DESIRE REPORT series

An overview of desertification problems in the study countries (maps & report)

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DESIRE

Work block 1: Report on Mapping

Spatial extent of degradation and conservation in DESIRE Study sites

Work package 1, deliverable 1.2.1

A report on mapping of land degradation and conservation with specific reference to the DESIRE study areas

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ALTERRA

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IRD - France	Mexico
MSUEE	Russia
INIA	Chile
INIDA	Cape Verde

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1 Introduction WP1.2: Assessment and Mapping

a) Rationale

Sustainable management of the natural resource base is one of the truly fundamental issues that the international community will have to address effectively over the next two decades. The last twenty years have seen an emphasis on global and national economic management; the next twenty will need to address environmental management effectively.

This needs to follow a globally structured approach, based on adequate, reliable, up-to-date data and knowledge, and governed by appropriate international strategies and agreements. One key product sorely lacking to reach this goal is an overview of *where* land degradation takes place at *what* intensity and *how* land users are addressing this problem through sustainable land management.

In order to fill this knowledge gap, three projects have collaborated closely to establish a standardised and generally applicable mapping method: DESIRE, WOCAT and LADA.

Within the context of WP1.2, the spatial extent of degradation as well as the extent of measures to combat this degradation in the DESIRE study sites have been studied. This has resulted in both descriptions of the study sites, and in maps. These maps show the degree of degradation, but they also show areas where protection and restoration measures have been applied and with what degree of success. This assessment enables putting the study sites in a broader environmental and socio-economic context.

b) Defining degradation

Land degradation has been defined (by LADA[1]) as the reduction in the capacity of the land to provide ecosystem goods and services (G&S) and assure its functions over a period of time for its beneficiaries.

Ecosystem goods represent the material products that are obtained from natural systems for human use (DeGroot et al. 2002). Ecosystems goods are generally tangible, material products that result from ecosystem processes, such as food, forage, timber, biomass fuels, and many pharmaceuticals.

Ecosystem services are the conditions and processes through which natural ecosystems sustain and contribute to allow humans to meet their (tangible and intangible) needs. Ecosystem services are the actual life-support functions, such as cleansing, recycling, and renewal, and they confer many intangible aesthetic and cultural benefits as well (Daily, 1997).

None of these G&S is easily defined. In order to use this scheme for assessment of degradation, these services should first be transferred into tangible, measurable entities because terms such as “regulating climate” are not readily measured or estimated as such. Biodiversity, being at the basis of most biological processes, is inherently linked to the ecosystem services, but the relationship may be difficult to quantify. Cultural and aesthetical services are more often considered as

[1] The Land Degradation Assessment in Drylands project (LADA), which is implemented by FAO with funding from GEF, develops tools and methods to assess land degradation in dryland ecosystems, at a range of spatial and temporal scales. It also builds the national, regional and international capacity for making interventions to mitigate land degradation and promote sustainable land use.

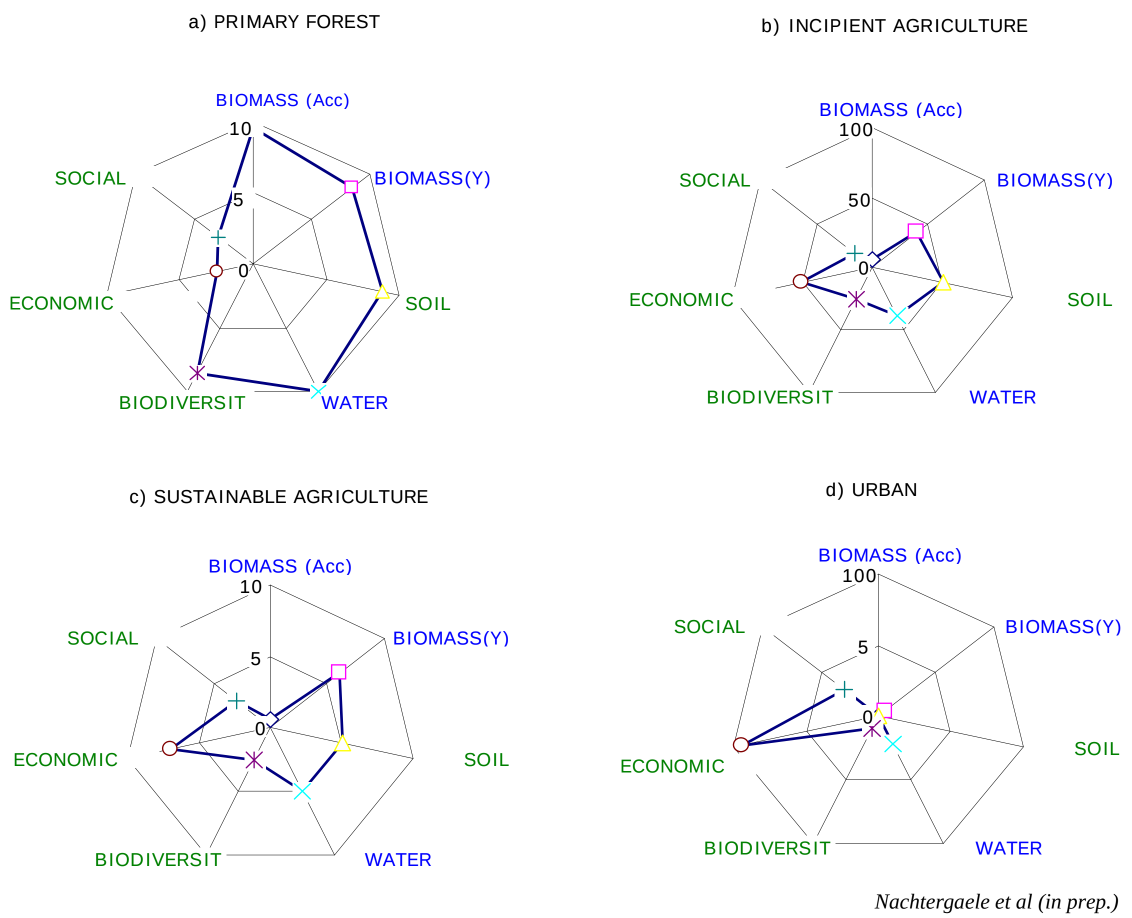
attributes of "landscapes" than of the ecosystems and the value attached to them can be not proportional to the ecosystem health.

To be able to measure and map the effects of land degradation on G&S, it would be useful to link these to quantifiable "resources", or "assets". A similar idea was introduced by the Ekins (1992) and, later, by Serageldin and Steer (1994) of the World Bank, by means of the "Capitals" framework: the state of the resources as a whole was reported in terms of its level of manufactured, human, social and natural capitals. By measuring or estimating all capitals available at different periods in time it should be possible to quantify the change due to land degradation according to a multi-dimensional perception.

According to the approach being developed by LADA, six key assets are defined in a way that makes it easier to relate them to G&S, thus providing a more consistent basis to quantify their relevance in relation to land degradation assessment. The six assets are listed below:

- Social and cultural benefits;
- Biodiversity;
- Soil health;
- Water quality and quantity;
- Opportunity value;
- Biomass: accumulated (standing and below-ground biomass) and biomass yearly increment;

Each change in land use will affect one or more of these assets negatively or positively. It is the



1980: Primary forest →1987: Incipient Agriculture →1996: Sustainable Agriculture →2002: Urban settlement
(Services in green; Goods in blue)

Figure 1: Effects of land use changes on ecosystem goods and services: forest cutting and introduction of agricultural activities. a) 1980: Primary forest. b) 1987: Incipient Agriculture. c) 1996: Sustainable Agriculture (improvements implemented) d) 2002: Urban settlement (transformed into building land).

total picture of negative and positive impacts that determines the perceived seriousness of degradation and this is again depending of priorities: urbanization clearly has a negative impact on total biomass or biodiversity but it has a positive impact – in most cases – on the social and economic assets.

2 Objectives WP 1.2

The objectives of WP 1.2 was to collect Study Site Descriptions provided by all Study Sites and to complement these with a spatial overview (mapping) of the occurrence of degradation and of the measures to prevent or mitigate this degradation.

The ultimate goal of the mapping exercise is to obtain a picture of the distribution and characteristics of land degradation and conservation / SLM activities for the different study sites. The final output can be generated on-line in the form of maps of land degradation status, causes and impacts, and conversely the conservation status and impacts for specific land use systems in the area.

3 Method and Results

1. STUDY SITE DESCRIPTIONS

A template for Study Site Descriptions was sent to all study sites with specific headings for which information needed to be supplied. The information was finally received from all sites and after editing and reviewing made available to the HIS by WB6. The individual Study site reports have also been compiled into a single document (DESIRE report 79) that includes a synthesis. A separate subject that was also studied is the availability of data for all the study sites. A questionnaire listing all required data was sent to all study sites, with the request to indicate whether these data were available. The results (see Annex 3 for details) indicate that although there are differences between sites, a significant amount of data was already available at the start of the DESIRE project.

The sections below list the main conclusions that could be drawn from the study site descriptions, for each of the six headings that were used in the template for study site descriptions.

1. General information

General conclusions:
The DESIRE Study sites represent various locations across the world and vary largely in size from less than 100 km^2 to several thousand km^2, but the majority is in the the order of a few hundred km^2. The main reasons for selecting the sites are among other things: presence of previous research, representativeness, “hot spot” of desertification/degradation problems and occurrence and/or potential for successful implementation of mitigation and preventive strategies.
A data availability questionnaire was filled in by all study sites and shows that a wealth of relevant data is available, though in widely varying formats and scales.

2. Bio-physical description

General conclusions:

Available natural resources vary greatly in the different study sites, as can be expected with their geographical distribution. Precipitation is, also predictably, rather low and especially unequally distributed and in several sites irrigation is practiced. Major land uses are permanent and semi-permanent agriculture, and grazing. The strength of many of these practices is that they are well established, traditional systems that have proved to work under the prevailing conditions. However, these are under increasing pressure by population growth, market pressures, urbanisation, and agricultural intensification / overgrazing (though sometimes land abandonment and agricultural extensification are causing degradation as well). The major degradation problems listed are erosion by water and wind, salinization and wildfires.

3. Socio-economic description

General conclusions:
Age distribution is uneven in many sites due to ex-migration of younger people. Also general depopulation in rural areas leads to land abandonment, which starts a vicious cycle of more degradation (e.g. lack of maintenance of conservation measures), which again results in more land abandonment. More dependence on off-farm income also leads to lower investments in agriculture and sustainable land management. Land fragmentation is also a problem in several sites.

4. Institutional and political setting

General conclusions:
In most sites local or national laws exist but implementation is often ineffective. The EU Common Agricultural Policy has some positive impacts, but also promotes the cultivation of unsuitable land in other places. A lack of cross-sectoral planning and collaboration is a very common problem. Weak extension services and low presence of govt. institutions are mentioned for several sites, but sometimes these gaps are filled by NGO's.

5. Relevant end-users / stakeholder groups (at all levels)

General conclusions:
Among the major stakeholders listed for the study sites are NRM Institutions, land users, NGO's, policy makers. Their interests however are sometimes conflicting.

6. Past and on-going projects

General conclusions:
In most if not all sites various projects focusing on desertification, land degradation and/or sustainable land management have been taking place or are still ongoing. These range from specific research activities to larger application-oriented projects. Various sites have been involved in other major global or regional desertification projects such as MEDALUS or DESERTLINKS.

2. MAPPING

Two parallel and complementary methods were used to map the extent of desertification and restoration measures in the study areas:

- The *"WOCAT" mapping method*, based on participatory expert assessment;
- *The GLADA mapping method:* using NDVI analysis of a 26 year time series, as has been applied in the LADA project.

A. WOCAT mapping

Together with individual case studies documented within WB3, this map will also show areas where protection and restoration measures have been applied and with what degree of success. This assessment will enable us to put the study sites in a broader environmental and socio-economic context. There are many environmental and socio-economic factors that influence the occurrence and expansion of land degradation, as well as the rate of success of mitigating measures. These factors will be identified at the local level (field sites) and their relevance for application at regional level will be assessed. They will serve as input parameters for an appropriate model to incorporate and apply them in the search for solutions (see WBs 4 & 5).

The "WOCAT" method used to map degradation and conservation in the study sites complements the study site descriptions provided by the individual study sites and was based on the original WOCAT mapping questionnaire (WOCAT, 2007), which was significantly revised in a joint effort of DESIRE, WOCAT and LADA in order to pay more attention to issues like biological and water degradation and placing more emphasis on direct and socio-economic causes of these phenomena and impacts on eco-system services. It evaluates what type of land degradation is actually happening where and why, and what is done about it in terms of Sustainable Land Management (SLM). Linking the information obtained through the questionnaire to a Geographical Information System (GIS) permits the production of maps as well as area calculations on various aspects of land degradation and conservation. The on-line map database is hosted by WOCAT, and the mapped outputs that can be generated from this database provide a powerful tool to obtain an overview of land degradation and conservation in a country, a region, or worldwide.

The mapping method consists of a spatial assessment of individual mapping units of a predefined base map, through the use of a questionnaire. The starting point for mapping degradation and conservation is land use. This is one of the main drivers of degradation / conservation and the basis for identifying the mapping units for which subsequently the information on land degradation and conservation was filled in. A hierarchical system for defining LUS-mapping units was used. Information that is contained in each specific unit will be displayed in the online system and contains the mapping unit delineations and a number of optional ecosystem and socio-economic attributes. The following steps were followed to delineate the base map units.

1. First, the main Land Use Type was delineated, e.g. Cropland, Grazing land, Forest/woodland, Mixed, or Other.
2. These main Land Use Types were subdivided: e.g. for Cropland: annual, perennial cropping; extensive or intensive Grazing land, etc.
3. Further subdivisions, if needed and sensible, were made on basis of physiographic or geomorphologic criteria, administrative units or socio-economic criteria

The Study Site leaders were left some degree of autonomy in their choice of additional criteria, which has resulted in base maps with slightly varying land use definitions (see maps I).

A base map unit is not necessarily confined to a single closed polygon, but may include many larger and smaller polygons, together forming a map unit for which degradation and conservation is assessed. The sizes/ scales of the different study sites vary between several km^2 and several hundred km^2 but on the average in the order of magnitude of 500 km^2. It was therefore proposed that for the larger study sites one or several representative area(s) - covering an area of up to a few hundred km^2 - was selected, for which the mapping is carried out. This will help in sharing experiences between the different study sites. Even though the mapping method is scale-independent, the accuracy and level of information of course vary with the scale.

The number of mapping units varies but should be more or less in the same order of magnitude for all study sites. Most study sites have in the order of 30- 50 units for which information was filled on the matrix tables. The size of the study area and the variability within the area will determine the scale of the mapping exercise and the size of the mapping units.

The base map was to be provided in a shapefile format to CDE (DESIRE partner 5) which is hosting the WOCAT database, where the DESIRE mapping data are also stored. The shapefile was entered into the system after which contributors could enter the attribute information in the on-line database system which has also been developed in a joint WOCAT/DESIRE/LADA effort. A viewer to display maps on-line is still under development at the moment of writing this report.

The mapping attributes on which information had to be collected are laid down in the so-called Questionnaire for Mapping (“QM”) and consist of the following blocks: Land use, Degradation and Conservation/SLM). The information on degradation and conservation is more or less “mirrored”, as shown in table 1 below.

The collected data are largely qualitative, based on expert opinion and consultation of land users. This permitted a fairly rapid and general assessment of the spatial extent, status and trend of degradation and extent, effectiveness and impact of SLM as well as their drivers.

Table 1.

Degradation / Mapping unit	SLM / Mapping unit
Type	Name / Group / Measure
Extent (area)	Extent (area)
Degree	Effectiveness
Impact on ecosystem services (type and level)	Impact on ecosystem services (type and level)
Direct causes	
Indirect causes	Degradation addressed
Recommendation	

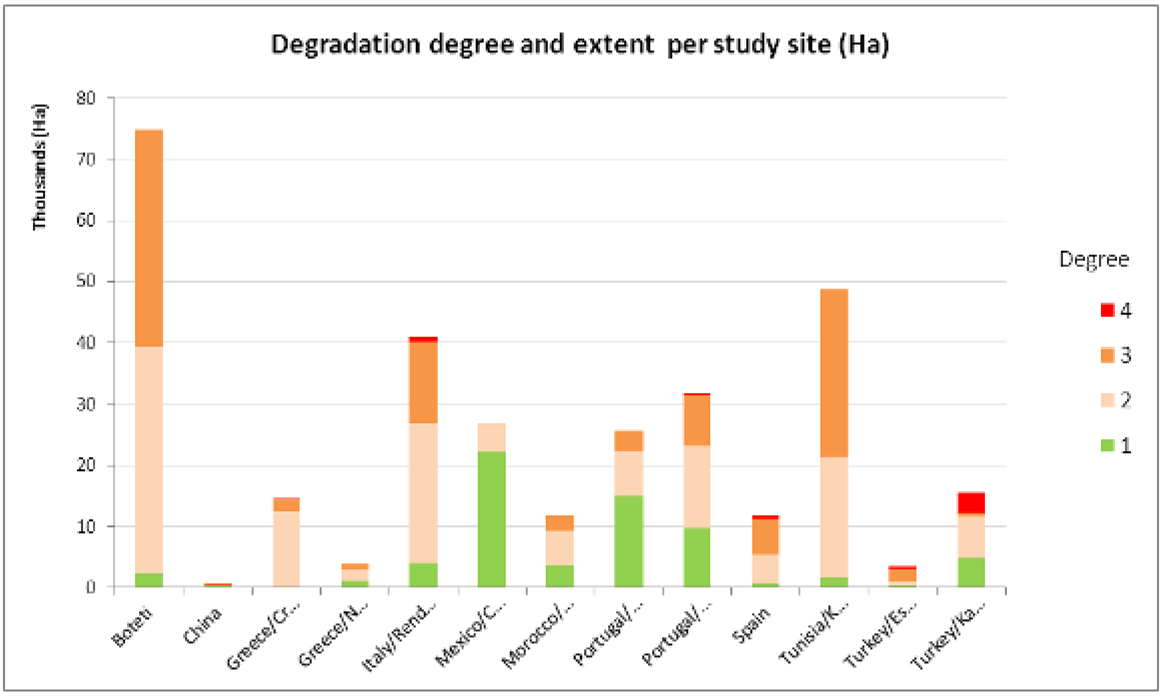
The information collected allows a wealth of different map outputs to be prepared, of which a few examples are given below in Annex I. For instance, the extent of degradation in general or of specific types can be displayed, as well as their impact on Ecosystems (in the enclosed maps only the occurrence of main degradation types is shown for four sites and the extent of (all) degradation for two other sites). Similarly, Conservation types and their effectiveness, as well as their impact on ecosystems can be shown. Both conservation and degradation can simultaneously have positive effects on some ecosystems and negative effects on others. Normally the balance would be negative for degradation and positive for conservation.

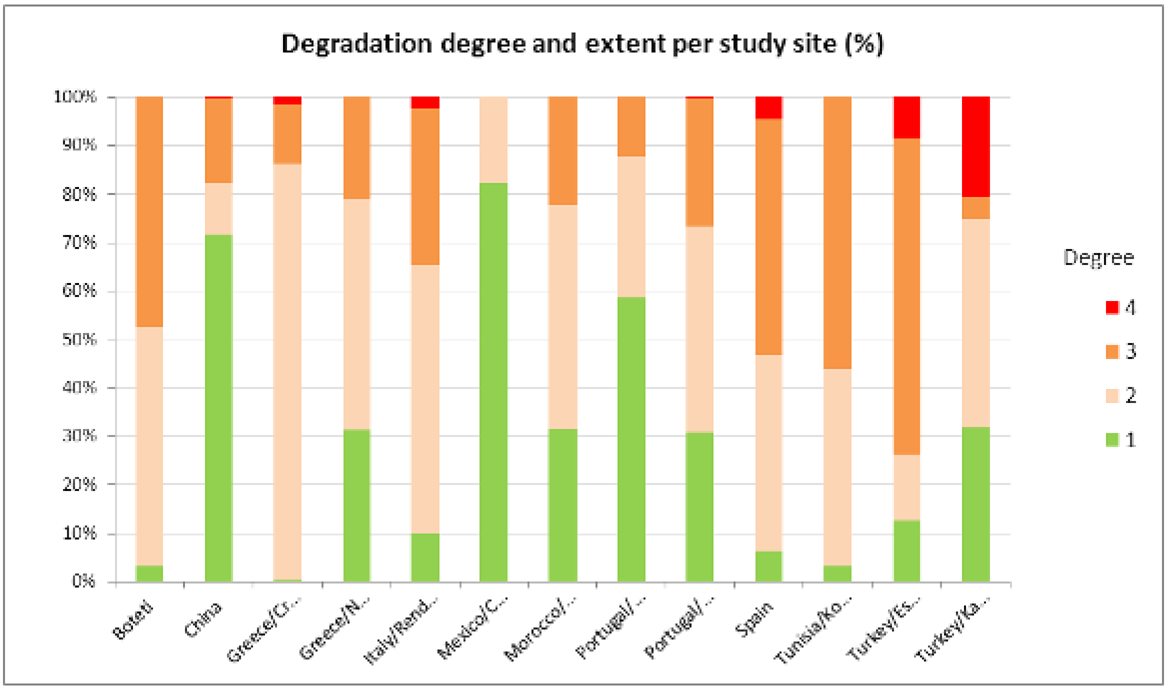
Results

The mapping database contains a wealth of attribute information, which cannot be shown in its entirety in the context of this report. Therefore examples of some maps are provided in Annex I, as well as the result of some area calculations below, showing tables and graphs on the extent of degradation and conservation. The full dataset is available on the DESIRE Website and can be used to create user-defined maps.

Furthermore, attribute data were analysed and graphs created for the area coverage of different land use types, degradation and conservation features. Some results are shown below for all study sites combined (except for the land use component, since different land use classes were used in the different study sites, so a generalised overview is not possible). Similar analyses have been made for the individual study sites.

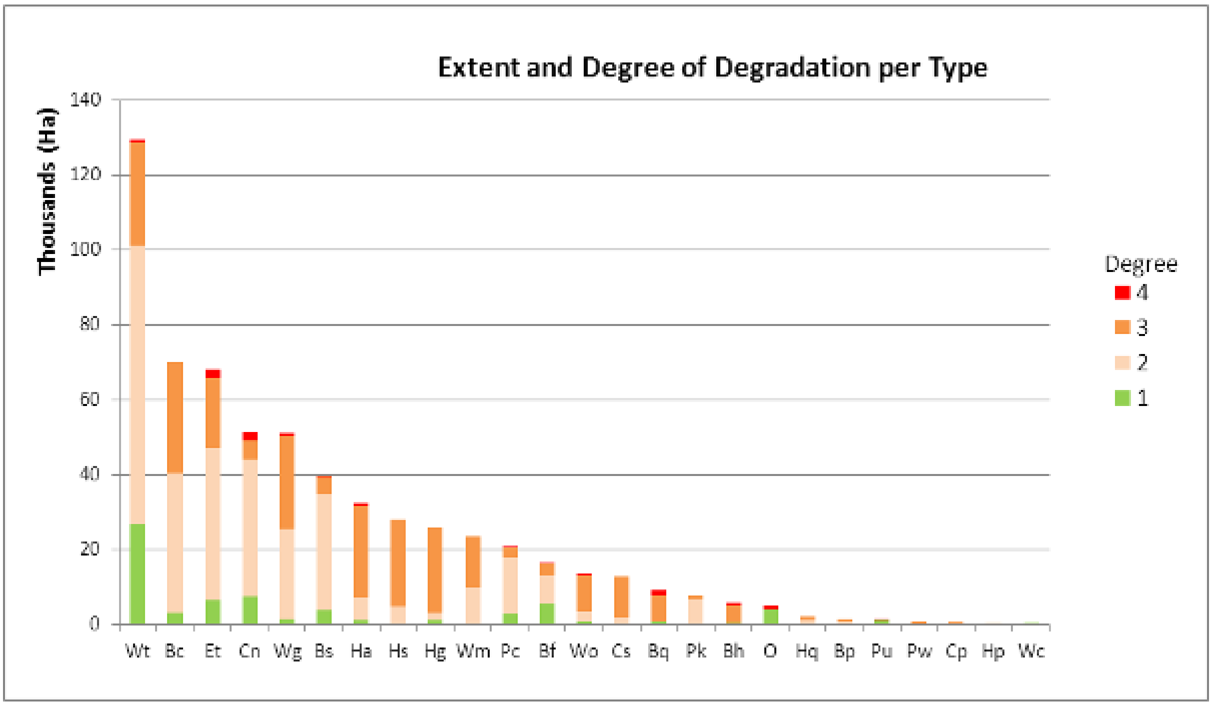
- Degradation degree and extent per study site (both in area coverage and as percentage of the study site area). The study site areas cover quite a range in size and therefore the relative graph (expressed in %) is better suited for comparison. It also shows that moderate and high degree (2 and 3) of degradation is fairly common in most sites, but that some sites are affected by more serious degradation (higher degree), e.g. Botswana, Spain, Tunisia, Turkey, than others, e.g. China, Mexico or Portual (Gois). The distribution of individual degradation types per study site is too diverse to show in a generalised table or graph and is therefore given in the individual study site data.

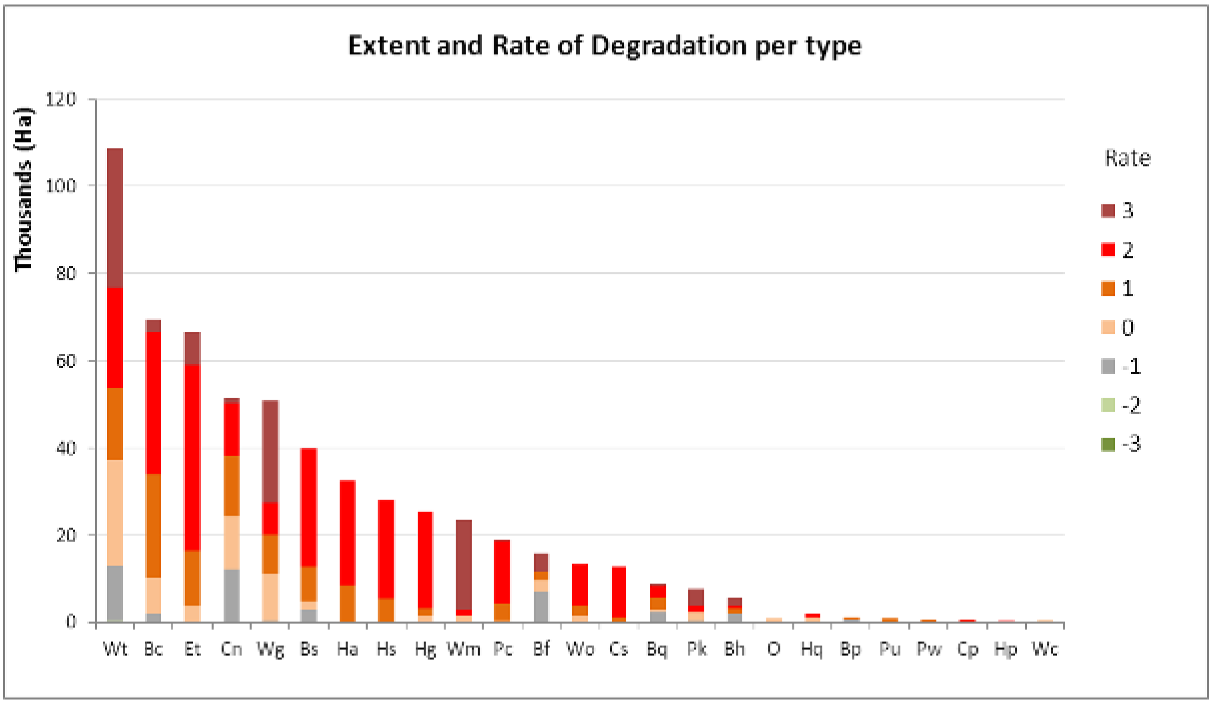




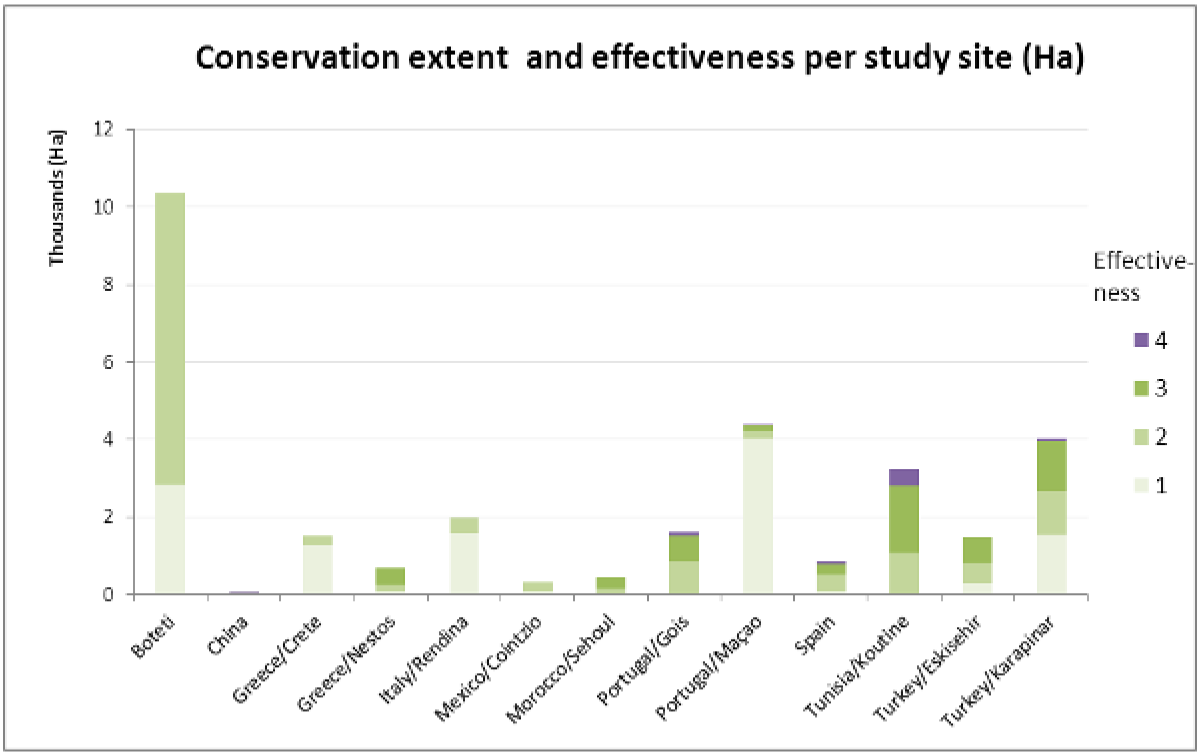
- Degradation Degree and Rate per degradation type. This clearly shows that sheet erosion by water (Wt) is the most common type of degradation on average, closely followed by biological degradation (Bc: Reduction of vegetation cover) and Wind erosion (Et), soil fertility decline (Cn) and gully erosion (Wg). Again moderate to high degree of degradation is predominant for most degradation types, but with a remarkable exception for various types water degradation (H), with mostly high degrees.

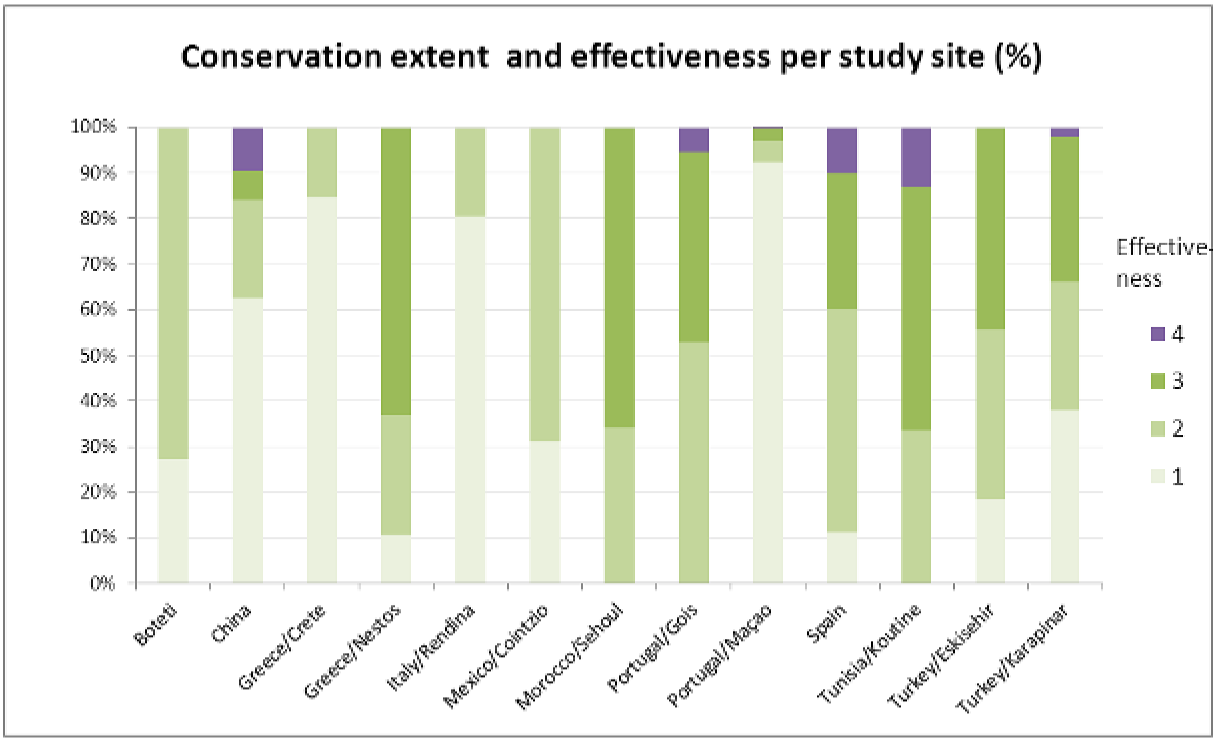
  All degradation types show an average positive rate of degradation for all study sites together, hence an increasing trend.



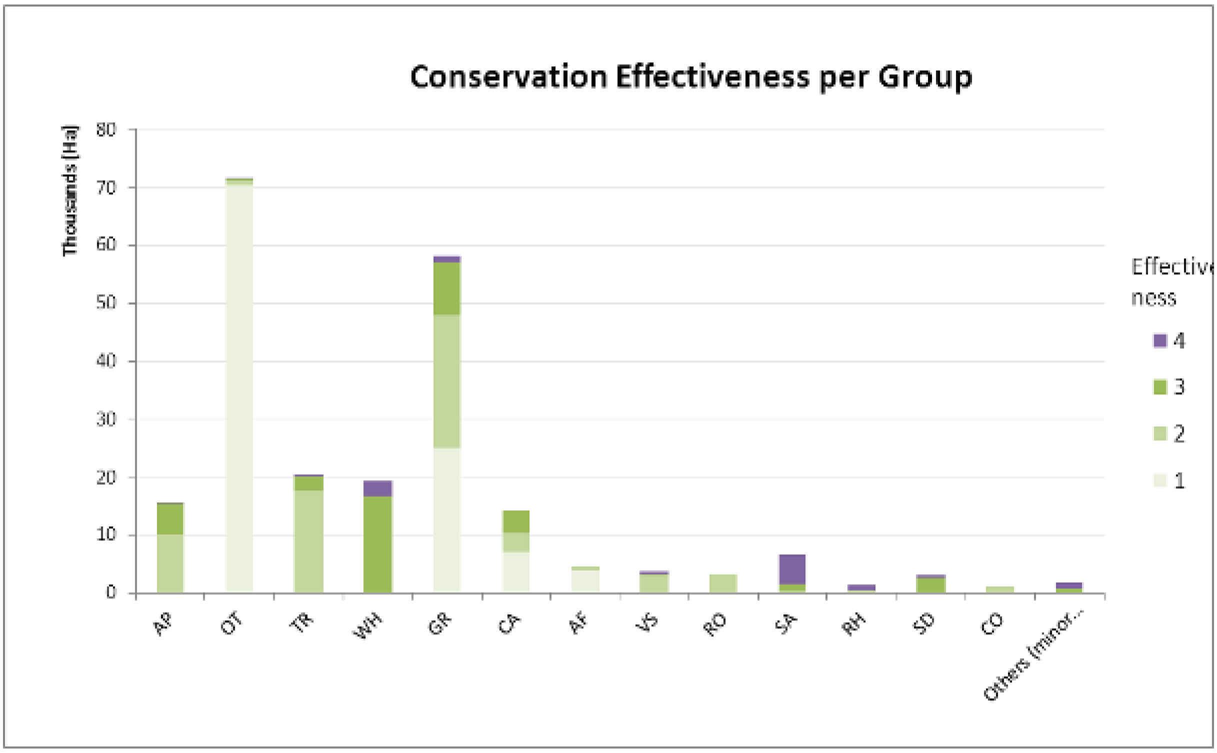


- The extent and effectiveness of conservation per study site, in Ha. (both in area coverage and as percentage of the study site area). As with degradation, the percentage graph is better suited for comparison between the sites. The (average) effectiveness in most sites ranges from moderate (2) to high (3), with the exception of Crete (Greece) and Rendina (Italy) and Maçao (Portugal) where effectiveness is relatively low (1 -2).



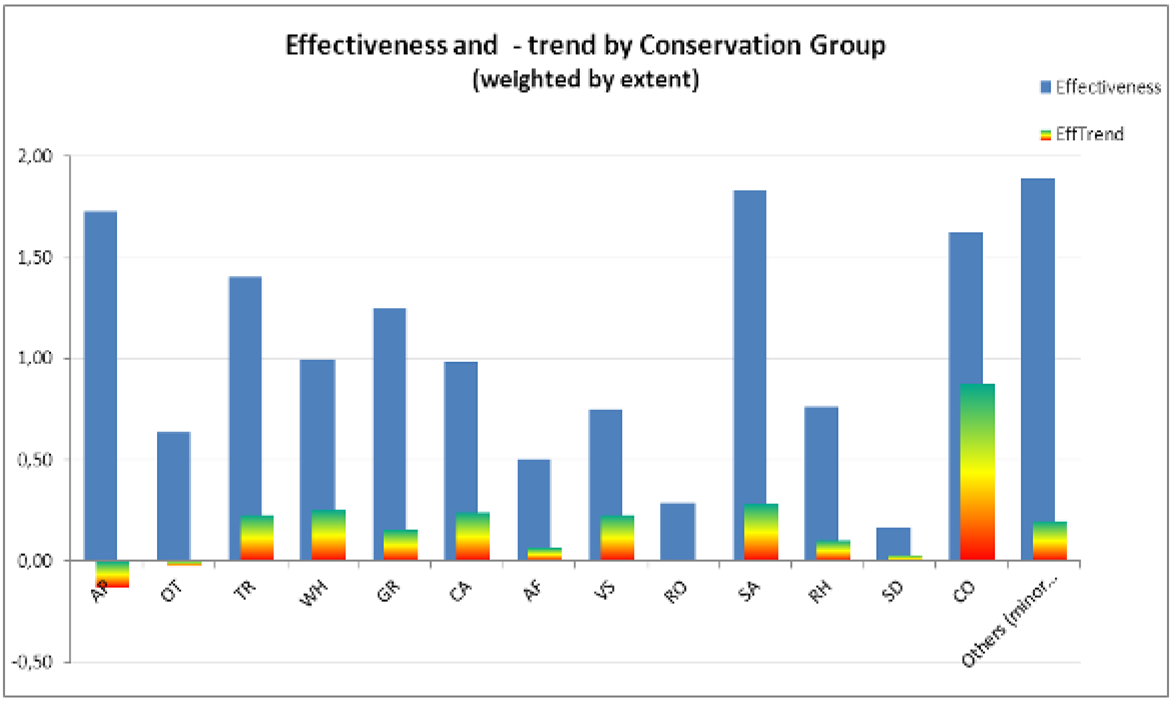


- The effectiveness of conservation and its trend per conservation group. This shows firstly that (in four of the sites) many conservation measures have been ranked under the group "Other", indicating that the current grouping system may still need some further refinement or more explanation. For the other measures the effectiveness is generally ranked moderate (2) to high (3). The effectiveness trend shows a stable to slightly increasing effectiveness for most conservation measures, but some negative trend too for Grazing land management (GR) and for "Other".



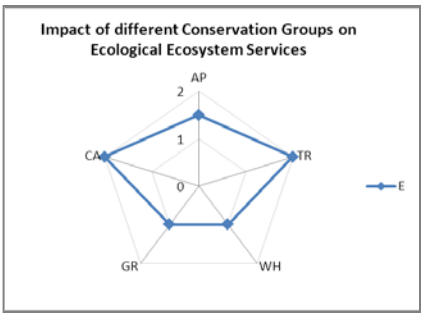
Conservation Groups

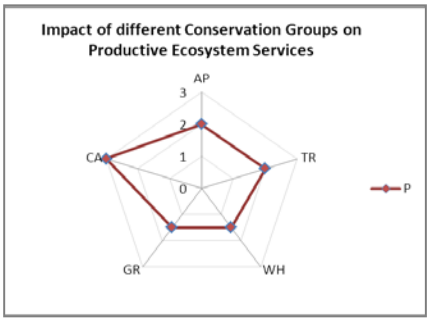
AP	Afforestation and forest protection
OT	Other
TR	Terraces (structural, but often combined with vegetative and agronomic measures)
WH	Water harvesting (structural, but also combined)
GR	Grazing land management (management practices with associated vegetative and agronomic measures)
CA	Conservation agriculture / mulching (mainly agronomic measures):
AF	Agroforestry (mainly vegetative, combined with agronomic)
VS	Vegetative strips / cover (mainly vegetative measures):
RO	Rotational system / shifting cultivation / fallow /slash and burn
SA	Groundwater / salinity regulation / water use efficiency
RH	Gully control / rehabilitation (structural combined with vegetative)
SD	Sand dune stabilization: (vegetative, structural and management)
CO	Conservation of natural biodiversity: Conservation of natural ecosystems and processes and the conservation of rare and endangered species.

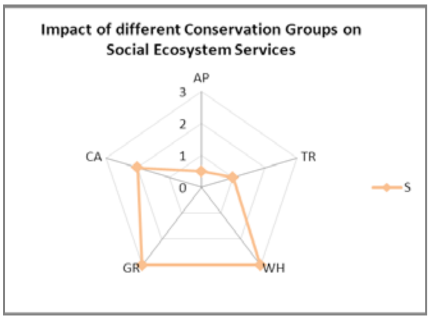


The database contains much more information that is worth analysing (direct and indirect causes, impact on ecosystems) but not all results can be shown here.

Spider (or radar) charts are best suited to show the various impacts on ecosystems where degradation (or conservation) may have a negative impact on some but a positive impact on other ecosystems at the same time. The example below shows the impact of 5 major "Conservation Groups" on Ecological Services (E), Productive Services (P) and Socio-cultural Services (S) respectively. It demonstrates that – in this example – Conservation Agriculture (CA) has a relatively high positive impact on Ecological and Productive Ecosystem Service, but less on Socio-cultural services. Water Harvesting and Grazing Management on the other hand show a high impact on Socio-cultural services. This also shows that the selection of a conservation strategy is not a straightforward one and can be determined by local priorities and politics (e.g. is the Productive Ecosystem considered more important than the Ecological or the Socio-cultural one, etc.







An interactive GIS-like map viewer is still under development but simple pre-defined maps (as shown in Annex I) are already provided as JPGs on the Website. Users with GIS facilities can download basemap shapefiles and attribute data and hence create their own custom maps.

B. GLADA mapping: Are the DESIRE sites browning or greening?

(by Zhanguo Bai)

The long-term loss of ecosystem function and productivity can be considered an important indicator of land degradation/desertification (Bai et al., 2008). It can be measured by change in net primary productivity (NPP - the rate at which vegetation fixes CO2 from the atmosphere less losses through respiration) where deviation from the norm may be taken as an indicator of land degradation/desertification or improvement. As a proxy, the remotely sensed normalized difference vegetation index (NDVI, calculated from a normalized transform of the near-infrared (NIR) and red reflectance ratio) has been shown to be related to biophysical variables that control vegetation productivity (Bai et al., 2008).

The GIMMS (Global Inventory Modelling and Mapping Studies) NDVI dataset (Version G, Pinzon et al., 2007) has been used in the LADA project to reveal the greenness evolution for six pilot countries and globally. The GIMMS dataset consists of NDVI data from 1981 through 2006, summarized fortnightly at 8 km resolution. The Harmonic Analysis of NDVI Time-Series (HANTS) algorithm (Verhoef et al., 1996, Roerink et al., 2000) was used to remove any residual cloud effects or other outliers (Jong de et al., 2011). The harmonized GIMMS NDVI time series 1981-2006 were used in an analysis of the DESIRE study sites.

A simple annual sum NDVI indicator was computed pixel-by-pixel for the calendar year for the countries in the northern hemisphere, and for October to the following September for the countries in the southern hemisphere (Botswana, see examples, and Chile), encompassing a complete growing season; the annual sum NDVI which reflects the aggregate of greenness over the growing season, was used as the standard surrogate for annual biomass productivity (Figure 1). The overall trend of the spatially aggregated annual sum NDVI for whole areas was shown in Figure 2. Trends of pixel by pixel were calculated by linear regression at an annual interval and mapped to depict spatial changes (Figure 3): a negative slope of linear regression indicates a decline of green biomass and a positive slope, an increase. The significance of trend analysis was set at 95% confidence level using t-test (Figure 4); In addition, SPSS and MS Excel were employed to analyse trends, correlations and significances of the non-gridded variables.

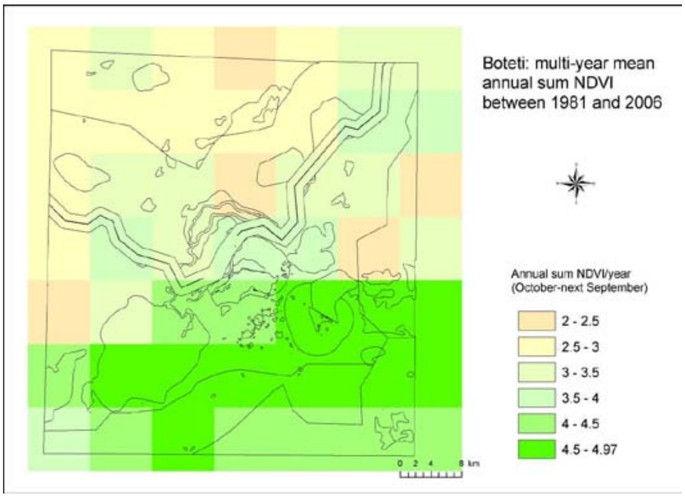


Figure 1: Average greenness over the growing season from 1981 - 2006 in the Botswana study site

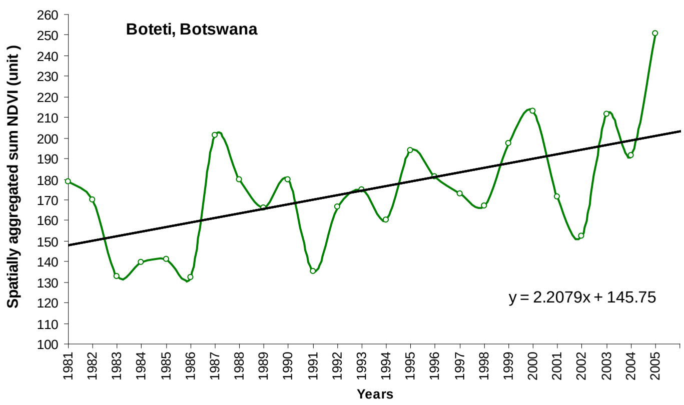


Figure 2: Trend in greenness from 1981 -2006 depicted by the slope of the linear regression

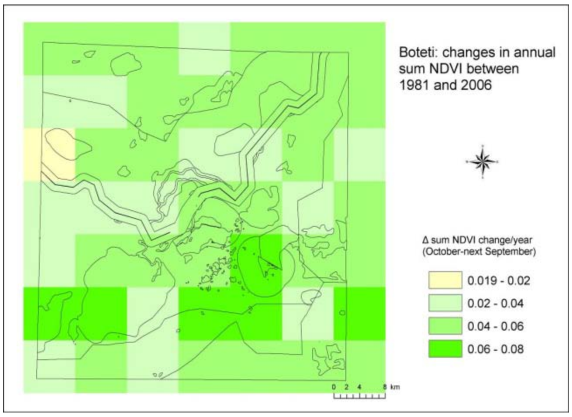


Figure 3: Changes in Greenness from 1981 - 2006

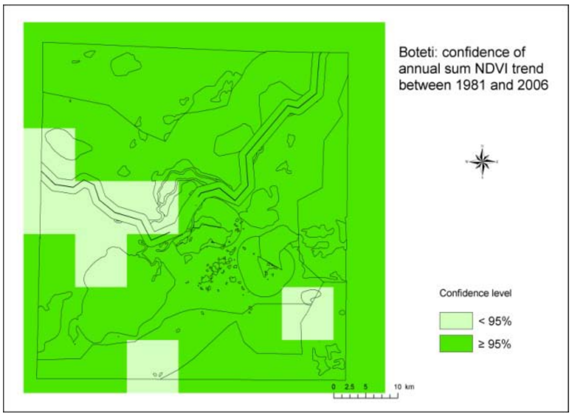


Figure 4: Confidence level for Greenness changes from 1981 - 2006

NDVI cannot be more than a proxy for greenness of vegetation. A negative trend in NDVI does not necessarily indicate land degradation/desertification, nor does a positive trend necessarily indicate land improvement. Biomass depends on several factors including: climate - especially fluctuations in rainfall, sunshine, and length of growing season; land use; large-scale ecosystem disturbances such as fires; and the global increase in nitrate deposition and atmospheric carbon dioxide. NDVI/NPP is used simply to identify areas where significant biological change is taking place. The trend of NDVI/NPP does not tell us anything about the nature of the changes; what is happening in Botswana is different from what is happening in for instance Mexico, both in terms of the driving changes in land use and the kind of land degradation. Better linkage and interpretation between NDVI/NPP change and land degradation/desertification are needed; comparisons with land cover, soil and terrain, and socio-economic data are recommendable.

NDVI is simply a ratio of red and near-infrared light reflected by the land surface. To get a measure open to economic analysis, the GIMMS NDVI time series has been translated to NPP using MODIS data (Justice et al., 2002, Running et al., 2004) for the overlapping period 2000-2006 (Figure 5). NPP was estimated by correlation with MODIS 8-day NPP values for the overlapping years of the GIMMS and MODIS datasets (2000-2006), re-sampling the annual mean MODIS NPP at 1km resolution to 8km resolution using nearest-neighbour assignment (Figure 6). This translation is approximate.

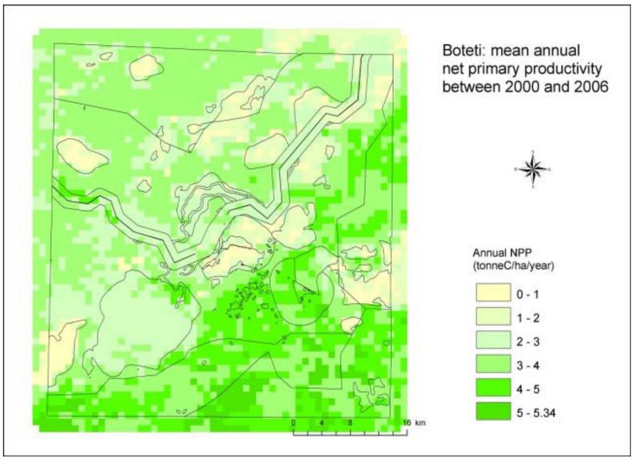


Figure 5: MODIS NPP from 2000 - 2006

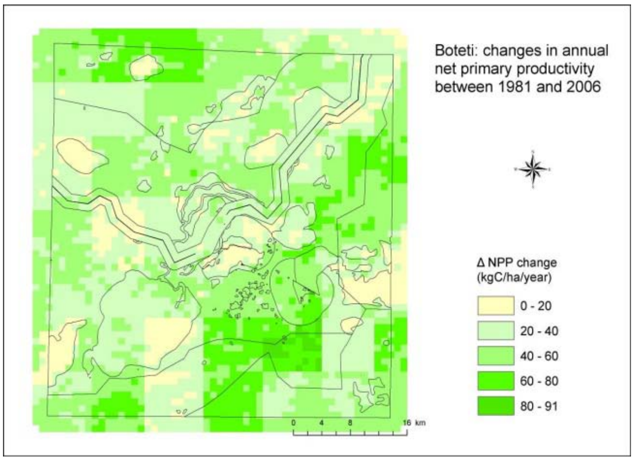


Figure 6: "Translated" NPP from 1981 - 2006

Caveat

The 8km resolution of the GIMMS data sets a limitation in two senses. First, an 8km pixel integrates the signal from a wider surrounding area. Many symptoms of even very severe land degradation, such as gullies, rarely extend over such a large area; they must be severe indeed to be seen against the signal of the surrounding unaffected areas. More detailed analysis is possible for those areas that have higher resolution time series data. Secondly, an 8km pixel or even a 1km pixel cannot be checked by a windscreen survey; and a 26-year trend cannot be checked by a single snapshot. In addition, NDVI signal can be saturated at closed vegetation canopy (Ripple, 1985). This means that NDVI is more sensitive for cropland and rangeland than for forest - leading to a lack of precision for forest mapping.

A declining trend of NDVI/NPP, as above-mentioned, even allowing for climatic variability, may not even be reckoned as land degradation: urban development is generally considered to be development - although it brings a loss of ecosystem function; land use change from forest or grassland to cropland of lesser biological productivity may or may not be accompanied by soil erosion, compaction and nutrient depletion - and it may well be sustainable and profitable, depending on management. Similarly, an increasing trend of NPP means greater biological production but may reflect, for instance, bush encroachment in rangeland or cropland - which is not land improvement as commonly understood.

Full sets for the NDVI analysis of all study sites are available on the DESIRE Website.

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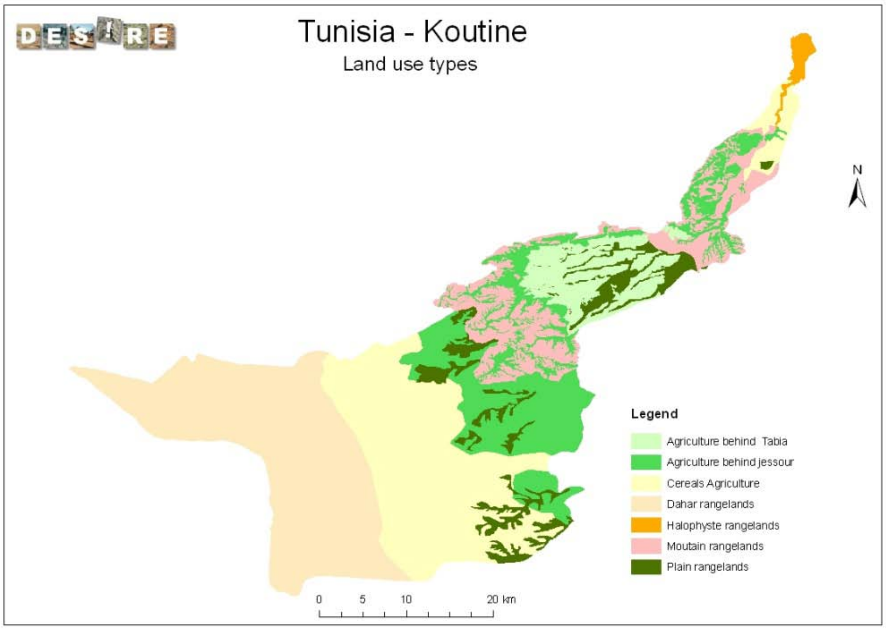
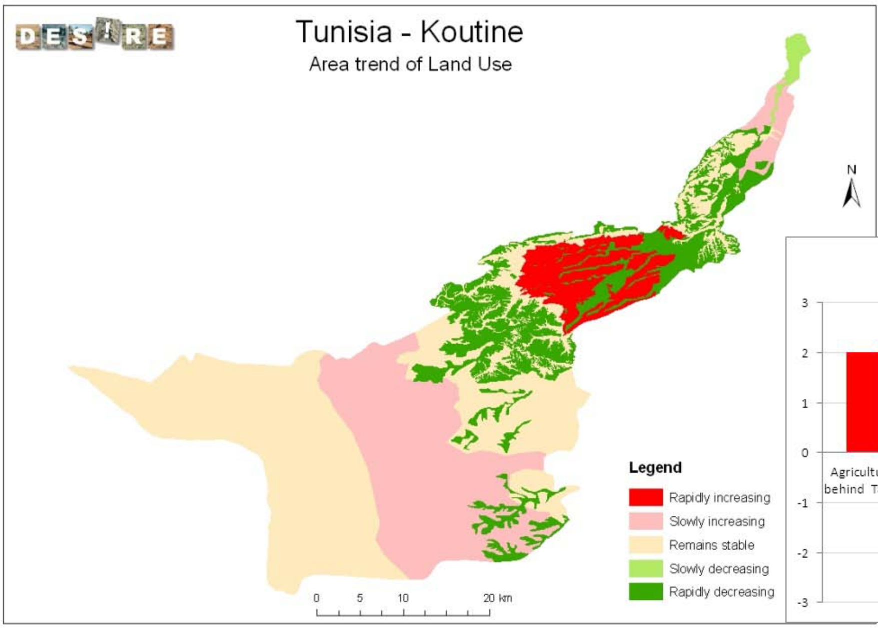
ANNEX 1 Map examples from individual Study Sites

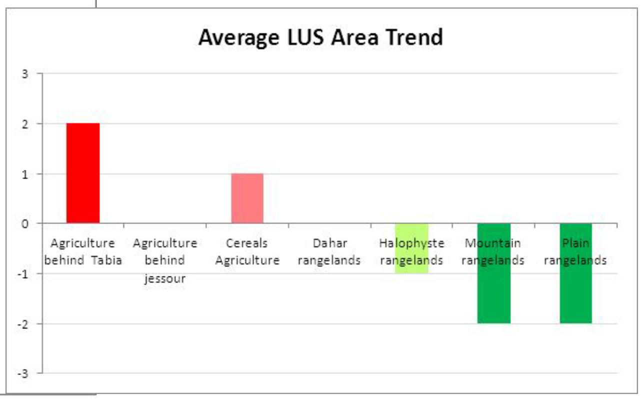
The mapping database contains a wealth of attribute information, which cannot be shown in its entirety in the context of this report. Therefore examples of some maps for (rather randomly) selected study sites are provided below. The full dataset is available on the DESIRE Website and can be used to create user-defined maps. The examples below show:

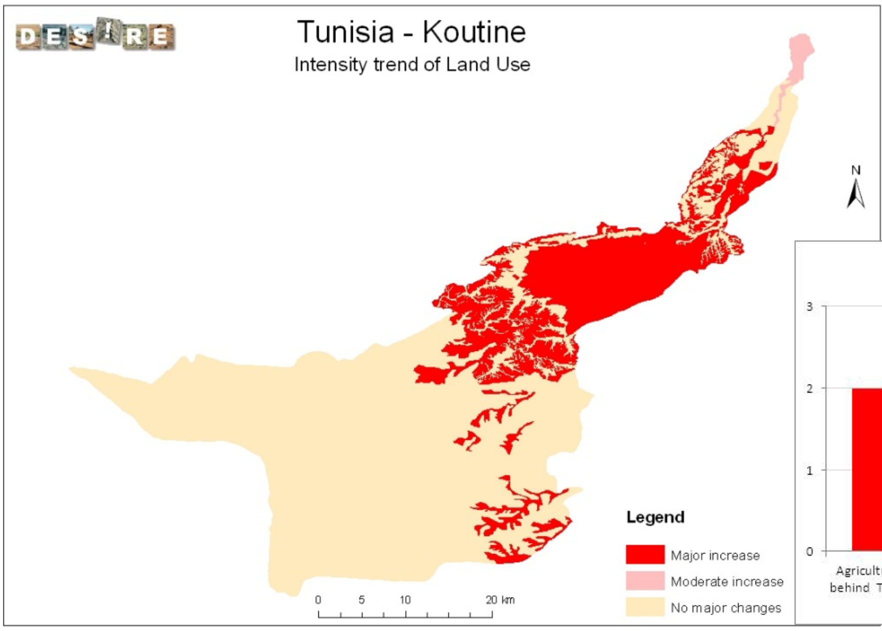
- The different land use types in Tunisia: land use formed the basis for the mapping units used to assess the degradation and conservation attributes;
- The Area trend and Intensity trend for these land use types. The Area trend map shows a “rapid increase” in “Agriculture behind Tabia”
- The main degradation type: within one mapping unit various types of degradation may occur and either or not overlap each other (cover the same area). The degradation types themselves were not delineated on the map, but for each type (or overlapping combination) the percentage of the mapping unit affected was asked. This means that especially in cases of low extent percentages the degradation can be anywhere within the mapping unit (this also applies to conservation measures). The smaller the scale of the map (and hence the smaller the units used), the less this is a problem. It was further assumed that in case of more degradation types per mapping unit, the type with the highest extent was considered the “main” type. Also, in case of combinations (overlapping degradation types), the first one listed was assumed to be the “main” type;
- The extent of degradation: the total percentage of the mapping unit covered by any type of degradation;
- The degree of degradation, weighted by area: degree multiplied by the extent percentage (e.g. Extent 20%, and Degree =2 → weighted degree = 0,4). In the case of more degradation types per mapping unit the weighted degrees for these types were added up;
- The rate of degradation, weighted by area;
- Total extent of conservation: the total percentage of the mapping unit covered by conservation;
- The main Conservation groups: WOCAT (2007) has made a grouping system reduce the wide range of conservation measures to a more manageable number. As with degradation types, there may be more than one group occurring within a single map unit, in which case the group with the highest extent is displayed;
- Extent of Conservation measures: conservation measures are a further categorisation of the conservation groups by means of the specific practice applied: agronomic, vegetative, structural, or management (including combinations);
- The effectiveness of conservation: the effectiveness of conservation is expressed in 4 classes from 1 (low: the measures need local adaptation and improvement in order to reduce land degradation to acceptable limits) to 4 (very high: the measures not only control the land degradation problems appropriately, but even improve the situation compared to the situation before degradation occurred). As with degradation degree and rate, the effectiveness is weighed by the extent of that conservation measure so that a conservation measure with effectiveness 3 but with an extent of 5% gets a proportionally lower value than another measure with effectiveness 3 but an extent of 80%.

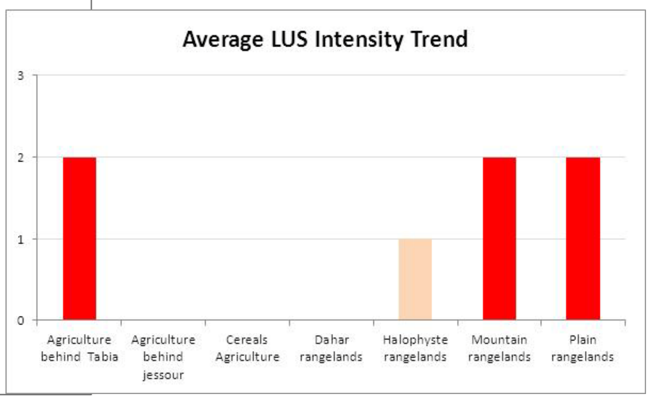
Land Use


DESIRE
Tunisia - Koutine
Land use types
N
Legend
Agriculture behind Tabia
Agriculture behind jessour
Cereals Agriculture
Dahar rangelands
Halophyste rangelands
Moutain rangelands
Plain rangelands
0 5 10 20 km

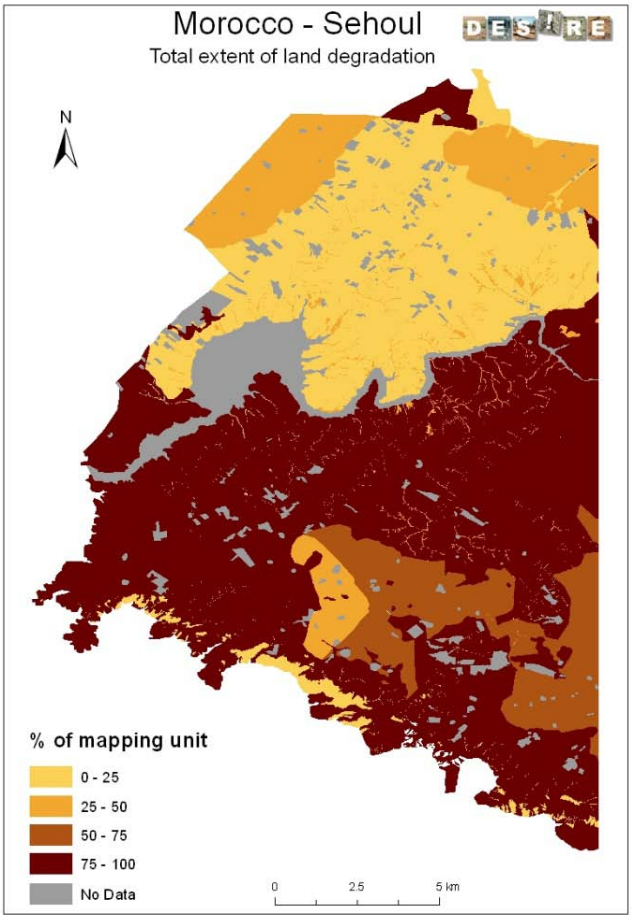

DESIRE
Tunisia - Koutine
Area trend of Land Use
N
Legend
Rapidly increasing
Slowly increasing
Remains stable
Slowly decreasing
Rapidly decreasing
0 5 10 20 km

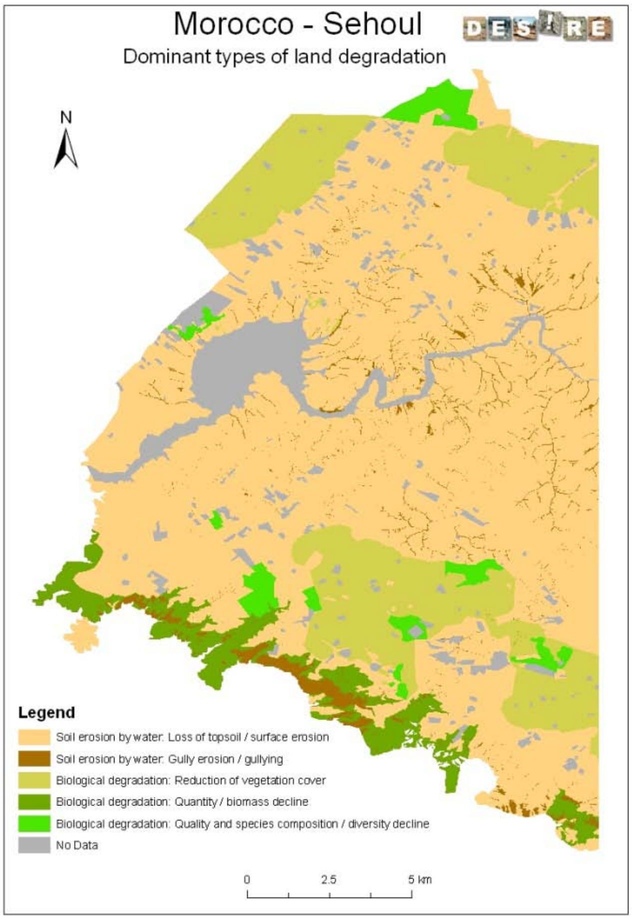

Average LUS Area Trend
3
2
1
0
-1
-2
-3
Agriculture behind Tabia
Agriculture behind jessour
Cereals Agriculture
Dahar rangelands
Halophyste rangelands
Mountain rangelands
Plain rangelands

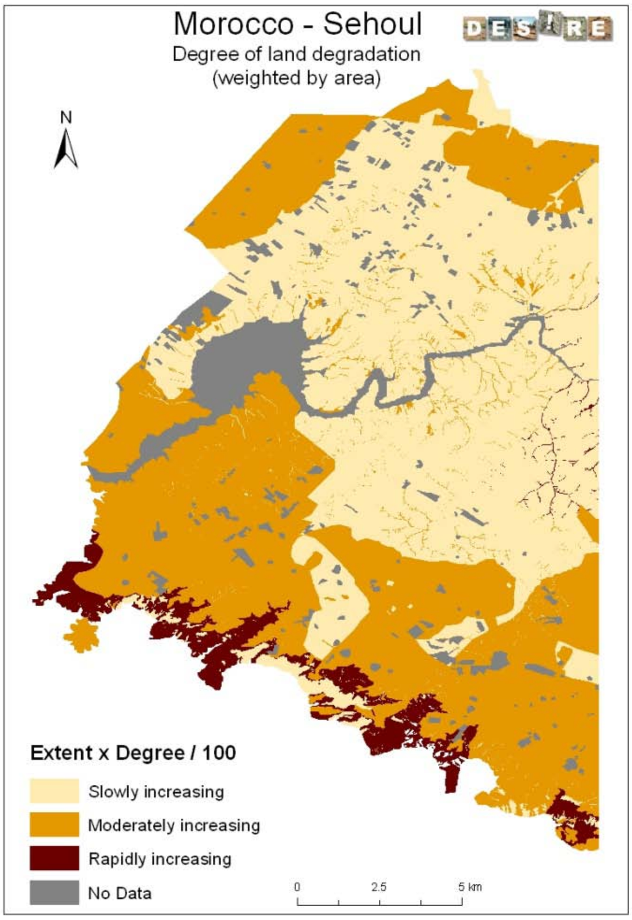

DESIRE
Tunisia - Koutine
Intensity trend of Land Use
N
Legend
Major increase
Moderate increase
No major changes
0 5 10 20 km

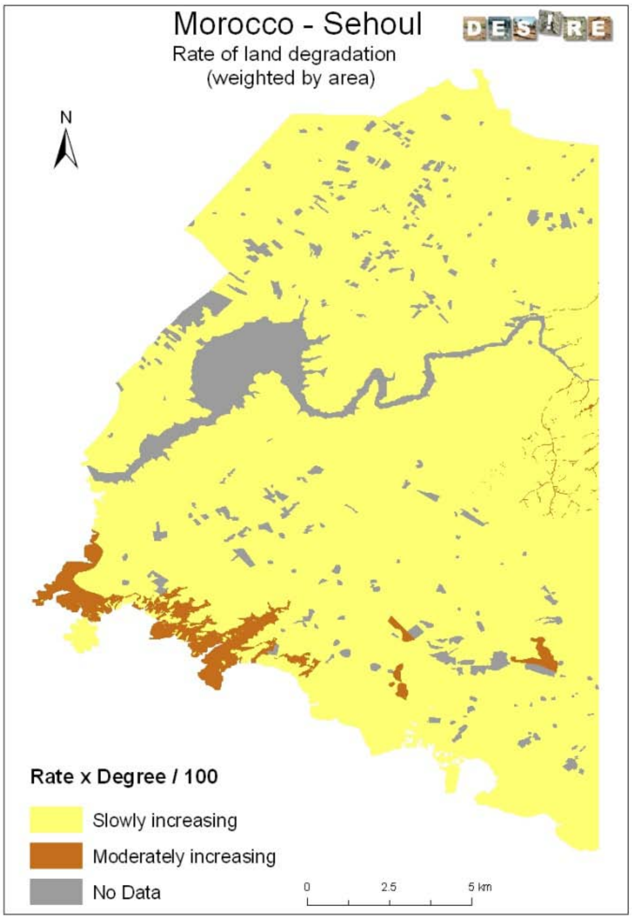

Average LUS Intensity Trend
3
2
1
0
Agriculture behind Tabia
Agriculture behind jessour
Cereals Agriculture
Dahar rangelands
Halophyste rangelands
Mountain rangelands
Plain rangelands

Degradation

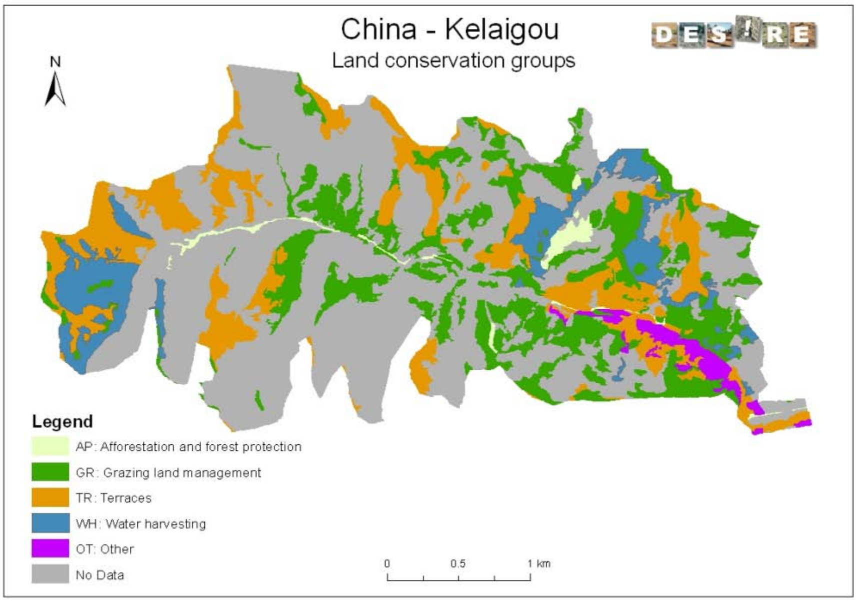


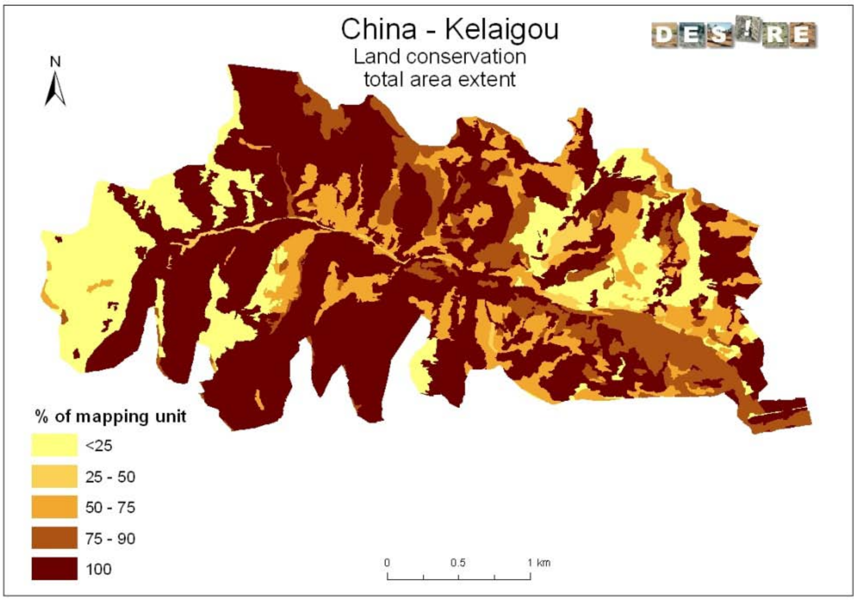


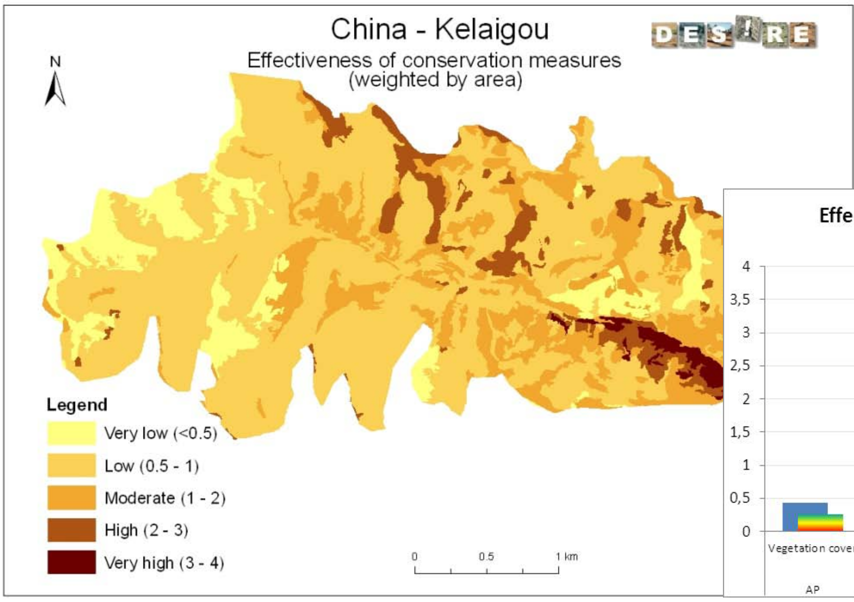


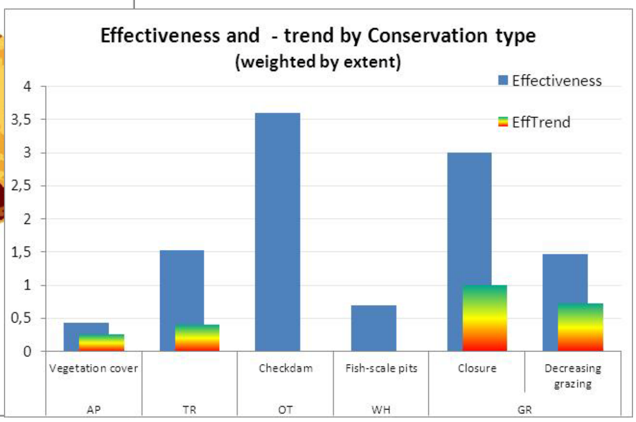


Conservation









ANNEX 2 Data availability study sites

Introduction

In the first project year of DESIRE, a questionnaire was distributed in which all study site partners were asked to indicate which information was already available. This questionnaire was a list of all pre-existing information that would be needed to execute the work of DESIRE in an optimal way. It listed which information was needed for which WB, and gave information about why certain information was needed. In cases were the same data were needed for several WBs, these data were only listed for the first WB for which they were necessary, to avoid repetition in the questionnaire. The tables on the following pages are a summary of those questionnaires.

The tables list the data needed for the different WBs, and also give information on the scale at which data are available, using the following scale levels: 1: questionnaire scale (and plot scale) → a few km^2, 2: sub-catchment → up to about 200 km^2, 3: whole study area, 4: larger than study area (region)

In addition to the information given in this appendix, the complete questionnaires also contain information on the formats in which the data are available, and on data sources.

Summary

The tables on the following pages indicate that although there are differences between sites, a significant amount of data was already available at the start of the DESIRE project. Table 1 gives a summary of the main data that were lacking at the start of the project for the different study sites of DESIRE according to the data questionnaire.

In case of missing data, the WB leaders have instructed Study Sites whether or not it is necessary to collect the missing data. Missing data are not equally serious for all types of data. For example, DEMs are lacking for several sites, but this might a) not be so serious, especially for sites in which the main problem is not water erosion. b) not a problem anyway as 90 m DEMs are freely available for all study sites of DESIRE. There are also cases in which the work for DESIRE can still be done, even if some data are missing. For example, PESERA can be run with the data listed in the tables, but can also be run using less detailed data. On the basis of this data availability, WB5 indicated that sufficient data is available to run PESERA for all sites. In other cases, missing data will have to be collected before project tasks can be executed. As the tables were completed in the first year of DESIRE, and as a lot of work has been done since, most of the missing data are now available.

Table 1. Data that were lacking for the different Study Sites at the start of DESIRE

Study Site	**Data lacking**	**Remarks**
Guadalentin, Spain	No major data missing.	
Macao/Gois, Portugal	Base map, land use map, soil map, evapotranspiration data	
Rendina, Italy	Information on degradation past 10 years, Evapotranspiration data	
Crete, Greece	Information on degradation past 10 years	
Nestos, Greece	Soil map, Land use map	
Konya, Turkey	Runoff data, meteo data on site, soil data	Runoff not a problem as main process is wind

		erosion
Eskisehir, Turkey	Runoff data, soil data, meteodata on site	
Mamora, Morocco	No data missing	
Zeuss, Tunisia	Evapotranspiration data, soil moisture data	These data are partly available
Djanybek, Russia	Land use map (being made), information on conservation past 10 years, rainfall data, evapotranspiration data, runoff data	
Novij, Russia	Land use map (being made), information on conservation past 10 years, rainfall data, evapotranspiration data, runoff data	
Yan River basin, China	Evapotranspiration data	
Boteti, Botswana	Administrative map, DEM, rainfall data, evapotranspiration data, biomass data for grazing	
Cointzio, Mexico	No data missing	
Secano, Chile	No data missing	
Santiago, Cape Verde	Land use map, Base map, DEM, available water in the soil, ground cover, rooting depth, bulk density	Data is being collected

Part 1: Study sites 1 - 4

		1. Guadalentin, Spain	2a & 2b. Macao & Gois, Pt	3 Rendina, Italy	4. Crete, Greece
Data	Scale level				
WB1					
WP1.2					
Base map: land use map, combined with administrative map	3, 4	3: Yes 4: Yes	No	Yes	Yes
Land use map	3, 4	See above	No	Yes	Yes
Administrative map	3	Yes	Yes	Yes	Yes
Info land use over past 10 years	1,2,3, 4	Yes for all scales.	Yes	Yes	Yes
Info degradation over past 10 years	1,2,3	Yes	Yes	No	No
Info conservation over past 10 years	1,2,3	Yes.	Yes	Yes	Yes
WP1.3					
Info drivers degradation field level	1	Yes partly available	No	Yes	Not yet
Info drivers degradation local level	1	Yes, partly available	No	See above	Not yet
Info drivers degradation policy level	2,3	Yes partly available	No	See above	Not yet
WP1.4					
List of local stakeholders	1	Yes	Yes	Yes	Yes
Stakeholder information needs	1,2,3		No		Yes
Set of sustainability goals	3	Yes	No	In preparation	Yes
WB2					
No pre-existing data required					
WB3					
No pre-existing data required					
WB4					
Spatial datasets					
50-100m DEM	1,2, 3, 4	Yes (all scales)	Yes	yes	Yes
Soil map	1,2, 3, 4	Yes (all scales)	No	Yes	Yes
Soil data					
Texture	1, 3, 4	Yes (3,4)	Yes	Yes	Yes
Porosity	1, 3, 4	No	Yes	Yes	No
Available water	1, 3, 4	Yes	Yes	Yes	Yes
Fertility	1, 3, 4	No	No	Only partly	No
Soil depth	1, 2, 3, 4	Yes (1, 2,3,4)	Yes	Yes	Yes

Part 1: Study sites 1 – 4 (continued)

		1. Guadalentin, Spain	2a & 2b. Macao & Gois, Pt	3. Rendina, Italy	4. Crete, Greece
Data	Scale level				
WB4					
Temporal datasets					
Rainfall					
Intensity	1, 3, 4	Yes	Yes	Yes	Not yet
Daily	1,2, 3, 4	Yes (1,2,3,4)	Yes	Yes	Yes
Monthly	1,2, 3, 4	Yes (1,2,3,4)	Yes	Yes	Yes
Evapotranspiration					
Hourly	1	Yes	No	No	No
Daily	1,2	Yes	No	No	Yes
Runoff					
Event based	1	Probably yes	Yes	no	Yes
Daily totals	1	Probably yes	Yes	Yet to get	Not yet
Soil moisture	1	Yes	Yes	no	Yes
WB5					
Climate					
Mean Potential Evapotranspiration (PET)	3,4	Yes	No/Yes	Yes	Yes
Mean temperature	3,4	Yes	No/Yes	Yes	Yes
Land use					
Crop data (if arable): Dominant crops and planting dates	3,4	Yes	Yes	Yes	Yes
Typical ground cover (if permanent)	3,4	Yes	Yes	Yes	Yes
Rootdepth	3,4	Yes	Yes		Yes
Aerial photos/satellite imagery of recent changes in land-use	3,4	Yes	Yes	Partly	Yes Copy-righted
Management practice (maps)	3,4	No	Yes		Yes
Soil					
Organic matter content	3,4	Yes	Yes		Yes
Bulk density	3,4	Yes	Yes		No
WB6					
No pre-existing data required					

Part 2: Study sites 5-8

		5. Nestos, Greece	6. Konya, Turkey	7. Eskisehir, Turkey	8. Mamora, Morocco
Data	Scale level				
WB1					
WP1.2					
Base map: land use map, combined with administrative map	3, 4	Yes	Yes, both scale	Yes, both scale	Yes for level 3
Land use map	3, 4	Yes	Yes, both scale	Yes, both scale	Yes for level 3
Administrative map	3	Yes	Yes	Yes	Yes 3 levels
Info land use over past 10 years	1,2,3, 4	Yes	Yes for scales 3 and lesser, NO for larger area	Yes for scales 3 and lesser, NO for larger area	Yes
Info degradation over past 10 years	1,2,3	Yes	Yes	Yes	Yes
Info conservation over past 10 years	1,2,3	Yes	Yes	Yes	Yes
WP1.3					
Info drivers degradation field level	1	Yes	Yes	Yes	Yes
Info drivers degradation local level	1	Yes	Yes	Yes	Yes
Info drivers degradation policy level	2,3	Yes	Yes	Yes	Yes
WP1.4					
List of local stakeholders	1	Yes	Yes	Yes	A first list is ready
Stakeholder information needs	1,2,3	Yes	Yes	Yes	Yes
Set of sustainability goals	3	No	Yes	Yes	
WB2					
No pre-existing data required					
WB3					
No pre-existing data required					
WB4					
Spatial datasets					
50-100m DEM	1,2, 3, 4	No			Level 1 and 2
Soil map	1,2, 3, 4	No	All scales at 1/25.000	All scales 1/25.000	Level 1 and 2
Soil data					
Texture	1, 3, 4	Yes	Yes	Yes	Level 1 and 2
Porosity	1, 3, 4	Yes	Yes	Yes	Not yet
Available water	1, 3, 4	Yes	Yes	Yes	Not yet
Fertility	1, 3, 4	Yes	Yes	Yes	Not yet
Soil depth	1, 2, 3, 4	Yes	Yes	Yes	Level 1 and 2

Part 2: Study sites 5-8 (continued)

		5. Nestos, Greece	6. Konya, Turkey	7. Eskisehir, Turkey	8. Mamora, Morocco
Data	Scale level				
WB4					
Temporal datasets					
Rainfall					
Intensity	1, 3, 4	No	No	No	Level 2
Daily	1,2, 3, 4	No	No	No	
Monthly	1,2, 3, 4	Yes	Yes	Yes	
Evapotranspiration					
Hourly	1	Yes	No	No	
Daily	1,2	Yes	No	No	
Runoff					
Event based	1	Yes	No	No	Yes
Daily totals	1	Yes	No	No	Yes
Soil moisture	1	Yes	Yes	Yes	Yes by rain simulation
WB5					
Climate					
Mean Potential Evapotranspiration (PET)	3,4	Yes	Yes	Yes	yes
Mean temperature	3,4	Yes	Yes	Yes	yes
Land use					
Crop data (if arable): Dominant crops and planting dates	3,4	Yes	Yes	Yes	yes
Typical ground cover (if permanent)	3,4	?	Yes	Yes	yes
Rootdepth	3,4	Yes	No	No	
Aerial photos/satellite imagery of recent changes in land-use	3,4	No	Yes	Yes	no
Management practice (maps)	3,4	No	No	No	Not yet available
Soil					
Organic matter content	3,4	Yes	Yes	Yes	Yes
Bulk density	3,4	Yes	Yes	Yes	Yes
WB6					
No pre-existing data required					

Part 3: Study sites 9-12

		9. Zeuss, Tunisia	10. Djanybek, Russia	11. Novij, Russia	12. Yan River Basin, China
Data	Scale level				
WB1					
WP1.2					
Base map: land use map, combined with administrative map	3, 4	Yes	No	No	3, yes.
Land use map	3, 4	Yes	No	No	3, yes
Administrative map	3	Yes	Yes	Yes	Yes
Info land use over past 10 years	1,2,3, 4	Yes	Yes	Yes	Yes
Info degradation over past 10 years	1,2,3	To be updated	Yes	Yes	Yes
Info conservation over past 10 years	1,2,3	Yes	No	No	Yes
WP1.3					
Info drivers degradation field level	1	In progress	Yes	Yes	Yes
Info drivers degradation local level	1	In progress	Yes	Yes	Yes
Info drivers degradation policy level	2,3	In progress	No	No	Yes
WP1.4					
List of local stakeholders	1	In progress	Yes	Yes	Yes
Stakeholder information needs	1,2,3	In progress	No	Yes	Yes
Set of sustainability goals	3	In progress	No	No	Yes
WB2					
No pre-existing data required					
WB3					
No pre-existing data required					
WB4					
Spatial datasets					
50-100m DEM	1,2, 3, 4	Yes	No	No	1,2, 3, yes
Soil map	1,2, 3, 4	Yes	No	No	1,2, 3, yes
Soil data					
Texture	1, 3, 4	Yes	Yes	Yes	1,3, yes
Porosity	1, 3, 4		Yes	Yes	1,3, yes
Available water	1, 3, 4	Yes	Yes	Yes	1,3, yes
Fertility	1, 3, 4	Not yet	Yes	Yes	1,3, yes
Soil depth	1, 2, 3, 4	Yes	Yes	Yes	Yes

Part 3: Study sites 9-12 (continued)

		9. Zeuss, Tunisia	10. Djanybek, Russia	11. Novij, Russia	12. Yan River Basin, China
Data	Scale level				
WB4					
Temporal datasets					
Rainfall					
Intensity	1, 3, 4	Not yet	No	No	Yes
Daily	1,2, 3, 4	Yes	No	No	No
Monthly	1,2, 3, 4	Yes	No	No	Yes
Evapotranspiration					
Hourly	1	Not yet	No	No	No
Daily	1,2	Not yet	No	No	No
Runoff					
Event based	1	Not yet	No	No	No
Daily totals	1	Yes (Partially)	No	No	No
Soil moisture	1	Not yet	No	No	Yes
WB5					
Climate					
Mean Potential Evapotranspiration (PET)	3,4	Yes	Yes	Yes	3, yes
Mean temperature	3,4	Yes	Yes	Yes	3, yes
Land use					
Crop data (if arable): Dominant crops and planting dates	3,4	In progress	Yes	Yes	3, yes
Typical ground cover (if permanent)	3,4	In progress	Yes	Yes	3, yes
Rootdepth	3,4	In progress	Yes	Yes	3, yes
Aerial photos/satellite imagery of recent changes in land-use	3,4	Yes	Yes	Yes	3, yes
Management practice (maps)	3,4	Yes	No	No	3, yes
Soil					
Organic matter content	3,4	Yes	Yes	Yes	3, yes
Bulk density	3,4	Yes	Yes	Yes	3, yes
WB6					
No pre-existing data required					

Part 4: Study sites 13-18

		13. Boteti, Botswana	14. Cointzio, Mexico	17. Secano Interior, Chile	18. Ribeira Seca, Cape Verde
Data	Scale level				
WB1					
WP1.2					
Base map: land use map, combined with administrative map	3, 4	Yes	Nearly	Yes	No
Land use map	3, 4	Yes	Yes	Yes	Yes
Administrative map	3	No	Yes	Yes	Yes
Info land use over past 10 years	1,2,3, 4	Yes	Yes	Yes	Yes (4)
Info degradation over past 10 years	1,2,3	Yes	Yes	Yes	Yes (4)
Info conservation over past 10 years	1,2,3	Yes	Yes	Yes	Yes
WP1.3					
Info drivers degradation field level	1	Yes	Nearly	Yes	Yes
Info drivers degradation local level	1	Yes	Nearly	Nearly	Yes
Info drivers degradation policy level	2,3	Yes	Nearly	Yes	Yes
WP1.4					
List of local stakeholders	1	Yes	Yes	Yes	Yes
Stakeholder information needs	1,2,3	Not yet	Yes	Yes	Yes
Set of sustainability goals	3	No	Yes	Yes	Yes
WB2					
No pre-existing data required					
WB3					
No pre-existing data required					
WB4					
Spatial datasets					
50-100m DEM	1,2, 3, 4	No	Yes	Yes	No
Soil map	1,2, 3, 4	Yes	Yes	Yes	Yes (4)
Soil data					
Texture	1, 3, 4	Yes	Yes	Yes	Yes (1.2.3)
Porosity	1, 3, 4	No	Yes	Yes	Yes (1.3)
Available water	1, 3, 4	No	Not all	Not yet	No
Fertility	1, 3, 4	Yes	Yes	Yes	Yes (1.3)
Soil depth	1, 2, 3, 4	Yes (general)	Yes	Yes	Yes (4)

Part 4: Study sites 13-18 (continued)

		13. Boteti, Botswana	14. Cointzio, Mexico	17. Secano Interior, Chile	18. Ribeira Seca, Cape Verde
Data	Scale level				
WB4					
Temporal datasets					
Rainfall					
Intensity	1, 3, 4	Not sure	Yes (second)	No	Yes (sub catchment)
Daily	1,2, 3, 4	No	Yes	Yes	
Monthly	1,2, 3, 4	Yes	Yes	Yes	Yes
Evapotranspiration					
Hourly	1	No	Yes	No	No
Daily	1,2	Unlikely	Yes	Yes	Yes
Runoff					
Event based	1	Unlikely	Yes	Yes	Yes
Daily totals	1	Unlikely	Yes	Yes	Yes
Soil moisture	1	Unlikely			Yes
WB5					
Climate					
Mean Potential Evapotranspiration (PET)	3,4	Not sure	Yes	Yes	YES
Mean temperature	3,4	Yes	Yes	Yes	YES
Land use					
Crop data (if arable): Dominant crops and planting dates	3,4	No	Yes	Yes	Yes
Typical ground cover (if permanent)	3,4	Yes	Yes	Yes	No
Rootdepth	3,4	Not sure	Yes	Yes	No
Aerial photos/satellite imagery of recent changes in land-use	3,4	Yes	Yes	Yes	Yes
Management practice (maps)	3,4	Yes	Yes	Yes	Yes (3)
Soil					
Organic matter content	3,4	Likely	Yes	Yes	Yes (3.4)
Bulk density	3,4	Yes	Yes	Yes	No
WB6					
No pre-existing data required					