Monitoring Land Degradation Neutrality

to support the implementation of the United Nations Convention to Combat Desertification and the Sustainable Development Goals

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As a way of reporting on the progress made towards achieving Land Degradation Neutrality, the countries involved have adopted land-based indicators which permit the parties concerned to monitor the improvements made to ecosystems. This article focuses on these indicators, as well as on the data and the tools used in calculating them.

Introduction

During the 13th session of the conference of the Parties to the United Nations Convention to Combat Desertification (UNCCD), the Parties adopted a new strategic framework for the implementation of the Convention for the period 2018 – 2030. This framework revolves around five strategic objectives (SO) underpinning the Convention relating to: the state ecosystems and the living conditions of affected populations, drought, the global environmental benefits generated by the UNCCD and the mobilization of both financial and non-financial resources. In particular, Strategic Objective 1 (SO1) aims to "improve the condition of affected ecosystems, combat desertification/land degradation, promote the sustainable land management and contribute to land degradation neutrality."

In order to adequately report the progress achieved related to SO1, the Parties to the UNCCD adopted during the 13th session of the Conference of Parties (CP) the following land-based (and related) indicators: i) Trends in ground cover (GC) (changes in GC); ii) Trends in the productivity of land or the functioning of soils (the dynamics of land productivity (DLP)); iii) Trends in carbon stocks, both surface and underground (organic carbon stocks in soil) (Decision 22/COP11).

By relying on these three indicators, the countries are enabled not only to monitor the progress of the implementation of the Strategic Framework of the Convention 2018 – 2030 but also to follow the progress made towards attaining Land Degradation Neutrality and to estimate indicator 15.3.1 of the SDG which corresponds to target 15.3 of the SDG, i.e.: "By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation neutral world."

The global LAD Target Setting Programme wasestablished in 2015 by the Global Mechanism and the Convention's secretariat in collaboration with 18 international partners, and has provided an ideal framework within which the assessment of land degradation trends, along with efforts aimed at defining targets to reach LDN, could be carried out.

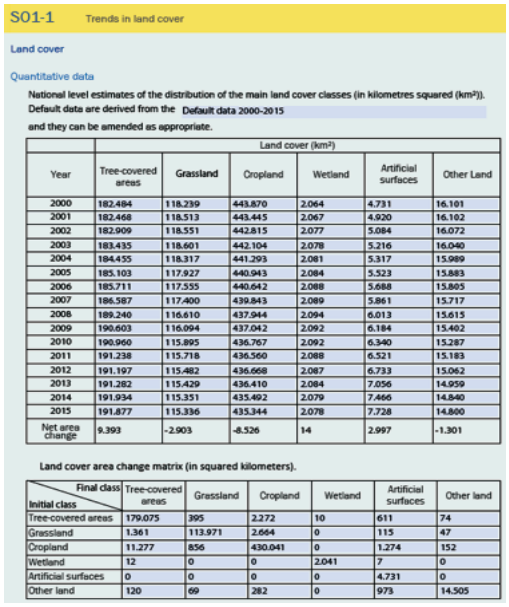
This programme has supported participating countries to define the LDN baseline and to set up a monitoring system based on the three LDN indicators. This article provides information on this support, in particular related to the adopted indicators a well as to the approach used, the data sources, and the tools, which help calculating these indicators.

Monitoring of land degradation trends and evaluation of LDN achievement

Indicators for monitoring LDN

Monitoring LDN is the assessment of the changes in the measurements in the values of the metrics identified for the indicators on natural capital of land compared to the baseline (t0). Land degradation trends are assessed using the SDG 15 target 15.3 indicator, the proportion of degraded land over total land area, derived from three sub-indicators:

– **Land cover** (change in land cover (LC)): refers to the observed bio-physical cover of the earth's surface, which describes the distribution of vegetation types, water bodies and man-made infrastructure. It also reflects the use of land resources (soil, water, biodiversity) for agriculture, forestry, human settlements and other objectives. This indicator fulfills two functions for the SDG indicator 15.3.1 of: (1) it reflects changes in the vegetation cover which can thus indicate land degradation when there is a loss of productivity in terms of ecosystem services and (2) a land cover classification system that can be used to disaggregate the other two sub-indicators (Fig. 1).



SO1-1 Trends in land cover

Land cover

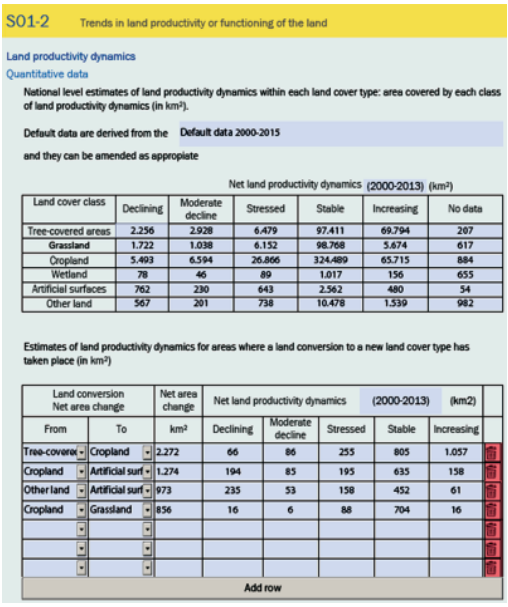
Quantitative data

National level estimates of the distribution of the main land cover classes (in kilometres squared (km²)).
Default data are derived from the Default data 2000-2015
and they can be amended as appropriate.

Year	Land cover (km²)					
	Tree-covered areas	Grassland	Cropland	Wetland	Artificial surfaces	Other Land
2000	182.484	118.239	443.870	2.064	4.731	16.101
2001	182.468	118.513	443.445	2.067	4.920	16.102
2002	182.909	118.551	442.815	2.077	5.084	16.072
2003	183.435	118.601	442.104	2.078	5.216	16.040
2004	184.455	118.317	441.293	2.081	5.317	15.989
2005	185.103	117.927	440.943	2.084	5.523	15.883
2006	185.711	117.555	440.642	2.088	5.688	15.805
2007	186.587	117.400	439.843	2.089	5.861	15.717
2008	189.240	116.610	437.944	2.094	6.013	15.615
2009	190.603	116.094	437.042	2.092	6.184	15.402
2010	190.960	115.895	436.767	2.092	6.340	15.287
2011	191.238	115.718	436.560	2.088	6.521	15.183
2012	191.197	115.482	436.668	2.087	6.733	15.062
2013	191.282	115.429	436.410	2.084	7.056	14.959
2014	191.934	115.351	435.492	2.079	7.466	14.840
2015	191.877	115.336	435.344	2.078	7.728	14.800
Net area change	9.393	-2.903	-8.526	14	2.997	-1.301

Land cover area change matrix (in squared kilometers).

Initial class \ Final class	Tree-covered areas	Grassland	Cropland	Wetland	Artificial surfaces	Other land
Tree-covered areas	179.075	395	2.272	10	611	74
Grassland	1.361	113.971	2.664	0	115	47
Cropland	11.277	856	430.041	0	1.274	152
Wetland	12	0	0	2.041	7	0
Artificial surfaces	0	0	0	0	4.731	0
Other land	120	69	282	0	973	14.505



SO1-2 Trends in land productivity or functioning of the land

Land productivity dynamics

Quantitative data

National level estimates of land productivity dynamics within each land cover type: area covered by each class of land productivity dynamics (in km²).

Default data are derived from the Default data 2000-2015

and they can be amended as appropiate

Net land productivity dynamics (2000-2013) (km²)

Land cover class	Declining	Moderate decline	Stressed	Stable	Increasing	No data
Tree-covered areas	2.256	2.928	6.479	97.411	69.794	207
Grassland	1.722	1.038	6.152	98.768	5.674	617
Cropland	5.493	6.594	26.866	324.489	65.715	884
Wetland	78	46	89	1.017	156	655
Artificial surfaces	762	230	643	2.562	480	54
Other land	567	201	738	10.478	1.539	982

Estimates of land productivity dynamics for areas where a land conversion to a new land cover type has taken place (in km²)

Land conversion Net area change		Net area change	Net land productivity dynamics (2000-2013) (km2)				
From	To	km²	Declining	Moderate decline	Stressed	Stable	Increasing
Tree-covere	Cropland	2.272	66	86	255	805	1.057
Cropland	Artificial surf	1.274	194	85	195	635	158
Other land	Artificial surf	973	235	53	158	452	61
Cropland	Grassland	856	16	6	88	704	16

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Figure 1 & 2: Example of reporting (country: Turkey) for the indicator "Change in ground cover" (on the left) and for the indicator "Net primary production" (on the right) as submitted by the country for the UNCCD reporting process on the performance review and assessment of implementation system (PRAIS) reporting platform.

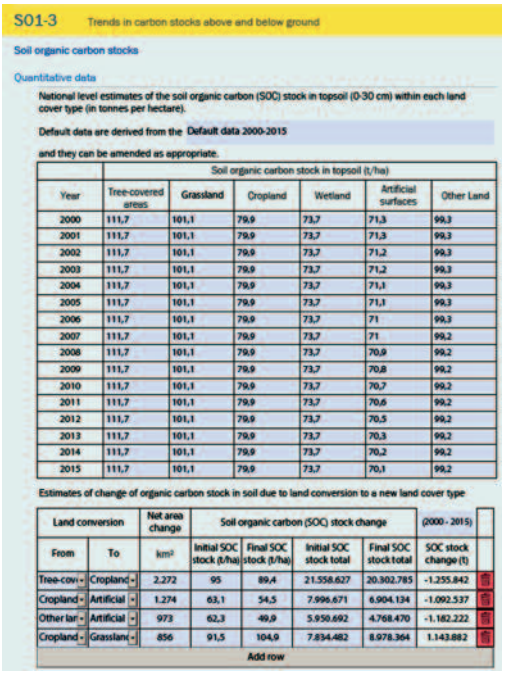
– **Land productivity** (net primary productivity (NPP)): refers to the total above-ground net primary productivity defined as the energy fixed by plants minus their respiration, which translates into the rate of biomass accumulation that delivers a suite of ecosystem services. This sub-indicator points to changes in the health and productive capacity of the land and reflects the net effects of changes in ecosystem functioning on plant and biomass growth, where declining trends are often a defining characteristic of land degradation (Fig. 2).

– **Carbon stock** (stock of soil organic carbon (OCS)): a reservoir which has the capacity to accumulate or release carbon and comprised of above- and below-ground biomass, dead organic matter, and soil organic carbon. The SOC is an indicator of overall soil quality associated with nutrient cycling and its aggregate stability and structure with direct implications for water infiltration, soil biodiversity, vulnerability to erosion, and ultimately the productivity of vegetation, and in agricultural contexts, yields. SOC stocks reflect the balance between organic matter gains, which depend on plant productivity and management practices that affect the productive potential of the soil. (Fig. 3).

The three sub-indicators provide exhaustive information on the land-based ecosystem services founding the underlying basis for achieving LDN and which, in combination, enable researchers to monitor the quantitative and qualitative aspects of the natural capital of land and soils and ecosystem services which derive from it. Furthermore, each indicator contributes to pinpointing different, but nevertheless relevant, changes in the state of the system.

To obtain a more relevant and exhaustive monitoring system, countries are encouraged to use supplementary indicators/measurements in order to provide an accurate indication of eco-systemic services along with their socio-economic impact, thus reflecting national and sub-national special features and priorities. These indicators could be related to the SDGs and include indicators on human well-being, such as erosion, sandstorms or biodiversity, such as the Red List Index.

To provide indicator-related data, countries have taken advantage of existing and already tested and used approaches and applications such as:



S01-3 Trends in carbon stocks above and below ground

Soil organic carbon stocks

Quantitative data

National level estimates of the soil organic carbon (SOC) stock in topsoil (0-30 cm) within each land cover type (in tonnes per hectare).

Default data are derived from the Default data 2000-2015

and they can be amended as appropriate.

	Soil organic carbon stock in topsoil (t/ha)					
Year	Tree-covered areas	Grassland	Cropland	Wetland	Artificial surfaces	Other Land
2000	111,7	101,1	79,9	73,7	71,3	99,3
2001	111,7	101,1	79,9	73,7	71,3	99,3
2002	111,7	101,1	79,9	73,7	71,2	99,3
2003	111,7	101,1	79,9	73,7	71,2	99,3
2004	111,7	101,1	79,9	73,7	71,1	99,3
2005	111,7	101,1	79,9	73,7	71,1	99,3
2006	111,7	101,1	79,9	73,7	71	99,3
2007	111,7	101,1	79,9	73,7	71	99,2
2008	111,7	101,1	79,9	73,7	70,9	99,2
2009	111,7	101,1	79,9	73,7	70,8	99,2
2010	111,7	101,1	79,9	73,7	70,7	99,2
2011	111,7	101,1	79,9	73,7	70,6	99,2
2012	111,7	101,1	79,9	73,7	70,5	99,2
2013	111,7	101,1	79,9	73,7	70,3	99,2
2014	111,7	101,1	79,9	73,7	70,2	99,2
2015	111,7	101,1	79,9	73,7	70,1	99,2

Estimates of change of organic carbon stock in soil due to land conversion to a new land cover type

Land conversion		Net area change	Soil organic carbon (SOC) stock change				(2000 - 2015)
From	To	km²	Initial SOC stock (t/ha)	Final SOC stock (t/ha)	Initial SOC stock total	Final SOC stock total	SOC stock change (t)
Tree-cov	Cropland	2.272	95	89,4	21.558.627	20.302.785	-1.255.842
Cropland	Artificial	1.274	63,1	54,5	7.996.671	6.904.134	-1.092.537
Other lar	Artificial	973	62,3	49,9	5.950.692	4.768.470	-1.182.222
Cropland	Grasslan	856	91,5	104,9	7.834.482	8.978.364	1.143.882

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Figure 3 :
Example of reporting (country: Turkey) on the Soil organic Carbon (SOC) indicator as submitted by the country on for the UNCCD reporting process on the performance review and assessment of implementation system (PRAIS) reporting platform.

– **Collect Earth:** a tool developed by the FAO that facilitates the gathering of data via Google Earth. By combining Google Earth, Bing Maps and Google Earth Engine, users can analyze high and very-high resolution satellite imagery to support national forest inventories, Land Use and Land Use Change and forestry (LULUCF) assessments, monitor agricultural land and urban areas, validate existing geospatial information. Collect Earth has been used by Cape Verde, São Tomé and Principe, Antigua and Barbuda to establish their LDN baseline and as a basis for discussion to identify their LDN targets;

– **Trends.Earth**: produced by a partnership of Conservation International, Lund University, and the National Aeronautics and Space Administration (NASA), with the support of the Global Environment Facility (GEF). It allows users to plot time series of key land change indicators (including degradation and improvement), produce maps and other graphs that can support monitoring and reporting, and track the impact of sustainable land management.

Trends.Earth has been used by most countries in the context of reporting to the UNCCD.

Approach for data collection and calculating indicators

At the country level, indicators should be calculated primarily, and to the extent possible, using comparable and standardized national official data sources. Global data sources could be used in the absence of, or to complement and support, national data sources.

In the context of the process of defining the targets for LDN, a stratified approach with three levels of detail has been recommended for calculating the LDN indicators. Such a tiered approach enables a country to use methods suited to its capabilities, its resources and the availability of data (Fig.4).

– **Tier 1:** Global / regional Earth Observation data, georeferenced information and modeling: Partnerships with the European Space Agency (ESA), the Joint Research Center of the European Commission (JRC) and the International Reference and Information Center Soil Survey (ISRIC) have enabled the Convention to provide countries with global default data sets for the three sub-indicators used to measure LDN.

– **Tier 2:** National statistics based on data compiled by reference administrative or natural units (for example, river basins) and derived from national Earth Observation data.

– **Tier 3:** Field surveys, assessments and ground measurements. Such an approach allows national authorities to use methods compatible with their capacities, resources and availability of data and facilitates comparisons at global level. Several countries like Mauritius and Cape Verde have used the Collect Earth tool at this level to supplement the default data.

Most countries have adopted a blended approach combining the three levels.

Indicator	Default data sources
Land cover (Land Cover Change)	ESA CCI-LC 300 m annual worldwide chronological series of CT from 1992 to 2015, ver. 2.0.7 (36 classes)
Land productivity or functioning of the land (net primary productivity - NPP)	Joint Research Centre (JRC) LPD datasets at 1 km resolution Global 15-year (1999 to 2013) time series of daily SPOTVGT normalized difference vegetation index (NDVI) images aggregated/composited for observation every 10 days (i.e. 540 observations overall for each pixel)
Carbon stocks stocks above and below ground (soil organic carbon (SOC) stock)	ISRIC SoilGrids 250m global soil mapping products (SOC percentage, bulk density, gravel content)

Table 1:
List of default data sources according to the indicators to be calculated.

Assessment of the proportion of degraded land: the "one-out, all-out" principle

The quantification/assessment of the LDN indicator is based on the assessment of the evolution of the sub-indicators (LC, NPP, SOC) to determine the extent of degraded land relative to the total land area based on negative trends, identified at the national level for each indicator. The observed changes should be tracked separately. The gains from one of the indicators cannot compensate for the losses from another indicator, since all three are complementary components, rather than additives. In fact, there is no scientific basis for combining them into a composite indicator to give a single aggregated value. This is the reason why LDN is not achieved when one of the indicators / parameters indicates a negative trend, even if the others are positive. This is the principle of the one-out, all-out parameter (Figure 5). Thus, according to the "one-out, all-out" principle, a degradation takes place when (in comparison to the baseline) whenever:

– the SOC drops considerably, or

– the NPP drops considerably, or

– the evolution of the ground cover is negative.

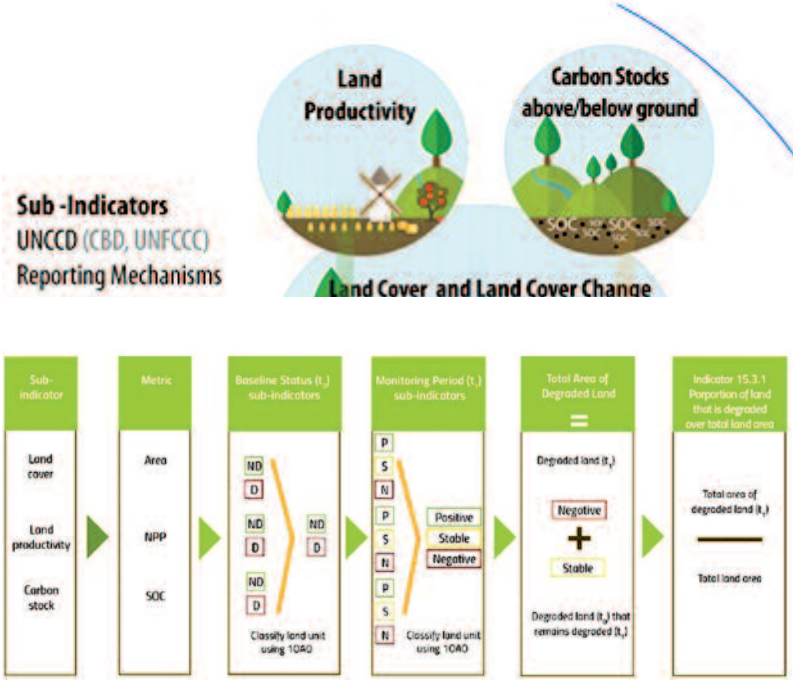
Consequently, the values of the three indicators will have to remain stable or improve to achieve LDN.

Assessment of land degradation trends in the Mediterranean region

Analysis of globally reported indicators shows that the majority of countries have used default data to report on land-based progress indicators as well as SDG indicator 15.3.1: "the proportion of degraded land over total land area".

The countries indicated that deforestation, overgrazing and unsuitable land management have been the factors directly causing the change in land use and that the indirect factors have been pressure from human population growth, land ownership patterns, poverty, governance and education.

At the level of the Mediterranean region, an analysis of the indicators for eight countries (Algeria, Egypt, France, Italy, Morocco, Spain, Tunisia and Turkey) has shown the land degradation trends as detailed in Table 2 and Figure 6.



Conclusion

By its implementation, the LDN target setting programme has reinforced national capacities in terms of land related data management, especially by identifying appropriate data sources, connecting to national SDG-related processes and working

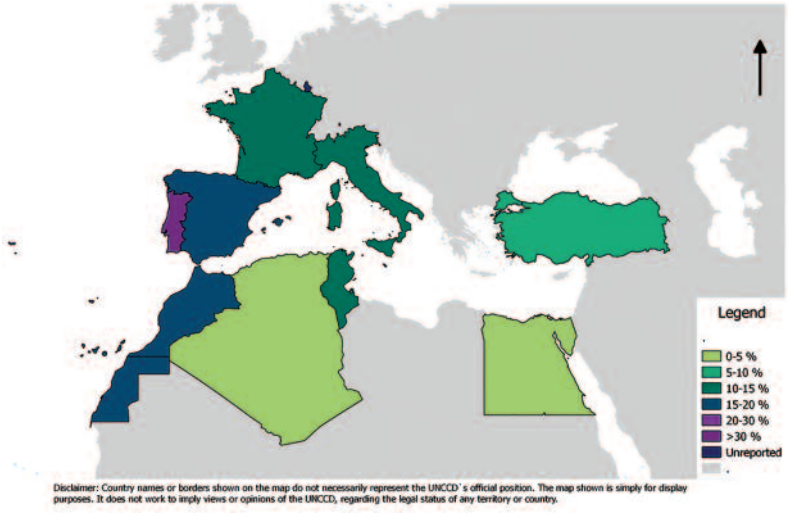


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Figure 4 :
Three-tier approach for data collection and calculating indicators.

Figure 5:
The "one-out, all-out" principle applied in the assessment of the proportion of degraded land (Orr *et al*, 2017).

Figure 6:
Proportion of degraded land in relation to total surface area (SDG indicator 15.3.1) (ICCD/CRIC(17)/https://www.unccd.int/sites/default/files/sessions/documents/2019-03/ICCD_CRIC%2817%29_2-1822319F.pdf).

Table 2:
Extent of degraded land in proportion to total surface area (indicator SDG 15.3.1).

Country	Total degraded area (km²)	Proportion of degraded area (%)
Algeria	18.5	0.8
Egypte	10.9	1.1
France	67.4	12.4
Italy	39.7	13.4
Morocco	134.5	18.9
Spain	91.3	18.2
Tunisia	19.5	12.6
Turkey	71.1	9.3

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with specialized partners at national and global levels.

The introduction of concepts, definitions, methodologies and the dissemination of standardized data for the assessment and monitoring of land degradation remains one of the most important achievements of the LDN target setting process. Participating countries highlighted at the end of the process the continuous international support required to reinforce national capacities in terms of implementing LDN, close the data gaps and fostering interconnection between already-existing national and regional information systems.

There is a clear need to establish interoperable systems for data collection, monitoring and dissemination in order to be able to assess LDN.

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Summary

Monitoring Land Degradation Neutrality (LDN) as a backup to the implementation of the United Nations Convention to Combat Desertification (UNCCD) along with the Goals of Sustainable Development (SDG)

Following the adoption of the SDGs by the UN General Assembly, Land Degradation Neutrality (LDN), referring to the SDG 15.3, was adopted by the United Nations Convention to Combat Desertification (UNCCD) at the 12th Session of the Conference of the Parties (COP 12) in Ankara in October 2015, as a "strong vehicle for driving the implementation of the Convention". COP 12 furthermore defined LDN as a "state whereby the amount and quality of land resources necessary to support ecosystem functions and services and enhance food security remain stable or increase within specified temporal and spatial scales and ecosystems". Through its LDN Target Setting Programme (TSP), the Global Mechanism of the United Nations Convention to Combat Desertification (UNCCD) had put in place a solid monitoring framework to evaluate the progress towards the achievement of LDN. In fact, the LDN TSP allowed the introduction of standardized concepts, definitions, methodologies and best available data to estimate and monitor LDN. Thanks to this process, the majority of Mediterranean countries, as of 2019, have established their baseline in terms of land degradation trends, based on the three land-based indicators (land cover, land productivity and soil organic carbon), identified the degradation drivers and set their LDN Targets to be achieved by 2030.