Land degradation neutrality, combatting desertification from the baseline

TERRASAFE
Cultivating resilience, restoring the earth.

Sharing is encouraged

EGU25-20157

Adriana Bruggeman, Christina Makri, Aman Kumar Meena, Andreas Savvides, and Jan Jacob Keizer
Energy Environment and Water Research Center, The Cyprus Institute, Nicosia, Cyprus; a.bruggeman@cyi.ac.cy
* University of Aveiro, Aveiro, Portugal

The Cyprus Institute
RESEARCH·TECHNOLOGY·INNOVATION

universidade de aveiro

Land Degradation Neutrality – the concept

The concept of land degradation neutrality (LDN) was introduced to stimulate a more effective policy response to land degradation. Land Degradation Neutrality was adopted as target for Sustainable Development Goal 15.3.1, and building capacity to achieve Land Degradation Neutrality is a primary goal of the United Nations Convention to Combat Desertification (UNCCD, 2016).

The UNCCD defines Land Degradation Neutrality (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.”

The neutrality mechanism supports the achievement of Land Degradation Neutrality through a pro-active focus on planning; it comprises the counterbalancing of anticipated losses in land-based natural capital with planned gains, within unique land types. In each biophysical or administrative land unit, counterbalancing should be managed within the same land type (“like for like”) to ensure conservation of unique ecosystems and to reduce risk of loss in ecosystem services (Orr et al., 2017).

Land type is determined by land potential, which depends on inherent features aligned with key ecosystem functions and determines the inherent, long-term capacity of the land to sustainably generate ecosystem services (UNEP, 2016).

The aim is to avoid or reduce new degradation via Sustainable Land Management (SLM) and to reverse past degradation via restoration and rehabilitation (Orr et al., 2017).

Land Degradation Neutrality considers all forms of land degradation, whether due to human or natural causes, such as droughts and wild fires. Thus, natural drivers and potential climate change impacts need to be anticipated to achieve Land Degradation Neutrality (Cowie at al., 2018).

In line with the Sustainable Development Goal framework, 2015 is set as the baseline year and 2030 as the target year. To minimise the effects of seasonality and inter-annual climate variability on the selected indicators, it is recommended to average indicators over a 15 year period (Orr et al., 2017) .

Three sub-indicators have been identified as a reasonable proxy for change in the land-based natural capital: land cover (metric: physical land cover), land productivity (metric: net primary productivity, NPP) and carbon stocks (metric: soil organic carbon, SOC) (Cowie et al., 2018).

A good practice guidance document has been developed to support implementation of the Tier I methods for the Land Degradation Neutrality Indicator (SDG 15.3.1). The Indicator is calculated by integrating the three sub-indicators using a one-out-all-out (1OAO) method, in which a significant reduction or negative change in any one of the three sub-indicators is considered to comprise land degradation (Sims et al., 2021).

Drought-affected rainfed cereal croplands in the Mesaoria plain of Cyprus, November 2024 (top left), January 2025 (top right) and March 2025 (bottom).

Criticism

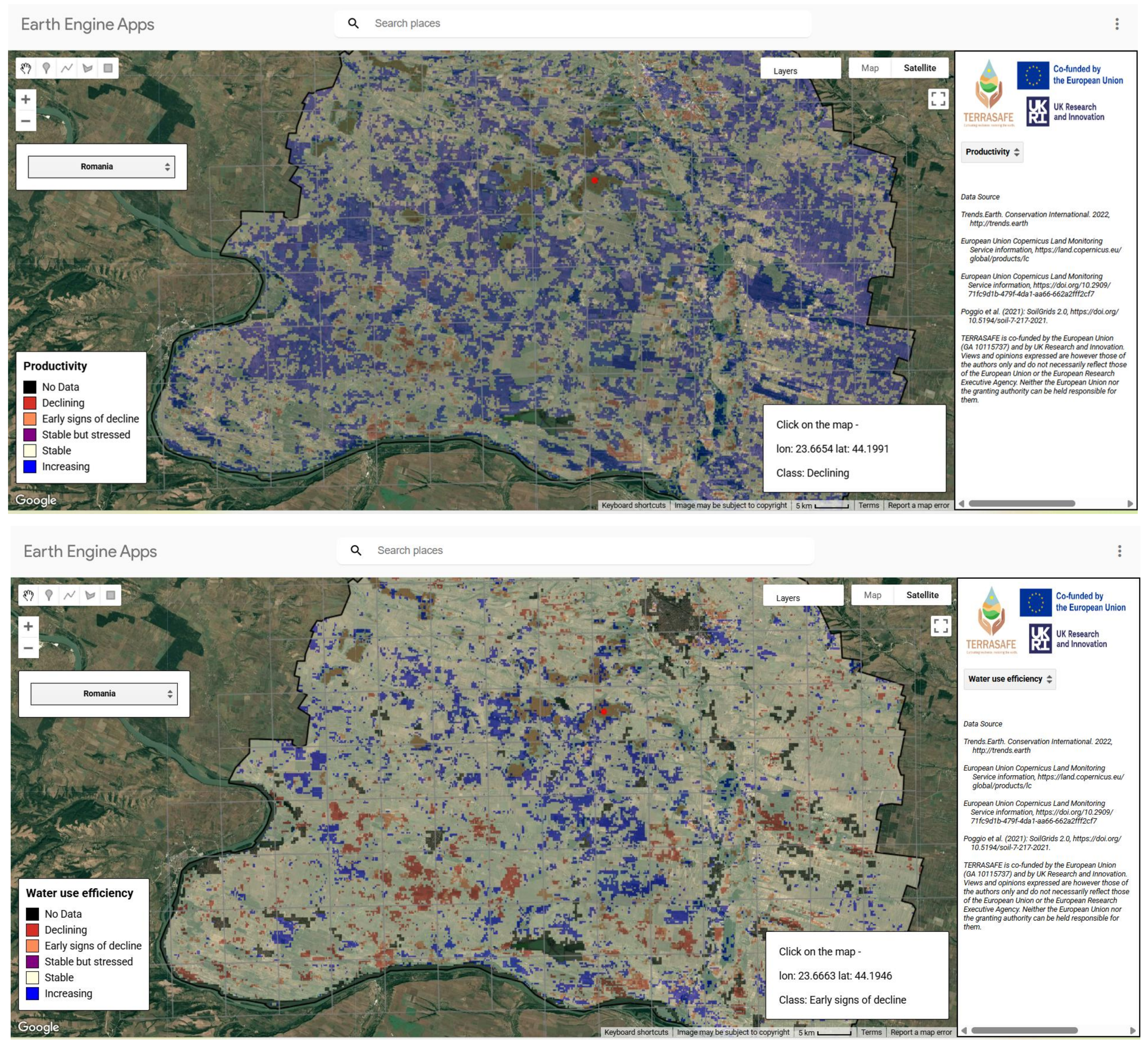
The Land Degradation Neutrality concept fully depends on the 2000-2015 baseline, but does not require that it is evaluated if it is a desirable state to compare with (Briassoulis, 2025).

Land degradation started long before the Land Degradation Neutrality 2000-2015 baseline. A meta-analysis of Montgomery (2007) found a median erosion rate of 1.54 mm/yr and a mean of 3.94 mm/yr for conventional agriculture (448 studies), while native vegetation (65 studies) had a median rate of 0.013 mm/yr and a mean of 0.053 mm/yr. The numbers for conventional agriculture are in stark contrast with those for soil production (188 studies) that showed a median rate of 0.017 mm/yr and a mean 0.036 mm/yr.

Observed increases in productivity or soil organic carbon may not serve the biodiversity of dryland ecosystems. Shrub encroachment has been found to lead to an increase soil organic carbon, but has also seen invasive species outcompeting native herbaceous species and negative effects on ecosystem structure and functioning in a meta-analysis of dryland studies (Eldridge et al., 2011).

Restoration of degraded natural ecosystems may not be achieved in a 15 year time span. Full restoration of natural ecosystems and species diversity in forests, steppes and tundras may take 40 to 300 years (Kust et al., 2023).

Climate change is expected to have a devastating impact on rainfed crop production in drylands. The FAO’s state of the world’s land and water resources for food and agriculture (SOLAW21) showed that the pessimistic RCP 8.5 scenario would result in a considerable decline of areas suitable for rainfed wheat in Spain, most of Africa, India, parts of Brazil and Central Asia for 2079-2099 (Anh Hoang et al., 2022).



Dolcj Province, Romania, 2008-2022 Productivity (productivity trend, status and performance) and Water use efficiency (water use efficiency trend, productivity status and performance) to explore land degradation beyond the effects of climate variability; data and analysis from Trends.Earth (http://trends.earth), as displayed in the TERRASAFE GEE App.

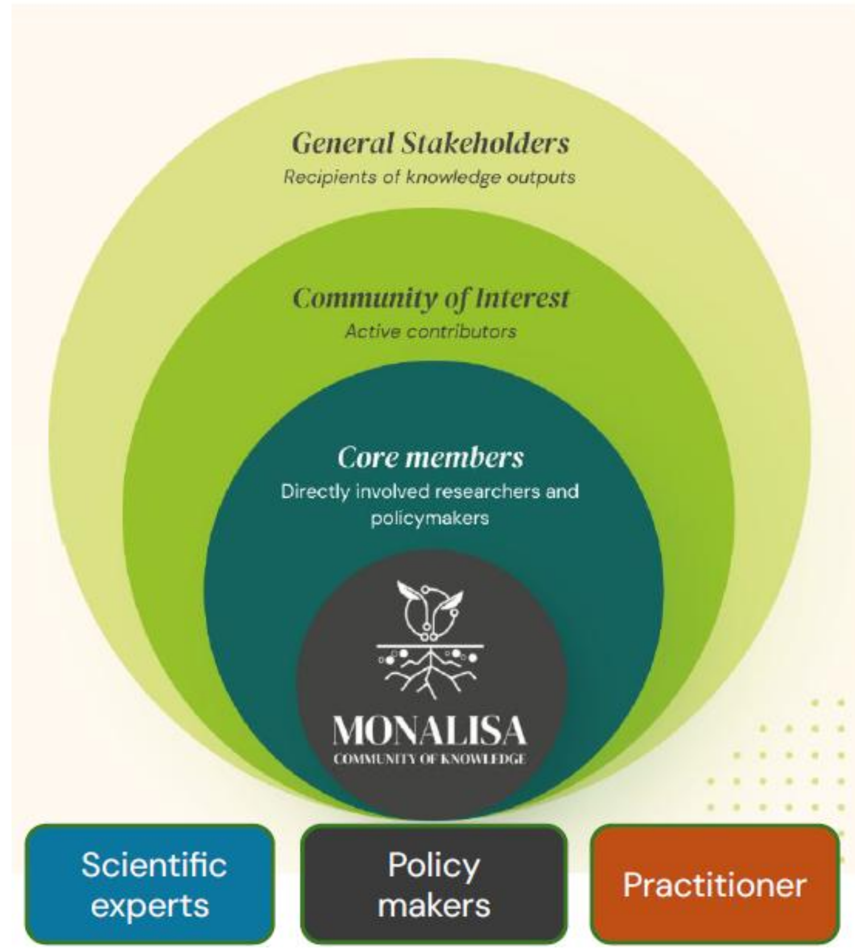
The way forward

Land Degradation Neutrality provides a globally established concept and assessment framework, with room for scientific improvement.

Productivity and water use efficiency could be the most clear indicators of desertification that can be derived from earth observation and climate data. Analysis should focus on the establishment of reference environments and identification of sites with optimal performance to which land productivity can be compared.

Ecosystems and land management practices of sites with optimal performance should be analysed to serve as examples for land improvement of their reference environment, with consideration of our changing climate.

Cooperation between experts through Communities of Practice and Knowledge is needed to optimize scientific knowledge and evidence for assessing and combatting desertification under our highly variable and changing global environmental and socioeconomic conditions.



Join the Desertification Communities of Knowledge and Practice hosted by the EU Mission Soil MONALISA and TERRASAFE Projects: https://terrasafe.eu/ and https://monalisa4land.eu/

References

Anh Hoang, T., Nachtergaele, F., Chiozza, F. and Ziadat, F. 2022. Land suitability for crop production in the future: SOLAW21 Technical background report. Rome, FAO. https://doi.org/10.4060/cc0878en

Briassoulis, H. 2025. Land Use Planning for Land Degradation Neutrality: Reflections and Critical Challenges. Land Degradation & Development, 2025; 36:975–1001. https://doi.org/10.1002/ldr.5407

Cowie, A.L., Orr, B.J., Sanchez, V.M.C., Chasek, P., Crossman, N.D., Erlewein, A., Louwagie, G. et al. 2018. Land in balance: the scientific conceptual framework for Land Degradation Neutrality. Environmental Science and Policy, 79: 25-35. https://doi.org/10.1016/j.envsci.2017.10.011

Eldridge, D.J., M.A. Bowker, F.T. Maestre, E. Roger, J.F. Reynolds, W.G. Whitford. 2011. Impacts of shrub encroachment on ecosystem structure and functioning: towards a global synthesis. Ecology Letters 14: 709–7. https://doi.org/10.1111/j.1461-0248.2011.01630.x

Kust, G., O. Andreeva, V. Lobkovskiy, J. Annagylyjova. 2023. Experience in application and adaptation of the land degradation neutrality concept in the Russian Federation. Land Degradation and Development 34(3): 573-590. https://doi.org/10.1002/ldr.4484

Montgomery, D.R. 2007. Soil erosion and agricultural sustainability. PNAS 104(33): 13268-13272. https://doi.org/10.1073/pnas.0611508104

Orr, B.J., Cowie, A.L., Castillo Sanchez, V.M., Chasek, P., Crossman, N.D., Erlewein, A., Louwagie, G., Maron, M., Metternicht, G.I., Minelli, S., Tengberg, A.E., Walter, S., Welton, S., 2017. Scientific Conceptual Framework for Land Degradation Neutrality. A Report of the Science Policy Interface. United Nations Convention to Combat Desertification (UNCCD), Bonn, Germany. https://www.unccd.int/publications/scientific-conceptual-framework-land-degradation-neutrality-report-science-policy

Sims, N.C., Newnham, G.J., England, J.R., Guerschman, J., Cox, S.J.D., Roxburgh, S.H., Viscarra Rossel, R.A., Fritz, S. and Wheeler, I. 2021. Good Practice Guidance. SDG Indicator 15.3.1, proportion of land that over total land area. Version 2.0. United Nations Convention to Combat Desertification, Bonn.

UNCCD. 2016. Report of the Conference of the Parties on its twelfth session, held in Ankara from 12 to 23 October 2015. Part two: Actions. ICCD/COP(12)/20/Add.1. United Nations Convention to Combat Desertification (UNCCD), Bonn. http://www.unccd.int/Lists/OfficialDocuments/cop12/20add1eng.pdf

UNEP, 2016. In: Herrick, J.E., Arnalds, O., Bestelmeyer, B., Bringezu, S., Han, G., Johnson, M.V., Kimiti, D., Lu, Yihe, Montanarella, L., Pengue, W., Toth, G., Tukahirwa, J., Velayutham, M., Zhang, G. (Eds.), Unlocking the Sustainable Potential of Land Resources: Evaluation Systems, Strategies and Tools. A Report of the Working Group on Land and Soils of the International Resource Panel. United Nations Environment Programme (UN Environment), Nairobi. http://resourcepanel.org/reports/unlocking-sustainable-potential-land-resources

TERRASAFE is co-funded by the EU’s Horizon Europe programme under grant agreement no. 10115737, and by the UKRI. .

TERRASAFE
Cultivating resilience, restoring the earth.
Co-funded by the European Union
UK Research and Innovation