Produce more wood while better preserving biodiversity

Contribution of the Forest biomass and biodiversity study

Is it possible to produce more wood while better preserving forest biodiversity? The question raises major issues in light of the energy situation. This study points out the limits to this policy launched by the Grenelle environmental agreement and a number of possible improvements.

The energy crisis and global warming are creating new opportunities for forest biomass. France has undertaken to increase by 2020 the percentage of renewable energy in its total energy consumption to 23%, i.e. three times the current level. The biomass consumed will come largely from forests, for which the Grenelle Environment Round Table process set a goal of an extra 20 million cubic metres harvested by 2020, i.e. 30% more than is currently the case. In addition, with the other European countries in the framework of the Convention on biological diversity adopted in 1992, France is committed to "halting biodiversity loss by 2010". The Grenelle process confirmed the commitment to preserving biodiversity.

The possibility of reconciling the goals of increasing biomass production and conserving biodiversity was discussed during the Grenelle process and the major forest stakeholders agreed to the goal of "producing more (wood) while better preserving (biodiversity)" in the framework of "a collaborative territorial approach respectful of multifunctional management techniques for forests" (France Nature Environnement *et al.*, 2007).

At the request of the Ecology ministry, GIP Ecofor (Forest ecosystem research-coordination unit) coordinated a study to summarise the potential implications of an increase in the use of forest biomass for biodiversity and natural resources (soil and water) in continental France (Landmann *et al.*, 2009). This article presents the main conclusions of that study, called Bio2 (see box 1).

The study successively addressed:

- the context, the outlook for use of forest biomass and the possible development scenarios for forest production over the mid-term;
- the potential impact of the changes on timber resources, forest biodiversity, forest soils and surface waters;
- recommendations in view of controlling the main risks and for the necessary governance procedures to effectively harvest more wood while preserving the forest environment and its biodiversity;
- the opportunities created by the new economic conditions, in view of using the biomass for applications outside standard forest management, e.g. fire prevention, development of natural areas, etc.

The study did not address (or only incidentally) micro-organic aspects, destructive insects, pathogenic fungi and the intraspecific variability of forest trees. Generally speaking, ecosystem operation (flows of mineral elements, etc.), links with climate change and the situation of tropical forests were not directly addressed.

1 Participants in the Bio2 study

- Luc Barbaro, Nathalie Bréda, Étienne Dambrine, Hervé Jactel, Jacques Ranger and Éric Rigolot (INRA).
- Laurent Bergès, Christophe Bouget, Christophe Chauvin, Christian Ginisty, Frédéric Gosselin, Marion Gosselin and Patrick Vallet (Cemagref).
- Emmanuel Cacot (FCBA).
- Claude Cosandey (CNRS).
- Grégoire Gautier (ONF, Cévennes national park).
- François Guérold (University of Metz).
- Guy Landmann and Jean-Luc Peyron (GIP Ecofor).
- Manuel Nicolas (INRA/ONF).
- Anne Probst (Toulouse polytechnical institute – National Institute of Agronomy in Toulouse).

❶ What are the effects on the soil fertility and the biodiversity if we highly increase the harvest of residuals?

The outlook for use of forest biomass

Attenuation of the greenhouse effect includes increased use of wood (a local supply if possible) as both a source of renewable energy and as an ecological material for building, furnishings and insulation. In the years to come, there will be efforts to increase exploitation of forests (current harvests are approximately 65 million cubic metres, i.e. only 70% of the annual biological production), to develop more productive forestry techniques and to create wood biomass crops intended for the fuel-wood sector (very short-rotation coppice [VSRC] and short-rotation high forest [SRHF]). What is more, energy prices should rise in the future and lead to a rise in prices for fuel wood as well as sawtimber. Given the considerable size of the energy market and the foreseeable tensions, forests will be subjected to increasingly high demands from society.

The short-term goals set by the Grenelle process will likely be achieved primarily through increased use of existing forest resources due to the insufficient profitability of energy-dedicated forests. These are, however, only potential resources because there is uncertainty concerning future market conditions, e.g. how much will the price of wood increase, how will that change decisions on the part of market participants, particularly private owners, and the demand for wood compared to other energies?

The long-term forecast for the use of forest biomass is unclear. Available scenarios predict that by 2050 production zones will reach between 10 and 20 million hectares, including up to 5 Mha of energy-dedicated forests, in a context of enhanced competition for land use between the food and energy sectors.

An increasingly common management goal in France is to achieve forest stands that are less dense, old and tall. The main arguments in favour of a limit or a drop in the stocks of standing trees have to do with managing various sorts of risks, notably concerning climate change and hazards. The means would be a temporary overshoot in harvests compared to annual growth and earlier regeneration of stands, linked with more dynamic management techniques (more frequent and vigorous thinning to obtain stands that are less dense, but comprise larger trees). These technical features might, however, be less favourable for other environmental goals (carbon storage or biodiversity) or social goals. It is well known, for example, that old stands and large quantities of dead wood are required for forest biodiversity.

Plans to use greater quantities of forest biomass thus raise once again the question of acceptable harvesting levels with respect to annual growth, a source of long-standing controversy.

Development scenarios for forest management

Modifications in forestry operations due to the new energy situation have not yet been adopted by a majority of owners and managers, probably because most people do not think the necessary conditions for a durable change in techniques exist yet.

As an exploratory effort, three contrasted scenarios have been proposed. The "current trend" scenario posits a continuation of recent trends, i.e. marginal use of fuel wood other than firewood, relative stability in harvests of sawtimber and cordwood, and progressive inclusion of biodiversity concerns in forest management. The intensive "multifunctional" version corresponds to a strong increase in harvests, but under tight regulations (local governments, State, EU). The intensive "industrial" scenario foresees maximum future harvests and production, by integrating forest management with the various wood industries and through functional zoning with two types of zones for production and protection.

Almost a third of forest land is currently not included in development programmes, but that could change with the arrival of economic entities capable of mobilising the sector, notably in areas not or little managed over the past decades, e.g. regenerated conifer stands where thinning is required, coppice with standards and old coppice, areas comprising "old stands, large trees and little management", mountain forests that are difficult to access, natural forest extensions, etc.

These scenarios must include certain fundamental trends, e.g. increasing mechanisation of forestry work, and, in view of "producing more" instead of just "harvesting more", the possible development of energy-dedicated forests (very short-rotation coppice and short-rotation high forest) as well as use of more productive species than the current ones.

Potential impact on forest biodiversity

In light of the above, the priorities for forest biodiversity concern:

- the biodiversity elements that are *a priori* affected by forest management, in particular the plant and animal species that depend on large, old trees and on dead wood;
- the elements on which correct forest functioning depend, notably the trees, soil flora and fauna;
- forest taxa threatened with extinction.

In terms of biodiversity, forests in continental France have a number of general characteristics that are *a priori* favourable, e.g. the forestry system, the policy for management and conservation of forest genetic resources, the variety of tree species and management systems, the increase in wooded land. Others are unfavourable, e.g. the low percentage of semi-natural stands that are protected for biodiversity purposes or very old, the high level of artificial regeneration.

The status of forest biodiversity is not well known (the lists of threatened species in France are limited to vertebrates and higher plants) and there is little long-term monitoring data covering the country as a whole. The data available for the best known taxa would suggest that forest biodiversity is, depending on the taxon, less than or equally threatened as the rest of biodiversity in France. Though imprecise, they run counter to the argument that forest biodiversity is systematically less threatened than elsewhere.

Increased use of biomass could impact forest biodiversity positively or negatively by modifying key compartments and characteristics of ecosystems, e.g. the volume of dead wood, the density of old stands and of large, old trees, the spatial distribution of habitats, microclimates and soil, etc.

On the one hand, opportunities are created by the development of forest biomass and will be discussed below. On the other, unfavourable aspects for forest biodiversity are those that increase:

- harvested quantities in managed plots, either short-term (increased farming of residues, timber or stumps) or long-term (more frequent and/or more intense thinning, shorter rotations);
- forest roads and mechanisation employing large machines;
- pressure on stands that are not farmed or very little (biological reserves, stands listed for their ecological value, islands of old and dying trees, old forests, large or old trees, abandoned forests).

An examination of biodiversity vulnerabilities to increased use of forest biomass leads to the conclusion that the Grenelle process for forests should be accompanied by three measures:

- an evaluation of conservation policies for forest biodiversity in light of the new situation;
- ancient forests must be taken into account in harvesting biomass;
- biodiversity monitoring must be set up.

During the study, it became clear that more work should be devoted to the conservation policy and notably to the networks of fully-protected biological reserves, managed biological reserves and nature reserves given their role in preserving forest biodiversity. The purpose of the work would be to define clear goals for these networks that could suffer from the pressures of increased harvesting of forest biomass, perhaps more under the intensive "multifunctional" scenario than under the intensive "industrial" scenario implementing some zoning.

The ancientness of forests is today considered a central factor in preserving forest biodiversity. Old forests constitute true "temporal corridors" enabling certain species to survive. Particular attention should be paid to their biodiversity and to the links between forest age and management intensity. In the meantime, it is necessary to study management techniques that are less intensive for old forests than for newer ones.

Given the scope of the current and/or future change, in terms of both climates and forests, it is important to organise, notably on the regional, national and European levels, monitoring of biodiversity and forest management to ensure the effectiveness of preservation policies and measure the impact of changes in management practices. Current forest monitoring and knowledge systems do not provide the quantitative data required to observe changes in biodiversity, even if they do provide useful background information (e.g. indicators for sustainable management, Agriculture ministry/National forest inventory, 2006). The trends described in the Bio2 study are generally qualitative and rarely broken down in terms of the biogeographic domain, the type of station or the age of the forest. In addition, they do not include the cumulative effects of the changes.

Monitoring must be based on an observation schedule covering representative aspects of the territory and adequately include the aspects of biodiversity that are *a priori* the most threatened by an increase in biomass harvests. A certain number of studies (Balland *et al.*, 2001; Gosselin et Dallari, 2007) have paved the way for a structured approach. In addition to the scales and goals already mentioned, monitoring could include the areas around power stations using biomass. Monitoring and the role it plays in later assessment of management decisions are a central element in adaptive governance of public policies and forest development, as noted during the Grenelle process.

Potential impact on soil and water

The mineral fertility of forest soil is a key factor in maintaining forest productivity and in sustainable management of forests. Forest soil can also store carbon and is home to significant biodiversity that is still poorly understood. We have gained considerable knowledge on the impact of biomass harvesting on soil fertility thanks to research carried out over the past three decades on acidification by conifers, exporting of mineral elements by short-rotation coppice and the impact of atmospheric deposits on forests. Over the past few years, major efforts to make practical use of this knowledge have been undertaken, e.g. assessment of soil sensitivity to biomass exports, management recommendations and, on the local scale, training of forest managers and operators (Cacot *et al.*, 2006). This is a field where regular, organised monitoring of forest soil was set up in the beginning of the 1990s.

The tendency of forests to be located on poor or spent soil explains why soil is by far the most limiting factor for the quantity of biomass that can be drawn off without restrictions (European Environment Agency, 2006). In French forests, a majority of which are managed extensively, the margin for increased exports of mineral elements without compensation should be determined. On poor soils and those being depleted, the margin will be low. If large quantities of biomass are to be withdrawn, analysis should include not only calcium and magnesium, which are limiting factors for acid soil, but also nitrogen and phosphorus which can become limiting factors for a wider range of soils. Even if scientists consider that "corrective" inputs (replacement fertilisation after exports) have no major inconveniences, there are nonetheless a number of obstacles, economic as well as cultural and ethical.

The risk of soil compaction was recently the topic of a multi-organisational study programme which produced practical recommendations. Maps of soil vulnerability to compaction will soon be available. Management of this risk is difficult due to the many different participants in forest work. In a context of increased cutting, the need for more operator training and monitoring will increase.

An intensification of forestry activities (increased use of conifers, increased biomass exports) can lead, on the scale of river basins, to nitrate loss and greater water acidification for sites exposed to acid deposits, but these effects are generally minor compared to those caused by intensive agriculture because the quantities of inputs for forests are very small.

Intensification of forest farming has variable effects on the water situation in river basins. We may expect a drop in run-off from stands if hardwood species are replaced


© Y. Paillet (Cemagref).

❷ Control the increasing the samplings may include not to cut down trees which represent habitats for the biodiversity.

by conifers, under identical climate and leaf-index conditions. We may also expect, if thinning is carried out, an increase in drainage from stands, but volumes would be low (unless thinning is quite vigorous), because the remaining trees would consume more water and thus compensate. Clearly negative effects on the water balance may be expected if large tracts of pasture or cultivated land are turned over to short-rotation coppice because trees can dry soil far more than pasture vegetation and most crops. In regions where water resources are limited or where there is competition between different uses for water, certain land-use scenarios may have difficulties.

The risks of soil erosion are minor in forest regions. Significant erosion may be caused by a combination of factors including steep slopes, heavy precipitation, instable soil and temporarily absent vegetation. Erosion in medium-altitude mountain regions caused by access roads and machines in cutting lots arranged up and down slopes requires more attention, particularly if harvests are to be increased in mountain regions.

Opportunities arising from greater use of forest biomass

Opportunities arising from greater use of forest biomass

Conditions favourable to forest-biomass harvesting can create various opportunities, namely:

- make once again possible forest work in favour of saw-timber production (particularly in thinned areas) and facilitate certain development work on forest environments, such as vegetation management to reduce forest-fire risks;
- contribute to the biodiversity of certain ecological groups that profit from increased cutting (spatially and frequency). Maintenance of open areas within forests could also help conservation of regional diversity. Similarly, replacement of annual agricultural crops with intensively managed forests would appear to encourage biodiversity, at least in areas with industrial crops;
- use forests intended specifically for biomass production to treat or improve treatment of polluted water, notably from farms.

It should also be noted that, compared to the existing situation, the opportunities created by ineased harvesting of forest biomass probably exceed the disadvantages (in terms of biodiversity and natural resources) under certain conditions, e.g. unmanaged plantations of exotic species on formerly agricultural land.

Forest governance action plan and adcraptive management

A policy to increase use of forest biomass while preserving biodiversity and natural resources must be based on greater participation of all involved, a widely accepted idea that is difficult to implement. In addition to calling on the "best know-how available", the goal is to integrate participants in the various steps of a process targeting adaptive management, defined as "management based on learning, capable of integrating in decisions the knowledge gained on the various levels through common sense, experience, monitoring and scientific experimentation" (Stankey *et al.*, 2005). This process of continuous improvement obviously calls on people to use their observational skills and memory, and recognises the need to adjust procedures if observations show that they are not suited to local conditions.

A territorial strategy should be based notably on targets in terms of the biomass harvest and biodiversity conservation, which may be derived from the national biodiversity strategy for territorial purposes. To reach these goals, it will probably be necessary to regularly update the technical recommendations summed up in the Bio2 study or even integrate them in a more structured ecological-engineering framework (Gosselin, 2008) to reinforce the links between forest management, biodiversity and natural resources (soil, water). Forest environmental measures, including funding for biodiversity, could be a powerful means to implicate forest owners.

There are many existing institutional frameworks in which these approaches could be developed. One example is the management plans for Natura 2000 zones in which rules are applied, principles are adapted to the local context, there are contracts and monitoring, but there are other examples as well, e.g. the frameworks now being developed for the territorial forestry charters, the National ecological network, or the development plans for mountain regions.

These territorial approaches will not gain much traction unless sector quality efforts are pursued downstream (product quality) and upstream (service quality), and links are improved between local (territorialised) production systems and larger systems exposed to competitive pressures.

To stimulate greater use of wood and development of the sector, funding and economic incentives will be necessary. To preserve fragile environmental situations and ensure a regular supply of wood for different uses, the regulatory framework must impose increasingly severe funding conditions in step with the economic pressure on the resource and provide the intermediate territorial levels with considerable autonomy.

Conclusion

Increased use of forest biomass to reduce greenhouse-gas emissions and better preserve forest biodiversity is a commitment undertaken by the nations that signed the two major international environmental conventions on climate change and biological diversity.

The goal of the Bio2 study was to scientifically study the implications of increased use of forest biomass on biodiversity and on natural resources (soil, water), taking into account economic and governance aspects. We note that in the current context, the reverse question is less frequently raised, i.e. what would be the implications of a more ambitious policy to preserve biodiversity and natural resources for efforts to increase biomass use?

Produce more wood while better preserving biodiversity is a goal of the partners in the Grenelle process. The Bio2 study made clear the existing and potential negative impacts that must be kept in mind and must be eliminated or attenuated through recommendations, regulations based on those recommendations or improvements in governance. It also identified sources of synergy. The study suggested a number of possibilities to improve knowledge, notably by placing questions, approaches and recommendations (rules for forest development and management) in context, and insisted on the need to design and set up monitoring on the ecological and economic impacts of public policies in view of subsequent evaluation and adaptive management.

A collective process of continuous improvement capable of combining over time increased use of wood with improvements in knowledge and the development of new forms of governance, and that prepares for major innovations in all these fields is indispensable if we are to meet the Grenelle challenge. There are many unknowns. They include the impact of public policies and the long-term changes in overall economic conditions, the social and ethical dimensions (often poorly taken into account) of these issues, and the capacity of participants, on various levels, to understand and share their respective goals. In all cases, a strong and rigorous scientific approach is certainly a necessary element in a process that will prove to be long and difficult, but fascinating. ■

© DR Cemagref

Authors

Guy Landmann
GIP Ecofor, c/o CIRAD,
42 rue Scheffer, 75116 Paris Cedex 16
landmann@gip-ecofor.org

Frédéric Gosselin
Cemagref, centre de Nogent-sur-Vernisson,
UR EFNO, Écosystèmes forestiers,
Domaine des Barres, 45290 Nogent-sur-Vernisson
frederic.gosselin@cemagref.fr

Marion Gosselin
Cemagref, centre de Nogent-sur-Vernisson,
UR EFNO, Écosystèmes forestiers,
Domaine des Barres, 45290 Nogent-sur-Vernisson
marion.gosselin@cemagref.fr

Key bibliographical references...

BALLAND, P., HUET, P., LAURENT, J.-L., LUMMAUX, J.-C., MARTIN, X., SCHLICH, R., 2001, *Rapport sur les Observatoires pour l'Environnement,* Paris, MATE et MR, 115 p.

CACOT, E. (coord.), EISNER, N., CHARNET, F., LEON, P., RANTIEN, C., RANGER, J., 2006, *La récolte raisonnée des rémanents en forêt. Angers*, Ademe, collection « Connaître pour agir », 36 p.

EUROPEAN ENVIRONMENTAL AGENCY, 2006, *How much bioenergy can Europe produce without harming the environment?*, Copenhagen, European Environmental Agency, EEA Report n° 7-2006, 67 p.

FRANCE NATURE ENVIRONNEMENT, FÉDÉRATION NATIONALE DES COMMUNES FORESTIÈRES DE FRANCE., OFFICE NATIONAL DES FORÊTS, FORESTIERS PRIVÉS DE FRANCE, 2007, *Forêt : Produire plus de bois tout en préservant mieux la biodiversité Une démarche territoriale concertée dans le respect de la gestion multifonctionnelle des forêts*, Contribution datée du 04 septembre 2007 au Groupe n° 2 du Grenelle de l'Environnement, 2 p.

LANDMANN, G., GOSSELIN, F., BONHÊME, I. (coord.), 2009, *Bio2, Biomasse et biodiversité forestières. Augmentation de l'utilisation de la biomasse forestière : implications pour la biodiversité et les ressources naturelles*, Paris, MEEDM-Ecofor, 209 p.
www.gip-ecofor.org

▶ You can consult the bibliography on **www.set-revue.fr**