. Affected country Parties of the region may, in accordance with article II of the Convention, prepare and implement subregional and/or regional action programmes in order to complement and increase the efficiency of national action programmes. Two or more affected country Parties of the region, may similarly agree to prepare a joint action programme between or among them.

2. The provisions of articles 5 and 6 shall apply mutatis mutandis to the preparation and implementation of subregional, regional and joint action programmes. In addition, such programmes may include the conduct of research and development activities concerning selected ecosystems in affected areas.

3. In preparing and implementing subregional, regional or joint action programmes, affected country Parties of the region shall, as appropriate:

   a) identify, in cooperation with national institutions, national objectives relating to Desertification which can better be met by such programmes and relevant activities which could be effectively carried out through them;
   b) evaluate the operational capacities and activities which could be effectively carried out through them;
   c) evaluate the operational capacities and activities of relevant regional, subregional and national institutions; and
   d) asses existing programmes relating to Desertification among Parties of the region and their relationship with national action programmes.

Art.8: Coordination of subregional, regional and joint action programmes

Affected country Parties preparing a subregional, regional or joint action programme may establish a coordination committee composed of representatives of each affected country Party concerned to review progress in combating Desertification, harmonise national action programmes, make recommendations at the various stages of preparation and implementation of the subregional, regional or joint action programme, and act as a focal point for the promotion and coordination of technical cooperation pursuant to articles 16 to 19 of the Convention.

Art. 9: Non-eligibility for financial assistance

In implementing national, subregional, regional and joint action programmes, affected developed country Parties of the region are not eligible to receive financial assistance under this Convention.

Art. 10: Coordination with other subregions and regions

Subregional, regional and joint action programmes in the northern Mediterranean region may be prepared and implemented in collaboration with those of other subregions, particularly with the subregion of northern Africa.

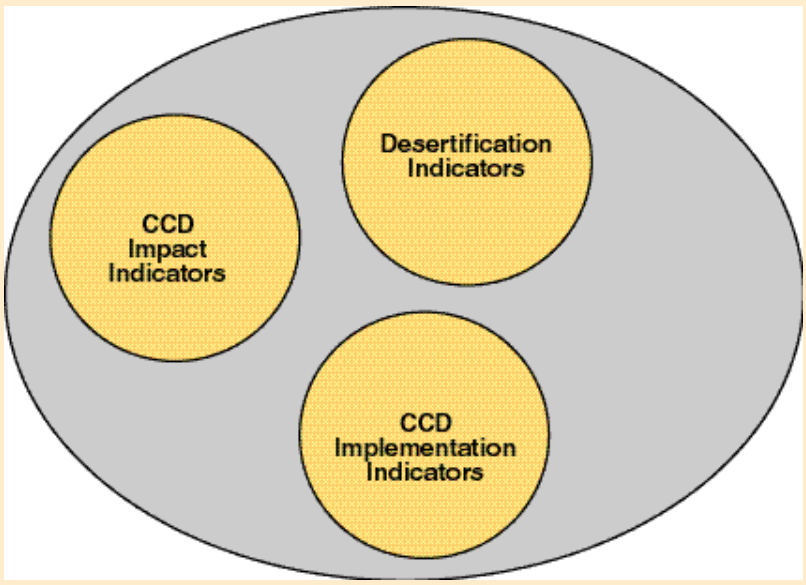
The necessity of elaborating indicators is one of the priorities identified by the United Nations Convention to combat Desertification (UNCCD). The Convention regards indicators as the appropriate instrument to provide operational support to a wide range of activities, including: estimating, assessing, mapping the extent of Desertification, as well as determining the causes, quantifying the impacts, justifying expenditure for mitigation measures and monitoring the efficiency of the measures taken.

In the text of the CCD Convention itself reference to indications is not always explicit; in fact the term is used only in article 16 ("Technical and Scientific cooperation - information collection, analysis and exchange") and in the first Regional Annex (for Africa), while explicit references to benchmarks[8] are to be found only in the second and fourth Regional Annexes (respectively for Asia and the northern Mediterranean), but there are many passages referring to the importance of the issue, where the terms "monitoring, systematic observation, assessment..." etc. are used. In any case, in the institutional stages following the adoption of the Convention, and in particular after the work produced by the Committee for Science and Technology (CST), described in detail below, indicators were considered of great importance and their key role in each of the Convention's implementation phases was recognised.

The CCD in fact identified three distinct areas requiring systematic measurement and therefore three sets of indicators:

- indicators to assess Desertification
- indicators to assess the implementation of the Convention
- indicators to assess the impact of the Convention.

Figure 4.I: The large family of indicators for use in the implementation of the Convention.



[8] The term benchmark, according to CST indications, refers to the notions both of "baseline" and "representative site". Benchmarks serve two purposes i) to facilitate the development of linkages between the different parameters; ii) act as baselines for assessment of changes over time

The first are Desertification indicators in the traditional sense of the term, i.e. "integrated series of physical, biological, social and economic indicators " aimed at achieving "systematic observation of land degradation in affected areas and to gain a better understanding of the processes and the effects of drought and Desertification".

The CCD implementation and impact indicators, as they figure in article 10 on National Action Programmes (NAP) are new creations stemming from the necessity of assessing progress made in the design and implementation of NAPs over time and to observe the effects of mitigation measures adopted in the affected areas. The latter, which can be regarded as two special sub-groups of the indicator family, focussing on the implementation of the Convention and combating Desertification, are characterised by very specific objectives since they are to constitute an integral part of the NAPs. They are therefore the CCD's operational tools and will play a key role in the years to come.

Implementation and impact indicators serve a dual purpose:

- to ensure that Governments of country Parties do not restrict themselves to drawing up declarations of intent or defining general or utopian objectives, as often happened in the past, but instead set themselves "measurable" objectives comprising targeted actions to be undertaken within defined deadlines, able to attain concrete, and verifiable objectives
- to facilitate the periodical and systematic exchange of information and experiences between Party countries, to ensure more effective coordination of actions.

Furthermore, a systematic evaluation both of the state of progress and of the effects of action taken serves to foster an objective analysis of possible delays and/or failures, with discussion on problems encountered and a periodical review of the objectives themselves. Impact indicators, in particular, are specifically designed to test the efficiency of action undertaken following the implementation of the Action Programmes; this should lead to the identification and correction, at an early stage, of possible shortcomings or mistakes, reducing the wastage of resources to the greatest extent possible.
Each Action Programme should be accompanied by a specific set of implementation and impact indicators.

According to the spirit of the Convention, the NAP is an open and on-going process in the course of which all the bodies, institutions, associations, communities involved, will look for and test solutions, examining and assessing their effects over time. The process must also be open to international partners because it must coordinate, through the Regional Action Programmes, and international coordination actions, with the progress made in other country Parties. So its aim is not to end with the elaboration of the Programme, but to continue in time so as to stimulate a progressive increase in awareness, a continuous and capillary diffusion of information from top (state administration) to bottom (community and local administration, associations) and vice versa. In this context it is essential to have reliable indicators at hand.

The CCD Committee for Science and Technology has also acknowledged that not sufficient data is presently available to define benchmarks for evaluating future progress and that existing knowledge on the subject of Desertification indicators is still too theoretical and needs to proceed to a test phase as soon as possible; in this respect it would be desirable to identify multidisciplinary pilot areas in regions representative of the issues connected to Desertification processes.

4.I. Desertification indicators

As was previously mentioned, the CCD refers explicitly to bio-physical and socio-economic indicators of Desertification in article 16, paragraph c. According to this article, Desertification indicators should help achieve the following general objectives: I) provide users with tools, in particular bearing in mind the special requirements of local communities and decision makers; ii) help set up an early warning system with respect to the effects of drought and Desertification.

Two major classes of indicators are mentioned here, the bio-physical and the socio-economic and it is stressed that due importance should be given to the latter and that they should be properly integrated with the former.

The task of developing these indicators is a multidisciplinary one, therefore, involving natural, social and economic sciences. Moreover, since amongst the causes of Desertification the Convention mentions political and cultural factors, we can certainly add that even the contribution of political science and anthropology is necessary to complete the frame of knowledge. Finally, the task of identifying a limited set of essential and efficient indicators not only requires the contribution of all the disciplines involved, but also calls for an awareness of the problem and a clear grasp of objectives within the individual groups of disciplines.

Unfortunately, even if much research has already been done on the subject of Desertification indicators even in the European Mediterranean region, the use of the concept of Desertification in the context of our regions is quite new for most of the scientific community. Furthermore, hitherto scientific work on the subject has not only been deficient in terms of interdisciplinarity, often restricted to the natural sciences, but even within the discipline themselves, there has not always been time enough to make the confrontations required to overcome the major differences in approach prevailing to this day. The results of the Porto Torres Seminar[9], notwithstanding the quality of the individual contributions, are proof of the existence of these problems. Consequently, there still remains much work to be done, especially to harmonise and compare, which hopefully could be done by interdisciplinary groups specially set up for the purpose.

The guidelines for determining indicators and benchmarks recently proposed by the COP to devise indicators to assess the impact of the Convention, describe a process which takes into account all these elements and in this regard can constitute a model for general reference, valid for any type of indicator connected to the Desertification processes.

[9] "Indicators for assessing Desertification in the Mediterranean", Porto Torres, 18-20 September 1998

For now, the present report also takes into consideration contributions from various disciplines, and principally from various approaches/objectives (studies on biodiversity conservation, on the effects of global climate change, environmental risk and impacts assessment, vulnerability and resilience of ecosystems, sustainable land use management, status or level of degradation of natural resources, etc.).
Fortunately, in the case of the European Mediterranean region, we can count on a vast and consolidated heritage in terms of knowledge and on the very many initiatives that in the last two years have greatly contributed to filling the gaps.

The second part of this report will be devoted to the outcome of this operation. In the following paragraphs, on the other hand, the role of indicators to assess the implementation and impact of the Convention will be thoroughly explored, in view of their institutional significance. Moreover, they have been the subject of detailed discussion both by the CST and the Conference of Parties, and many international organizations have work on the subject: as already stated, the methodology of work developed for these indicators can be regarded as generally applicable.

4.2. Indicators to assess the implementation and impact of the Convention

4.2.1. The institutional context

Article 10, sub-paragraph 2 g. of the CCD refers to the need, in designing the National Action Programme (NAP), of defining implementation indicators to assess the level of implementation of the Action Programmes over time. Such indicators must constitute a reference base for the drawing up of periodical progress reports that Parties have to submit to the COP and to the Secretariat of the Convention (according to the provisions of articles 22,23,26) and the specific references in the regional annexes (Annex 1, art.9; Annex II, art. 4; Annex IV, art.5) confirming the relevance of this aspect in the Convention. The importance of ensuring an efficient and on-going process of systematic assessment is emphasised in subparagraph 2.a where it is stressed that the NAP should define long-term strategies and integrate them into national policies for sustainable development.
In view of the above, and in view also of the fact that these particular indicators must necessarily be operational from the first phase of the implementation process of NAPs, and taking into account the urgent measures for Africa defined during the fifth session of the Intergovernmental Negotiation Committee for the Convention[10], the procedures and indicators for assessing and reviewing implementation had already become an official topic of discussion in the sessions of the Negotiation Committee in the course of the ad interim period which ran from the adoption (17 June '94) to the entry into force (26 December 1996) of the Convention.

From the sixth Negotiation session[11] onwards the chapter devoted to "Procedures for communication of information for the review of implementation of the Convention" was open and a specially set up working group (Working Group II) was entrusted with

[10] INCD-5, Paris, 6-17 June 1994: "Resolution on interim arrangements and on urgent action for Africa"

[11] INCD-6, doc. A/AC.241/L.24, New York, 9-20 January 1995

the preparatory work[12] and later with drawing up the guidelines for the compilation of progress reports, with particular reference to the contents ("categories of information") and to the format.
After further intermediary stages[13] the work resulted in the final proposed procedures contained in document A/AC.241/49/Rev[14].

At the same time, during the course of the Eighth session[15] the ad interim secretariat was asked to initiate work on the determination of benchmarks and implementation and impact indicators, while during the Ninth Session[16] an open and informal consultation on indicators was established, and its first result was document A/AC.241/inf.4 presented to the Tenth and last session[17].
This document reports on the results of the work on implementation indicators and the general indications for future work on impact indicators, which indeed were taken up and developed in an informal consultation held in Ottawa (15-17 July 1997). Both contributions, referring to implementation and impact indicators were successively submitted, with a few additional comments, to the Committee for Science and Technology of the first COP[18] held in Rome, respectively by means of documents CST/3 and CST/3/add.1.

The first COP's greatest contribution was however the constitution of an ad hoc panel to encourage and coordinate informal consultations aimed at:

- examining the methodology proposed in the above mentioned document CST/3/add.1 to define impact indicators;
- determine how this methodology could be applied and if its use should be recommend to the COP.

The ad hoc committee met twice[19] between the First and the Second COP, and its results were submitted, with a few additional comments, to the Second COP[20] held in Dakar under document CST (2)/3 and CST (2)/3/add.1.

Finally, the Third COP[21], recently held in Recife, did not add any Methodological contributions, but strongly called for an intense and focussed test phase of the methods and indicators proposed so far to get under way. COP-3 also produced a stricter definition of the modalities for compiling progress reports, proposing a "help guide" (doc./ICCD/COP/(3)/INF.3) also containing a revised model for implementation indicators, considerably more detailed compared to the first one compiled three years earlier.

4.2.2. Implementation indicators: general aspects and assessment parameters

The following general considerations should facilitate and guide the elaboration of a set of implementation indicators to meet the specific requirements of the Convention. Those proposed by the official documents referred to in the preceding paragraphs are not always directly applicable to specific national contexts, because they were devised to provide a means of assessing the implementation of a generic NAP, designed along the general lines indicated in articles 9 and 10 of the CCD. In fact, each of the four

[12] INCD-7, doc. A/AC.241/39, Nairobi, 7-18 August 1995

[13] INCD-8,doc. A/AC. 241/49, Geneva, 5-16 February 1996

[14] INCD-9, New York, 3-13 September 1996

[15] INCD-8, decision 8/8

[16] INCD-9, decision 9/12

[17] INCD-10, New York, 6-17 January 1997

[18] COP-1, Rome, 29/9-10/10 1997

[19] Peking, 20-22 May 1998; Geneva, 1-3 September 1998

[20] COP-2, Dakar, 30/11-11/12 1998

[21] COP-3, Recife, 15-26 November 1999

regional annexes contains various specific recommendations. Furthermore, each individual country's NAP will comprise specific elements (objectives, mechanisms, etc.) and the implementation indicators will have to provide for the possibility of assessing whether or not a Programme, and ensuing actions, conform to the principles it has laid out for itself.

The ideas proposed hereafter are based on the outcome of an analysis undertaken on the results of various international seminars and on elements gathered from the experience of African countries, who were the first to complete their implementation reports. In fact, recently, on the occasion of COP-3 held in Recife, in compliance with commitments made during COP-2, 39 African countries (75% of country Parties from the region) presented their first progress report. Since the countries belonging to the other Regional Annexes, including Italy therefore, will only present their reports as from the next COP-4, African country reports can furnish very interesting indications, particularly if an analysis of the problems and shortcomings most frequently referred to is undertaken.

Indicators should be limited in number to be easily managed by different countries and to simplify the reporting procedure at the Conference of Parties, and they must respect all the components of the NAP.

Conformity with the principles of the Convention should be carefully assessed, paying particular attention to whether the decentralised and bottom-up approach stipulated by the Convention has been adequately adopted. This implies an emphasis on local indicators. These should be able to document the level of implementation at the different levels (national, sub-national administrative unit, community...).

It is essential to establish benchmarks for indicators, for example in terms of standard situation or baseline. It is also important to weight parameters so that a quantitative evaluation can be made.

Particular emphasis should be placed on indicators showing the efforts made in the field of institutional reforms aimed at decentralising and harmonising the numerous sectorial policies. Most African country reports present an analysis of existing environmental and sectorial policies concluding that legislation in force is fragmentary, weak and inefficient. The development of strategies to foster coordination and cooperation in the implementation of development plans and Conventions seems to be the biggest challenge recognised by these countries.

Capacity building should play a determining role in the development of scientific competence within local institutions engaged in the implementation of the Convention. The identification of potential users of implementation indicators and of the bodies and organizations to which the various tasks relating to indicators could be entrusted is therefore a very important aspect.

Data should be broken-down according to gender, for all indicators referring to the participation of the population in the process. Even the existence of gender policies and data on the number of women involved in the process can be used as an indicator in this regard.

Indicators on the media (audiovisual, press, Internet, etc.) should be included to quantify the efforts made to spread information, and indicators to assess the increase in awareness within the local population. It is equally important to register whether awareness building, on the local level, was implemented promptly and by means of concrete actions as was the case in many countries: this activity creates much expectation amongst the local populations and sometimes they risk being disappointed. It has also been observed in many countries that information forums and seminars were organised on the national level only and that awareness building activities to involve the local and district level were overlooked.

It must equally be emphasized that indicators describing the severity or the extent of Desertification and its socio-economic consequences could be useful to develop implementation indicators. Indicators to assess the efficiency of mitigation measures, as well as socio-economic, state and degradation indicators, should consequently be developed simultaneously.

The fact of whether or not a country has started work on indicators constitutes an important indicator in itself.
Annex I contains a proposed model for implementation indicators fully based on indications from the COP and other international bodies.

4.2.3 Impact indicators: methodology of design

The production of a set of impact indicators should constitute an important step towards creating a Desertification Monitoring System. In affected Countries these would have the dual function of:

- providing a diagnosis, integrated in space and time, of the state of natural resources and of populations of the affected regions;
- supporting the decision-making process, providing information on environmental issues, both of a bio-physical and socio-economic nature

In particular, the DMS should help actors at all levels to review their progress, analyse the weaknesses of the policies implemented and determine priority actions.
The DMS will obviously require a set of coherent and homogeneous indicators.
Considering the multitude and complexity of forms and processes that Desertification takes on in each of the affected regions, in view of the varying relative importance the same problems can assume in different contexts (to the extent of being perceived in some contexts as priorities while in others as secondary aspects) and taking into account the varying degree of data availability and technical knowledge in the different countries, the International Community has understood that it is impossible to define a universal set of indicators, but rather that it is necessary to come up with a methodology enabling the different Affected Countries to create the indicators most appropriate to their own specific context. Only on the basis of these will it be possible, in a later phase, to identify indicators of a more general and possibly global applicability.

The ad hoc committee set up by the Conference of Parties determined the general

characteristics that such a methodology should possess.
First, indicators should be determined by means of a fully Participative, on-going, open and iterative, bottom-up consultative process. The methodology for defining them must in fact be very flexible, so as to adapt to local contexts and to changes taking place in the dynamics connected with Desertification, this is why it has to be based on a system for circulating information that systematically and continuously involves all the actors, from the farmers on the local level, to the decision-makers at all levels. The flow of information must be from bottom to top in as far as each actor, particularly from the local level, must contribute information and advice, all the more precious because it comes from a different perspective and spatial scale from those of decision makers and with a pragmatic perception of the problems. Circulation of information amongst actors within the same levels and between levels in both direction will guarantee that each will acquire a real perception of the problem. The flow of information described above must be continuous and on-going so as to guarantee in time that responses are always up to date.
Secondly, it must be born in mind that combating Desertification, besides requiring a different perception of Desertification, implies that the affected populations adopt new standards of behaviour: an adequate level of involvement of women and young people at all levels is a prerequisite to this.

Finally, it is essential that the process lead to the identification and promotion of actors able to make a direct contribution to developing indicators and collecting data.

4.2.3.1 Proposal for a synthetic procedure to produce impact indicators

General considerations

As stated already in referring to implementation indicators and in addition to the fundamental principles outlined by the COP and summarised in the preceding paragraph, a few indications are given below concerning impact indicators, resulting from the analysis of contributions from various international bodies (in particular OSS-CILSS, 1999), with an aim to facilitate the establishment of a selection mechanism for the indicators described by the COP. The summary comments that follow will serve as an integration for the recapitulative table illustrated in table 4.I.

Impact indicators selected at the end of the process should not be numerous but should be significant, simple, easy to use. A skilful choice of indicators should ensure the:

- monitoring of the evolution of specific aspects of action programmes in the countries concerned;
- comparison of the evolution of actions to combat Desertification and the results obtained in the different countries

Indicators must be a tool of dialogue, a tool to support decisions taken by all actors together and not an end in themselves. This explains the importance of consultation mechanisms; in this regard, two fundamental questions must be answered:

- what type of mechanism should be set up on the national level to match availability of data with requests for information?

- what approach/procedure should be used to encourage dynamic consultation focussed on the need to monitor and assess the impact of the Action Programmes?

Socio-economic indicators are particularly important, in as far as they provide information regarding the economic and social costs of Desertification and the effects of drought, and the social and economic benefits resulting from the application of prevention and mitigation measures.

Discussion on impact indicators has shown that there is a widespread need to refer to logical frameworks to guide data collection and the definition of indicators. The pertinence of logical frameworks has been acknowledged and underlined on several occasions as they help to distinguish the causal relationships amongst the processes contributing to Desertification.
Amongst these, the PSR (Pressure State Response) proposed by the World Bank, is one of the most frequently used, although recently there has been a preference for larger scope models, better apt at explaining the linkages between the elements of the system and in particular the driving forces (key forces that in the final analysis cause the process), like the DPSIR model (Driving force Pressure State Impact Response).

The importance of the context within which each indicator is characterised and/or applied must be grasped: it must always be characterised in relation to a context of reference or benchmark site. This is essential for the analysis and interpretation of the evolution measured.
Finally, it must also be borne in mind that once the indicators have been produced they will have to be integrated into synthetic indices to serve as operational tools in the hands of decision- makers.

Table 4.I Schematic procedure for the production of impact indicators

Step	Annotations
1. Identification of the general and specific objectives and their classification according to the specific field of application and users	The NAP should serve as the point of departure for the discussion. The objectives it seeks to achieve should be arranged according to the following three criteria: - nature of the set objective; - level: regional, sub-regional, national, sub-national, local; - target-users of the action, at the different levels identified above. The research organizations are particularly necessary to provide support at all levels.
2. Establishment of a mechanism for consultation amongst all the potential users and the potential providers of data.	Here it is required that the process of preparing indicators be participatory and encourage the inter-change between those possessing data and those needing it. This process should also encourage an assessment-monitoring system and instruments for the circulation of information. The actors of the spatial level concerned should be those to elaborate indicators and collect data, assisted when need be by organizations at other levels.
3. Integrated analysis of the objectives and key issues to which they pertain, referring the DPSIR logical framework.	The scope of this step is to identify the key issues on which efforts should be focussed. It is essential that actors at each level endeavour to sum up the problem in a few key points which in turn will be identified and given priority along with the expected results. In particular for this purpose it will be necessary to: determine the causes and mechanisms of human or natural "pressures" on the environment. understand what action should be taken to reduce or eliminate sources of such "pressures".
4. Identification of indicators able to best describe, at each level, the key issues identified above.	It will be necessary to determine a limited number of indicators using at least the following selection criteria: - relevance: - simplicity; - ease of communication; - comparability.
5. Identification and characterisation of necessary data to measure and/or derive the adopted indicators and benchmarks.	It will be necessary to draw up technical data forms (a suggested form will be presented below) to describe the needs of each indicator in terms of data, with particular mention of: - data required to measure/derive the indicator; - the spatial scale and the time scale necessary to produce the indicator; - the source or sources of information; - etc.
6. Analysis of national and/or local situations relative to production and/or availability of data on the different key issues identified.	What data is available ? When data exists, but has a low level of standardisation and/or availability, step 2 becomes particularly relevant. It is necessary to select indicators for which data is already available or can be obtained at reasonable cost. The real costs of developing indicators must be taken into account. The collection and analysis of a large quantity of data could require considerable resources in terms of funds, work force and time. This could dissuade country parties from attempting to develop indicators.

Step	Annotations
7. Calculation/measurement and analysis of indicators	The calculation should be supported by an analysis of the evolution of the indicator over time, in the specific context.
8. Preparation of an action plan to provide for the production of necessary but as yet unavailable data.	If the necessary data does not yet exist, it will be necessary to define a plan to produce missing data and which should include : - who is going to produce it; when, how and at what price - The time interval between the planning of a collection campaign and the start of the systematic collection must be taken into account. Especially if it is on a national scale, it could be of several years, therefore it is preferable that indicators be based as far as possible on existing data.
9. Dissemination of results	The indicator must be interpreted and presented so as to be understood by the users. The collection of data and the dissemination of results must be strengthened on the local level in particular.
10. Testing perception (feed-back from users)	The true effectiveness of an indicator must also be assessed with respect to the response from users, especially at the local level. In this manner the less effective indicators can be revised.

Additional annotations to some of the points described above

Step 1) With respect to the definition of objectives, the point of departure will of course be the general ones listed in the CCD, i.e.:

i. The global objectives (article 2 paragraph 1), which are:
combating Desertification
mitigating the effects of drought;
contributing to achieving sustainable development

ii. The secondary objectives that can contribute to accomplishing the global ones (art. 2 paragraph 2):
improving land productivity;
rehabilitating, improving and managing land and water resources;
improving living conditions of communities.

iii. The specific objectives to be defined by the Action Programmes

Step 4) Concerning the selection and evaluation of indicators, besides the criteria listed in the table, it would be necessary to evaluate each indicator on the basis of:

- how efficiently it represents the problem and the expected result;
- how adequately it is able to cover the relative spatial level;
- how methodological reliable it is.

Moreover it is advisable to review indicators periodically to up-date, remove or modify them according to need.
Finally the evaluation should include feedback from the users.

The general considerations on the characteristics of an "optimal indicator" figuring in chapter 5 obviously also apply to impact indicators.

Step 10) To monitor and asses the efficiency of indicators on the local level, an operational monitoring system should be set up including, at least, the following:

- a permanent system of representative sites determined according to criteria of agro-ecological homogeneity
- an environmental information system based on data base management procedures;
- information exchange agreements on associations and scientific co-operation.

It will be necessary to go through certain steps to establish an operational monitoring and assessment system, amongst these :

- specification of the needs of users and decision makers
- evaluation of the existing situation, including availability of information;
- multidisciplinary studies and collection of minimal data sets in representative sites to facilitate comparison between the different agro-ecological zones;
- determination of an appropriate time interval to monitor and assess in accordance with the needs of users;
- consolidation of existing national capacities.

Example of basic indicators produced in certain African countries

Burkina Faso Mali, Senegal and Tunisia identified 5 general common objectives:

1. combating poverty;
2. conservation of natural resources;
3. ameliorating institutional organization;
4. understanding Desertification;
5. monitoring and assessing the effects of drought.

These countries have also identified specific objectives and basic indicators as described in tables 1 and 2 on the following pages.

Table 1: *General and specific objectives of the NAPs of four African countries already in the phase of elaborating impact indicators according to the methodology proposed by the COP.*

General objective	Specific objectives within NAPs			
	Mali	**Senegal**	**Burkina**	**Tunisia**
1. Poverty eradicaton	Link combating poverty with the National Environmental Action Plan (NEAP) and the NAP	Satisfy basic needs (access to drinking water, food security; availability of domestic fuel).	Create an enabling environment (economic, political, legislative, institutional) Improve living conditions of rural and semi-urban populations	Improve the socio-economic conditions of the population
2. management of natural resources	Stop degradation of natural resources Improve water management and access Identify tools for sustainable management of resources at community level Contribute to satisfying domestic fuel needs reducing pressure on forests	Regenerate forest resources Combat soil degradation. Combat wildfires Combat wind and water erosion	Sustainable management of resources (wildlife, vegetation, water, soil)	Combat water erosion. Combat salinisation Combat sand invasion
3. Ameliorating institutional organization	Promote education and participation. Facilitate access to environmental information (information collection and dissemination Ensure coherence in the implementation of the different Conventions.	Improve the institutional framework	Capacity building of actors engaged in combating Desertification. Reinforce the economic and commercial potential of vulnerable groups Promote institutional co-operation	Increase existing capacities in the struggle against Desertification and in the production of information and monitoring. Institutional capacity building at various levels Increase environmental education and awareness. Prepare and disseminate a natural resources management code Sustainable funding of the NAP and other Desertification control measures.
4. Improving knowledge of Desertification	Ensure better results in the field of environmental research	Stimulate existing capacities in grass-roots organizatons and local communities Sustainable funding Develop partnership agreements amongst actors	Support research	Support research

Table 2: *Common basic indicators selected by Burkina, Mali, Senegal, Tunisia.*

General objective	Selected basic indicators (responding directly to the key issues identified by the different countries)
1. Eradication of poverty	Percentage of the population under the poverty threshold Men/women income ratio Rural exodus Nutritional state of children under 5 years of age
2. Natural resources management	Land occupation Land vulnerability Precipitation (distribution in time and space) Geographical distribution of useable water resources (quantity and quality) Depletion of useable water resources index Evolution of vegetation cover Evolution of vegetation biomass Agricultural resources Animal biodiversity
3. Ameliorating institutional organization	Percentage of the national budget allocated to local communities Percentage of local communities in the process of implementing a local development plan Investment in activities and projects included in the NAPs
4. Improvement of knowledge on Desertification	Budget allocated to research and development to combat Desertification Number of scientists within groups working in research and development programmes included in the NAPs.

	THEMATIC FIELD	ASSESSMENT PARAMETERS	NOTES
Strategies and priorities established within the framework of sustainable development policies			
1	National plans and strategies within other social and economic policies	- National development plans - National environmental plans or strategies	- Basic information on the existence of such plans or strategies, if relevant to the context of combating Desertification.
2	National plans and strategies developed in the field of combating Desertification before the entry into force of the UNCCD	- National and local Agenda 21 - National conservation strategies - Other plans in relevant sectors (agriculture, energy, education, health, poverty, markets, natural resources, etc)	- Which plans are relevant, what is their level of implementation and integration, what are the priorities identified by such plans. - Information on the presence in such plans of important connections with the NAPs or of explicit references to the struggle against Desertification - Basic information on the existence of plans in the field of Desertification, in particular those possibly resulting from the Nairobi Conference (UNCOD) in 1977.
Institutional measures taken to implement the Convention			
3	National Coordination Unit (NCU) In the case of Italy the National Committee	- Legal status - Resources - Intersectorial, interinstitutional and multidisciplinary character - Composition and operational methods	- The status of the NCU provides an indication of its institutional capacity and the freedom of action determined by the State itself, as stated in its statutes, the choice of supervisory governmental services, its mandates etc. - Resources (human, financial and material) are an indication of the NCU's capacity to act - Its intersectorial and multidisciplinary character should be reflected within the NCU, through the presence of expert staff covering the various sectors of activity, staff with complementary training and experience in the various socio-economic fields and in natural resource management. It is particularly important to identify the relevant sectors; the social categories represented; the form and means of communication amongst members - The latter parameter should describe how the NCU involve the different actors in its work, with special reference to NGOs and representatives of the local population: how are they chosen and appointed; what is the composition in terms of institutional/civilian and men/women ratios; the frequency of their meetings and the control and supervision mechanisms..
4	Institutional framework for coherent and functional controlling of Desertification	- Measures identified and adopted to reorganise or consolidate the institutional framework - Measures adopted to consolidate existing local and national institutions	- Analysis of existing mechanisms to coordinate and harmonise actions to control Desertification (at the local and national levels) should draw lessons from past experience. This analysis should lead to measures for the reorganisation, consolidation, and adaptation of existing mechanisms, to ensure particularly the participation of local actors. It is also important to check whether existing mechanisms to ensure harmonisation and coordination of actions have been used and if new ones have been proposed or if measures have been taken to improve their efficiency - This parameter comprises several actions in favour of capacity building that will have to be implemented in the short and medium term. The question as to whether work has been done in this direction and if it has produced positive results must be posed.
5	The NAP as part of the national economic and social development plan	- NAP coherent with other strategic contexts - Connection of the NAP with approaches contained in the national, regional and local policies - Connection of the NAP with the Sub-Regional Action Programme - Government support	- It is important to ensure that a concerted analysis is made of existing plans. This is also necessary to render strategies of international partners on national level coherent. Assess how the CCD principles are given relevance in other spheres of environmental policy (participation, partnership, programme approach, approach based on synergy and complementarity, etc. - The NAP should be part of all levels of the national economic and social development plan. - Connections with the SRAP and RAP should be clear and properly articulated; the actions under the NAP with a supra-national dimension should be indicated. - Indicate if the Government has officially adopted a plan and what priority has been assigned to it, equally in terms of budget.

6	Coherent and functional legal and regulatory context	- Analysis of legislation and application of environmental laws. - Measures to adapt legislation in force or enacting new laws: - land tenure - decentralisation - management of natural resources (forestation, pastures, water, etc.)	- The cross analysis of environmental legislation and other legislation should lead specifically to proposals involving greater responsibility in the hand of local populations. Check if such an analysis has been undertaken. Check what measures have been adopted to reinforce participation and awareness on the local level. - All measures should be supported by efforts to supply all major users with information on national orientations and on the content of laws and regulations so as to ensure greater participation of local populations. Indicate what measures have been taken in this regard..
Participative approach in support of the preparation and implementation of the NAP			
7	Effective participation of the actors involved in the determination of national priorities	- Modalities for participation of the different actors - Representation of the different actors in the process of identifying national priorities (local fora and national forum) - Nature and scope of action supporting information, education and communication - Level of recognition given to: - local issues at the national level - results of national consultations on the local level	- This implies verifying the level of involvement of local actors in defining national priorities: local communities, NGOs, etc. Indicate if a strategy for communication and involvement exists, how it has been implemented, what contents were transmitted and what social categories are implicated; indicate the relationship between sexes and if measures have been taken to secure the involvement of women. Describe if and how the mechanism of on-going consultation has been implemented. - Providing local actors with accurate and comprehensive information, with particular reference to the CCD principles and selected national options is essential to their total implication in the decision-making process. Indicate the existence of data bases, access to Internet, Internet site, tools for circulating information; in particular, information concerning the information systems available to the NCU, and which are specifically run by the NCU; what other information systems are available in the country and what information exchange activity is the NCU involved in. - Indicate how the representatives of the social and institutional categories involved are designated and which local contributions have been incorporated into the NAP
Consultation process for the preparation and implementation of the NAP and partnership agreements			
8	Appropriate support from international partners	- Degree of participation of international organizations in the consultation process - an efficient consultation and harmonisation process of actions undertaken by Partner	- Commitments of international partners should imply their participation in local and national consultations and to them providing financial support. Indicate measures taken in this regard. - Amongst other, informal consultations should be organised amongst partner countries through the nomination of a leader country to act as an intermediary.
Measures taken or planned in the NAP framework			
9	Adequate diagnosis of past experience	- Synthesis and evaluation of action undertaken in the past	- The diagnosis should provide information on the state of natural resources at the start of NAP implementation. Indicate if such a diagnostic had been made in an exhaustive manner and outline according to what modalities and if it provided the expected outcomes, i.e. a sound basis for the NAP.

10	Technical programmes and integrated, functional projects to combat Desertification	- Inventory, adaptation and integration into the design process of NAP of projects in progress. - Identification of new actions - Actions aimed at building national capacities to combat Desertification particularly at local level	- Projects on resources management and on Desertification control should be examined in the light of the CCD principles and, if necessary, made to conform to them. It should be done gradually at medium term. Indicate if and how this has been achieved or planned. - Indicate what new actions have been identified and proposed to combat Desertification. - Specific technical and scientific training programmes should be planned. Indicate if and how this has been done or planned, what are the priorities and what is the outcome.
11	Implementation of the action programme in conformity with the priorities assigned by the Convention.	- Measures to conserve natural resources - Measures to improve institutional organization - Measures to disseminate knowledge of Desertification - Measures to monitor and assess the effects of Desertification - Measures to improve the economic and social environment	- The content of the various measures derive from the content of the Action Programme adopted by each affected country. Article 8 of the Annex for Africa provides an example of the content that could be included to adopted measures. Describe the measures taken in this regard and how such measures have been integrated into other policies and economic plans.
12	Connection with the regional and sub-regional action programme	- Development on the national level of programmes of a sub-regional or regional nature - Improvement of the scientific network - Evaluation of the action implemented by other affected Countries	- Desertification control programmes adopted on the sub-regional level should be included in national programmes. The SRAP and RAP are complementary and must support the NAP. - The contribution of scientific networks can be measured by evaluating the relationship between these and the national actors.
13	Effectiveness of capacity building measures on the local level.	- Degree of responsibility assigned to local communities for natural resources management. - Degree of decentralisation achieved - Involvement of actors in the monitoring and assessment process	- The degree of authority States delegate to local actors and the support measures (training, organization, etc,) should be clearly indicated.

14	Enhancement of scientific and technological capacities and of technology transfer	- Technological and scientific agreements concluded - Percentage of resources allocated for research, development and training - Level of technological know-how at the local level - Extension of technical assistance to local operators	- All agreements should refer to the CCD provisions concerning, inter alia, scientific and technological priorities, national capacity building and participation of local actors.
15	Partnership agreements	- Operational status of internal partnership agreements. - Operational status of the consultation and coordination process - Resources allocated to the implementation of the NAP - Number of partner countries - Role of global mechanisms	- The following must be assessed: nature and scope of international partners' commitments within the partnership agreement; degree of harmonisation of partners' actions on the national level.
Allocation and mobilisation of financial resources			
16	Financial mechanisms adopted	- Measures to facilitate access of local actors to existing funds - Elaboration of new methods for mobilising internal and external resources	- A review of existing financial mechanisms should render financial instruments more readily accessible to local actors. Indicate what measures have been taken to ensure access to funds, if such measures are temporary or permanent, etc. - New forms of funding could include a National Fund for Combating Desertification or the promotion of funds at the local level. In this context the State should define the terms and conditions governing the participation of the different actors in financing and in the management of activities to control Desertification. International partners should also contribute financial support. Indicate if new forms of funding have been introduced and what are their mechanisms.
17	NAP funding	- Mobilisation of national resources - Mobilisation of external resources - Role of the Global Mechanism - Number of partners providing financial support - Global available resources	- The mobilisation of internal resources indicates the level of priority assigned to Desertification. - The mobilisation of external resources is an indicator of the level of involvement and commitment of international partners - In both cases the efforts made to mobilise resources should be described, who in fact supports the NAP implementation, etc.
18	Technical cooperation developed	- Mobilisation of technical cooperation - Identification of priority needs within the framework of technical cooperation	- This point refers primarily to developing countries, as they will have to demonstrate that they have taken sufficient action to obtain technical assistance from international partners..

Revision and assessment of the NAP and of the indicators used to measure the progress accomplished			
19	Operational mechanisms for monitoring and assessment	- Introduction and/or up-grading of environmental monitoring at national level - Establishment of a mechanism and criteria for monitoring the NAP's impact - National information system on Desertification - Access of actors to available information - Mechanisms for consultation on the analysis of results - Issuing of reports at regular intervals - Participation of technical and scientific institutions in the monitoring/assessment phase - Feedback from the evaluation of programme management	- Affected countries should be able to use relevant environmental information, have the possibility of collecting, analysing, elaborating information, producing impact indicators, assessing the impact of actions undertaken in the field of the NAP. These should also have efficient operational means of disseminating information and harmonising information systems in related fields (environment, agriculture, energy, etc). Reports should explain how countries are moving in this direction, measures taken or planned, etc. - The harmonisation of existing systems could be considered as one possible measure. The work also includes assessing the functional efficiency of information systems. A separate office for information on Desertification is not to be suggested but rather the use of existing structures should be encouraged.
20	Review of the NAP and partner commitments	- Approval of the NAP by the actors	- Ratification could take place during the National Conference (or Forum). The international partners involved should determine their position with respect to the planned programmes. Partnership agreements, that should equally involve local actors, will be redefined during the review process and the approval of NAP.

USERS AND/OR TOOLS FOR THE CCD MONITORING PROCESS.		
Users	**Monitoring Instruments**	**Responsibility assigned to:**
Conference of Parties	Minimal set of standardised indicators applicable all over the world	COP/CST
Regional organizations	Minimal set of regional indicators	Ex. Regional Coordination Unit for African countries
Sub-Regional organizations	Minimal set of sub-regional indicators	IGAD/CILSS/UMA/SADC/ACSAD,etc.
	List of indicators for the monitoring process	
Affected States (developing and countries)	Set of specific indicators for the country (process and impact)	National coordination body and CCD Secretariat
Natural Resources users at the local level	Participative evaluation process	Local community with programme unity, NGO

*The above-mentioned organizations could entrust the work to specialized institutions, ad hoc commissions, or working groups

Part two

5.1 The role of indicators in supporting environmental and development policies

Many international and national organizations now recognise that environmental indicators are playing an increasingly important role in support of development policies. The most widespread and widely used are the economic indicators used to give a synthetic description of the state of health of an economy. For instance, the GDP (Gross Domestic Product), the inflation index, and the unemployment rate are certainly the best-known indicators. Economists ascribe increasing significance to indicators, the information media have made wide use of them because they are simple to read, an increasing number of citizens are using them everyday, and although they are unaware of how the values were actually calculated, they have nevertheless learnt how to interpret them. Many countries have long- establish statistical services (like the ISTAT in Italy or EUROSTAT in the EU) whose task it is to report on the state of the nation at regular intervals by means of synthetic parameters. Certain International Agencies, like the World Bank, FAO, UNEP, UNICEF, UNDP, have also developed the use of indicators to make their own periodical reports more incisive. Thanks to these Agencies, social or environmental indices like infant mortality, equivalent emissions of greenhouse gases, are acquiring increasing weight in the minds of international public opinion. This is of fundamental importance because after the Rio conference, with the adoption of Agenda 21, governments undertook to assess their national economic systems, no longer on the basis only of macro-economic performance data, but also with respect to the relative social and environmental costs and the real prospects for long-term sustainable development.

Research on Desertification indicators falls into this context and presents the most innovative approach; in as far as the aim is to create tools to tackle some of the most serious social and environmental problems afflicting humanity in an integrated manner.

In adopting this approach, the European Community recently affirmed the necessity of supporting development and the dissemination of environmental indicators able to discern the "environmental quality" of policies, to counterbalance the excessive weight of macro-economic indicators and it has launched a programme for a European system of indicators and indices of Environmental pressure.

In the European Community's approach to indicators the following functions have been identified (Gentile, 1998):

- an means of supporting evaluation of present political measures and identification of priorities for the future;
- n instrument for measuring and assessing the performance of a country;
- an instrument to link the environmental, social, economic dimensions of sustainable development in an easily understandable manner;
- a means of focussing monitoring activities and the preparation of information reports.

The function of an indicator is precisely: to synthesise and communicate relevant information for the assessment of an issue in a clear and unequivocal manner. Indicators generally simplify reality to make complex processes quantifiable so that the information obtained can be communicated. This characteristic makes the use of indicators important not only in communication between citizens and administrators, but also in communication between different sectors of the administration (sectorial policies), amongst the social categories

and between the different scientific disciplines.
The identification of truly valid indicators will ensure the most effective use of limited data provided by monitoring systems as well as of allocated resources.

Consequently, many international organizations have recently launched programmes, and in some cases within the framework of joint projects, aimed at designing indicators for the specific needs of environmental and development policies.

Some of the most important are listed below:

- "Land quality indicators (LQI)" a Programme sponsored by the World Bank and developed in cooperation with FAO, UNEP, UNDP;
- "Sustainable Development indicators", developed by the United Nations within the framework of actions to implement the Rio and Agenda 21 commitments in particular;
- "Environmental indicators " within the UNEP Global Monitoring System;
- "European Environmental Agency (EEA) framework for policy relevant indicators", the European Agency's new reference for environmental reports, within which the first progress report on Environmental Pressure indicators has recently been published.
- "Rural indicators " form the OECD department of land development
- Other programmes that cannot be mentioned for sake of space, are in progress within governmental organizations (for instance, USDA - United States department of Agriculture, EPA - United States Environment Protection Agency, etc), research institutes, non-governmental organizations.

In view of the great complexity and transversality of issues linked to Desertification processes and since Desertification is the form in which many environmental and development problems of various nature are manifested in the affected areas, in as far as each contributes to land degradation, all the above mentioned areas of research will no doubt make significant contributions to the determination of Desertification indicators.

5.2 Definition of environmental indicators and Desertification indicators

5.2.I Environmental indicators

An indicator is a parameter or an index[1] providing concise and clear-cut information on a process it is sought to characterise, measure and monitor and this with reference to a specific objective. An indicator contains quantitative information that helps to explain how processes evolve over time and vary in space. An environmental indicator in particular provides information on the status and the trends of the state of the environment, of human activities influencing or being influenced by the environment and on the interactions between these two variables. (EEA 1998).

The distinction between parameters and indices should be pointed out: usually in scientific disciplines these terms are used to indicate respectively, a unit of primary or un-processed information (measured directly, therefore dimensional) and a unit of derived information, a-dimensional). The primary unit, the parameter, is the direct result of a simple and standardised measurement of a physical quantity, whereas the derived information, the index, is the result of a mathematical operation applied to the primary variable (for example a mathematical

[1]We give the term "index" its general and most widely used meaning in scientific disciplines, i.e. "generally a-dimensional numeric quantity used to indicate a physical scale of magnitude " or more simply, a value derived from parameters.

average), or on several variables at the same time (for example a ratio).[2]
The term index also has another meaning, more commonly used in economics and statistics, where index provides highly aggregated information specifically designed to indicate in a synthetic but exhaustive manner the dimension of a state or process. In this sense of the term, indices are generally obtained from an aggregation of indicators: several indicators can be identified in relation to a given process and a single index obtained from the aggregation of these.

A few further considerations of a general order are required to clarify the role and the characteristics of environmental indicators:

1) bio-physical parameters that are easily and accurately measurable, cost little in terms of acquiring and processing data, are rich in information, and can therefore be considered truly efficient as indicators, are not so many, probably only a few in fact.

2) Some of these can be highly significant, from many points of view, i.e. the same parameter or index can be a pertinent indicator of many relevant environmental aspects; for example, "% of organic matter soil content" is considered a significant indicator at least with respect to all the subjects listed below:

- general soil fertility
- soil moisture retention capacity
- soil structural stability and erodibility
- presence and biodiversity of edaphic fauna
- carbon cycle and potential for trapping atmospheric carbon dioxide.

This list illustrates some of the main functions attributed to the parameter in relation to soil ecology, sustainability of agro-ecosystems, balance of the biosphere.

3) Consequently what identifies a parameter or an index as an indicator (of something specific) is a set of characteristics, amongst which:

i) Objective: an indicator is such when it serves to characterise/measure/monitor a state or process in a determined context, for a specific purpose;

ii) Method: the method of measurement and/or calculation of the value of a parameter/index; level of accuracy required, number of repeats, periodicity, statistical processing, fields and contexts of application, spatial scale at which it is significant;

iii) Benchmarks of the parameter/index: (threshold values, reference intervals);

iiii) Type and quality of the final information; site-specific or distributed spatially; spatial density of the sampling; specific techniques for space/time interpolation of point data (data from a single site are often interpolated with undiscerning use of geostatistical algorithms, whereas the choice of a suitable method is an important aspect).

To conclude, it could be said that an environmental indicator is not a parameter/index, but a set defined by at least five elements: parameter/index; objective; method of measurement; benchmarks; type and quality of information output. The following formula borrowed from vector algebra may be applied:

[2]The distinction is not really clear (probably more a conventional one) and it depends on the context. In fact even "primary" information can be sensitive to the tool and to the conditions of measurement or can require pre-treatment. For example with respect to a spot measurement of soil pollution undertaken according to widely used standardised methods, the data exists only as an average of several measurements; for some applications the temperature measurement itself is calibrated according to the type of thermometer and the conditions of measurement. Perhaps it could be said that the main difference lies in the different quantity of "meta-information" (information on the data) which completes and describes the data.

indicator = (parameter, objective, method, benchmark, spatial scale/type of spatial extension)

5.2.2. Definition of an optimal environmental indicator

An environmental indicator can be considered optimal if it guarantees the best result with respect to a series of criteria of efficiency. According to the definition given by the World Bank LQI Programme (Schomaker, 1977), these criteria can be summed up as "SMART" (specific, measurable, achievable, relevant, time-bound).

Relevance to end-users, who must be clearly identified, and availability of data necessary to produce the indicators are particularly important. Another aspect to be considered is the possibility of resorting to "proxy data" i.e. lacking the strictly necessary data, the user should be able to resort to other, more readily available data enabling an estimate to be made with an acceptable degree of approximation.

Rubio and Bochet (1998) tackle the subject of Desertification indicators in considerable detail and propose a synthetic list of criteria (table 5.I), and a procedure for the selection, evaluation and application of indicators. This contribution is particularly interesting because it is explicitly directed towards Desertification indicators for the European Mediterranean region.

Table 5.1. Criteria for evaluating indicators, from Rubio and Bochet (1998)

1. Reliable 2. Biologically, policy and socially relevant 3. Measurable 4. Sensitive to stressors	5. Cost effective 6. Target Level 7. Assess present status 8. Assess trends over time	9. Interpretable 10.Readily available data and historical data 11. European conditions

5.2.3 "Desertification indicators for the European Mediterranean region"

It has been said that an indicator can be qualified as such if it responds to a specific purpose, that an indicator is a good one if it meets the purpose with maximum efficiency and that it would even be an ideal indicator if it supplied all the necessary information on its own.

It should be added at this point that when a complex process has to be described (for example the process of soil erosion), a single indicator is generally not sufficient, and several indicators would be necessary, even if not many, but organised into a precise set.

This set is defined by a broader objective than the specific objective pertaining to an individual indicator (for example describing the state of degradation caused by presumed processes of erosion, or characterising the vulnerability of land with respect to these processes). Usually a model of the interactions between the individual environmental factors to which the indicators refer accompanies a set of this kind (for example a physical property of soil interacts with the characteristics of the vegetation, contributing to erosion vulnerability). Within the set, individual indicators become complementary as regards meeting the general objective. When defining indicators intended to be part of such a set, even these aspects (general objectives, needs linked to the overall structure of the

set, i.e. to the nature of the correlation between the individual elements) have to be given due attention. This can lead individual indicators to loose in general applicability, therefore making it very difficult or even impossible to reuse them individually in a different context.

Looking, for instance, at the "Erosion Risk Assessment" diagram elaborated within the EU CORINE programme (1992), it can be seen that different parameters and indices contribute to modelling water erosion risk at a reduced detail (1:1000000) geographical scale in the context of the European Mediterranean region.

If individual indicators are removed from the conceptual model, geographical context and spatial scale of reference (in the sense of indices, reference values, means of assessment) they inevitably lose most of their efficiency. Similarly, the "weights " defining the relative importance of different parameters within a system of indicators can be closely linked to context and to scale. This second problematical aspect is due to the fact that it is almost always necessary to aggregate a large number of indicators to form a relatively small number of synthetic indices: different levels of aggregation generally call for different criteria of synthesis.

If this is a necessary premise to the interpretation of a set of indicators referring to the single process of land degradation, it is all the more so when discussing Desertification indicators.

Desertification is an extremely complex phenomenon, in which the many processes contributing to degradation are governed by systems of causes and driving forces, where the determining factors are very heterogeneous and the causal links and interactions at play amongst these factors are not always obvious and tend to become manifest at varying degrees depending on the different scale of spatial and temporal observation. These systems of causes are also in many cases linked to particular regional contexts (as, in our case, the European Mediterranean region) or local contexts, so, as the Convention itself recognizes, there will probably never exist a single synthetic model to describe them.

In turn, all these aspects cannot be disregarded when determining Desertification indicators, no more than the specific strategic objectives to which the indicators refer. Depending on the context and time and according to the objectives, the weight of certain factors, for instance economic factors, may be overriding and render the others insignificant; or, what in one region is a consequence of land degradation, for example poverty, in another region or at another time could be the driving force of the process. Similarly, if the final objective is prevention, it would be important to have indicators capable of discerning the driving forces or the contributing factors; if on the other hand the objective is mitigation, indicators will have to describe the state of the land and the sustainability of actions and policies implemented and planned, and so on.

Despite the complexity, the Convention states that to be considered an indicator of Desertification, the indicator will have to fit into an organic framework able to characterise, measure, and systematically observe all the processes that UNCCD qualifies as Desertification in the northern Mediterranean. According to the methodology put forward by the Conference of Parties the path to follow to attain this goal is from bottom to top, from the particular to the general, from local to global: to start from valid and efficient indicators referring to concrete objectives and adapt them to local contexts, and then pick out

along the way, those that are more broadly applicable, until the determination of a synthetic set of national, sub-regional and regional indicators is achieved.

5.3. Existing Desertification indicators and possible approaches to classification.

On the global level there exists an almost endless bibliography on the subject of land degradation. Even within European Mediterranean countries, the subject has been investigated in countless research projects, which, although with very different aims and approaches, have on the whole described the most common degradation processes, exposing the factors and mechanisms governing them. As the CCD Secretariat underlined during the concluding discussion of the Porto Torres International Seminar, the heritage of experience and knowledge available is already enormous. But existing studies have often been too focussed on local conditions and there has rarely been an effort made to translate this knowledge into proper systems of more generally valid indicators; and when this has been done, it has not always been clear what the requisites of an indicator should be. If we wanted to restrict ourselves to analysing work explicitly devoted to Desertification indicators for the northern Mediterranean, based on a definition of an indicator in keeping with the one proposed by the CCD Conference of Parties, it would not take long. Even many of the experts invited to Porto Torres to talk about indicators, in fact confined themselves to listing significant parameters regarding this or that problem without proposing reference values, benchmarks, scales of relative importance, etc. The major part of available material is therefore an "indirect source". Obviously, it is not always possible, nor appropriate, to "extrapolate" indicators from sources of this type. But it is very important to identify experts, institutes, disciplines and sectors of research that have provided the potentially more pertinent contributions and encourage them to develop them further in the future. To this end, it is necessary to spread a culture surrounding this issue and make an effort to organise acquisitions in a systematic manner. A hierarchical list of existing "sources of indicators" and a possible approach to classification of Desertification indicators (cfr para. 5.4) is laid out below.

5.3.1. Sources of indicators

The following are listed in order of decreasing direct relevance:

a) Research programmes specifically on the subject of Desertification indicators in the Mediterranean environment or on a global, regional, or national level. For example, projects for monitoring Desertification using satellite data, like DEMON (Desertification Monitoring, or studies on the topic of sensitivity to Desertification, such as ESA (Environmental Sensitive Areas) produced in the framework of MEDALUS or again studies on the of National Action Programmes, like indicators for "Desertification Prone Areas" by the implementation Portuguese National Committee, or other studies and methodological contributions like in Imeson (2000). The material produced by the ex European Topic Centre on Soils, which developed Desertification indicators referring to soils is very interesting.

b) Interdisciplinary research programmes on Desertification on a regional scale, like MEDALUS

as a whole, are certainly amongst the priority sources as they represent the most advanced level of research on the topic.

c) Programmes for the development of indicators on the global, regional or national scale referring to related themes, for example those mentioned above referring to sustainable development, land quality etc. are important for the careful methodological approach they adopt to develop indicators, many of which can no doubt be adopted (or adapted) as Desertification indicators.

d) Interdisciplinary research on general topics (land degradation, biodiversity..) not focussed on indicators.

e) Research in the classical disciplinary fields.

5.3.2. Classification of Desertification indicators

There are very numerous potential Desertification indicators and they are very heterogeneous, and could be classified according to various criteria. The most plausible amongst these will be described hereafter: disciplinary fields of competence and environmental components criteria; criteria of objectives; logical framework criteria; spatial scales criteria; acquisition and/or measurement techniques criteria .

Several criteria often coexist in hierarchical order in a single classification. The fact that there are many plausible criteria reflects the existence of issues at many different levels.

Criteria of disciplinary fields of competence and environmental components

In the more classical approach, indicators are classified by first sub-dividing them into socio-economic and biophysical categories and the latter are then subdivided into climatic, soil, water, vegetation, biodiversity related, etc. In other words, in the contributions presented by many scientific research institutes at international meetings like Port Torres, indicators are usually organised and classified so as to reflect the fields of competence of individual disciplines and the experience gathered in specific experimental contexts; rarely do we see an effort made to consider all the components of environmental systems in an integrated manner. These criteria can no longer constitute the first discriminating factor for classifying indicators because it does not meet the requirements of an integrated and multidisciplinary approach.

Criteria of objectives

Indicators are sometimes grouped together according to the objectives for which they have been designed. Particularly, in some documents referring to impact indicators, such objectives reproduce the major issues defined by the CCD:

- knowledge of and monitoring of Desertification and drought processes;
- conservation, rehabilitation and sustainable management of natural resources;
- increased production and amelioration of living conditions;
- combating poverty;
- improvement of institutional organization

Alternatively, the classification can fulfil the three operational objectives of the struggle against Desertification, i.e.

- Prevention
- Monitoring
- Mitigation

Criteria of logical framework
(conceptual frames of reference for the development and classification of Desertification indicators).

In the specific programmes launched by various international or national agencies on the subject of environmental indicators and in particular on indicators to support sustainable development and Desertification control policies, the need to resort to conceptual frames of reference arose, to ensure a more efficient organization of knowledge and greater ease of communication. This is how what the UN documents refer to as "assessing and reporting frameworks" came into being, amongst which the PSR (Pressure State Response) probably the best known. The structure of these systems directly reflects conceptual model used from time to time to describe the complexity of the processes under study, such systems, therefore, are not simple methods of classification but proper working tools, able to encourage and guide those who may, in the future, want to contribute to research.

Some of those found in literature are listed below:

DI, Direct indicators / indirect indicators (Mabutt, 1986).
This framework constitutes one of the first attempts at systematic classification of all Desertification indicators. According to this framework, direct indicators are those constituting a diagnostic element within the system of the processes constituting the environmental conditions under review, while the indirect ones are those that reveal secondary or consequential interactions in correlated systems.

PSR, Pressure / State / Response, (OECD - Organization for Economic Cooperation and Development).
They were devised to meet the need for an integrated approach in which interactions between environmental systems and human systems are assigned primary importance in the understanding of degradation processes, for which it is sought to reconstruct the chain of causes that link and control them. This chain is described as a circular system in which three categories of key-variables are identified, respectively describing:

- pressure of human systems on environmental systems
- the state of environmental systems
- the social feed-back subsequent to degradation of resources;

Once the system of interactions leading to Desertification has been reconstructed, it is placed into the described framework, and the indicators needed to characterise each of the three links of the chain are then identified.

DPSIR, Driving force / Pressure / State / Impact / Response, EEA (European Environment Agency).
Introduced by the European Environment Agency as a basis for their programme on environmental pressure indicators, it is evolved from the PSR model, where two further elements of the chain are identified: the driving forces that determine pressures and the

direct impacts of degradation of the state on society, impacts which in turn induce the feed-back. This integration is explained by the necessity of making indicators truly operational tools: in order to prevent Desertification is not sufficient to recognise the pressure factors, it is also necessary to act on the forces that drive them into the system; to mitigate, it is necessary to know how degradation of resources impacts on the social system.

DPSIR, Driving force / Technology / Pressure / State / Impact / Response, EEA (European Environment Agency).
This framework represents a further evolution of the PSR model, applicable to technological systems. The principle is the same: identify and characterise the elements of the system on which it is reasonably possible to act. In this case, it is assumed that the way in which driving forces are expressed as pressures is conditioned by technology: for example the increase in the number of vehicles (D) produces increased emissions (P) that degrade the atmosphere (S) conditioned by the technological level (T) of the vehicle themselves: D cannot be acted upon as it is an inevitable tendency, so it will be necessary to concentrate on T to reach the set target, for example, S.

The same approach can be applied to tackle the problem of degradation in rural environments caused by the mechanisation of agriculture. In this case the indicators of technological quality (adequately defined) applied to machinery, could become a key factor in understanding the system.

DPSIR-DPEW, Driving force / Pressure / State / Impact / Response - Descriptive indicators / Performance / Efficiency / Welfare, EEA (European Environment Agency)
In this latest approach the EEA couples DPSIR with another framework defined as "Typology of four Environmental Indicators" based on criteria of the ecological efficiency of human activities. They answer respectively the questions:
"what is happening ?", i.e. the indicators that detect processes in progress, for example emissions of pollutants in the atmosphere;
"is it important ?", i.e. the indicators of performance must indicate to what extent whatever is happening constitutes a problem;
"are we improving ? ", i.e. the indicators of efficiency, have to indicate to what degree of eco-efficiency are resources being used and if our efficiency shows a positive trend;
"how do we rate ourselves on the whole ?", a question requiring a general evaluation which could be provided by an indicator such as the "Gross domestic green product"

PSR-PDI Pressure / State / Response - Potential / Dynamics / Innovations (Hurni et al., 1999).
This framework developed in the Centre for Environmental Development (CDE) at Berne University, is perhaps the most modern amongst those mentioned. It constitutes a synthesis (that the authors define as "transdisciplinary") of multidisciplinary and Participatory approaches applied to mitigation of Desertification "syndromes"[3]. This framework also represents a dynamic approach (the present state of human, economic and natural resources must be described as a dynamic system, so the indicators must be appropriate for this type of use and an optimistic one (changes do not necessarily lead only to pressures on resources, but also to new potential and these can lead to innovations and creative solutions): only through the active implication of all social actors and in particular those who are the

[3]By the term "syndrome" the authors mean " unfavorable functional structures typically originating from interactions, in certain regions, between human society and the environment; they are characteristic constellations of natural and civilisational trends and their respective interactions, and can be identified in many regions of the world."

protagonists of change, can the pressure factors be controlled and the potential exploited.

IOOI Input / Output / Outcome / Impact, Observatory for the Sahara and the Sahel - OSS.
This framework has been put forward to facilitate the identification of CCD impact indicators and in general for monitoring and assessing natural resources management programmes: in particular it sheds light on the intermediary elements between the actions and the impacts. Input and output indicators serve to monitor the execution of a project (input refers both to the single activities in the project, and to the human and financial resources employed; output refers to the direct results; outcome and impact are used to describe the effects of the project's execution (outcome describes the level of enhancement achieved by the action undertaken with respect to the potential; impact is the concrete benefit produced or expected, for example the improvement in the standard of living of affected populations).

Criteria of spatial scales
The necessity of identifying indicators applicable to different spatial scales and to different environmental contexts is one of the fundamental problems of research on indicators. As underlined by Imeson (2000), the indicators proposed are often site-specific and so are not comparable; indicators focussing on processes are generally defined for a single spatial scale, but in some cases it may be demonstrated that a property of a system which at a scale of detail appears to be negative may be positive at a smaller scale. At other times, indicators at different scales are selected, but the relationships between the different scales of the environmental system are not clear, and consequently the resulting set of indicators cannot effectively be used to assess the state of degradation of the overall environmental system.
In general, with the same objective, different indicators are applied to the different spatial scales.
This is why great importance is sometimes attached to the criteria of scale and indicators are grouped together according to homogeneous scales. However, there is more than one way of subdividing spatial scale, in fact there are many ways, either special to the different scientific disciplines or linked to specific objectives and /or to particular working tools (for example a widely used framework reflects the potential of the different remote sensing platforms. Furthermore, systems based on criteria of physical regional sub-divisions are not really compatible with those of the geo-political type, which from the point of view of Desertification are no less important

Criteria of acquisition and/or measurement techniques criteria
Indicators are often grouped together according to the tools used for acquiring data and sometimes according to measurement techniques. For example it is common practice to consider indicators based on remote sensing data as forming a class of their own, which does not help the development of organic sets of indicators.

Other criteria are sometimes used: for example in institutional contexts, indicators may be classified primarily according to the economic-institutional sector involved (agricultural, industrial, commercial policies...).

5.4. Proposed classification framework

In this chapter 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". Fact sheet 5 presents a chart listing all the methodological information that should accompany a ready - for - use indicator.
The classification framework serves to facilitate the placement of available indicators into a rational framework. The chart indicates and describes all the information necessary to qualifying an indicator as such.
The task we set ourselves of drawing up this report on the state-of-the-art, led us to search all known sources of indicators pertaining to Desertification in the Mediterranean environment, to catalogue them according to criteria described below and to compile a descriptive data sheet for each one of them. The sources were mainly scientific publications and reports from international Agencies, Programmes and Seminars.
In fact, information available in literature was almost never sufficiently comprehensive to be used to fill in the data sheet, in some cases it was not even sufficient to determine with certainty the indicator's position with respect to the five general criteria proposed hereafter, this is why we decided, for the time being, to restrict ourselves to sufficiently characterised indicators only. For some of these, the full data sheet is presented in Annex II, as an example. In the second part of the same annex, a summary description is given of other indicators while some others are simply listed.

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 the following few subclasses 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. 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).

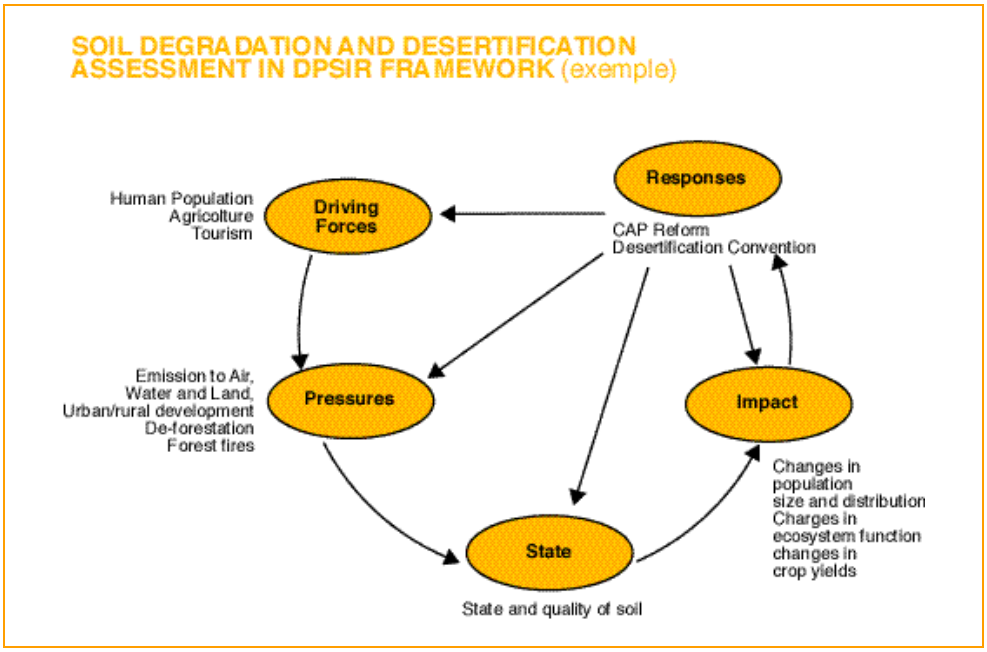
A special chapter (chapter 6) will be devoted to indicators designed for prevention of Desertification, for which there exist specific and recent studies. Obviously certain parameters can be indicators for each of the three objectives, but the manner in which they will be considered, the methods of measure, 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 (figure 5.I illustrates an example provided by the EEA applied to soil degradation).

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. Otherwise, the classification proposed for indicators discussed in Annex II is based exclusively on available information to qualify the indicator, even if insufficient at times, and on considerations of a very general nature; therefore they do not claim to be final, but rather to encourage further attempts at refinement.

Figure 5.1. Example of the DPSIR framework applied to soil degradation (EEA, in Gentile, 1998)



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 work, for physical regional sub-divisions, the framework proposed by Mitchell, 1991(reproduced in figure 5.2) 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 5.3 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 5.I Hierarchical classification of terrain, soil, and ecological units.

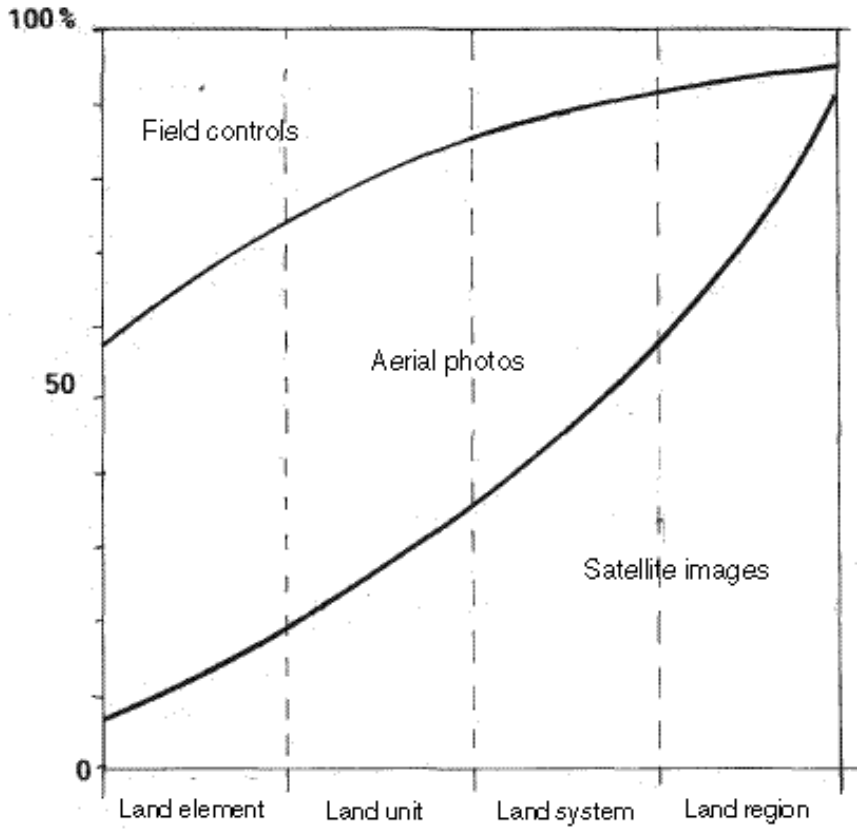
Hierarchical classification of terrain, soil, and ecological units

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 écologique*	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 component of a land system	Association	*Secteur écologique*	1:80 000– 1:200 000	
Land facet	Reasonably homogeneous 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 processes 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 5.3. 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**).

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.

5.4.1. 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 logical framework		driving force	pressure	state	impact	response
		D	P	S	I	R
Scale	space	station	local	sub-region	region	European Mediterranean region
		S	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		In 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

Framework for defining and characterising Desertification indicators

The Nucleo Ricerca Desertificazione wishes to promote a fully participative type of process for developing of indicators based on the methodology proposed by the Conference of Parties (described in chapter 4), in which organizations in possession of relevant knowledge, from the scientific to knowledge at all levels, will undertake to organise their experience systematically in order to come up with simple indicators so that they may be used by a wide range of users and be clearly and unequivocally interpreted. To this end the following methodological data sheet is being proposed to act as a guide and encouragement to the process.

1.Definition	
Name	Name (or acronym) of indicator
Brief definition	Brief definition of the indicator in relation to its purpose in the particular context in which it will be used.
Unit of measure	Unit of measure appropriate to quantifying the variations of the proposed indicator.
2. Position within the logical framework	
Type of indicator	Indicate to which category the indicator belongs within the logical framework (DPSIR,- Driving forces, Pressures, State, Impacts, Responses).
3. Target and political pertinence	
Objective / target of the indicator	Summary description of the main objective it is sought to achieve by using the indicator.
Palace within Agenda 21	Indicate in which chapter of Agenda 21 the indicator could ideally be placed, i.e. the "reason" for its existence. In the case of Desertification indicators this is chapter 12: Management of fragile ecosystems: combating Desertification and aridity. An indicator can also be relevant to other issues.
Importance with respect to sustainable development	Indicate if, how and at what scale the indicator could contribute to the elabo ration of sustainable development strategies, to understanding and monitoring trends and the efficiency of sustainable development policies.
International Conventions and agreements	Indicate other international agreements and conventions for which the use and design of the particular indicator can provide a significant contribution.
Secondary objectives of the indicator	Describe possible objectives other than the main ones mentioned above, to which the indicator could contribute.
Linkages with other indicators	Indicate, if relevant,the relationship between the indicator in question and other indicators (for example, within a same methodology, model or forecasting system) so as to better clarify both the context in which the indicator proves the most useful, and the ultimate target of the indicator itself.

4.Methodological description and basic definitions	
Definitions and basic concepts	Broad definition with reference to the nature of the indicator and its importance in relation to the state of the art of knowledge in the specific context (why this indicator and not another to reach the same assigned target).
Methods of measurement	Description of the methodology to be followed to measure, calculate and exploit the indicator.
Limits of the indicator	Describe the possible reasons for and conditions under which the indicator could not fulfil its purpose (for example, indicate at what spatial scale the indicator provides adequate information and explain why it cannot apply to a different scale).
The indicator within the DPSIR structure. (Driving forces, Pressures, State, Impacts, Responses).	Give the reasons for placing the indicator in one of the categories of the logical framework and indicate what other indicators should be placed in this category or in others, to complete the description of the system (for example, if an indicator of state is proposed for a process of soil salinisation, indicate, if possible, any other likely indicators of state applicable to this particular problem,and related pressure, response, etc. indicators, also providing information on the persons / organizations best able to define them thoroughly. inoltre informazioni circa le persone / organizzazioni in grado di definirli in modo compiuto).
Other definitions sometimes used.	Indicate, other names or definitions used for the same indicator if they exist.
5. Valutazione della disponibilità dei dati	
Data required to calculate the indicator culate	Give a detailed indication of the characteristics of data required to measure, cal- and elaborate the indicator.
Availability of data from national and international sources	Indicate whether the required data is easily available or not and specify if obtaining it is reasonably cost effective.
Data sources	Indicate the sources from which data can be gathered.
6. Institutions that have participated in developing the indicator	
Main institutions responsible for development	
Other contributing organizations	
7.Additional information	
Bibliography	
Other references	Internet addresses and other useful references
Contacts	Name and address of the organization that elaborated the indicator:person to contact.

Recent studies specifically devoted to the subject have mostly described three groups of indicators:

- Indicators of structural vulnerability, both of the biophysical (mostly climatic) and socio-economic type, with a predominance of the latter component, applicable at the scale of a geopolitical region or a single country.
- Indicators of physical vulnerability based on the major morpho-geopedological or bio-climatic units on the scale of the whole Mediterranean basin.
- Indicators of specific sensitivity / vulnerability of land to the main processes of degradation at play in the northern Mediterranean region, predominantly biophysical in nature and applicable at varying scales of detail, but mainly medium to small.

A common characteristic of this type of indicator is the fact that it belongs to an evaluation system in which each indicator possesses a specific relative weight in relation to the others. Therefore, the description of the individual indicators cannot disregard their position within their respective systems. This is why a separate chapter is devoted to prevention indicators.

6.1. Indicators of structural vulnerability

Even if the terminology has been borrowed from economic theory, it has been used also to indicate the series of Desertification risk factors linked to all land characteristics regarded as not easily modifiable over a brief or medium term period, or as being constant.
In a recently published approach (CeSIA - IATA, 1998) a few climatic and socio-economic indicators were proposed in combination as tools to classify "rural structural vulnerability" on the scale of the whole Mediterranean basin. A summary description of the evaluation system is given hereafter.

Model for the evaluation of rural structural vulnerability
To develop strategies for action at the regional level, the model considers climatic data (mean annual rainfall) and data of a socio-economic nature such as data on population composition and density and land used for agricultural purposes. Indicators are combined in the following manner: 1) In relating rainfall and agricultural areas the vulnerability of an agricultural zone may be determined with respect to the actual water resources available; 2) By relating the population density factor to the agricultural area, the vulnerability of an agricultural region can be determined in relation to human pressure; 3) By relating the population density factor to rainfall and agricultural areas, more complete information is obtained on the degree of a region's structural vulnerability.
By further integrating other basic climatic indicators (annual and seasonal temperature trend, variations is the advent of extreme events and soil surface temperature) it is possible to obtain a few comprehensive indices of vulnerability capable of predicting, for example, the length and the beginning of a productive season or the extent of biomass development.
On the regional level, these constitute the basis for identifying the areas in which priority action should take place.

6.2. Indicators of physical vulnerability

Many other studies have recently been devoted to factors of vulnerability at a small scale, but have concentrated only on the biophysical aspects.

Amongst these, some have attempted to model the incidence and the intensity of specific degradation processes, as for example CORINE (1992), for erosion risk in European Mediterranean countries.

Other studies have been carried out in the sphere of single disciplines. Amongst these, figure a study on the intrinsic vulnerability of soils in the major geomorphological regions of the Mediterranean (Yassoglou, 1999) and reports on the vulnerability, availability and renewal capacity of underground water resources in the Mediterranean basin as a whole, inventories of fragile ecosystems, etc.

6.3 Indicators of land sensitivity / vulnerability

These are systems of indicators developed mainly within major research projects like MEDALUS, or in the context of studies aimed at identifying areas at risk within the framework of the implementation of National Action programmes.

A detailed description shall be given hereafter of the ESA methodology (Environmental Sensitive Areas to Desertification: Kosmas et al., 1999), one of the most relevant results achieved by MEDALUS, and developed in four different "target areas" in Greece, Italy, Spain and Portugal, and more briefly, those proposed by the "Desertification Prone Areas" system developed by the Portuguese Action Committee and by the "Map of areas vulnerable to Desertification" presented by the Italian National Committee. Each of these systems is based on the use of Geographic Information Systems.

6.3.1. the Environmental Sensitive Areas to Desertification (ESAs)

The theoretical premises of this model can be summed up as follows:

The areas risking Desertification in the Mediterranean region are vulnerable for different reasons. In general they have a high natural vulnerability due to low precipitation, to the frequency of extreme events, to reduced vegetation cover, to the limited resistance of vegetation to drought, to steep slopes or highly erodible soils. But high vulnerability can also be linked to a type of land use and management in cases where inappropriate use of soils is encouraged in fragile areas.

The various types of areas sensitive to Desertification can be distinguished and mapped with the help of indicators capable of evaluating the capacity of land to tolerate degradation processes. Key indicators, used on the regional and national levels can be classified into four broad categories that define the quality of soil, climate, vegetation and land use management.

Soil quality indicators to define sensitive areas can be linked to (a) water storage capacity b) resistance to erosion. These qualities can be assessed by using simple properties or characteristics provided by ordinary soil surveys, such as depth, texture, drainage, characteristics of the parent rock, slope, and superficial stoniness.

The climatic risk conditions are those determining the major water shortages. Scarce precipitation, combined with high levels of evapotranspiration drastically reduces the soil moisture content available for plant growth. The quantity and the distribution of

rainfall can be the main determining factors of biomass production.
Key indicators of Desertification linked to existing natural or agricultural vegetation can be considered in relation to the percentage of vegetation cover, to the fire risk and to the vegetation's capacity to recover, to its protective function against erosion and its resistance to drought.
Finally with regard to vulnerability to human activities, obviously any type of soil management is conditioned by the influence of environmental, social, economic, technological and political factors. Depending on the type of management, soil resources are subject to a varying degree of stress. Furthermore, the application of environmental policies to an area moderates the predicted impacts of a given type of land use, with respect to what the situation would be if these policies were not applied.
The methodology adopted for evaluation comprises two phases;

- calculation of the four indices, SQI (Soil Quality Index), CQI, (Climate Quality Index), VQI (Vegetation Quality Index) and MQI (Management quality index);
- combination of the four indices obtained into the ESAI synthetic index = $(SQI*CQI*VQI*MQI*)^{1/4}$.

At the end of this second phase, the synthetic result will be placed into one of the four classes of ESAs:

- **Critical ESAs** are already highly degraded areas due to preceding mismanagement and constitute a threat for the environment of surrounding areas. For example, highly eroded areas subject to strong superficial flows and loss of sediments;
- **Fragile ESAs** are areas in which any change that could alter the delicate balance between natural resources and human activities could, most probably, lead to Desertification. For example, the areas in which warming due to the green-house effect causes an increase in arid conditions, thus to a reduction of vegetation cover, and finally to an increase in erosion processes.
- **Potential ESAs**, which are areas at risk of Desertification, only if significant climate changes or particular combinations of land use take place. Abandoned land, which was not properly managed in the past, can fall into this category. Also the use of these areas must be carefully planned, despite the fact that conditions are better than in the preceding class.
- Non affected areas.

In the first phase, each index is calculated on the basis of variables (or indicators), the values of each one having previously been assigned a score. The result is the following:.

A **Soil Quality Index**, obtained in its turn by means of the formula figuring below, from a texture index, an index attributed to the type of parent rock, an index of superficial stoniness, a depth index, one of slope and one relative to drainage:
SQI = $(texture*parent\ rock*superficial\ stoniness*depth*slope*drainage)^{1/6}$
A **Climate Quality Index**, obtained as above, from a rainfall index, an aridity index and one relative to terrain aspect;
CQI=$(precipitation*aridity*aspect)^{1/3}$
A **Vegetation Quality Index**, similarly obtained by a fire risk index, an erosion protection one, one referring to resistance to aridity and another to vegetation cover;

VQI= (fire risk*erosion protection*resistance to aridity*vegetation cover)$^{1/4}$
A **Soil Management Quality Index**, also derived from several indices: intensity of land use and implementation of environmental protection and conservation policies.
MQI= (intensity of land use*policies applied)$^{1/2}$

In all, the model uses 15 indicators (6 for soil, 3 for climate, 4 for vegetation, 2 for management).

To each of these, the ESA method attributes a score according to specific criteria that take into account the relative weight of the variables. Reference tables should be used for this, and readers can refer to them in the work cited in the bibliography (Kosmas et al 1999).

Another common characteristic of these indicators is that the spatial variability of each of them has to be mapped at a scale compatible with the one intended for the final output, so that all the layers of information can be inserted into a Geographic Information System to carry out the mathematical operations mentioned above.

In view of the nature of the information required for the evaluation, it is most effectively applicable only at a medium to large scale of detail (from local, up to scales in the order of 1:100000).

The case of Val d'Agri
As mentioned, the model was used and tested in four target areas; in one of these, the Agri Basin in Basilicata, it was thought necessary to introduce some modifications, in view of the physical and socio-economic characteristics peculiar to the region.
The difference refers mainly to the assignment of scores to some of the variables (reason for which readers are referred to the work mentioned in the bibliography) and a different definition of socio-economic type indicators. Here, some aspects of a demographic nature are given particular relevance such as the ageing population, the level of illiteracy, the number of pensioners and the level of occupation.
The choice is justified by the particular situation of Val d'Agri, although it could be representative of many regions of southern Italy. In fact, there exists a strong demographic imbalance in the region (one child for every 10 elderly people) and the population's low level of school education, the high proportion of retired persons and the lack of any prospect of finding a source of well being in the area is resulting in land abandonment. The other fundamental index is that of occupation: in fact it is closely related to the large number of agricultural jobs, due to a choice dictated by the lack of any valid alternative.

6.3.2 Desertification prone areas (Portuguese Action Programme)

The following system of evaluation is contained in the Portuguese National Action Programme and its main objective is to identify Desertification prone areas, with particular reference to the degradation of soil and water resources.
It is based on a multiplicative combination of three different indices within a Geographic Information System.

- the first of these indices, the climate index, is the one indicated by the Convention as an index enabling a region to be placed in the category of an area at risk of desertification.

It is defined as the P/ETP ratio between average annual precipitation and average annual evapotranspiration calculated with Penman's formula. The benchmark values are those indicated by the Convention: < 0.5 for arid or semi-arid zones; between 0.5 and > 0.65 for dry sub-humid areas; 0.65 for humid zones. By definition, only arid, semi-arid, dry-sub-humid areas are considered to be potentially at risk.

- the second index gives a measure of potential soil loss due to erosion, caused by precipitation, to vegetation cover, to the type of soil and the slope.
- the third index provides a description, on the regional level of the frequency and intensity of drought. It is characterised on the basis of three different parameters;

- water deficit understood both as a measure of the "magnitude" of drought (water scarcity below a certain threshold), and as a measure of "severity" (maximum water deficit to mean water deficit ratio);
- the average number of drought years (number of drought years to total years number ratio).
- average of all areas suffering from drought (which is a measure of the extent of the phenomenon).

For each of these indices appropriate time-scales are proposed with relative coefficients of vulnerability. The coefficients calculated for the various layers of information are multiplied amongst each other in the final phase of elaboration.
All data used in this methodology, digital or mapping are part of the Portuguese water resources information system (SNIRH).

6.3.3. Map of areas vulnerable to Desertification (Italian National Action Committee)

The identification of areas sensitive to Desertification in our country was done by a "Working group on areas vulnerable to Desertification" set up by the Italian National Action Committee. The Committee proposed that the identification of vulnerable areas should proceed in two distinct phases: a summary survey at national scale, followed by more detailed investigation of the individual regions and catchment areas concerned. The working group proposed a minimum set of 4 indicators of vulnerability to make an assessment at national scale, with reference to the four components: climate, soil, vegetation, human pressure (Loguercio, 1999).
As regards the climatic vulnerability index, the one proposed by the Convention was adopted: vulnerable areas are those with an arid, semi-arid, dry-sub-humid climate, i.e. with a P/EP ratio (mean annual precipitation and mean potential evapotranspiration) below 0.65.
With respect to soil vulnerability, the soil moisture regime, defined according to the criteria of the United States Soil Survey Staff, is proposed as an indicator based on the following assumption: soils with a moisture regime consistent with the most arid classes (from udic to xeric to xeric-torric) are to be considered most vulnerable.
As for the vegetation component, the classes of the Corine Land Cover Map were rearranged so as to distinguish the various degrees of vulnerability connected to different typologies of cover/soil use.

In the case of human pressure, vulnerable areas were identified as such, in as far as they are subject to strong human pressure, if between 1981 and 1999 they registered a significant demographic variation, either in the negative or in the positive sense. The threshold values of 20% and 40% were put forward to discriminate amongst population variations that to a more or less great extent may induce a process of land degradation.

These indicators are not generally included in evaluation systems such as the ones mentioned in the preceding chapter, but are developed as the need arises according to different approaches and objectives.
Some amongst those sufficiently defined by their respective authors are described in the data Sheets included in Annex II; some others are described in tables and synthetic lists.

Number:					**1**
Indicator name:					POPULATION DENSITY - Indicator of agricultural structural vulnerability
Authors:					Maracchi et al.
Synthetic classification:	S	P	M/R - s	SE	B

1. Definition	
Name	Population density
Brief definition	Number of inhabitants per surface unit within an administrative region
Unit of measure	Number of inhabitants per Km^2 (inh/Km^2)
2. Position in the logical framework	
Type of indicator	Pressure (DPSIR framework)
3. Target and political pertinence	
Objective / target of the indicator	Contribution to prevention of land degradation or Desertification on the scale of the Mediterranean basin.Within the agricultural structural vulnerability model proposed by Maracchi et al (1998),for the moment applicable only to the North African region of the Mediterranean basin,population density is combined with the annual or seasonal precipitation trend and with the agricultural area in order to provide information on the structural vulnerability of a given area.
Position within Agenda 21	Chapter 12 - Management of fragile ecosystems:combating Desertification and drought
Importance with respect to sustainable development	This type of indicator constitutes a tool for socio-economic analysis, which at different scales, local,national regional and global,serves to identify the fragility of an area on the basis of the human pressure to which it is subjected.
Linkages with other indicators	To elaborate strategies for action at the regional level,the model also considers climatic data (annual and seasonal rainfall trend,annual and seasonal temperature trend, variation in the advent of extreme events and soil surface temperature) and data on land reserved for agricultural purposes.
Secondary objectives of the indicator	
International Conventions and agreements	The CCD emphasises the fact that combating Desertification must be tackled within the general framework of actions to promote sustainable development
4. Methodological description and basic definition	
Definition and basic concepts	Population density is an indicator of how population is distributed within a given administrative region.On the southern shore of the Mediterranean,where this indicator was developed,there are both completely unpopulated zones and zones with more than 1000 inh/km2(especially the costal zones and the Nile valley).Obviously, extremely high concentrations such as the one mentioned,make the affected zone particularly sensitive even to the slightest agro-climatic variation.
Method of measure	Within the model,the authors identify 8 classes of density (<10,10-25,25-50,50-100,100-200,200-400,400-800,>800 inh/Km2) corresponding to increasing human pressure and consequently to increasing vulnerability of the land.
The indicator within the DPSIR structure (Driving forces, Pressures, State, impacts, Responses)	The indicator is closely correlated to the level of human pressure to which as area is subjected. Therefore, within the DPSIR framework,it is to be treated as a factor of Pressure.
Limits of the indicator	Linked mainly to the difficulty of applying the same classification in different socio-economic contexts. If it is true that on the southern shore of the Mediterranean increasing human pressure leads to an ever increasing exploitation of natural resources, leading to the risk of Desertification,often on the northern shore the contrary applies:in fact, abandonment of marginal land is one of the main problems causing an intensification of land degradation processes.
Other definitions sometimes used.	
5. Evaluation of data availability	
Data required for calculating the indicator	National level demographic statistics.
Availability of data from national and international sources	The necessary data is easily available and accessible at relatively low cost.
Data sources	Data banks available in the main national institutions concerned with statistics.
6.Institutions that have participated in developing the indicator	
Main institutions responsible for the development	CeSIA - Accadmia dei Georgofili IATA – National Research Council
Other contributing organisations	

7. Informazioni accessorie	
Bibliography	CeSIA - Accademia deil Gergofili,IATA - National Research Council, 1998.Classification de la vulnérabilité structurelle. Une demo à partir d'Internet.In: Workshop Proceedings of:Desertification information system for planning needs in the Mediterranean region,Marrakech (Morocco),November 9-13. Maracchi G.,Di Vecchia A.,De Filippis T.,Gozzini B.,Meneguzzo F., Tarchiani V., Vignaroli P.,Zipoli G.,1998. Climate indicators for Desertification monitoring.Proceedings of the International Seminar held in Porto Torres, Italy 18-20 September, 1998:pp. 37-44.
Other references	
Contacts	Maracchi G. - LaMMA, Via A.Einstein n.35B, 50145 Florence, Italy.

Number:					**2**
Indicator name:					ROCK FRAGMENTS - ESAs, soil quality indicators
Authors:					Kosmas et al
Synthetic classification:	P	S	S/Sr - s	S	F

1. Definition	
Name	Rock Fragments
Brief definition	Quantity of stones or pebbles present on the soil surface per unit of surface area
Unit of measure	Percentage value (%) of the land surface area covered by such material.
2. Position in the logical framework	
Type of indicator	State (DPSIR framework)
3. Target and field of policy	
Objective / target of the indicator	Contribution to defining and mapping of ESAs (Kosmas et al.,1999) through the definition of a Soil Quality Index.
Position within Agenda 21	Chapter 12.Management of fragile ecosystems:combating Desertification and drought.
Importance with respect to sustainable development	This indicator is part of a set of tools to identify and mitigate land degradation developed in the different Medalus target areas. Together with the other indicators of soil vulnerability, it contributes to producing a scale of soil quality and consequently to elaborate development strategies compatible with the resources available in the given area.
Linkages with other indicators	The indicator is combined with other indicators referring to the type of parent material,the texture, soil depth,slope, and drainage to obtain a single Soil Quality Index.
Secondary objectives of the Indicator	Within the ESAs model: a) Investigation of single processes linked to land degradation and to Desertification;b) development of countermeasures and strategies for protecting land from Desertification and promoting sustainable development;c) comparison with the physical-environmental characteristics of target areas.
Conventions and international agreements	The CCD emphasises the fact that combating Desertification must be tackled in the general framework of actions to promote sustainable development.
4. Methodological description and basic definition	
Definition and basic concepts	Rock fragments have a relevant but variable effect on run-off and soil erosion,on water conservation and on biomass production,and so have an important role to play in the protection of soils in the Mediterranean region.Generally, run-off and sediment loss are greater in stony soils than in soils containing no stones, but for soils rich in superficial coarse fragments and subjected to intense rain,as is typical of the Mediterranean,the overall effect is a protective one (less splash impact,greater slope rugosity).Moreover, stones have a beneficial effect on soil moisture conservation in conditions of moderate moisture stress such as exists in spring and early summer, the most important periods for winter crops productivity. The presence of stones can be very positive, in particular in drought years, to store substantial quantities of water accumulated in preceding periods or absorbed during the night and to protect,therefore, extensive areas from Desertification.Stony soils, despite their usual low productivity, can supply considerable quantities of previously accumulated water to plants under stress and allow adequate production of biomass during dry years.
Method of measure	In the present context,a quantitative measurement is made of the rock fragment content.By means of field sampling, the quantity of fragments is expressed as a percentage (%) of covered soil surface. On this basis the soils are divided into three classes:very stony (>60%),stony (20-60%) and bare to slightly stony (<20%).Each class has a score assigned to it,which contributes to calculating the Soil Quality Index.
The indicator within the DPSIR structure (Driving forces, Pressures, State, Impacts, Responses)	Within the DPSIR framework,this indicator should be considered a factor of State. In referring to a soil property linked to degradation and Desertification processes, it influences two principal parameters, which are the soil's capacity to store and retain water and resistance to erosion.Naturally, for a comprehensive description of the system other parameters, of state also, will have to be taken into account, such as the parent rock,the percentage of rock fragments, depth,drainage capacity, slope etc.
Limits of the indicator	The limits of the indicator's applicability are closely linked to the measurement modalities (estimation) of superficial stoniness, which is always done visually and is station-based (reduced portions of surface area) and to the way in which the station-specific data is scaled spatially. In the absence of soil maps able to adequately describe the spatial distribution of the variable on the working scale, geostatistical techniques can be applied.In very general terms, the efficiency of these techniques diminishes as the scale and the number of samples (station based estimation) diminishes. The most appropriate spatial scales are from station to local; at a lesser scale the contribution of this indicator might be uncertain.Other problems refer to data availability (see below).
Other definitions sometimes used	

5. Evaluation of data availability	
Data required to calculate the indicator	Soil map ensuring that for the parameter under consideration,there exists a sufficient degree of homogeneity within the map units, in relation to the working scale and the objectives in terms of accuracy.
Availability of data from national and international sources	Various soil maps:they exist at every scale, territorial coverage is discontinuous and they have been drawn up according to different approaches and criteria;there exists no single, comprehensive catalogue.
Data sources	European Soil Information System-EUSIS (digital and available upon request):European Soil Map scale 1:1000000; European Soil Map 1:250000 (in process of completion);data bank with station-based samples. FAO / ISRIC (SOTER, GLASOD, etc.) Data banks, Other national or regional data banks
6.Institutions that have participated in development of the indicator	
Main institutions responsible for development	Agricultural University of Athens
Other contributing organizations	Universities of Lisbon,Murcia,Basilicata,Amsterdam,Leeds.
7.Additional information	
Bibliography	Kosmas C.,Kirkby M., Geeson N..[EDS] (1999). The Medalus Project,Mediterranean Desertification and land use. Manual on key indicators of Desertification and mapping environmentally sensitive areas to Desertification.EUR 18882.
Other references	Kosmas C.,1998.Qualitative indicators of Desertification.Proceedings of the International Seminar held in Porto Torres, Italy 18-20 September, 1998:pp. 81-100.
Contacts	Agricultural University of Athens Scientific responsibility:Dr Constantinos Kosmas Address:Laboratory of Soils and Agricultural Chemistry, Iera Odos 75,Botanikos 11855,Athens GR Telephone/fax:(30) 1 529 4097 Email L Isos2kok @audec.aua.gr

Number:					**3**
Indicator name:					SOIL DEPTH - ESAs, Soil Quality Indicators
Authors:					Kosmas et al.
Synthetic classification:	P	S	S/Sr - m	S	F

1.Definizione	
Name	Soil depth
Brief definition	Soil depth is the depth of the profile taken from the soil surface to the lithic or paralithic contact (i.e. with a horizon preventing the penetration of roots and traditional ploughing instruments).
Unit of measure	Centimetres
2. Position in the logical framework	
Type of indicator	State (DPSIR framework)
3. Target and field of policy	
Objective / target of the indicator	Contribution to the definition and mapping of ESAs (Kosmas et as.,1999) through the definition of a Soil Quality Index.
Position within Agenda 21	Chapter 12 - Management of fragile ecosystems;combating Desertification and drought.
Importance with respect to sustainable development	This indicator is part of a set of tools to identify and mitigate land degradation developed in the different Medalus target areas. Together with the other indicators of soil vulnerability, it contributes to producing a scale of soil quality and consequently to elaborate development strategies compatible with the resources available in the given area.
Linkages with other indicators	The depth indicator is combined with other indicators referring to the type of parent material,rock fragments, texture, slope and drainage, to obtain a single Soil Quality Index.
Secondary objectives of the Indicator	Within the ESAs model: a) Investigation of single processes linked to land degradation and to Desertification;b) development of countermeasures and strategies for protecting land from Desertification and promoting sustainable development;c) comparison with the physical-environmental characteristics of target areas.
Conventions and international agreements	The CCD emphasises the fact that combating Desertification must be tackled in the general framework of actions to promote sustainable development.
4. Methodological description and basic definition	
Definition and basic concepts	Soil depth is the depth of the profile extending from the soil surface to the lithic or paralithic contact.Because even small variations of such a parameter influence the soil's capacity to accumulate and store water and its resilience with respect to erosion processes, the author proposes four classes of depth:deep (>75cm),moderate(75-30 cm),shallow (15-30cm) and very shallow (<15). These classes are assigned a score that goes from 1 for the "deep"class to 4 for the "very shallow"class. This score, multiplied by the others referring to texture, rock fragments, slope, parent rock and drainage, will form the Soil Quality Index
Method of measure	Depth is estimated by digging holes into the ground with the appropriate drill until the lithic or paralithic layer is reached. This depth is expressed in centimetres. The correct sampling method is reported within protocols that are internationally valid.
The indicator within the DPSIR structure (Driving forces, Pressures, State, Impacts, Responses)	In the DPSIR system soil depth must be considered a factor of State.
Limits of the indicator	Like all soil parameters derived from station samples, the major limitation to the use of the indicator consists of the difficulty of spatial interpolation.In the absence of soil maps able to adequately describe the spatial distribution of the variable on the working scale, geostatistical techniques can be applied.In very general terms the efficiency of these techniques diminishes as the scale and the number of samples (a quick drill or a profile) diminishes. The most appropriate spatial scales are from station to local;at a lesser scale the contribution of this indicator might be uncertain. Other problems refer to data availability (see below).
Other definitions sometimes used	

5. Evaluation of data availability	
Data required to calculate the indicator	Soil map ensuring that for the parameter under consideration, a sufficient degree of homogeneity exists within the map units, in relation to the working scale and the objectives in terms of accuracy. It is what is most often used. Or a set of georeferenced station based data to process with geostatistical techniques.
Availability of data from national and international sources	Various Soil Maps:they exist at every scale, territorial coverage is discontinuous and they have been drawn up according to different approaches and criteria;there exists no single,comprehensive catalogue. There exist only a few data banks containing georeferenced punctual samples, data is not much standardized and is difficult to gather.
Data sources	European Soil Information System- EUSIS (digital and available upon request):European Soil Map scale 1:1000000; European Soil Map 1:250000 (in process of completion);data bank with station-based samples. FAO / ISRIC (SOTER,GLASOD, etc.) data banks. Other national or regional data banks
6. Institutions that have participated in development of the indicator	
Main institutions responsible for development	Agricultural University of Athens
Other contributing organisations	Universities of:Lisbon,Murcia,Basilicata,Amsterdam,Leeds.
7.Additional information	
Bibliography	Kosmas C.,Kirkby M.,Geeson N..[EDS] (1999). The Medalus Project,Mediterranean Desertification and land use. Manual on key indicators of Desertification and mapping environmentally sensitive areas to Desertification.EUR 18882
Other references	Kosmas C.,1998.Qualitative indicators of Desertification.Proceedings of the International Seminar held in Porto Torres, Italy 18-20 September, 1998:pp. 81-100.
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Number:					**4**
Indicator name:					SLOPE - ESAs, Soil quality indicator
Authors:					Kosmas et al.
Synthetic classification:	P	S	S to R - s	S	F

1.Definition	
Name	Slope
Brief definition	Slope is the degree of deviation from horizontal between two points on the surface of the land.
Unit of measure	Percentage value
2. Position in the logical framework	
Type of indicator	State (DPSIR framework)
3. Target and field of policy	
Objective / target of the indicator	Contribution to the definition and mapping of ESAs (Kosmas et al.,1999) through the definition of a Soil Quality Index
Position within Agenda 21	Chapter 12 - Management of fragile ecosystems:combating Desertification and drought.
Importance with respect to sustainable development	This indicator is part of a set of tools to identify and mitigate land degradation,developed in the different Medalus target areas. It is a fundamental parameter, as it is the main factor controlling soil erodibility. Together with the other indicators of soil vulnerability, it contributes to forming a scale of soil quality and consequently to elaborate development strategies compatible with the resources available in the given area.
Linkages with other indicators	The slope indicator is combined with other indicators referring to the type of parent material,rock fragments, soil depth, texture and drainage, to obtain a single Soil Quality Index.
Secondary objectives of the Indicator	Within the ESAs model: a) Investigation of single processes linked to land degradation and to Desertification;b) development of countermeasures and strategies for protecting land from Desertification and promoting sustainable development;c) comparison with the physical-environmental characteristics of target areas.
Conventions and international agreements	The CCD emphasises the fact that combating Desertification must be tackled in the general framework of actions to promote sustainable development.
4. Methodological description and basic definition	
Definition and basic concepts	Slope is the degree of deviation from the horizontal between two points on the land surface. It has to be taken into consideration because of its consequences on erosion (the steeper the slope, the greater will be erosion due to increased speed of surface run-off water) and on the capacity of water to infiltrate the soil (the steeper the slope, with equal quantities of water and rain intensity, the lower will be the percentage of moisture contained in the soil)
Method of measure	The slope is measured with the help of topographic maps and land is classed into 4 classes of slopes:very gentle to flat (<6%);gentle (6-18%);steep (18-35%);very steep >35%).A score is attributed to each of these, which will be taken into account to calculate the Soil Quality Index.
The indicator within the DPSIR structure (Driving forces, Pressures, State, Impacts, Responses)	In the DPSIR system this indicator is considered a factor of State. In fact,referring to the soil property that influences degradation and Desertification processes, it acts on two main parameters, which are the soil's capacity to accumulate and store water and resistance to erosion.Of course, to give a comprehensive description of the system other parameters, also of state, will have to be considered such as the parent rock,the % of stones, depth,drainage capacity, texture etc.
Limits of the indicator	The indicator is simple and easy to manage with GIS technology, obtained automatically from a DTM (Digital Terrain Model).In this sense, the limits of the indicator lie in the effort that has to be made to acquire the necessary data in digital format.In any case, from the scale of 1:100000 there now exists comprehensive DTM coverage of vast regions of the world,including Italy.
Other definitions sometimes used	
5.Evaluation of data availability	
Data required to calculate the indicator	The necessary data can be obtained from topographic maps. The GIS elaboration implies making a digital model of the terrain.
Availability of data from national and international sources	There are topographic maps at many different scales with total coverage of extensive regions:they are easily found and available at fairly reasonable cost.
Data sources	National Mapping Agencies

6.Institutions that have participated in development of the indicator	
Main institutions responsible for development	Agricultural University of Athens
Other contributing organizations	Universities of:Lisbon,Murcia,Basilicata,Amsterdam,Leeds
7.Additional information	
Bibliography	Kosmas C.,Kirkby M.,Geeson N..[EDS] (1999). The Medalus Project,Mediterranean Desertification and land use. Manual on key indicators of Desertification and mapping environmentally sensitive areas to Desertification.EUR 18882
Other references	Kosmas C.,1998.Qualitative indicators of Desertification.Proceedings of the International Seminar held in Porto Torres, Italy 18-20 September, 1998:pp. 81-100.
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Number:					**5**
Indicator name:					RAINFALL-ESAs, Climate quality indicator
Authors:					Kosmas et al.
Synthetic classification:	P	S	L to R - s	C	B

1. Definition	
Name	Rainfall
Brief definition	The term rainfall is understood as mean annual precipitation
Unit of measurement	Millimetres
2. Position in the logical framework	
Type of indicator	State (DPSIR framework)
3. Target and field of policy	
Objective / target of the indicator	Contribution to the definition and mapping of ESAs (Kosmas et al.,1999) through the definition of a Climate Quality Index
Position within Agenda 21	Chapter 12 – Management of fragile ecosystems;combating Desertification and drought
Importance with respect to sustainable development	This indicator is part of a set of tools to identify and mitigate land degradation;developed in the different Medalus target areas. It is a fundamental parameter, on the one hand because it is the primary factor of soil erosion and on the other because of its influence on the development of vegetation. Together with the other climate indicators, it contributes to forming a scale of climate quality and consequently to the elaboration of development strategies compatible with the resources available in the given area.
Linkages with other indicators	Rainfall is combined with aridity and with aspect in order to form a Climate Quality Index
Secondary objectives of the Indicator	Within the ESAs model: a) Investigation of the individual processes linked to land degradation and Desertification; b) development of counter-measures and strategies to protect land from Desertification and to promote sustainable development;c) comparison with the physical-environmental characteristics of other target areas.
Conventions and international agreements	The CCD emphasizes the fact that combating Desertification must be tackled within the general framework of actions to promote sustainable development.
4. Methodological description and basic definition	
Definition and basic concepts	The scarcity of precipitations, their irregular annual and interannual distribution,the extreme events and the out-of-season rainy and vegetative periods in the semi-arid and arid zones of the Mediterranean are the main climatic factors contributing to land degradation since they give rise to intense erosion in places where soils present an intrinsic vulnerability. It is predicted that global climate change will increase the present extent of vulnerable zones in the Mediterranean. Rainfall in particular is a primary factor determining the average water available for natural vegetation and crops. Other factors being the same, "drier" areas are to be considered more fragile, also because of the greater inputs required for agricultural use.
Method of measurement	The rainfall parameter is easy to quantify with the help of a pluviometer and pluviograph.Within the ESAs model,three rainfall classes have been identified (>650mm, 280-650mm,<280mm) and each one has a score ascribed to it.
The indicator within the DPSIR structure (Driving forces, Pressures, State, Impacts, Responses)	Since this indicator refers to a climatic condition that is typical of the area under study it must be considered as being an indicator of State within the DPSIR framework.
Limits of the indicator	The quality of the indicator depends on the number and distribution of the rain monitoring stations over the area. Since rainfall is very variable in time and in space, to obtain mean monthly, seasonal and annual values in a determined area, the stations have to be evenly distributed across the country.
Other definitions sometimes used	
5. Evaluation of data availability	
Data required to calculate the indicator	Data required is annual rainfall statistics available from the various stations situated in the area under study, on the basis of series spanning at least a period of 30 years.
Availability of data from national and international sources	The necessary data is usually available and accessible and the cost/benefit ratio is reasonable.
Data sources	Data can be obtained from various regional,national or international institutions involved in collecting and elaborating such data.

6. Institutions that have participated in development of the indicator	
Main institutions responsible for development	Agricultural University of Athens
Other contributing organisations	Universities of:Lisbon,Murcia,Basilicata,Amsterdam,Leeds.
7.Additional information	
Bibliography	Kosmas C.,Kirkby M.,Geeson N.[EDS] (1999). The Medalus Project,Mediterranean Desertification and land use. Manual on key indicators of Desertification and mapping environmentally sensitive areas to Desertification.EUR 18882
Other references	Kosmas C.,1998.Qualitative indicators of Desertification.Proceedings of the International Seminar held in Porto Torres, Italy 18-20 September, 1998:pp. 81-100.
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Number:					**6**
Indicator name:					ARIDITY - ESAs Climate Quality Indicators
Authors:					Kosmas et al.
Synthetic classification:	P	S	L to R - s	C	B

1.Definition	
Name	Aridity Index
Brief definition	Bagnouls-Gaussen Aridity Index
Unit of measure	a-dimensional index
2. Position in the logical framework	
Type of indicator	State (DPSIR framework)
3. Target and field of policy	
Objective / target of the indicator	Contribution to the definition and mapping of ESAs (Kosmas et al.,1999) through the definition of a Climate Quality Index.
Position within Agenda 21	Chapter 12 – Management of fragile ecosystems:combating Desertification and drought.
Importance with respect to sustainable development	This indicator is part of a set of tools to identify and mitigate land degradation;developed in the different Medalus target areas. The Bagnouls-Gausssen diagram compares the annual temperature regime with that of rainfall. Together with rainfall and aspect indicators, it contributes to forming a scale of climate quality and consequently to elaborating development strategies compatible with the resources available in the given area.
Linkages with other indicators	The aridity index is combined with rainfall and aspect to form a Climate Quality Index
Secondary objectives of the Indicator	Within the ESAs model: a) Investigation of the individual processes linked to land degradation and Desertification; b) development of counter-measures and strategies to protect land from Desertification and to promote sustainable development;c) comparison with the physical-environmental characteristics of other target areas.
Conventions and international agreements	The CCD emphasizes the fact that combating Desertification must be tackled within the general framework of actions to promote sustainable development.
4. Methodological description and basic definition	
Definition and basic concepts	Aridity is a critical factor in determining the evolution of natural vegetation. Water stress leads to a reduction in vegetation cover and to a modification in the composition of plant species in favour of the most resistant species. Mediterranean vegetation presents a great capacity to adapt and resist to arid conditions. Most of the species it is constituted by are able to survive prolonged drought and soil moisture content below the theoretical wilting point for months at a time. Aridity is not only linked to rainfall but to the relationship between precipitation and evapotranspiration during the course of the year, so it is a limiting factor for biological activity. Other factors being the same, areas with greater aridity are to be considered more fragile, also because of the greater input required for agricultural use.
Method of measurement	The Bagnouls-Gaussen graph (ombrothermal) plots the months of the year on the horizontal and on the vertical rainfall and relative temperature (the scale of temperature values is double the scale given for rainfall). The Bagnoouls-Gaussen aridity index is defined according to the formula: n BGI= S (2ti - Pi)) k i=1 Where ti is the average air temperature during month i in oC, Pi is the total monthly rainfall in mm;k represents the percentage of months in which 2ti –Pi>0. Within the ESAs model 6 classes of aridity have been identified (<50,50-75,75-100,100-125,125-150,>150) and a score attributed to each of them.
The indicator within the DPSIR structure (Driving forces, Pressures, State, Impacts, Responses)	Since this indicator represents a climatic condition that is specific to the area under study, it must be considered a factor of State within the DPSIR framework.
Limits of the indicator	The quality of the indicator depends on the number and the distribution over the country of thermo-pluviometric stations in respect to the working scale and the length of the historical series of climatic data.
Other definitions sometimes used	

5. Evaluation of data availability	
Data required to calculate the indicator	The necessary data are annual temperature and rainfall statistics obtainable from the various stations situated in the area under study. Series of data over a sufficiently representative period (at least thirty years) are required.
Availability of data from national and international sources	The necessary data is usually available and at reasonably cost-effective conditions.
Data sources	Data can be obtained from various regional, national or international institutions involved in collecting and elaborating such data.
6.Institutions that have participated in development of the indicator	
Main institutions responsible for development	Agricultural University of Athens
Other contributing organisations	Universities of Lisbon,Murcia,Basilicata,Amsterdam,Leeds.
7.Additional information	
Bibliography	Kosmas C.,Kirkby M.,Geeson N..[EDS] (1999). The Medalus Project,Mediterranean Desertification and land use. Manual on key indicators of Desertification and mapping environmentally sensitive areas to Desertification.EUR 18882.
Other references	Kosmas C., 1998.Qualitative indicators of Desertification.Proceedings of the International Seminar held in Porto Torres, Italy 18-20 September, 1998:pp. 81-100.
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Number:					**7**
Indicator name:					FIRE RISK – ESAs Vegetation Quality Indicators
Authors:					Kosmas et al.
Synthetic classification:	P	S	L to R - s	V	F/RS

1.Definition	
Name	Fire Risk
Brief definition	Fire risk is determined by the particular composition of vegetation and therefore both by its flammability and combustion capacity and its capacity to recover after fire.
Unit of measure	A relative value assigned to different classes of vegetation cover (fire risk cannot be quantified in a simple manner, but it can be estimated on the basis of the flammability of the species present and the structure of the vegetation).
2. Position in the logical framework	
Type of indicator	State (DPSIR framework)
3. Target and field of policy	
Objective / target of the indicator	Contribution to the definition and mapping of ESAs (Kosmas et al.,1999) through the definition of a Vegetation Quality Index.
Position within Agenda 21	Chapter 12 – Management of fragile ecosystems:combating Desertification and drought.
Importance with respect to sustainable development	This indicator is part of a set of tools to identify and mitigate land degradation developed in the different Medalus target areas. Together with other vegetation vulnerability indicators, it contributes to producing a scale of vegetation quality and consequently to the elaboration of development strategies compatible with the resources available in the given area.
Linkages with other indicators	Fire risk is combined with plant cover, erosion protection drought resistance to define a Vegetation Quality Index.
Secondary objectives of the Indicator	Within the ESAs model: a) Investigation of the individual processes linked to land degradation and Desertification; b) development of counter-measures and strategies to protect land from Desertification and to promote sustainable development;c) comparison with the physical-environmental characteristics of other target areas.
Conventions and international agreements	The CCD emphasizes the fact that combating Desertification must be tackled within the general framework of actions to promote sustainable development.
4. Methodological description and basic definition	
Definition and basic concepts	Amongst the properties of vegetation,fire risk serves to indicate capacity to resist the destructive action of fire and to recover after the advent of fire.
Method of measure	Since fire risk is estimated on the basis of the type of vegetation present,the latter has to be accurately defined. Vegetation is thus defined on the basis of structure and dominant species (prevalence of maquis, shrubs, olive trees, conifers, deciduous oaks or evergreen oaks, annual species and also the prevalence of areas without vegetation). The incidence expressed in percentage of different species in a given area can be determined through the remote sensing techniques and field surveys. On the basis of this, four classes of fire risk were determined corresponding to as many typologies of vegetation:low (bare land,polyannual crops, annual crops such as maize, tobacco, sunflower); moderate (annual crops such as cereals or meadows, deciduous oaks, mixed deciduous and evergreen oaks, mixed Mediterranean maquis and evergreen forests):high (Mediterranean maquis);very high (conifer forests).A score is attributed to each class; the score is multiplied with the scores referring to erosion protection,drought resistance and plant cover to form a Vegetation Quality Index.
The indicator within the DPSIR structure (Driving forces, Pressures, State, Impacts, Responses)	Within the DPSIR framework fire risk should be considered as an indicator of State providing information on the vulnerability of vegetation to wildfires.
Limits of the indicator	These are linked to the highly simplified classification proposed:the third class (Med.maquis) comprises many typologies of maquis covering huge areas of the Mediterranean basin,which in this context are treated as if they were homogeneous. This is why the indicator seems principally suited to the medium/small scale, from sub-regional to regional.
Other definitions sometimes used	

5. Evaluation of data availability	
Data required to calculate the indicator	Data on the type of vegetation, defined on the basis of structure and dominant species in: 1) mixed Mediterranean maquis/evergreen forest;2) Mediterranean maquis; 3) permanent meadows; 4) annual meadows; 5) deciduous forests; 6) pine forests; 7) evergreen forests with the exception of pine forests; 8) polyannual evergreen crops; 9) polyannual deciduous crops; 10) annual cycle winter crops; 11) annual cycle summer crops; 12) bare land.
Availability of data from national and international sources	If data derives from field surveys their cost will be high. If, on the other hand it derives from the interpretation of aerial photographs the cost will be much more reasonable. If remotely sensed data from satellites is used, the cost for the moment is quite high, but it is likely to drop quite considerably, in the near future.
Data sources	Land cover maps with vegetation classes of the physionomical-structural type. Aerial photographs taken from public agencies (ex IGMI) and private ones. LANDSAT, SPOT,NOAA,etc.satellite images.
6.Institutions that have participated in development of the indicator	
Main institutions responsible for development	Agricultural University of Athens.
Other contributing organisations	Universities of:Lisbon,Murcia,Basilicata,Amsterdam,Leeds.
7.Additional information	
Bibliography	Kosmas C. Ferrara A.,Briassouli H.,Imeson I.,1999 Methodology for mapping ESAs to Desertification. The Medalus Project,Mediterranean Desertification and land use. Manual on key indicators of Desertification and mapping environmentally sensitive areas to Desertification.Edited by Kosmas C.,M.,Geeson N. EUR 18882.pp. 31-47
Other references	Kosmas C.,1998.Qualitative indicators of Desertification.Proceedings of the International Seminar held in Porto Torres, Italy 18-20 September, 1998:pp. 81-100.
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Number:					**8**
Indicator name:					EROSION PROTECTION -ESAs Vegetation Quality Indicators
Authors:					Kosmas et al.
Synthetic classification:	P	S	L to R - s	V	F/RS

1. Definition	
Name	erosion Protection
Brief definition	The degree of protection afforded by vegetation against the action of different erosive agents.
Unit of measure	Relative value assigned to different classes of vegetation cover (protection against erosion is not an easily quantifiable factor, but it can be estimated on the basis of the species present and the vegetation structure).
2. Position in the logical framework	
Type of indicator	State (DPSIR framework)
3. Target and field of policy	
Objective / target of the indicator	Contribution to the definition and mapping of ESAs (Kosmas et al.,1999) through the definition of a Vegetation Quality Index.
Position within Agenda 21	Chapter 12 – Management of fragile ecosystems;combating Desertification and drought.
Importance with respect to sustainable development	This indicator is part of a set of tools to identify and mitigate land degradation developed in the different Medalus target areas. Together with other vegetation vulnerability indicators, it contributes to producing a scale of vegetation quality and consequently to the elaboration of development strategies compatible with the resources available in the given area.
Linkages with other indicators	The capacity of vegetation to protect against erosion is combined with the extent of plant cover, fire risk and drought resistance of vegetation to define a Vegetation Quality Index.
Secondary objectives of the Indicator	Within the ESAs model: a) Investigation of the individual processes linked to land degradation and Desertification; b) development of counter-measures and strategies to protect land from Desertification and to promote sustainable development;c) comparison with the physical-environmental characteristics of other target areas.
Conventions and international agreements	The CCD emphasizes the fact that combating Desertification must be tackled within the general framework of actions to promote sustainable development.
4. Methodological description and basic definition	
Definition and basic concepts	In this context,protection against erosion is defined in terms of the capacity of the different vegetation formations present in the area under study to fulfil the function. Particular attention is given to:capacity of the shrub and tree components to attenuate the effect of rainfall on the soil and to slow down the surface flow of rain water on sloping ground; capacity of the grass component to impede run-off, the detachment and washing away of soil particles.
Method of measure	A simple definition is required of the vegetation,classified according to vegetation associations or crops present in the area under study, by means of remote sensing and field surveys. There are 5 distinct classes, corresponding to the different capacities of the different vegetation typologies to prevent erosion:very high (mixed Mediterranean maquis/evergreen forest); high (Mediterranean maquis, pine forests, permanent meadows, evergreen polyannual crops); moderate (deciduous forests);low (polyannual deciduous crops such as almond and fruit trees);very low (annual cycle crops such as cereals and annual meadows).Each of the 5 classes is assigned a score:the scores are multiplied with the scores of fire risk,drought resistance and plant cover indicators to form a Vegetation Quality Index.
The indicator within the DPSIR structure (Driving forces, Pressures, State, Impacts, Responses)	Within the DPSIR system,protection from erosion must be considered as a factor of State. In fact,as a property of vegetation linked to degradation and Desertification processes, it represents the capacity of vegetation to oppose the action of climatic agents responsible for soil erosion.
Limits of the indicator	These are linked to the high degree of simplification of the classifications proposed:in particular, many typologies of Mediterranean maquis, managed in very different ways, and covering vast areas of the Mediterranean basin figure in the class of Mediterranean maquis and they are treated in a homogeneous manner. For this reason the indicator is better suited to a medium scale, from local to regional.
Other definitions sometimes used	

5. Evaluation of data availability	
Data required to calculate the indicator	Information has to be obtained on the type of vegetation, defined on the basis of structure and dominant species of: 1) mixed Mediterranean smaquis/evergreen forests; 2)Mediterranean maquis; 3) permanent meadows; 4) annual meadows; 5)deciduous forests; 6) pine forests; 7) evergreen forests with the exception of pine forests; 8) polyannual evergreen crops; 9) polyannual deciduous crops 10) winter annual crops; 11) summer annual crops; 12) bare land.
Availability of data from national and international sources	If data results from field surveys their cost is high.If it derives from the interpretation of aerial photographs the cost is much more reasonable. If remotely sensed data from satellites is to be resorted to, their cost at present is quite high, but it will drop quite considerably in the near future.
Data sources	Land cover maps with vegetation classes of the physionomical-structural type. Aerial photographs taken from private and public agencies (ex.IGMI).LANDSAT, SPOT, NOAA satellite images. Planning type data surveys on crop quality are not longer reliable since they are not longer up-dated.
6.Institutions that have participated in development of the indicator	
Main institutions responsible for development	Agricultural University of Athens
Other contributing organisations	Universities of Lisbon,Murcia,Basilicata,Amsterdam,Leeds.
7.Additional information	
Bibliography	Kosmas C. Ferrara A.,Briassouli H.,Imeson I.,1999 Methodology for mapping ESAs to Desertification. The Medalus Project,Mediterranean Desertification and land use. Manual on key indicators of Desertification and mapping environmentally sensitive areas to Desertification.Edited by Kosmas C.,M.,Geeson N. EUR 18882.pp. 31-47
Other references	Kosmas C.,1998.Qualitative indicators of Desertification.Proceedings of the International Seminar held in Porto Torres, Italy 18-20 September, 1998:pp. 81-100.
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Number:					**9**
Indicator name:					DROUGHT RESISTANCE – ESAs, Vegetation Quality Indicators
Authors:					Kosmas et al.
Synthetic classification:	P	S	L to R - s	V	F/RS

1. Definition	
Name	Drought resistance
Brief definition	Resistance to aridity is determined by the capacity of vegetation species to resist serious or moderate water stress
Unit of measure	A relative value assigned to different classes of vegetation cover (this indicator cannot be quantified in a simple manner but can be estimated on the basis of the properties of the single species to resist under conditions of water scarcity even for prolonged periods.
2. Position in the logical framework	
Type of indicator	State (DPSIR framework)
3. Target and field of policy	
Objective / target of the indicator	Contribution to the definition and mapping of ESAs (Kosmas et al.,1999) through the definition of a Vegetation Quality Index.
Position within Agenda 21	Chapter 12 – Management of fragile ecosystems:combating Desertification and drought.
Importance with respect to sustainable development	This indicator is part of a set of tools to identify and mitigate land degradation developed in the different Medalus target areas. Together with other vegetation vulnerability indicators, it contributes to producing a scale of vegetation quality and consequently to the elaboration of development strategies compatible with the resources available in the given area.
Linkages with other indicators	Resistance to aridity is combined with plant cover, erosion protection and fire risk to form a Vegetation Quality Index.
Secondary objectives of the Indicator	Within the ESAs model: a) Investigation of the individual processes linked to land degradation and Desertification; b) development of counter-measures and strategies to protect land from Desertification and to promote sustainable development;c) comparison with the physical-environmental characteristics of other target areas.
Conventions and international agreements	The CCD emphasizes the fact that combating Desertification must be tackled within the general framework of actions to promote sustainable development.
4. Methodological description and basic definition	
Definition and basic concepts	Resistance to aridity is defined as the capacity of individual plant species or plant communities, to resist moisture stress, which is typical of arid and semi-arid environments. Since the response to a reduction in water availability leads to a reduction in the plant's above-ground surface and consequently to the leaf coverage index,the presence of species with a reduced capacity to tolerate water scarcity (or the absence of tolerant species) increases the probability of major erosion occurring with the arrival of the rainy season.But,the presence of species highly resistant to long periods of drought ensures an adequate ground cover.
Method of measure	The vegetation has to be classified on the basis of aridity-resistance characteristics of the individual species, of the plant communities, of the crops present,by means of field surveys or remote sensing.5 different classes have been defined corresponding to the differing resistance capacities of the different classes:very high (mixed Mediterranean maquis/evergreen forests, Mediterranean maquis;high (conifers, deciduous forest species, olive trees);moderate (poliannual tree crops such as vine, almond,fruit trees);low (polyannual meadows);very low (annual crops, annual meadows).A score is attributed to each of the 5 classes:the scores are multiplied with the scores of fire risk;erosion protection and plantcover indicators to form Vegetation Quality Index.
The indicator within the DPSIR structure (Driving forces, Pressures, State, Impacts, Responses)	Within the DPSIR system resistance to aridity must be considered as a factor of State. In fact,as a vegetation property linked to Desertification,it has an influence on the capacity of the vegetation component to oppose the action of erosive agents.
Limits of the indicator	They are linked to the high level of simplification of the proposed classification.
Other definitions sometimes used	

5. Evaluation of data availability	
Data required to calculate the indicator	Information has to be obtained on the type of vegetation,defined on the basis of structure and dominant species of: 1) mixed Mediterranean maquis/evergreen forests;2)Mediterranean maquis;3) permanent meadows;4) annual meadows;5)deciduous forests;6) pine forests;7) evergreen forests with the exception of pine forests;8) polyannual evergreen crops;9) polyannual deciduous crops 10) winter annual crops;11) summer annual crops;12) bare land.
Availability of data from national and international sources	If data results from field surveys their cost is high.If it derives from the interpretation of aerial photographs the cost is much more reasonable. If remotely sensed data from satellites is to be resorted to, their cost at present is quite high, but it will drop quite considerably in the near future.
Data sources	Land cover maps with vegetation classes of the physionomical-structural type. Aerial photographs taken from private and public agencies (ex. IGMI). LANDSAT, SPOT, NOAA satellite images.
6.Institutions that have participated in development of the indicator	
Main institutions responsible for development	University of Athens
Other contributing organisations	Universities of:Lisbon,Murcia,Basilicata,Amsterdam,Leeds
7.Additional information	
Bibliography	Kosmas C. Ferrara A.,Briassouli H.,Imeson I.,1999 Methodology for mapping ESAs to Desertification. The Medalus Project,Mediterranean Desertification and land use. Manual on key indicators of Desertification and mapping environmentally sensitive areas to Desertification.Edited by Kosmas C.,M.,Geeson N. EUR 18882.pp. 31-47
Other references	Kosmas C.,1998.Qualitative indicators of Desertification.Proceedings of the International Seminar held in Porto Torres, Italy 18-20 September, 1998:pp. 81-100.
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Number:					**10**
Indicator name:					PLANT COVER – ESAs, Vegetation quality indicators
Authors:					Kosmas et al.
Synthetic classification:	P	S	L to R - a/m	V	F/RS

1. Definition	
Name	Plant cover
Brief definition	Ratio of land covered with vegetation to total land surface area.
Unit of measure	Percentage value
2. Position in the logical framework	
Type of indicator	State (DPSIR framework)
3. Target and field of policy	
Objective / target of the indicator	Contribution to the definition and mapping of ESAs (Kosmas et al.,1999) through the definition of a Vegetation Quality Index.
Position within Agenda 21	Chapter 12 – Management of fragile ecosystems:combating Desertification and drought.
Importance with respect to sustainable development	This indicator is part of a set of tools to identify and mitigate land degradation developed in the different Medalus target areas. Together with other vegetation vulnerability indicators, it contributes to producing a scale of vegetation quality and consequently to the elaboration of development strategies compatible with the resources available in the given area.
Linkages with other indicators	Vegetation quality is combined with the vegetation's capacity to erosion protection,with fire risk and drought resistance in order to define a Vegetation Quality Index.
Secondary objectives of the Indicator	Within the ESAs model: a) Investigation of the individual processes linked to land degradation and Desertification; b) development of counter-measures and strategies to protect land from Desertification and to promote sustainable development;c) comparison with the physical-environmental characteristics of other target areas.
Conventions and international agreements	The CCD emphasizes the fact that combating Desertification must be tackled within the general framework of actions to promote sustainable development.
4.Methodological description and basic definition	
Definition and basic concepts	Vegetation cover is the ratio of vegetation covered land compared to the total surface area of land.In the context of the protection provided to soil against erosive agents by vegetation,the ratio is a determinant factor:it is enough to consider that run-off and sediment loss is reduced exponentially with the increase in the percentage of vegetation cover. The identification of the critical value (threshold below which vegetation cover no longer provides sufficient protection to soil) is essential for all areas;but it must be borne in mind that such a threshold value can be modified depending on the type of vegetation,the intensity of precipitation and some other aspects pertaining to soil,in particular slope and depth.
Method of measure	Vegetation cover can be determined on the basis of remote sensing techniques and field surveys. This should lead to the identification of three classes (high coverage>40% low 10-40% and very low <10%) and to the attribution of a score to each,which multiplied by the scores of fire risk,drought resistance and erosion protection indicators will define a Vegetation Quality Index.
The indicator within the DPSIR structure (Driving forces, Pressures, State, Impacts, Responses)	Within the DPSIR system, Vegetation cover should be considered a factor of State.
Limits of the indicator	These reside in the temporal dynamics of vegetation cover in the Mediterranean environment.In particular the maquis and above all the typical maquis formation of the silvo-pastoral environments, subject to fire and to processes of periodical elimination and recolonisation. These aspects should also be taken into account when defining this indicator, which,therefore requires constant monitoring over time, for example on the seasonal or annual basis.
Other definitions sometimes used	

5. Evaluation of data availability	
Data required to calculate the indicator	Data referring to the extent of vegetation cover:vegetation maps giving indicative values of coverage for each unit present;aerial photographs, satellite images.
Availability of data from national and international sources	If data results from field surveys their cost is high.If it derives from the interpretation of aerial photographs the cost is much more reasonable. If remotely sensed data from satellites is to be resorted to, their cost at present is quite high, but it is likely to drop quite considerably in the near future. The use of multi temporal satellite images is today perhaps the most efficient means of estimating the coverage rate, because it makes it relatively simple to make an accurate distinction between bare soil and vegetation.
Data sources	Aerial photographs taken from public agencies (ex IGMI) as well as private ones. LANDSAT, SPOT, NOAA,etc. satellite images.
6.Institutions that have participated in development of the indicator	
Main institutions responsible for development	Agricultural University of Athens.
Other contributing organisations	Universities of Lisbon,Murcia,Basilicata,Amsterdam,Leeds.
7.Additional information	
Bibliography	Kosmas C. Ferrara A.,Briassouli H.,Imeson I.,1999 Methodology for mapping ESAs to Desertification. The Medalus Project,Mediterranean Desertification and land use. Manual on key indicators of Desertification and mapping environmentally sensitive areas to Desertification.Edited by Kosmas C.,M.,Geeson N. EUR 18882.pp. 31-47
Other references	Kosmas C.,1998.Qualitative indicators of Desertification.Proceedings of the International Seminar held in Porto Torres, Italy 18-20 September, 1998:pp. 81-100.
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Number:					**11**
Indicator Name:					EMPLOYMENT INDEX – Land management quality indicators
Authors:					Ferrara et al
Synthetic classification:	P	D	L to Mb	SE	B

1. Definition	
Name	Employment Index
Brief definition	The employment index provides a measure of the number of people employed with respect to the total active population
Unit of measure	% of number of workers with a stable job out of total active population
2. Position in the logical framework	
Type of indicator	Driving forces (DPSIR framework)
3. Target and field of policy	
Objective / target of the indicator	To identify and define areas at risk of Desertification in the Agri Valley choosing indicators of land use management based on demographic considerations
Position within Agenda 21	Chapter 12 – Management of fragile ecosystems: combating Desertification and drought.
Importance with respect to sustainable development	This indicator is part of a set of tools to develop an index of Management Quality for the definition and mapping of Environmental Sensitive Areas with particular reference to the Agri Valley in Basilicata. Together with the indicators of Soil, Vegetation and Climate Quality, it contributes to elaborate development strategies compatible with the resources available in a given area.
Linkages with other indicators	The purpose of the employment index, together with the old age, retirement and literacy indices, is to define an indirect index of land management quality concerning an area with particular demographic characteristics compared to the rest of the country.
Secondary objectives of the Indicator	Within the ESAs model: a) Investigation of the individual processes linked to land degradation and Desertification; b) development of countermeasures and strategies to protect land from Desertification and to promote sustainable development; c) comparison with the physical-environmental characteristics of other target areas.
Conventions and international agreements	The CCD emphasizes the fact that combating Desertification must be tackled within the general framework of actions to promote sustainable development.
4.Methodological description and basic definition	
Definition and basic concepts	The employment index provides a measurement of the number of persons with stable employment in relation to the total active population. In the present context it is associated with the large number of people employed in agriculture. The high number of agricultural jobs in many poor rural areas of the Mediterranean is due to the lack of any real alternative so that people remain in the sector despite the low income it provides.
Method of measure	The % of workers with a stable job out of the total active population. With the model the authors distinguish four classes of employment (>40%, 30-40%, 20-30% <20%) to which a score is attributed. The score is multiplied with the scores pertaining to retirement, literacy and old age, to define the Management Quality Index.
The indicator within the DPSIR structure (Driving forces, Pressures, State, Impacts, Responses)	The indicator is best placed in the category of Driving forces since it provides information on the pressure on the environment indirectly caused by certain major economic constraints such as the lack of alternatives, that can result in the over-exploitation of marginal agricultural areas.
Limits of the indicator	These are linked to the difficulty of applying the classification in contexts other than the one in which the indicator was developed, i.e. an economically marginal context of rural poverty in areas with limited prospects of development.
Other definitions sometimes used	
5. Evaluation of data availability	
Data required to calculate the indicator	Statistics on the total number of employed persons in the region are required.
Availability of data from national and international sources	This data is easily obtainable from the main national statistics institutions.
Data sources	National statistics institutions
6.Institutions that have participated in development of the indicator	
Main institutions responsible for development	Dipartimento di Produzione Vegetale – University of Basilicata
Other contributing organisations	

7.Additional information	
Bibliography	Ferrara A., Taberner M., De Natale F., Bellotti A., Mancino G., Faretta S., 1999. Identification and assessment of environmental sensitive areas by remote sensing. In. Mediterrannean Desertification and Land Use – Final report phase III (1996-1999). Contract ENV4-CT95-0119. Thatcham, UK, pp. 397-428 Basso F., Bellotti A., Faretta S., Ferrara A., Mancino G., Pisante M., Quaranta G., Taberner M.; 1998. Degradation processes in the Agri basin: evaluating environmental sensitivity to Desertification at basin scale. Proceedings of the International Seminar held in Porto Torres, Italy 18-20 September 1998: pp 131-145.
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Number:					**12**
Indicator Name:					OLD AGEINDEX - ESAs, indicators of quality of land use management
Authors:					Ferrara et al
Synthetic classification:	P	D	L to Mb	SE	B

1. Definition	
Name	Old age index
Brief definition	Ratio of population over the age of 65 and population under the age of 5.
Unit of measure	Percentage
2. Position in the logical framework	
Type of indicator	Driving force (DPSIR framework)
3. Target and field of policy	
Objective / target of the indicator	Determine and define the areas at risk of Desertification in the Agri Valley choosing to use indicators of land use management quality based on characteristics and status of the population
Position within Agenda 21	Chapter 12 – Management of fragile ecosystems: combating Desertification and drought
Importance with respect to sustainable development	This indicator is part of a set of tools to develop a Land Management Quality Index to define and map Environmental Sensitive Areas with particular reference to the Agri Valley in Baisilicata. Together with the other indicators of soil, vegetation and climate quality, it contributes to the elaboration of development strategies compatible with the resources available in a given area.
Linkages with other indicators	The old age index, combined with the indices of retirement, employment and illiteracy is used to form an indirect index of the management quality of an area with specific demographic characteristics compared to the rest of the country.
Secondary objectives of the Indicator	Within the ESAs model: a) Investigation of the individual processes linked to land degradation and Desertification; b) development of countermeasures and strategies to protect land from Desertification and to promote sustainable development; c) comparison with the physical-environmental characteristics of other target areas.
Conventions and international agreements	The CCD emphasizes the fact that combating Desertification must be tackled within the general framework of actions to promote sustainable development.
4.Methodological description and basic definition	
Definition and basic concepts	The age index measures the relationship between the population over the age of 65 and that under the age of 5. In the context of the Agri Valley, the purpose of the indicator is to point to the strong imbalance that exists between the large number of elderly people and the low birth rate.
Method of measure	In the framework of the model, on the basis of the age index, the authors distinguished four classes (<200, 200-400, 400-500, >500) to which they assigned a score. The score, multiplied by the other scores pertaining to retirement, literacy and employment, defines the Management Quality Index.
The indicator within the DPSIR structure (Driving forces, Pressures, State, Impacts, Responses)	The age index is to be considered a Driving Force indicator in as far as the strong demographic imbalance in this marginal, rural context, is the result of the heavy emigration rate of young people, which in turn is a cause of land abandonment and degradation.
Limits of the indicator	These are linked to the difficulty of applying the classification in different contexts to the one in which the indicator was developed, i.e. an economically marginal context of rural poverty in an area with limited development prospects.
Other definitions sometimes used	
5. Evaluation of data availability	
Data required to calculate the indicator	Statistics pertaining to the characteristics and status of the population.
Availability of data from national and international sources	The data is easily obtainable from the main national statistical institutions.
Data sources	National statistics institutions
6.Institutions that have participated in development of the indicator	
Main institutions responsible for development	Dipartimento di Produzione Vegetale – University of Baislicata
Other contributing organisations	

7.Additional information	
Bibliography	Ferrara A., Taberner M., De Natale F., Bellotti A., Mancino G., Faretta S., 1999. Identification and assessment of environmental sensitive areas by remote sensing. In. Mediterrannean Desertification and Land Use – Final report phase III (1996-1999). Contract ENV4-CT95-0119. Thatcham, UK, pp. 397-428 Basso F., Bellotti A., Faretta S., Ferrara A., Mancino G., Pisante M., Quaranta G., Taberner M.; 1998. Degradation processes in the Agri basin: evaluating environmental sensitivity to Desertification at basin scale. Proceedings of the International Seminar held in Porto Torres, Italy 18-20 September 1998: pp 131-145.
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Number:					**13**
Indicator Name:					ARIDITY INDEX – Desertification Prone Areas, Portuguese NAP
Authors:					DGF- Direcçao-Geral das Florestas. Ministèrio da Agricultura,do Desenvolviment Rural e das Pescas.
Synthetic classification:	P	S	R to Ms	C	B

1. Definition	
Name	Aridity index
Brief definition	It is an index of the average water available in the soil, defined as the ratio between mean annual precipitation (P) and mean annual evapotranspiration - (ETP) calculated with the Penman formula.
Unit of measure	Numeric value of P/ETP ratio
2. Position in the logical framework	
Type of indicator	State (DPSIR framework)
3. Target and field of policy	
Objective / target of the indicator	The primary objective is the identification of Desertification prone areas, with particular reference to degradation of soil and water resources.
Position within Agenda 21	Chapter 12 – Management of fragile ecosystems: combating Desertification and drought.
Importance with respect to sustainable development	This indicator is part of a set of tools to identify and mitigate land degradation, devised in Portugal. Along with the soil loss index and the drought index, it contributes to producing a scale of the vulnerability of soil and water resources and consequently to the elaboration of development strategies compatible with the resources available in a given area.
Linkages with other indicators	The aridity index, the soil loss index and the drought index, each of which is linked to specific processes, to do with degradation, that have a direct relationship to water resources and are combined into a single index (the multiplication of the three indices) which, by means of a Geographical Information system (GIS) serves to map Desertification prone areas.
Secondary objectives of the Indicator	
Conventions and international agreements	The CCD emphasizes the fact that combating Desertification must be tackled within the general framework of actions to promote sustainable development.
4.Methodological description and basic definition	
Definition and basic concepts	The aridity index measures the average water available in the soils of a region and reflects the soil's moisture content and the stress deriving from water scarcity.
Method of measure	This index is the one proposed by the CCD to identify arid, semi-arid, dry sub-humid areas, potentially at risk of Desertification. It provides a measure of the average water available for plants and the relation between mean annual precipitations and mean annual evapotranspiration calculated with Penman's formula. On the basis of the above ratio (P/ETP) three classes have been determined (>0.65, 0.5-0.65, <0.5) each corresponding to as many climatic zones (humid, dry sub-humid; arid and semi-arid respectively) and a different score is assigned to each.
The indicator within the DPSIR structure (Driving forces, Pressures, State, Impacts, Responses)	Since this indicator represents a typical climatic condition of the area under study, within the DPSIR logical framework, it is to be considered a factor of State.
Limits of the indicator	These are mainly linked to the difficulty of calculating the ETP with the Penman method, which in itself is rather complicated and requires a lot of data that it is not always easy to obtain.
Other definitions sometimes used	
5. Evaluation of data availability	
Date required to calculate the indicator	For the definition of the P parameter, the data required are annual rainfall statistics obtainable from the various stations located in the area under study. As for the indirect calculation of the ETP, using the Penman formula, data requirements for the period under study, consist of average values of temperature, ambient humidity, speed of wind and solar radiation averages.
Availability of data from national and international sources	Data on rainfall are generally readily available and are reasonably cost effective, while those relative to the ETP calculation are harder to gather.
Data sources	Data can be obtained from the different regional, national or international institutions dealing with the collection and elaboration of such data, or, if not available, they must be collected by the user with the help of meteorological stations located within the area under study.
6.Institutions that have participated in development of the indicator	
Main institutions responsible for development	DGF – Direcçao-Geral das Florestas. Ministèrio da Agricultura, do Desenvolvimento Rural e das Pescas.
Other contributing organizations	

7.Additional information	
Bibliography	
Other references	http: //www.dgf.min-agricultura.pt.
Contacts	Direcçao-Geral das Florestas Av.a Joao Crisòstomo, n. 28-5. 1069-040 Lisboa- Portugal Tel: +351.1.312 49 58 FAX: +351.1.312 49 89 Email dgf.web@mail.telepac.pt

Number:					**14**
Indicator Name:					RAIN EROSIVITY– Desertification Prone Areas, Portuguese NAP
Authors:					DGF- Direcçao-Geral das Florestas. Ministèrio da Agricultura,do Desenvolviment Rural e das Pescas.
Synthetic classification:	P	S	S to Ms	C	B

1.Definition	
Name	Rain erosivity
Brief definition	Intensity of 30 millimetres of rain with a return period of 100 years
Unit of measure	Millimetres/hour
2. Position in the logical framework	
Type of indicator	State (DPSIR framework)
3. Target and field of policy	
Objective / target of the indicator	The main objective is the identification of Desertification prone areas, with particular reference to degradation of soil and water resources.
Position within Agenda 21	Chapter 12 – Management of fragile ecosystems: combating Desertification and drought.
Importance with respect to sustainable development	This indicator is part of a set of tools to identify and mitigate land degradation, developed in Portugal. As such it contributes to producing a scale of potential soil loss and consequently, to the elaboration of development strategies compatible with the resources available in the given area.
Linkages with other indicators	Together with the indices defining soil type, vegetation cover and slope, this indicator contributes to defining the soil loss index. The soil loss index, along with the aridity index and the drought index, each of which is linked to a specific process, to do with degradation, that have a direct relationship to water resources and are combined into a single index (the multiplication of the three indices), which, by means of a Geographical Information System (GIS) serves to map Desertification prone areas.
Secondary objectives of the Indicator	
Conventions and international agreements	The CCD emphasizes the fact that combating Desertification must be tackled within the general framework of actions to promote sustainable development.
4. Methodological description and basic definition	
Definition and basic concepts	The intensity of 30 millimetres of rain with a return period of 100 years, i.e. once the intensity per hour of all rainfall reaching 30mm is calculated, the lowest one with a return period of 100 years is identified. The greater the intensity, the highest is the probability of experiencing extreme events.
Method of measure	Four classes of erosive power have been distinguished; <60mm/h; between 60 and 67.5mm/h; between 67.5 and 75mm/h; >75mm/h); a score has been attributed to each class which is then multiplied by the score of the other indicators to obtain the soil loss indicator.
The indicator within the DPSIR structure (Driving forces, Pressures, State, Impacts, Responses)	Since the indicator represents a typical condition of the area under study, it must be considered a factor of State within the DPSIR logical framework.
Limits of the indicator	These are linked mainly to the difficulty of interpolating the data and applying them to different spatial scales, because the techniques used to do so have a low level of standardisation. Moreover, there are problems of application to areas where data is not available in sufficient quantity and quality (100 year series)
Other definitions sometimes used	
5.Evaluation of data availability	
Data required to calculate the indicator	Data on rainfall over a period of at least 100 years.
Availability of data from national and international sources	The data required is not always easily available, but if it is, the cost-effectiveness is reasonable.
Data sources	Meteorological data can be obtained from various regional, national or international institutions involved in the collection and elaboration of such data.
6.Institutions that have participated in development of the indicator	
Main institutions responsible for development	DGF – Direcçao-Geral das Florestas. Ministèrio da Agricultura, do Desenvolvimento Rural e das Pescas.
Other contributing organisations	

7.Additional information	
Bibliography	National Action Programme to combat Desertification – Portugal 17 June 1999.
Other references	http: //www.dgf.min-agricultura.pt. Contacts Direcçao-Geral das Florestas Av.a Joao Crisòstomo, n. 28-5. 1069-040 Lisboa- Portugal Tel: +351.1.312 49 58 FAX: +351.1.312 49 89 Email dgf.web@mail.telepac.pt

Number:					**15**
Indicator Name:					DROUGHT INDEX – Desertification Prone Areas, Portuguese NAP
Authors:					DGF- Direcçao-Geral das Florestas. Ministèrio da Agricultura, do Desenvolviment Rural e das Pescas.
Synthetic classification:	P	S	L to Ms	C	B

1. Definition	
Name	Drought index
Brief definition	The index provides a description, on the regional level, of the frequency and severity of drought.
Unit of measure	a-dimensional index
2. Position in the logical framework	
Type of indicator	State (DPSIR framework)
3. Target and field of policy	
Objective / target of the indicator	The main objective is the identification of Desertification prone areas, with particular reference to degradation of soil and water resources.
Position within Agenda 21	Chapter 12 – Management of fragile ecosystems: combating Desertification and drought.
Importance with respect to sustainable development	This indicator is part of a set of tools to identify and mitigate land degradation, devised in Portugal. Along with the soil loss index and the aridity index, it contributes to producing a scale of the vulnerability of soil and water resources and consequently to the elaboration of development strategies compatible with the resources available in a given area.
Linkages with other indicators	The aridity index, the soil loss index and the drought index, each of which is linked to a specific process, to do with degradation, that have a direct relationship to water resources and are combined into a single index (the multiplication of the three indices), which, by means of a Geographical Information System (GIS) serves to map Desertification prone areas.
Secondary objectives of the Indicator	
Conventions and international agreements	The CCD emphasizes the fact that combating Desertification must be tackled within the general framework of actions to promote sustainable development.
4. Methodological description and basic definition	
Definition and basic concepts	Drought can be characterised on the basis of three different parameters: I) water deficit, in the sense of the "magnitude" of drought (lack of water below a certain threshold value), or as a measure of the severity of drought (relation between the maximum water deficit and the mean water deficit); ii) the mean number of drought years (relation between the number of drought years and the total number of years under consideration); iii) the surface area affected by drought (which is a measure of the extent of the phenomenon).
Method of measure	Since characterising drought implies a certain degree of subjectivity in the analysis, a simple methodology was employed based on the definition of a threshold below which a certain degree of drought occurs. This threshold value is obtained from the probability value that the level of precipitation will not be above the annual average. 1%, 5% and 10% are the threshold values distinguishing the increasing severity of drought. The distribution of drought is represented by means of the Thyessen polygons figuring around the stations where rainfall is measured.
The indicator within the DPSIR structure (Driving forces, Pressures, State, Impacts, Responses)	Since the indicator represents a typical climatic condition of the area under study, it must be considered a factor of State within the DPSIR logical framework.
Limits of the indicator	These are mainly linked to the type of methodology adopted to represent the distribution of drought. The method of Thyessen polygons is a technique which, because of its extreme rigidity, is not widely used. In any case, since the level of standardisation of spatial interpolation techniques is not very high at the moment, problems arise for all the indicators of this type.
Other definitions sometimes used	
5. Evaluation of data availability	
Data required to calculate the indicator	The necessary data are annual rainfall statistics, obtainable from the various stations located in the area under study, for a sufficiently representative period of time.
Availability of data from national and international sources	The required data is generally easily available and is reasonably cost-effective.
Data sources	Data can be obtained from the various regional, national or international institutions involved in collecting and elaborating this kind of data, or, if not available, it must be collected by the user with the help of the meteorological stations spread around the area under study.

6.Institutions that have participated in development of the indicator	
Main institutions responsible for development	DGF – Direcçao-Geral das Florestas. Ministèrio da Agricultura, do Desenvolvimento Rural e das Pescas.
Other contributing organisations	
7.Additional information	
Bibliography	
Other references	http: //www.dgf.min-agricultura.pt.
Contacts	Direcçao-Geral das Florestas Av.a Joao Crisòstomo, n. 28-5. 1069-040 Lisboa- Portugal Tel: +351.1.312 49 58 FAX: +351.1.312 49 89 Email dgf.web@mail.telepac.pt

Number:					**16**
Indicator Name:					URBAN SPRAWL – Land use management quality
Authors:					Sommer et al.
Synthetic classification:	Mo/Mi	P	L to M	S/V	RS

1.Definition	
Name	Urban sprawl
Brief definition	Uncontrolled expansion of urban settlements onto semi-natural and agricultural areas along the coast
Unit of measure	Extension of urbanised area (ha) or its variation over time.
2. Position in the logical framework	
Type of indicator	Pressure (DPSIR framework)
3. Target and field of policy	
Objective / target of the indicator	Asses the risk of Desertification with particular reference to: I) loss and degradation of agricultural land with a high production potential; ii) depletion of the water table (uncontrolled exploitation); iii) salination and pollution of phreatic ground water and deep acquifers; iv) alteration of the hydrological balance.
Position within Agenda 21	Chapter 12 – Management of fragile ecosystems: combating Desertification and drought.
Importance with respect to sustainable development	The analysis of the socio-economic context in which urban sprawl occurs is essential in order to define strategies to control and mitigate the process. In fact, so as to draw up and implement development and land use management plans it is necessary to draw up permanently up-to date mapping of urban sprawl. It will thus be possible to I) provide the physical basis for implementation of national urban planning legislation at the commune level (Communal Urban Plan), taking into consideration the development of urban centres and neighbouring agricultural and natural land; ii) provide the appropriate framework for defining the territorial units and their optimal use, integrating information on the bio-physical qualities of the environmental resources with those pertaining to historical land use; iii) develop standardised tools to provide mapped documentation of the processes of current urban expansion on the local, national and regional scales (ex. Mediterranean Basin), to the greatest extent possible using remotely sensed satellite images.
Linkages with other indicators	This indicator can usefully be combined with the common statistical and urbanisation indicators, for example the percentage of variation in the population of administrative units, or the variation in average density (inhabitants per ha) of population on fertile agricultural land and irrigated areas, to highlight the consumption of potential agricultural resources.
Secondary objectives of the Indicator	
Conventions and international agreements	The CCD emphasizes the fact that combating Desertification must be tackled within the general framework of actions to promote sustainable development.
4.Methodological description and basic definition	
Definition and basic concepts	The indicator was developed within an interdisciplinary study undertaken in Sardinia in the framework of the MEDALUS project since uncontrolled urban sprawl is one of the major causes of loss of environmental resources in the Mediterranean basin. Its purpose is to compare and combine mapping methods based on field surveys and remote sensing images for an efficient separation between built-up areas and semi-natural/agricultural areas.
Method of measure	The methodology calls for the comparison and combination of: I) detailed land surveys; ii) analysis of remotely sensed images. Remotely sensed images from multitemporal satellites provide accurate and current information, over extensive areas, on uncontrolled urban sprawl over seminatural and agricultural areas. Field surveys, on the one hand, provide a means of calibrating the procedure of quantifying urban sprawl based on the use of remotely sense data, and on the other hand, they serve to assess the accuracy of the results obtained.
The indicator within the DPSIR structure (Driving forces, Pressures, State, Impacts, Responses)	The indicator's position as an indicator of Pressure is justified by the fact that uncontrolled urbanisation is a process that can directly cause the loss and degradation of agricultural land, the depletion of the water table due to uncontrolled exploitation, salination and pollution of phreatic and deep underground water and the alteration of the hydrological balance.
Limits of the indicator	The indicator is valid at a very broad scale, from local to national and beyond. The limits of this indicator are for the moment linked to the difficulty of collecting data, especially in terms of cost and labour involved: indeed, it is true that the cost of remotely sensed satellite images is slowly decreasing but at present it is still high; also, field surveys require the use of many operational units over a long period of time.
Other definitions sometimes used	

5. Evaluation of data availability	
Data required to calculate the indicator	Multitemporal archives of satellite images and/or aerial photographs referring to the entire region and covering a sufficiently long period of time to enable comparison between different urban centres. Supporting information from maps of topography, soils, and geology.
Availability of data from national and international sources	Remotely sensed satellite images are at present available at a quite high cost.
Data sources	Landsat-TM- archives; other RS data archives. Topographical, soil and geological maps.
6. Institutions that have participated in development of the indicator	
Main institutions responsible for development	Space Applications Institute (SAI) of the EC DG JRC Ispra, and Department of Soil Sciences of the University of Cagliari in the sphere of the Medalus project.
Other contributing organizations	
7.Additional information	
Bibliography	Sommer S., Loddo S., Puddu R., Indicators of soil consumption by urbanisation and industrial activities. Proceedings of the International Seminar held in Porto Torres, Italy 18-20 September 1998: pp 116-125.
Other references	
Contacts	Environmental Modelling and Mapping Unit (EMAP), Space Appications Insititute (SAI), Joint Research Centre, 21020 Ispra (VA) Italy, Tel. +39 0332 789631, Fax =39 0332 789469, Email: sommer@jrc.it

Number:					**17**
Indicator Name:					INFILTRATION CAPACITY – Soil vulnerability
Authors:					Imeson et al.
Synthetic classification:	P	S	S/L	S	F

1. Definition	
Name	Infiltration capacity
Brief definition	The property of soil which determines the infiltration rate of rain water.
Unit of measure	Millimetre/hour
2. Position in the logical framework	
Type of indicator	State (DPSIR framework)
3. Target and field of policy	
Objective / target of the indicator	Contribution to the identification of environmentally sensitive areas by assessing how soil fulfils the function of storing water.
Position within Agenda 21	Chapter 12 – Management of fragile ecosystems: combating Desertification and drought.
Importance with respect to sustainable development	This indicator is part of a set of tools to identify and mitigate land degradation, developed in the Medalus target area of Alentejo. Together with the indicators of soil stability and data relative to the occurrence of extreme rain events, it contributes to assessing the vulnerability of land itself and consequently to the elaboration of development strategies compatible with the resources available in a given area.
Linkages with other indicators	Infiltration capacity, along with soil stability is part of a system designed to identify and characterise in detail, then to classify, a series of source areas, (areas that after the advent of rainfall of varying intensity become sources of sediment and surface flow).
Secondary objectives of the Indicator	
Conventions and international agreements	The CCD emphasizes the fact that combating Desertification must be tackled within the general framework of actions to promote sustainable development.
4. Methodological description and basic definition	
Definition and basic concepts	The indicator defines the soil property on which the speed of rain water infiltration depends.
Method of measure	Two techniques are used to determine infiltration capacity: I) experiments in drip irrigation; ii) rain simulation. Drip irrigation experiments should be applied to an unbroken layer of surface crust, since the presence of cracks has a strong bearing on the infiltration capacity of the crust, whereas it should exclusively be due to gravitational flow. The soil surface should be wet beforehand. Vegetation has to be eliminated to prevent it intercepting water. Water is poured from a container with a constant level equipped with a drip. The flow rate Q, also constant, is measured according to a millimetric scale applied to the container and a watch. On the ground around the drip, a damp, generally oval shaped patch is formed which becomes increasingly large until it stops expanding after about thirty minutes. The contours of the patch are marked with pegs after which the experiment is repeated at least twice with decreasing flow rates at each time; the damp patches, which have become smaller and smaller, are also pegged out. Thus three damp surfaces are created and their diameter and then their respective surface areas are measured (A). After this, the infiltration rate qi is calculated by means of the Darcy equation. The flow rate is calculated by Q=A*qi The rain simulation experiment can be carried out with the help of simple portable rain simulators. It is important to identify a number of sites sufficiently representative of the source area and for each site at least four different simulations of differing intensity should be carried out in comparable plots. Rain intensity is calculated on the basis of variations in the level of water in the instrument's tank during a certain time interval.
The indicator within the DPSIR structure (Driving forces, Pressures, State, Impacts, Responses)	Infiltration capacity should be considered a factor of State in as far as it is an intrinsic characteristic of an index of soil vulnerability to the splash of rain, to loss of sediment, and to runoff.
Limits of the indicator	These are mainly limits of an operational nature due: to the high cost, both in terms of time and of personnel, of surveys; to the difficulty of identifying a number of sufficiently representative sites within the same area; to the difficulty of finding comparable plots within the same site, i.e. with characteristics that are not likely to bias the subsequent statistical data analysis.
Other definitions sometimes used	
5.Evaluation of data availability	
Data required to calculate the indicator	Data must necessarily be obtained from specific field surveys
Availability of data from national and international sources	
Data sources	

6.Institutions that have participated in development of the indicator	
Main institutions responsible for development	University of Amsterdam, University of Lisbon.
Other contributing organisations	
7.Additional information	
Bibliography	Imeson A.C., Suryana N., Bergkamp G., Bolwidt L., Haring R., van Leuzen P., Seijmonsbergen H., Hoogteiling D., (1999). Developing and applying indicators of Desertification derived from soil-water-vegetation relationships. Mediterranean Desertification and Land Use – Final report phase III (1996-1999). Contract ENV4-CT95-0119. Thatcham, UK, pp. 47-85.
Other references	A.C.Imeson@frw.uva.nl
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Number:					**18**
Indicator Name:					STABILITY OF THE SURFACE HORIZON – Soil vulnerability
Authors:					meson et al.
Synthetic classification:	P	S	S/L	S	F

1.Definition	
Name	Stability of the soil surface horizon
Brief definition	It is an indicator of soil aggregate stability
Unit of measure	The stability of the soil surface horizon is measured either in terms of resistance to break-up (torvane method), and in this case the unit of measure is in Kg/cm2, or by means of a test of dispersion of particles in water, and in this case the unit of measurement is represented by two different qualitative indices estimated visually.
2. Position in the logical framework	
Type of indicator	State (DPSIR framework)
3. Target and field of policy	
Objective / target of the indicator	Contribution to the identification of environmentally sensitive areas by assessing how the soil fulfils the function of water storage and conservation and of resistance to erosion.
Position within Agenda 21	Chapter 12 – management of fragile ecosystems: combating Desertification and drought.
Importance with respect to sustainable development	This indicator is part of a set of tools to identify and mitigate land degradation, developed in the Medalus target area of Alentejo. Together with the indicators of soil infiltration capacity and data relative to the occurrence of extreme rain events, it contributes to assessing land vulnerability and consequently to the elaboration of development strategies compatible with the resources available in a given area.
Linkages with other indicators	Soil stability along with Infiltration capacity, is part of a system designed to identify, characterise in detail and then to classify, a series of source areas, (areas that after the advent of rainfall of varying intensity become sources of sediment and surface flow).
Secondary objectives of the Indicator	
Conventions and international agreements	The CCD emphasizes the fact that combating Desertification must be tackled within the general framework of actions to promote sustainable development.
4. Methodological description and basic definition	
Definition and basic concepts	The stability of the soil surface layer is defined by means of resistance to the break-up of the soil itself and on the basis of the degree of soil particle breakdown in water. Resistance to the breaking force is an estimate of the soil particles resistance to forces exercised by gravity, by the movement of fluids and by mechanical means on soil. Together with infiltration capacity and aggregate stability, it influences erodibility and the soil's capacity to store water. The degree of breakdown in water of particles of an undisturbed soil sample is an indicator of resistance to break-up and to the impact of raindrops and is also a factor determining soil erodibility.
Method of measure	Two methods are used to determine the stability of the soil surface horizon: 1) the torvane method (Imeson et al., 1999) and ii) the dispersion test. The dispersion test is a simple laboratory test. In order to describe the results of the test, the author proposes two indices. The first is the Breakdown index (B), which distinguishes the degree to which aggregates breakdown in water in: I) no breakdown (there is no breakdown and the original lump remains unmodified); ii) slight breakdown (the clear-cut edges of the lump breakdown); iii) moderate breakdown (the edges breakdown and the lump divides into smaller lumps); iv) strong breakdown (some small lumps can still be distinguished amongst the dispersed particles); v) complete breakdown (all the lumps are divided into single particles). The second index, on the other hand, the Suspension index (S), based on the milkiness of the sample, distinguishes samples: I) not milky (the water is perfectly clear); ii) slightly milky (water is slightly muddy with a milky suspension at the bottom) iii) moderately milky (water is muddy, but it is still possible to see through the beaker); iv) very milky (only the lower part of the beaker has a degree of turbidity making it impossible to see the bottom) v) extremely milky (a muddy suspension fills the whole beaker). Both indices, B and S are estimated visually.
The indicator within the DPSIR structure (Driving forces, Pressures, State, Impacts, Responses)	Aggregate stability must be considered as a factor of State as it is a soil property determining vulnerability to the splash of rain drops and to surface runoff.
Limits of the indicator	These are mainly limits of an operational nature. Especially the dispersion test, which is based on visual observation (and thus highly subjective from the outset) requires further adjustments to be considered valid, which will necessarily lead to an increase in experimental errors.
Other definitions sometimes used	

5.Evaluation of data availability	
Data required to calculate the indicator	Data has to be collected by means of specific field surveys and laboratory analyses.
Availability of data from national and international sources	
Data sources	
6.Institutions that have participated in development of the indicator	
Main institutions responsible for development	University of Amsterdam, University of Lisbon.
Other contributing organisations	
7.Additional information	
Bibliography	Imeson A.C., Suryana N., Bergkamp G., Bolwidt L., Haring R., van Leuzen P., Seijmonsbergen H., Hoogteiling D., (1999). Developing and applying indicators of Desertification derived from soil-water-vegetation relationships. Mediterranean Desertification and Land Use – Final report phase III (1996-1999). Contract ENV4-CT95-0119. Thatcham, UK, pp. 47-85.
Other references	A.C.Imeson@frw.uva.nl
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Number:					**19**
Indicator Name:					GRAZING INTENSITY – vegetation and soil degradation index
Authors:					Papanastasis
Synthetic classification:	M	P	L/Srm	V/S/SE	F/B/RS

1.Definition	
Name	Grazing intensity
Brief definition	Grazing intensity in silvo-pastoral environments is defined as a value included between 0 and 1, obtained as r2 relative to a direct correlation between the level of vegetation cover (%) and the livestock stocking rate (animal heads/ha per year) The value represents the contribution of grazing to the level of pressure vegetation is subjected to.
Unit of measure	A-dimensional, values between 0 and 1.
2. Position in the logical framework	
Type of indicator	Pressure (DPSIR framework).
3. Target and field of policy	
Objective / target of the indicator	The objective of the indicator is to establish to what extent grazing is responsible for the advanced state of degradation occurring in various semi-natural ecosystems of the Mediterranean region, with particular reference to the Psilotires mountain in Crete, where it has been tested.
Position within Agenda 21	Chapter 12 – Management of fragile ecosystems: combating Desertification and drought.
Importance with respect to sustainable development	Overgrazing can cause degradation of soil and vegetation. Therefore, the intensity of grazing can serve as an index of environmental pressure. Its importance within the framework of sustainable development is linked to the possibility of becoming a tool to define a model for an agro-silvo-pastoral system compatible with the productive potential of the land.
Linkages with other indicators	Overgrazing on its own can only partly explain the process of land degradation. This means that to define a sustainable model for an agro-silvo-pastoral system other indicators have to be taken into consideration pertaining to land degradation, climate, vegetation (fire risk in this context appears to be the indicator best able to complement grazing intensity to explain degradation of vegetation) and socio-economic conditions.
Secondary objectives of the Indicator	
Conventions and international agreements	The CCD emphasizes the fact that combating Desertification must be tackled within the general framework of actions to promote sustainable development.
4. Methodological description and basic definition	
Definition and basic concepts	The one in question is an indicator measuring how grazing influences vegetation cover, modifies the plant community, influences diversity of fauna and exposes soil to erosion. Grazing has multiple effects on the agro-ecosystem. Animals defoliate vegetation and consequently influence growth, the strength and the reproduction of plants and the composition of species as well as vegetation cover and biomass, while at the same time they trample the ground, compacting it, reducing infiltration rates and increasing surface flows. All these effects, however, are minor and thus reversible if the intensity of grazing is low or moderate. Conversely, they become major and irreversible if the grazing intensity is very high.
Method of measure	To calculate the indicator, data relative to the typology and extent of vegetation cover is required, as well as on the effective livestock stocking rate. It is necessary to draw-up a map of the various classes of ground cover of the area under study. To determine the real stocking rate the number of heads of animals of the different species must be known, as well as the grazing management system, the feeding requirements. The indicator within the DPSIR structure (Driving forces, Pressures, State, Impacts, Responses) In the context of the logical framework of reference (DPSIR) grazing intensity must be considered an indicator of Pressure since it provides an estimate of the degree of intensity with which a livestock stocking rate which is not commensurate to the productive potential of the area, triggers and accelerates the process of degradation and Desertification.
Limits of the indicator	The first limit derives from the fact that overgrazing in itself can only partly explain degradation processes due to pastoral activity and that for the remaining part other human activities must be taken into consideration, especially fires. A second limit, on the other hand, is constituted by the fact that this indicator, since it was elaborated in the context of traditional silvo-pastoral systems wherein external inputs are very low, requires adaptation to be applicable to less extensive systems.
Other definitions sometimes used	

5. Evaluation of data availability	
Data required to calculate the indicator	Data relative to the typology and degree of forest vegetation cover; data relative to the livestock numbers, the livestock feeding systems, the pasture management system.
Availability of data from national and international sources	Aerial photographs and land cover maps, if they exist, are readily available at a relatively low cost, while data gathered by means of investigating livestock farmers is more costly.
Data sources	Aerial photographs; Corine Land Cover: scale 1:100000 available for the entire European area.
6.Institutions that have participated in development of the indicator	
Main institutions responsible for development	This research was conducted at the Chania Mediterranean Agronomical Institute, Crete, for the MEDIMONT project (coordinated by Dr. M. Dubost, ICALPE) with the financial support of the European Commission (DG XII – EVSVC1910045)
Other contributing organisations	
7.Additional information	
Bibliography	Papanastasis V.P., 1998. Grazing intensity as an index of degradation in semi-natural ecosystems: the case of Psiloirtes mountain in Crete. Proceedings of the International Seminar held in Porto Torres, Italy 18-20 September 1998: pp. 146-158.
Other references	E-mail: vpapan@for.auth.gr
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Indicators of population dynamics and primary sector economic indicators.

The National Institute of Agrarian Economy (INEA, 1999) elaborated a set of socio-economic indicators pertaining to the primary sector to undertake an analysis of the middle Agri river valley and the valley of the Sauro torrent where a strong tendency of land abandonment by the younger population was observed. Both areas (a total of 1387 Km2 approximately) are classed as "marginal and disadvantaged" and placed according to article 21-25 of the CE950/97 Regulations, in the category of total disadvantage with regard to physical terrain, socio-demography and economics.

A site analysis, of each commune within the area under study was carried out with the help of the following indicators:

Indicators of environmental conditions:

Number:					**1**
Indicator Name:					Productive capacity of the environment[1]
Authors:					National Institute of Agrarian Economy
Synthetic classification:	Mi	S	L/Sr/R- b	S/W/V	B/F/RS

Indicators of demographic dynamics:

Number:					**2**
Indicator Name:					Percentage variation of the population[2]
Authors:					National Institute of Agrarian Economy
Synthetic classification:	Mi	P	L/Sr/R -b	SE	B

Number:					**3**
Indicator Name:					Population density
Authors:					National Institute of Agrarian Economy
Synthetic classification:	Mi	P	L/Sr/R-b	SE	B

Number:					**4**
Indicator Name:					Generation change rate[3]
Authors:					National Institute of Agrarian Economy
Synthetic classification:	Mi	P	L/Sr/R-b	SE	B

Indictors of economic dynamics within the agricultural sector[4]:

Number:					**5**
Indicator Name:					Gross marketable production /useable agricultural areas (UAA)
Authors:					National Institute of Agrarian Economy
Synthetic classification:	Mi	P	L/Sr/R-b	SE	B

Number:					**6**
Indicator Name:					% variation of the UAA
Authors:					National Institute of Agrarian Economy
Synthetic classification:	Mi	P	L/Sr/R-b	SE	B

Number:					**7**
Indicator Name:					% variation in the number of agricultural enterprises
Authors:					National Institute of Agrarian Economy
Synthetic classification:	Mi	P	L/Sr/R-b	SE	B

Number:					**8**
Indicator Name:					Percentage of "enterprises with uncertain future" (5)
Authors:					National Institute of Agrarian Economy
Synthetic classification:	Mi	P	L/Sr/R-b	SE	B

NOTES:

(1)Enables the classification of the area according to the capacity of the fundamental biotic elements to sustain agricultural productive processes.

(2)Depends both on the birth rate and the migration balance. In this particular case it indicates an effective process of depopulation.

(3)It is the relationship between the population under the age of 14 and the population over 65. In the communes of the area under study there is a marked ageing of the population.

(4)In Basilicata, the growth in GDP was coupled with a negative employment trend (the average regional unemployment rate is of 20%), which means that increased production was almost exclusively due to an increase in productivity per worker. In the agricultural sector, the closing down of many marginal enterprises and the decrease of the UAA led to a strong drop in agricultural employment; notwithstanding this fact, the percentage of persons employed in agriculture remains above the national average (15% against 7%).

(5)Future is uncertain because of the low probability of continuity, due to emigration of young people.

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Towards sustainable development – Growth indicators. Rome, 15-17 December 1999.
Indicators of degradation for silvo-pastoral systems of the "dehesa" type (Louro et Sequeira, 1998)

Louro and Sequeira (1998) propose a series of indictors designed for monitoring the state of health and vitality of silvo-pastoral systems and for the restoration of degraded forest soils, with particular reference to montados (Portugal) and to dehesas (Spain).

The evolution of montados and dehesas was, in the past, strongly conditioned by agro-silvo-pastoral activities (cultivation of cereal crops on superficial soils on steep slopes, due to policies to boost cereal production) which, from the 30's to the 60's led to a drastic reduction in these areas. This type of situation provoked degradation and very serious soil erosion. Subsequently, the progressive abandon of these areas, which had become unproductive and no longer suitable for cereal production, led to the natural return of the montados.

Indicators of the state of health and vitality of vegetation:

Number:					**9**
Indicator Name:					State of health and vitality of vegetation and forests
Authors:					Louro V. and Sequeira E.M.
Synthetic classification:	Mo/Mi	S	L/Sr/R-m/a	V	F

Number:					**10**
Indicator Name:					Composition and density of natural vegetation
Authors:					Louro V. and Sequeira E.M.
Synthetic classification:	Mo/Mi	S	L/Sr/R a/b	V	F/RS

Indicators of health and vitality of water bodies:

Number:					**11**
Indicator Name:					Characteristics of the bordering vegetation
Authors:					Louro V. and Sequeira E.M.
Synthetic classification:	Mo/Mi	S	L/Sr –a/b	V	F

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Louro V., Sequeira E.M., 1998. Indicators of degradation in montados / dehesas. Proceedings of the International Seminar held in Porto Torres, Italy 18-20 September, 1998: pp. 126-130

Indicators of soil quality to identify Desertification risk in Mediterranean ecosystems (Pinzari et al., 1998).

Pinzari et al., (1998) elaborated a series of indicators aimed at prevention of soil degradation processes, designed to assess the activity of microbial biomass and the quality of organic matter as possible indicators of disturbance as well as being descriptive of the state of soils in natural systems. The authors identify:

Static indicators; enable identification of change only over a long period

Number:					**12**
Indicator Name:					Soil organic matter content
Authors:					Pinzari et al.
Synthetic classification:	P	S	S/L-m	S	F

Number:					**13**
Indicator Name:					C/N Ratio
Authors:					Pinzari et al.
Synthetic classification:	P	S	S/L-m	S	F

Dynamic indicators: particularly sensitive to signalling changes in state over a short time

Number:					**14**
Indicator Name:					Mineralisation speed of organic carbon
Authors:					Pinzari et al.
Synthetic classification:	P	S	S/L-m	S	F

Number:					**15**
Indicator Name:					Mineralisation speed of carbon in microbial biomass
Authors:					Pinzari et al.
Synthetic classification:	P	S	S/L-m	S	C

Number:					**16**
Indicator Name:					Microbial biomass carbon/total organic carbon ratio[1]
Authors:					Pinzari et al.
Synthetic classification:	P	S	S/L-m	S	F

Number:					**17**
Indicator Name:					Odum metabolic quotient[2] – q(CO^2)
Authors:					Pinzari et al.
Synthetic classification:	Mo	S	S/L-m	S	F

NOTES:

(1)The relation between biomass carbon and total organic carbon, which is a quantitative representation of the correlation between soil organic matter and microbial biomass, should be constant in stable systems. A deviation from the state of equilibrium, hence from the ratio value, should therefore indicate an increase or a decrease in the stability of organic matter with respect to microbial activity.

(2)It is the relation between the value of basal respiration of the microbial biomass and the biomass carbon content and it is based on the theory of the succession of ecosystems (Odum, 1969). The values of q (CO_2) are lower in soils whose microbial biomass is particularly efficient in conserving organic carbon: the indicator therefore points to increasingly low values in passing from young ecosystems to more mature ecosystems. Moreover, q(CO_2) responds positively to events of anthropic or natural soil disturbance (compacting, organic or inorganic pollution, tilling, grazing, etc.) increasing the value in case of a modification in the system.

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ARIDUSEUROMED. An EU project to study the evolution of European Mediterranean landscapes.
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CAMALEO. is a research project funded by the European Commission on long term changes in Mediterranean arid ecosystems and on remote sensing information to monitor the environment in arid regions.
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EMAP-MECOM, (Mediterranean Ecosystems Monitoring Sector and Environmental Mapping and Modelling), JRC. The objectives of this institution are various, amongst the objectives: 1) to define indicators based on remote sensing that serve to identify ecological change in the Mediterranean basin for monitoring land degradation and for natural resource management.
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List of indicators, significance, methodology, bibliography

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