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AGRICULTURAL RESEARCH FOR DEVELOPMENT

Managing degraded forests, a new priority in the Brazilian Amazon

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In the Brazilian Amazon, degraded forests dominate the landscapes on the agricultural frontiers. This region is now facing a major challenge: halting degradation and sustainably managing these forests. Today, degraded forests represent a class of forest in their own right. They can nevertheless play a key role in combating climate change, and can also help to improve the ecological functioning of the different territories. Implementing public policies with the twin objectives of reducing degradation and promoting these forests implies strong support from research. In this *Perspective*, we focus on four research priorities: developing methods to characterise and monitor degraded forests; drafting specific forest management plans; understanding the role played by all social actors; and supporting policies at the territorial level.

Human impacts on the Amazonian forests in Brazil can no longer be assessed using indicators of deforestation alone. Degraded forests, which are characterised by the partial destruction of their canopy, are now emerging as a class of forest in its own right. Although the term forest degradation is subject to debate and covers a range of meanings, degraded forests are an ecological reality that can no longer be ignored when it comes to taking stock of the role this ecosystem can play in climate change.

However, the drastic measures that enabled Brazil to slash the annual rate of deforestation in the Amazon from 27 770 km^2 in 2005 to 5 830 km^2 in 2015 have had no impact on forest degradation. The policy to curb deforestation was implemented by a specific prevention and control programme entailing a set of measures launched by the Federal government, with 14 ministries involved. Repressive measures have prohibited the marketing of products resulting from deforestation and denied access to rural credit. These have been supported by private sector initiatives (livestock production and soy, in particular), which have reorganised their production chains in order to guarantee "zero deforestation" products.

Growing awareness among the scientific community of the importance of degraded forests in the Amazonian landscapes may be associated with a paradigm shift at the policy level. Preventing forest degradation implies devising specific measures to monitor and promote these forests and to control activities conducted in them. Modelled on what has been done to curb deforestation since 2005, a second stage should be launched, involving the prevention and control of forest degradation.

The importance of degraded forests

In the Brazilian Amazon, the distinction between forested and deforested zones traditionally used to map the state of the Amazon does not reflect the reality of the forest situation. Degraded forests are very prevalent on the agricultural frontiers, regions that were colonised from the 1960s onwards. They differ greatly from intact or relatively undisturbed forests. In the colonised regions, forest resources (timber, non-timber forest products and wildlife) have been harvested on a massive scale. This harvesting has dramatically altered the structure and functioning of these forests: a decline in biomass, a lower canopy, a reduction in productivity, etc. Recurrent harvesting, which still occurs, prevents the recovery of these resources. Finally, these forests have lost most of their economic potential and no longer provide the same ecosystem services (carbon sequestration, biodiversity) as a primary forest or a sustainably managed forest.

These degraded forests now dominate the forest landscape in the colonised regions. By way of example, in the state of Pará, the *municipe* (municipality) of Paragominas is one of these agricultural frontiers colonised since the 1960s. Once entirely forested, this *municipe* became a regional centre first for timber production, and then for livestock production. Only about half of its land area is now forested. The findings, from preliminary works conducted by the Sustainable Amazon network (RAS) and the ECOTERA project (see box p. 4) show that these residual forests have lost 35 to 80% of their initial carbon stock.

Across the Brazilian Amazon, forest degradation is a massive problem. The DEGRAD satellite monitoring programme developed by INPE (the Brazilian National Institute for Space Research) has been providing data for a decade. Between 2007 and 2012, 55 906 km^2 of forest were converted to pastures or farmland. Over the same period, an area almost double that size (102 923 km^2) was degraded.

These figures highlight the urgent need to consider forest degradation as a threat to the maintenance of the integrity and functioning of the Amazonian forests. Preventing this degradation is becoming an environmental priority, first to limit flows of carbon towards the atmosphere, in connection with climate change, and second, to preserve the remarkable biodiversity of this region. It is also a social priority, since degraded forests provide the homes and livelihoods of rural Amazonian peoples.

Developing public policies aimed at reducing forest degradation and promoting these forests with strong support from research will be a major challenge in the Amazon region in the coming decades. To accompany public decision-making and to implement these public policies, we propose four research priorities.

Priority n° 1. Developing methods and indicators to characterise the wide variety of degraded forests, their dynamics and their territorial scope

No policy to prevent forest degradation will be effective if the impacts of this degradation on forests cannot be accurately pinpointed and monitored over time. The PRODES programme (satellite monitoring of deforestation implemented by INPE) has been one of the keys to the success of efforts to tackle deforestation. But whereas it is now easy to measure deforestation using satellite monitoring, it is far more difficult to measure any partial destruction of forest cover.

The partial opening of the canopy further to selective logging or to forest fires is a transient problem that is difficult to detect by satellite monitoring. Vegetation returns to these clearings at different rates depending on the state of the soil and the surrounding vegetation and, in just a few months, the opening in the canopy may no longer be detectable by satellite imagery.

A temporal analysis is therefore essential in order to identify each degradation event at regular, frequent intervals. The accumulation over time of areas affected by these degradation events makes it possible to determine the extent of degraded forest areas for a given period and region. Temporal analysis implies first developing algorithms in order to identify small impacted areas and, second, obtaining frequent, high quality (cloudless) satellite imagery. These difficulties explain the differences in results – which may be as much as a factor of three depending on the year – provided by the two programmes set up to estimate surface areas of degraded forests, the INPE DEGRAD programme and the programme run by the non-governmental organisation IMAZON.

Until now, the frequency and spatial resolution of images available have been a limiting factor in obtaining sufficiently accurate measurements in time and space. This limitation could be partly overcome thanks to the availability since 2016 of high and very high spatial resolution imagery from the European Space Agency's series of Earth observation satellites, SENTINEL-1 and SENTINEL-2.

One alternative solution is to assess forest health by measuring the carbon stock, which tells us about past impacts. Remote sensing using laser (LIDAR) or radar is promising and has the advantage of being unaffected by the presence of clouds, unlike optical images. There is currently no satellite

A degraded forest next to a field of soy in the municipality of Paragominas.

Degraded forests are characterised by the partial destruction of their canopy. They dominate forest landscapes in the colonised regions of the Amazon. Protecting these forests against new degradation and promoting them through innovative forest management plans are now a priority. Photo © V. Gond

sensor of this type capable of providing an estimate for the whole of the Amazon. But from 2020, a radar satellite will begin providing 3D data on forest structure and forest biomass at the global level – the BIOMASS programme run by the European Space Agency and the French National Centre for Space Studies.

Priority n° 2. Drafting forest management plans tailored to degraded forests

The forest management plan model implemented in the Brazilian Amazon is not appropriate for degraded forests. This model entails selective logging (of only some of the harvestable timber) in a given area, then no further intervention in that area for 35 years to enable the forest to recover its timber stock. Any remaining harvestable timber and undersized commercial trees thus form the future harvest. However, degraded forests have lost all or some of this potential, since even trees with diameters of less than 60 or 70 cm have been felled. These forests can therefore no longer rebuild their harvestable timber volume in 35 years, but they retain their capacity to recover: this is one of the findings of a recent study by the TmFO network (Tropical managed Forests Observatory, see box p. 4).

The TmFO network study shows that the logged Amazonian forests retain this capacity to replenish carbon stock no matter what the logging intensity may be. It also shows that the time to recover is simply dependent on this intensity. Thus, a forest with moderate logging, equivalent to 10 to 20% of its initial carbon stock, will recover this stock in less than 25 years: this is the case of managed forests with management plans. However, a forest with logging of 50 to 60% of its initial carbon stock, a rate often recorded for degraded forests, will take up to 75 years to recover. The prerequisite for this recovery is that no logging should occur during this period. Furthermore, the forests must not suffer any other degradation, such as fire.

This study also shows that forest recovery capacity is the same across the whole of the Amazon: whether they are close to the Atlantic coast or at the foot of the Andes, the Amazonian forests have the same potential for recovery, which is mainly determined by logging intensity.

These findings are a source of information for the development of management plans that are suited to the diversity of degraded forests. Such plans could also include specific silvicultural techniques to accelerate the recovery of these forests, for example enriching stands with commercial tree species or creating selective clearings to hasten the growth of young trees. This forest management could target both timber and non-timber forest products – Brazil nuts, palm fruits, oil and resins.

Priority n° 3. Understanding the role played by all social actors in forest degradation

Scientific studies have focused in particular on the environmental impacts of degradation: they need to become more interdisciplinary and give greater weight to the social sciences. The many different actors involved in degradation vary from one territory to another, and are concerned by a variety of alliances and conflicts. For example, poor local populations, which are largely agricultural, benefit from forest harvesting – hunting, timber for construction, the sale or production of charcoal. Analysing their forestry and agricultural practices would help to determine the role and value these populations give to the forest in economic and social terms.

This knowledge will contribute to technical and economic proposals that are more tailored to local populations, as well as individual and collective rules on forest resource management that are understood and accepted by all actors. Some proposals, especially those concerning support for family farming and including community forest management, could be the practical basis of a policy aimed at poor populations and could thereby boost the effectiveness of public policies to tackle forest degradation. Other proposals could encourage actors on the agricultural frontiers to become involved in promoting and protecting their forest ecosystems.

Priority n° 4. Supporting policies at the *municipe* territorial level in order to guarantee sustainable, multifunctional landscapes

The *municipe* (municipality) is an appropriate territorial level for multifunctional management, yet public and private actions in this field lack coherence at this level. A transition towards territorial approaches would enable changes in technical practices, renewed relations between actors and, finally, new modes of governance.

To forge these new rules and to accompany this transition, the role of research is to create tools based on support and participatory modelling. These tools are aimed at developing a territorial vision and help to regulate territorial changes when individual choices have an impact on the whole of the area concerned. One example is the forest code: at present, it contains a legal requirement for all landowners to maintain 50 to 80% of their property as a forest reserve, which must include permanent protection areas (riverbanks, hillsides). In some cases, this results in highly fragmented forest cover. These forest fragments are often extremely degraded, very vulnerable to fire and subject to agricultural extension; in the long term, they are likely to disappear. The application of the forest code at the level of individual properties does not therefore guarantee a multifunctional, sustainable forest landscape at the territorial level. Research could help to steer the forest code regulations, especially those concerning private property, towards a broader application at the territorial level.

In conclusion, recognising forest degradation as a serious threat to the protection of natural resources in the Amazon is a priority for scientists. This recognition also calls for the mobilisation of civil society and policy makers, as has been the case with programmes to prevent deforestation in the Amazon. ■

Perspective n° 40 is the result of research conducted within the Platform in Partnership for Research and Training "Forests, agriculture and territories in the Amazon" www.dp-amazonie.org/), in the context of different projects:

– the ECOTERA project (ECOefficiencies and TERritorial development in the Brazilian Amazon, ANR-13-AGRO-0003, www.agence-nationale-recherche.fr/?Projet=ANR-13-AGRO-0003) financed by ANR (the French National Research Agency);

– the TmFO network (Tropical managed Forests Observatory, www.tmfo.org/) was set up by CIRAD in 2012 as part of the FTA research programme (Forest Trees and Agroforestry, http://foreststreesagroforestry.org/) coordinated by CGIAR (Consultative Group on International Agricultural Research, www.cgiar.org/);

– the Sustainable Amazon network (RAS, Rede Amazônia Sustentável, Assessing land-use sustainability in the Brazilian Amazon, www.redeamazoniasustentavel.org/).

On the issue of degraded forests in the humid tropics, this research has led to several publications, including:

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A few links

European Space Agency (ESA), SENTINEL Missions. https://sentinel.esa.int/web/sentinel/missions

IMAZON (non-governmental organisation). http://imazon.org.br/

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