Land productivity

Indicator name **Land productivity dynamics (LPD)**

Indicator unit Area in km^2 with decreasing, stable or increasing trend in land productivity from 1999 to 2013. Land productivity is calculated from satellite observations of photosynthetically active vegetation as the above-ground biomass production accumulated during the annual growing season.

Area of interest The LPD has been calculated in DOPA for each terrestrial and coastal protected area, for their 10km unprotected buffer, as well as for countries and terrestrial ecoregions, and is provided in DOPA Explorer for all terrestrial and coastal protected areas of size ≥ 1 km^2 , for countries and for terrestrial ecoregions.

Related targets

Sustainable Development Goal 15 on life on land

Aichi Biodiversity Target 5 on loss of natural habitats

Aichi Biodiversity Target 11 on protected areas

Aichi Biodiversity Target 14 on ecosystems that provide essential services

Policy question Humans need increasing amounts of plant biomass for producing food, fodder, fibre and energy. Being able to meet these demands in the long term requires a sustainable use of land and vegetation resources. A persistent reduction in biomass production or land productivity will directly and indirectly impact almost all terrestrial ecosystem services and benefits that form the basis for sustainable livelihoods of all human communities. Tracking changes in land productivity is, therefore, an essential part of monitoring ecosystem changes and land transformations that are typically associated with land degradation. The state of the Earth's vegetation cover and its development over time is one reliable and accepted measure associated with land productivity.

Use and interpretation LPD maps, with a spatial resolution of 1 km, the persistent trajectory of land productivity during 15 years (1999-2013), characterized by the following five qualitative classes indicating different directions and intensity of changes:

1. Persistent severe decline in productivity
2. Persistent moderate decline in productivity
3. Stable, but stressed; persistent strong inter-annual productivity variations
4. Stable productivity
5. Persistent increase in productivity

Desertic areas and water bodies, where no productivity is detected, are not classified.

LPD is a remotely-sensed global product based on vegetation phenological metrics that is related to the land's capacity to sustain primary production. It is derived from time series of indices of vegetation photosynthetic activity, namely the Normalized Difference Vegetation Index (NDVI), obtained from satellite data acquired by the SPOT VEGETATION sensor.

Persistent land productivity changes, as assessed by LPD, point to long-term alteration of the health and productive capacity of the land. The primary productivity of a stable land system is not a steady state, but often highly variable between different years and vegetation growth cycles due to natural variation and/or human intervention. This implies that land productivity changes cannot be assessed by comparing land productivity values of single reference years or averages of a few years. On the contrary, approaches must be based on longer term trends on multi-temporal change and trend analysis which are continuously repeated (persistent) in defined time steps using an extended time series, as is the case for LPD.

LPD trends detect areas with persistent and active declines in primary productivity that might point to ongoing land degradation, rather than areas which have already undergone degradation prior to the observation period and have reached a new equilibrium from which they do not further degrade within the observation period.

LPD refers to observed changes of above-ground biomass and is conceptually different from, and not necessarily related to, agricultural production or income per unit area.

Trends in land productivity have been adopted as one of three land-based progress indicators of the United Nations Convention to Combat Desertification (UNCCD). These indicators are used for mandatory reporting and have been proposed as one sub-indicator for monitoring and assessing progress towards achieving target 15.3 of the Sustainable Development Goals (SDG) on a land degradation-neutral world.

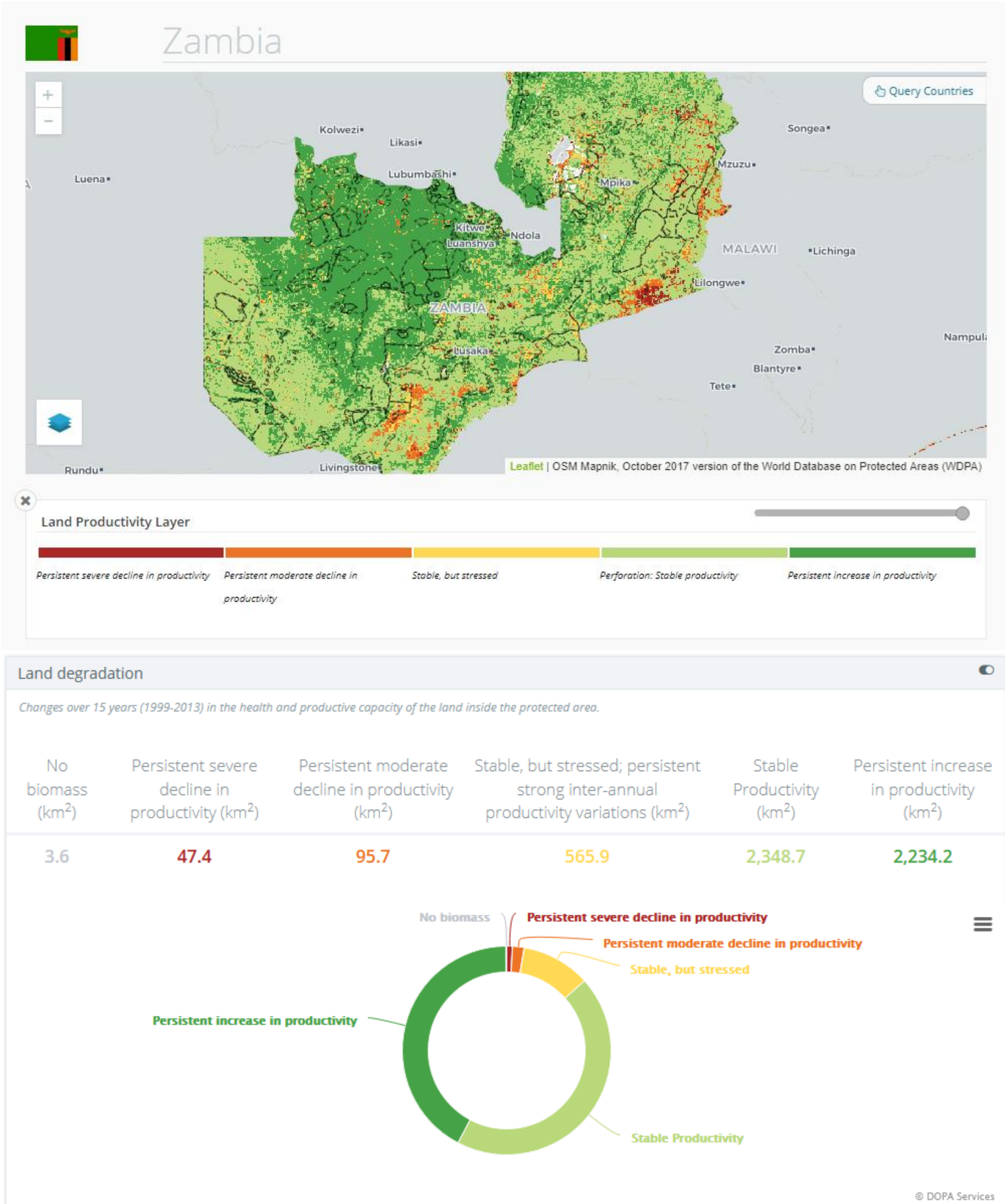

Figure 1. Land productivity dynamics (1999-2013) data are presented in DOPA Explorer by means of maps (Top, map of LPD classes for Zambia), charts and tables at the protected area, ecoregion and country levels (bottom, statistics for the Dja National Park in Cameroon).

Key caveats

Declining productivity as assessed through LPD refers to observed changes of above-ground biomass, and is certainly not the sole indicator of possible land degradation. Land degradation is a multifaceted global phenomenon with distinct variations between regions and across key land cover/land use systems which cannot be captured by a single or a limited set of indicators. Declining trends in LPD do not indicate land degradation per se, nor do increasing trends in LPD indicate recovery. For instance, increased productivity is sometimes achieved at the cost of other land resources, such as water or soil, in which case it can lead to degradation, which is observable only in later stages.

Research has shown that time series of remotely sensed vegetation indices, such as those used for deriving LPD, are correlated with biophysically meaningful vegetation characteristics such as photosynthetic capacity and primary production. These characteristics are closely related to global land surface changes and biomass trajectories that can be associated with processes of land degradation and recovery. However, it is necessary to incorporate other factors different from biomass trends into the analysis of land degradation. To identify critical land degradation zones, land productivity must be analysed within the context of anthropogenic land use and other environmental changes.

LPD is based on the NDVI, which is the most commonly used vegetation index and has demonstrated and strong relationships with primary productivity. There are however other vegetation indices that have been shown to perform better under some specific vegetation conditions such as sparse vegetation cover, although their derivation requires additional adjustment factors or model inputs that are not always available or that cannot be always measured reliably.

Land areas with no significant vegetation primary productivity, i.e., hyper-arid, arctic and very-high altitude mountain regions, as well as water bodies, are not included in the LPD classification.

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Because the area of the five LPD classes is computed within the boundaries for each terrestrial and coastal protected area and for its buffer, results will be affected by the accuracy of the available protected area boundaries.

Indicator status

LPD global results have been published in the World Atlas of Desertification (Cherlet *et al*., 2018).
The assessment of LPD in protected areas and in their buffers has been published in De la Fuente B *et al*., 2020.

Available data and resources

Data available LPD values are available for each country, terrestrial ecoregion and each terrestrial and coastal protected area of size ≥ 1 km^2 on the DOPA Explorer website: http://dopa.jrc.ec.europa.eu/explorer/

Data updates Planned with each update of DOPA.

Codes Standard GIS operations applied to vector and raster data.

Methodology

Methodology The LPD map contains information on persistent trajectories of land productivity dynamics during 15 years, from 1999 to 2013, which are summarised by five qualitative classes, plus a 'No productivity' class (see above). Provided with a resolution of 1 Km, the LPD data were overlaid with the boundaries of each terrestrial or coastal protected, and with the 10 km unprotected buffer around each protected area of size ≥ 5 km^2, as well as with the boundaries of countries and ecoregions, to calculate the absolute (km^2) and relative surface (%) covered by the different LPD qualitative classes. UNESCO Biosphere Reserves were discarded as well as protected areas with known areas but undefined boundaries. Only the part of the buffer around each protected area that does not overlap with other protected areas is considered; therefore, there might be cases of protected areas with no LPD information in their buffer area, when such buffer area fully overlaps with other surrounding protected areas.

Input datasets The indicator uses the following input datasets:

Protected Areas

- WDPA of January 2021 (UNEP-WCMC & IUCN, 2021).
    - Latest version available from: www.protectedplanet.net

Country boundaries

Country boundaries are built from a combination of GAUL country boundaries and EEZ exclusive economic zones (see Bastin *et al.*, 2017).

- Global Administrative Unit Layers (GAUL), revision 2015.
    - Latest version available online: http://www.fao.org/geonetwork/srv/en/metadata.show?id=12691
- Exclusive Economic Zones (EEZ) v9 (2016-10-21)
    - Latest version available from: http://www.marineregions.org/downloads.php

Terrestrial Ecoregions of the World

- TEOW (Olson *et al.*, 2001)

- Latest version available from: https://www.worldwildlife.org/publications/terrestrial-ecoregions-of-the-world

Land Productivity Dynamics

- LPD trends during 15 years, from 1999 to 2013.
  - Available at: https://wad.jrc.ec.europa.eu/landproductivity

References

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UNEP-WCMC & IUCN. (2021). Protected Planet: The World Database on Protected Areas (WDPA) [On-line], [January/2021], Cambridge, UK: UNEP-WCMC and IUCN. www.protectedplanet.net

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