Criterion summary

Summary of observations

The future of forests and their services to society are weighed down by environmental changes. Although media concerns are changing and tend to focus on a specific threat in each era (acid rain in the 1980s, climate change today), it is important to comprehend the effects of environmental changes as a whole by monitoring dominant pressures applied to the forest ecosystem (fires, storms, droughts, phytosanitary damage, atmospheric pollution, herbivorous pressure, climate change, mechanical damage to soils, etc.) and by monitoring the state of health of the ecosystem (tree defoliation, timber production, chemical fertility and carbon stock in soils, biodiversity of the ecosystem, etc.).

The sustainable management indicators provide us with information on some of the **pressures** which are being applied to the forest ecosystems in metropolitan France:

– acidifying atmospheric pollutions have been dropping for twenty years and this trend has continued in the last five, mainly depositions of sulfur and also to a lesser extent of nitrogen (***Indicator 2.1***);
– attacks from pathogens have changed in contrasting fashion. The main outbreaks have ended in the last five years: the responsible insects have returned to an endemic state either at the end of a regular cycle (pine processionary caterpillar, larch leafroller) or by natural control of the phenomenon (conifer bark beetles). Conversely, the impacts from new, exotic agents spread (e.g. ash dieback and chestnut gall wasp, seen for the first time in France in 2008 and 2010 respectively) (***Indicator 2.4***);
– the major increase in removals by hunting for the past thirty years mirrors a rise in populations of wild ungulates (both in terms of geographical expansion and in demographic growth) and therefore an increasing pressure applied by these animals on the forest environment (***Indicator 2.4.1***);
– there was little damage caused by wind and fire during the 2009-2014 period compared with the two previous periods (1999 and 2009 storms, 2003 drought-heatwave) (***Indicator 2.4***).

The indicators also provide us with information on the **state** of health of the ecosystem:

– without massive dieback of forests, the state of health of trees has deteriorated on average in terms of changes in their defoliation in the 16 km x 16 km systematic grid (***Indicator 2.3***). This global trend shows huge variations, however, according to the species and geographical contexts. The state of health of trees has deteriorated especially in Mediterranean forests. Contrastingly, the sessile and pedunculated oaks show a remarkably stable national tendency. The temporal trend in tree defoliation is influenced by many factors and cannot be attributed categorically to the effect of a change in climate. Nevertheless, intensive monitoring in the Renecofor network highlights the dominant role of variations in water supply from one year to the next. The 2003 drought-heatwave marked the observation period especially and seems to be the starting point for the deterioration of defoliation of the majority of species.
– the first temporal repetition of soil sampling in the Renecofor network reveals several significant changes during the last fifteen years (***Indicator 2.2***). Despite a huge reduction in acidifying atmospheric pollutions, the most acid soils have continued to acidify, without nevertheless getting poorer in nutrient cations (the magnesium that trees were potentially lacking in the 1980s has increased particularly in exchangeable stocks). The continuing fertility of the most acid soils is due to the increase in their nutrient retention capacity, mainly through organic carbon sequestration. Forest soils have indeed behaved like carbon sinks, a positive factor with respect to the climate change mitigation challenges. Total nitrogen stocks in the soils have also taken a significant downwards turn: an in-depth analysis of the incoming and outgoing ecosystem flows will be needed to determine the causes of this change and its implications (especially for the nutrition of trees).

In addition, timber production and the biodiversity of forests, major parameters in the state of health of forests, are qualified by Indicator 3.1 and indicators under Criterion 4, respectively.

To summarize, twenty years' monitoring of forest ecosystem vitality indicators have revealed major trends. Some were expected, like the drop in acidifying pollutions, others less so like carbon sequestration in the soils or the lack of massive dieback of forest trees, despite the unfavorable climate events (1999 and 2009 storms, 2003 drought-heatwave) and other noted pressures (appearance of exotic parasites). We see however the state of deteriorated health for species in the Mediterranean region.

Outlook

The changes illustrate the advantage of observation devices and their continuity with respect to current environmental changes. They also call for additional measuring of the pressure factors and impacts for which no information has been received so far.

– It would be useful initially to be able to monitor the pressures applied by climate change and their impacts on the forest ecosystems. There are nevertheless several difficulties in defining such indicators despite the existence of numerous data sources[1]. Firstly, it is difficult to select indicators for synthetic and relevant pressures in terms of the multitude of bioclimatic variables influencing the forest ecosystems. Secondly, although climate change is likely to affect many parameters noted within the ecosystems, it is, however, difficult to distinguish between its potential impacts and the impacts of other influential factors (atmospheric pollutions, forestry management, changes in the biodiversity and biotic interactions, etc.). Add to this the fact that the series of observation data available for forests still do not go back long enough to characterize the climate (at least thirty years). Indicators from models could be envisaged to counteract these difficulties and used to extrapolate observation series in the long term (e.g. tree phenology) or assess the effects which can be attributed specifically to climate change. This would however require a major development and validation effort.

– Another potential additional measurement relates to the pressure applied by the wild ungulates. The major increase in their populations is a huge cause for concern among slviculturists, who currently have no indicators for monitoring the actual impacts of these animals on the forest environment. Depending on population levels, the effects can be positive (e.g. rise in the specific wealth by disseminating seeds and controlling the development of invasive species) and negative (e.g. through consumption of vegetation, drop in the diversity of the flora and, through a cascade effect, of invertebrates and birds[2]). Economically, strong pressure on forest stands being renewed can generate forest damage, i.e. affect the yield of these stands or even raise doubts over the forestry objective assigned by the managers[3]. Indicators to supplement the existing ones will therefore have to be developed to characterize the effect of wild ungulates on the forest environment and assess their impact on such major issues as wood supply, adapting stands to climate change, conservation of species and habitats and even human health.

– Settling of soils is a third example of a topic of interest that is currently lacking in the sustainable forest management indicators. The increase in the frequency and intensity of machinery moving through forests poses a huge risk for the deterioration of the physical fertility of soils: reduced drainage capacity, congestion phenomena, constraint to rooting and biological activity, etc. It is difficult to reverse such deterioration, which can have major impacts on the ability of forest stands to regenerate and withstand episodes of stress. Forest managers attempt to prevent the risks of deterioration by channeling machinery movements onto specific tracks (partitions) and trying to restrict logging to periods when the soil can bear the load[4]. Nevertheless, there is a shortage of indicators on the topic, mainly through lack of a system for monitoring the state of soil settlement.

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