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Understanding and measuring tropical forest degradation: a key condition for more effective policies

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Forest degradation, which is less visible than deforestation but has comparable impacts, is largely elusive in public policies. Yet, without a common definition and an operational monitoring method, it is difficult to integrate in regulatory systems such as the EUDR. An innovative methodology, developed by a scientific consortium, now provides concrete solutions to better identify, map and include degradation in international and national forest protection policies.

FOREST DEGRADATION: AN ISSUE THAT REMAINS ELUSIVE IN PUBLIC POLICIES

Forest degradation generates progressive alteration in the capacity of forests to provide essential ecosystem services (timber, biodiversity, carbon storage, water regulation), without complete loss of the forest cover (FAO[1], 2020). Mainly caused by human activities, it precedes and favours deforestation, and acts in synergy with the latter, accentuating biodiversity losses, carbon emissions and climate disturbances, with significant repercussions on human wellbeing across the world.

Although public policies have been focused on combatting deforestation – sometimes successfully, for example in Brazil –, prevention of forest degradation, in the sense given above, is still widely overlooked, even though there is a high level of degradation, in particular due to the resurgence of forest fires. Regulatory measures for the prevention of degradation are still rare, nationally and internationally. This lack of intergration is paradoxical, given the importance of public policies for the restoration of nature.

A key challenge to the explicit integration of degradation in policy frameworks is the difficulty of defining a "degraded" forest and implementing operational monitoring. There are two major reasons for this blockage.

A polysemous concept that is difficult to measure

Contrary to deforestation, which is a net loss of cover related to a change in land use, degradation refers to a range of processes: decrease in biomass, functional diversity, density of cover, and weakening of ecological resilience. There are multiple anthropic causes (overexploitation of timber, fires, overgrazing, fragmentation of habitats).

In the scientific field, notably tropical ecology, degradation is studied as a diversity of measurable processes. But these robust approaches are difficult to apply on a large scale, and have not led to operational monitoring systems. These alterations, which are often progressive, widespread and not highly visible, can be partially detected through standard analyses of satellite images, which are better suited to the detection of net cover losses.

A notion perceived differently according to contexts

There is no consensus on forest degradation. What is identified as degradation in an ecological approach can be perceived locally as legitimate use or productive valorisation of land. Agroforestry (cocoa farms under forest cover

1. FAO. 2020. *Global forest resources assessment 2020 – Key findings.* Rome. https://doi.org/10.4060/ca8753en.

for example), forest plantations or silvopasture can be interpreted as forms of sustainable management, or as signs of degradation, depending on benchmarks.

This diversity is reflected in regulatory spheres. The European regulation on deforestation and forest degradation (EUDR[2], 2023) clearly illustrates this tension. The regulation prohibits the sale or export on the European market of products originating from forests that were cut down or degraded after 31 December 2020, but it contains a very restrictive definition of degradation, limited to the conversion of "primary forests" or "naturally regenerated forests" to "plantation forests" or "other wooded surfaces", and the conversion of "primary forests" to "planted forests". This definition excludes the major causes of degradation (fires, overexploitation of timber), despite the fact that they are omnipresent in tropical forests and often precursors of deforestation.

WHAT SCIENCE CAN CONTRIBUTE

These two obstacles —conceptual complexity and diversity of perceptions — are intrinsically linked. The absence of a common, operational definition of degradation prevents the development of monitoring tools, which are crucial in the effectiveness of regulatory measures.

Boosting the fight against degradation therefore requires the development of a shared operational framework, capable of integrating the diversity of scientific knowledge while retaining focus on existing regulatory frameworks. This is a key prerequisite to increase the scope and the relevance of natural forest protection policies.

2. EUDR 2023. https://eur-lex.europa.eu/eli/reg/2023/1115/oj/

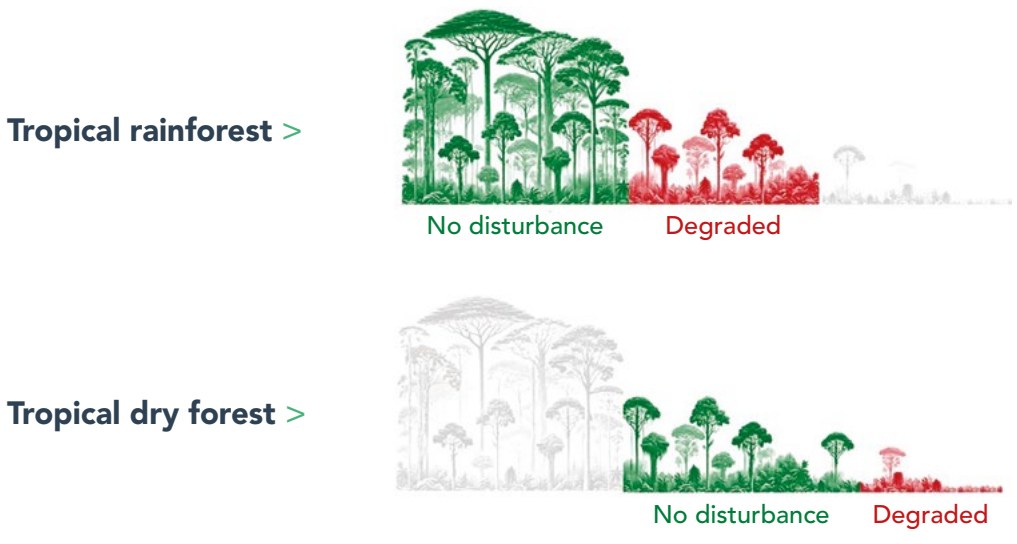
METHODOLOGICAL PROGRESS LED BY A SCIENTIFIC CONSORTIUM

To date, no operational method enables forest degradation to be measured on a global scale that sufficiently integrates the diversity of ecological contexts while building on an existing regulatory and legal framework. The main challenge for this method would be to qualify a forest as "degraded".

This is the challenge CIRAD, IRD, CNRS and ECOFOR attempted to address, as part of the Forest Committee's activities, via the production of an analytical framework and an innovative method that is reproducible in different contexts (see Rezende *et al.*, in progress). This framework is based on a broader definition of degradation than that of the EUDR, integrating a wider range of causes of degradation, such as fires and overexploitation of forests. Degradation is measured as a decrease in the height of the canopy and the forest cover (ground surface covered by the canopy of trees), compared to reference values specific to each type of forest and biome (rainforest, dry forest, tropical forest, subtropical forest, temperate forest, etc.). It is essential to work by forest types, because the structure and forest cover of a degraded forest for one type can correspond to a forest with no disturbance for another type, as shown in figure 1.

The principle of the method is to identify, for each forest type, a reference area (with no measured or supposed or potential disturbances) by establishing the reference values for the height of the canopy and the forest cover that are appropriate to the ecological contexts. These values are subsequently compared to those calculated outside of the reference area in order to identify degraded forests. This makes it possible to produce a map of surfaces of degraded forests per forest type.

FIGURE 1. DEGRADED TROPICAL RAINFORESTS CAN HAVE A FOREST STRUCTURE (HEIGHT OF CANOPY AND FOREST COVER) SIMILAR TO THAT OF A TROPICAL DRY FOREST WITH NO DISTURBANCE



The analytical framework consists of three stages, applied to each forest country:

1. **Classification of forest types.** A typology of forest types in the country is firstly established based on the best vegetation maps available, and aligned with the IUCN international nomenclature (Global Ecosystem Topology 2.0). This harmonisation ensures reproducibility, interregional comparability and interoperability with national classifications.
2. **Identification of intact areas.** For each forest type, reference areas referred to as "intact" (with no known or supposed disturbance) are identified using public world or regional databases. According to countries and regions, these databases provide more or less accurate information on disturbances. This information can for example be a direct measure of disturbances (for example the JRC-TMF database for tropical rainforests between 1990 and 2025) or an indirect indication of disturbances such as the distance from forests to roads or infrastructure.
3. **Estimation of the intensity of degradation.** Based on the information on intact areas, a model for each forest type predicts the expected structure (forest height and cover according to ecological contexts) in the absence of disturbance. This reference structure is subsequently compared to the actual forest height and cover data. The difference observed makes it possible to quantify the intensity of degradation. The result is a map of degraded forests, differentiated by forest type.

This analytical framework is operational, adaptable, reproducible and interoperable. It can be applied to different countries or regions according to available data, by mobilising open data and using tools that can be accessed freely via Google Earth Engine with scripts shared in open source.

POTENTIAL OF THE METHODOLOGY AND POLITICAL IMPACTS

This new analytical framework has strong operational potential to improve the definition, monitoring and inclusion of forest degradation in regulation measures related to the fight against deforestation and forest degradation.

As part of the EUDR, the methodology proposed provides an operational tool to assess the eligibility of forest surfaces for exportation to the EU, based on an expanded definition of degradation. Applied to Cameroon (see figure 2 page 4), it distinguishes 8 forest types and wooded ecosystems, and makes it possible to identify, for each type, degraded areas (in yellow in figure 2, example of dry forests) and non-degraded areas (in green). Our methodology thus informs the capacity of the EUDR, in a future version, to target eligible forests according to a broader definition of degradation.

This approach would also be relevant for innovative funding mechanisms such as the TFFF (Tropical Forests Forever Facility), aimed at inciting countries to prevent deforestation and degradation, the implementation of which depends on joint monitoring of deforestation and degradation.

Amazonian forests degraded by fire, municipality of Paragominas, Para State, Brazil (CIRAD, Lilian Blanc)

Apart from regulatory and financial frameworks related to the fight against deforestation and forest degradation, an immediate prospect of this methodology is its application at national levels, in order to provide reliable estimations of degraded surfaces in the countries concerned, to complement the evaluations provided by the FAO on global forest resources (FAO FRA reports).

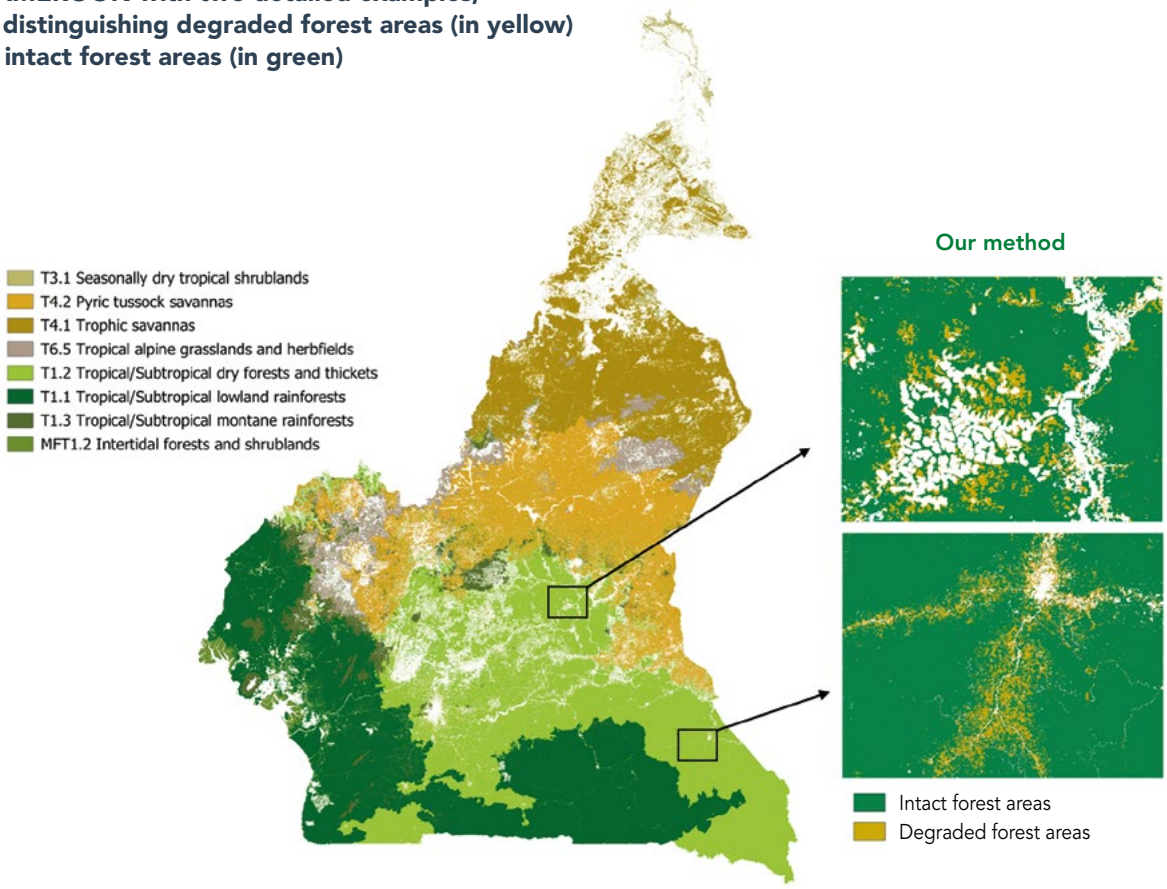
PROSPECTS

This analytical framework is appropriate to the context of tropical forests and to the causes of degradation that affect them. However, it must be complemented by broader reflection on the status of productive forest systems, such as forest plantations, or cocoa or coffee agroforests. These systems cover a very wide diversity of ecological situations (from mono-specific systems to biodiverse systems) and social situations (from industrial actors to family farmers). For these systems, an analysis limited to changes in forest height and cover is clearly insufficient, and too partial to characterise the state of the system. It is necessary to include other ecological and socio-economic variables.

This analytical framework aims to inform ongoing and future discussions on the evolution of the EUDR in terms of consideration of "other wooded ecosystems" and revision of the definition of forest degradation, in order to prevent disturbances of natural forests. These expected evolutions will require the integration of new decision variables and the mobilisation of relevant data sets, most likely based on forest ecosystem types.

Reducing forest degradation globally does not, however, depend solely on better characterisation of ecological changes, although it is a necessary stage. An entire field of research on humanities and social sciences remains open to understand the human dynamics underpinning the qualitative deterioration of forests in order to reverse the trend or, failing that, to minimise its negative consequences.

FIGURE 2. MAP OF FOREST TYPES IN 2020 (INCLUDING WOODED ECOSYSTEMS) IN CAMEROON with two detailed examples, each distinguishing degraded forest areas (in yellow) from intact forest areas (in green)



SUMMARY

Forest degradation is a progressive alteration of forests' capacity to provide ecosystem services, without complete loss of forest cover. Its impacts, which are comparable to those of deforestation, remain largely elusive in public policies.

There is a dual explanation for this situation: the difficulty of measuring a widespread, multi-facetted phenomenon, and the diversity of perceptions and definitions, from scientific approaches to regulatory frameworks such as the EUDR, which have a restrictive vision that excludes major causes such as fires or overexploitation. To address this challenge, a scientific consortium (CIRAD, IRD, CNRS and ECOFOR) developed an innovative methodology which distinguishes intact and degraded forests by forest type. An example is presented for the seven types of forests in Cameroon.

This methodology is an operational tool that can guide public policies and inform action on forest degradation, including implementation of innovative funding mechanisms and improvement of national reports.

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