National Observatory for the Impacts of Global Warming

Trees and forests in a changing climate

Report to the Prime Minister and Parliament

Foreword, Executive Summary

2014

ONERC Publications

Êtes-vous prêt ? Guide pour l'adaptation à l'attention des collectivités locales ("Are you ready? Guide to adaptation for local authorities"). ONERC, 2004

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A word from the President

Trees and forests at home and abroad have developed and changed over the centuries following changes in the climate. More broadly, every component of biodiversity expands or decreases depending on more or less favourable conditions for nutrition and reproduction When the climate changes more gradually than landscape or ecosystem development, the evolution of the forest fits into climatic history in a manner imperceptible at the scale of a human life. But today the industrial era has subjected climatic systems to very rapid change, similar to a sudden shock. Twenty-first century humans can and will continue to see the resulting impact on forests for many decades.

The *Holocene Optimum* (i.e. 7,000 to 9,000 years ago) was warmer than the twentieth century by about 2°C. Dating techniques enable confirmation that the Mediterranean forest at that time extended to the north to the confluence of the Saône and the Rhône.

Conversely, during the last glacial maximum, about 18,000 years ago, while the average temperature was lower by 4 to 5°C than that of the twentieth century, boreal forests and forested steppes were located in the Rhône valley.

Overseas, too, forests evolved slowly over the historic and prehistoric periods.

Closer to home, deforestation linked to the expansion of agricultural areas in the Middle Ages mobilised people for centuries. The use of wood as a raw material and a source of energy is still a reality in the early twenty-first century, whatever the country or culture. The timber trade provides wealth for France of significant economic potential.

Today forests face a challenge of considerable magnitude. Indeed, as pointed out by the Intergovernmental Panel on Climate Change (IPCC) in its Fifth Assessment Report, climate change is likely to progress at such a rate that spontaneous evolution in most tree species will struggle to keep pace with the average rate of change in weather conditions.

The expansion or spontaneous displacement of most species is very slow, based on rates of tree growth. Forests are often restricted to relatively small areas for geographical, climatic and historical reasons, and will be more vulnerable as their areas of expansion are reduced.

What can be done in this context? Wait and see what happens? Do we not already have the means to anticipate certain developments? Do we not have the ability to limit the extent of the changes?

Our responsibility is undoubtedly to take action to ensure that the nine to ten billion humans who will inhabit the planet by the mid-twenty-first century live in harmony with their forests. This will only be possible if we are able to organise ourselves to achieve a significant reduction in greenhouse gas emissions. Such an effort, if sufficiently large, will succeed in containing climate change, stabilising it at an acceptable balanced level for human activities and biodiversity.

As well as cutting greenhouse gas emissions, which remains the highest priority, action is also needed to assess the potential for the adaptation of forests, in order to prepare for managing them differently as and when it becomes necessary.

There remain several unknowns within the changing climate; some are very large, such as the long-term organisation of our society. We also need to question our behaviour, the issue of demographic change and future migration flows.

However, we cannot remain passive in relation to the information we do have at our disposal. It is for this reason that the ONERC advisory board decided to undertake the drafting of a report to the Prime Minister and Parliament, to shed recent and documented light upon the most important aspects of the impact of climate change on forests and trees and their adaptation to it.

Paul Vergès

Executive Summary

As reported widely by the IPCC, the impacts of climate change could have significant consequences for the growth, and indeed the survival, of trees and forested lands. Henceforth, foresters must incorporate these changes, as forests will be directly affected. This formidable challenge for forestry is an opportunity to better account for ecosystem services in order to guide the silvicultural choices that will take effect in the decades to come. Such services contribute to improving the strength and resilience of forests to those hazards and crises they will encounter.

Forest ecosystems[1] have long development and reproductive cycles, varying from fifty to two hundred and fifty years on average.

Forest managers will have to act on several fronts to support the adaptation of forests in order to ensure the persistence of forested land, safeguard the supply of goods and environmental services to society and maintain their role in mitigating climate change. This annual report addresses the vulnerability and adaptation of trees and forests in mainland France. With regard to aspects of this topic concerning overseas departments, please refer to the corresponding ONERC report, *Les outre-mer face au défi du changement climatique* ("Overseas departments facing the challenge of climate change").

- *Expected effects of climate change on trees and forests*

Multiple natural and anthropogenic factors, such glaciation, crises and transitions, deforestation, technological revolutions, wars, epidemics, forest management plans and climatic fluctuations affect the growth, vitality and composition of forests, which, to the observer, appear only as instantaneous states within a process of dynamic evolution.

Essentially, life is conditioned by climate, which is itself characterised in terms including available light energy, temperature and water availability. These parameters are particularly critical for trees, species which are immobile and long-lived. Each species has its own demands in terms of its need for heat, tolerance for cold and ability to face a lack of water, which together define what is called its climatic niche, or climate envelope.

Climate change is likely to result eventually in a gradual rearrangement of their geographical distribution. Thus rising temperatures allow species to move further north or higher in altitude. In the mountains, lifting cold-related constraints allows the upslope advance of some species. Changes in precipitation, difficult to model at our latitudes, are a major source of uncertainty for the future development of our forests.

Global warming is also responsible for significant changes to the annual cycle of tree development. The trees' period of activity has increased over the last fifty years, which explains in part the increase in productivity of our forests over the same period. Certain models establish links between climatic conditions and the soil on the one hand and phenology, physiology, growth, survival and reproductive rates of trees on the other. They predict, by the end of the century, massive regressions in the southern margins of distribution and even in the centre of the territory for warming scenarios of about 6°C by 2100, mainly due to winters no longer harsh enough to allow the breaking of bud dormancy, yet also because of too great a shortage of water.

Thus far, very little research effort has been devoted to understanding forest regeneration capacities depending on weather and edaphic[2] conditions, from the production of viable seed to the planting of seedlings.

Changes in the atmosphere and climate act in contradictory ways on tree physiology. For example, drier soils lead to a decrease in forest productivity, while an increase in the concentration of CO_2 has positive effects on growth. Similarly, the nitrogen cycle may be affected.

Aside from the uncertainties related to variability of response to complex interactions between species and the multiple components of climate change, a trend of increasing insect pests and pathogens seems to be emerging and may continue in the coming years.

Faced with climate change, forest adaptation capacities (magnitude and speed of evolution, tolerance thresholds) remain poorly understood, depending on the one hand upon species diversity (genetic resources) and, on the other, upon the intensity of the evolutionary forces. All this varies by geographical region and species. Forest policy and management can influence not only genetic diversity but also the evolutionary forces at play.

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1 Entity formed by an association or a community of living things with its environment.

2 Relating to the character of the soil.

Yet our vision of the potential impacts of climate change remains fragmented, conditioned as it is by those actions already undertaken, the various scenarios projected and the entities of the ecosystem under consideration. Imagining possible futures based on a global approach which takes account of climate change and adaptation requires inclusive approaches.

- *The protective forest faced with climate change*

Issues related to the potential change in the protective functions of forests fall into several categories. The forest operates to varying degrees in limiting or slowing avalanches in the forest environment, the triggering and impact of rockfalls, landslides, surface erosion, riverbank erosion, flooding in downstream areas and the erosion of coastal dunes.

In the long term, the migration of conifers to higher altitudes, generated by warming, should favour the function of elevated conifer stands as barriers to avalanches at a time when avalanches are expected to occur at higher altitudes.
Developing the prudent management of productive forests faced with climate change will require significant research and environmental monitoring, as well as the mobilisation of many stakeholders. Qualitatively, it is also about:
– raising awareness and visibility. The "protective forest" is a misunderstood concept outside of the disasters with which it is associated;
– reviewing and revisiting. Established wisdom needs to be reviewed in the light of current threats;
– improving the flow of information. As in other areas, pooling data;
– extension. Vulnerability assessments must be not only improved but also systematically extended beyond the customary areas of concern;
– and finally bringing together notions of the "protective" and "threatened" forest.

- *Adaptation to climate change and forest management*

Faced with a general change in climate, living beings usually have two solutions for survival: adapt or escape.

The present change in climate, largely man-made, is currently proceeding at a more rapid pace than the warming at the end of the Ice Age. Thus the northward shift of potential bioclimatic envelopes[3] should be of the order of 500 km in a century, while the natural migration rate of forest species does not exceed 50 km per century, as evidenced by recent studies by palynologists and population geneticists.

It is therefore very difficult to anticipate the natural reaction of the forest to climate change.

The great difficulty is that it is not only a matter of protecting forests against occasional hazards: we must anticipate gradual, sometimes jerky, changes in environmental conditions, which establish a permanent state of ecosystem imbalance with no possibility of reversal. Adaptive capacity depends on multiple factors, often interacting with each other.

A number of recommendations assume that the spontaneous adaptability of the forest will not be sufficient, and we must act to increase the resistance and resilience of forests, without going so far as to adopt the logic of intensive forest management.

It would be presumptuous and ultimately perilous to seek to offer universal off-the-shelf solutions, whose proponents could have no chance of assuring their successful application. Nevertheless, this complexity should not discourage us. The worst option would be to do nothing in a situation where we know there will be changes which we have already begun to perceive.

Moreover, another mistake would be to act only in response to climate change, while many other parameters influence forest management, often shorter-term and particularly in the socio-economic areas: rapidly evolving product opportunities, the increasing importance of ecosystem services and social demands.

This report proposes a consistent three-stage approach to decision-making: diagnosis (knowledge and understanding), definition of management objectives (decision), choice of management techniques[4] (action). Foresters must take ownership of this approach, adapting it to each individual case.

The above approach is positioned at the local level (forest, plot). It is clearly part of a national strategy. From an operational point of view, the actions of the various forestry agencies are harmonised by the *Réseau mixte*

3 Geographical entity within which the climatic conditions influencing species distribution are homogeneous.

4 Definition of successive silvicultural interventions (harvesting and other works) which lead to a target within a given context.

technologique (mixed technology network) AFORCE.

● *The role of trees in agricultural land management adaptation: the potential of agroforestry*

Just as forest trees represent important and multifunctional wealth for France, agricultural trees are the other trees of our landscapes. Agroforestry systems are mixed production systems which cover all the pairings of trees with livestock or crops, such as the hedgerows of the west, the olive groves associated with market gardening in the south-east, Normandy's silvopastoral orchards and the walnut groves with cereals of Isère. These days, agriculture is gradually returning to being a high-performing sector. Thus, having been forsaken for the profits wrought from intensification and specialisation, agricultural trees are gradually regaining their place as interest grows in their multi-functionality.

The development of agroforestry systems requires a long-term strategy that integrates experimentation, the development of benchmarks and support for stakeholders. Though it is difficult to describe the agriculture of tomorrow, it is easier to identify the challenges it faces today which will shape its future.

Field trees are of multiple functionality and are the subject of renewed interest in meeting economic, social and environmental issues. They produce wood, providing a renewable raw material and source of energy. They also contribute to the quality of the countryside and rural life. Finally, trees contribute to the maintenance of water quality and support biodiversity. They also have strong advantages in the support of agricultural areas' adjustment to climate change, by way of evolving cropping techniques. Agricultural practices would be hard pressed to adapt to climate change if they overlooked trees.

• *Timber trades at the heart of climate change*

Forest industries constitute a significant sector of the French economy with high potential and bring together multiple interconnected activities. They have a major role to play in enabling the adaptation of forests to climate change and mitigating it. In the medium term, timber harvesting could increase due to increased productivity and dieback, forest adaptation measures and the development of wood products. In the long term, it will have to adapt to the constraints imposed on the forest by climate in terms of species and their productivity. It will also face additional harvesting constraints, with likely wetter winters and prolonged growing seasons, as well as increased risk of fire in wood processing plants during intense drought or heatwaves.

In recent decades, major forest issues have more often concerned the functioning of ecosystems, biodiversity, climate change, storms or sustainable forest management than the forest industries.

However, these industries retain a central and strategic role in relation to most of these themes, and are regaining importance in the context of the green transition and the energy transition. Their smooth operation and dynamism are prerequisites for any forestry action, and thus for both proactive and passive adaptations to climate change, in managing both trends and crises. The forest industries are fundamental too in combating the greenhouse effect, and within them relationships are forged between climate change adaptation and mitigation. They are and will remain, of course, subject to the consequences of climate change. Yet most important is the fact that the timber trades play a critical role faced with and thanks to climate change. This requires that they manage to overcome periodic difficulties and remain flexible, active and diversified enough to play their role fully when the need of them is really felt. It is also necessary for the timber trades to be associated with and involved in discussions on the adaptation of forests to climate change.

● *A walk in the forest in 2050*

Finally, in the form of a fictionalised account, here is an exercise in perspective. To have a clear idea of the forest landscape in 2050, let's walk through it. With scientific support, this story offers us a projection of the future in the Tronçais forest, 10,600 hectares of state oak groves in Allier, north of the Massif Central. Lacking certainty and full of assumptions in the light of current knowledge, this description is intended to be as plausible as possible in a world that has become environmentally responsible.

Abstract

The work of the Working Group II of the Intergovernmental Panel on Climate Change (IPCC) was presented in March 2014. Entitled *Climate Change 2014: Impacts, Adaptation and Vulnerability*, this second volume of the fifth IPCC Assessment Report details the impacts of climate change to date, future risks due to climate change and opportunities for effective intervention to reduce these risks. The effects of climate change are already being felt in all sectors and in all areas (agriculture, health, land and ocean ecosystems, water supply), and on every land mass and ocean (from small islands to large continents) from the richest to the poorest. Climatic change often interacts with other sources of stress to increase risk. The world is nevertheless unprepared for the risks of climate change and adaptation can contribute greatly to reducing them.

Since its creation in 2001, the *Observatoire national sur les effets du réchauffement climatique* or ONERC has worked for the dissemination of knowledge on climate change and its expected impacts on natural and human systems.

Published in 2011 under the aegis of ONERC, the *Plan national d'adaptation au changement climatique* (national plan for adaptation to climate change) (PNACC) points out that the forest sector has been facing serious crises over the last decade, such as storms, droughts and recurrent forest fires. Climate change appears as an additional risk factor, which must therefore be afforded the keenest attention. From this point on, in addition to these exceptional events we must also take stock of background developments, given the length of forest life cycles. These events and developments present a double aspect, with some more favourable (increased productivity in some areas) and others more problematic (changes to the areas of distribution of species, increased risks), both requiring management.

The ONERC advisory board wanted the 2013 report to take up the issue of trees and forests facing the challenges of climate change. This report is intentionally limited to mainland France, since for overseas areas the topic has already been the subject of a chapter in the sector-specific analysis of a previous report entitled *Les outre-mer face au défi du changement climatique* ("Overseas departments facing the challenge of climate change"). Moreover, most of the elements related to forest management are still relevant for overseas areas.

This report is organized into seven chapters.

The first introduces the problem, outlining the different aspects of trees and forests and explaining the different services they provide.

The second deals with the visible or expected effects of climate change on trees and forests.

The third deals with protective forests and explores possible developments of this particular service.

The fourth looks at forest management methods promoting the adaptation of forests and trees.

The fifth tackles the lesser known problem of agroforestry, the usefulness of trees for adaptation in agricultural areas.

The sixth reflects upon those economic activities related to the forest industries.

The seventh and final chapter addresses the topic with an unusual perspective, suggesting a walk in the Tronçais forest in 2050.

Three appendices complete this report :
Appendix 1 - report on the observatory's activity
Appendix 2 - abbreviations and acronyms
Appendix 3 - contributors and acknowledgements