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LATEST NEWS

Czech Forests After Bark Beetle Calamity – Adaptation Strategies and Mitigation Potential Related to Climate Change

The extent of clear-cut areas in Czech forests has been increasing significantly since 2017, raising concerns about its environmental and economic impact (Table 1). The reason was the bark-beetle calamity, especially in Norway's spruce stands. This main commercial tree species was used in the last centuries for forest restoration to a large extent. From a natural 11.2% in natural forests of Czech lands, the share of this species increased to more than 55% at the end of the last century; later, it decreased with forest restoration to 54.1% in the year 2000 and 46.0% in the year 2023. Nevertheless, the recommended proportion in the Czech forest is 28.3%, which is previewed for the coming decades and centuries.

The reasons for the still-running calamity are:

- Planting and regeneration of Norway spruce on non-native sites, even in very low altitudes with climate and site conditions unsuitable and extreme for it,
- The climatic extremes consisting of increased temperatures and decreased soil moisture, especially in lower altitudes, increasing the sensitivity of spruce to bark-beetles and other pests,
- The aging of Czech forests, the mean rotation increased from 93.4 years in 1980 to 115.1 years in 2023, conditioning lowering of the stand stability and higher susceptibility to abiotic as well as biotic damaging factors,
- Finally, the forest management system, especially in state-owned forests, lowers the operation flexibility in prevention and curative treatments (Figure 1).

Figure 1: *Large area clear-cuts originated in the last years as a result of Norway spruce decline, i.e., areas with extreme microclimatic conditions*

As a result, the salvage fellings increased considerably, as did the area of clear-cuts (Figure 2). The logging volume was based mainly on areas with the calamity; the capacities were oriented at this problem, too.

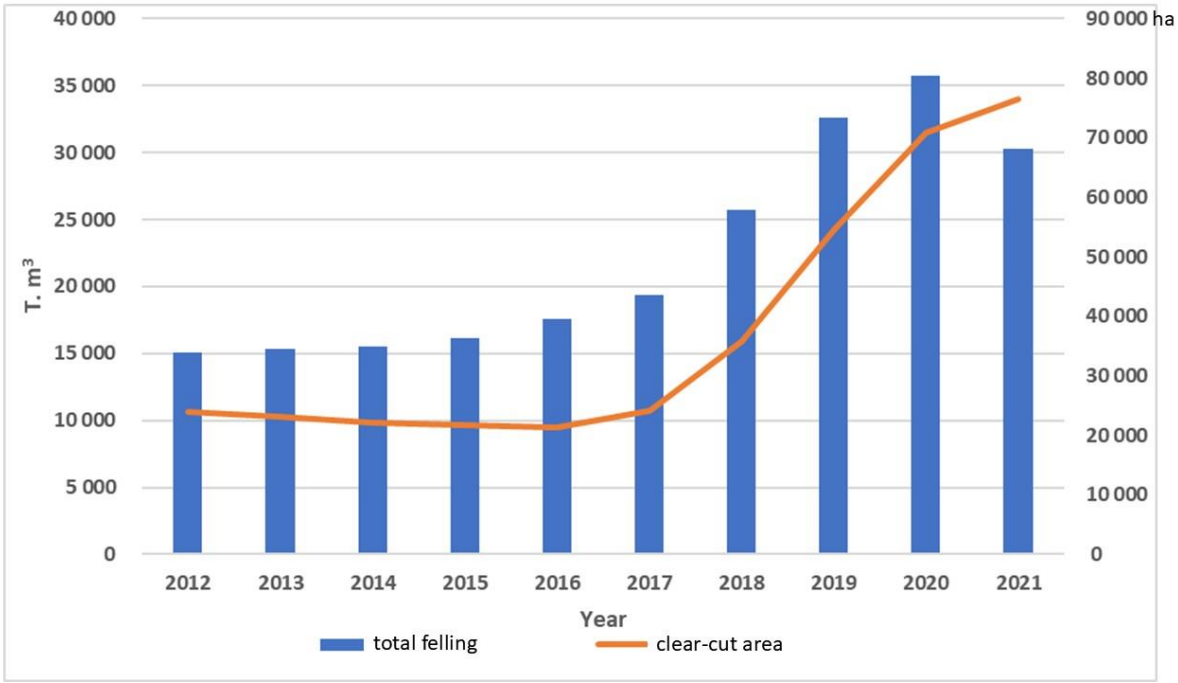

Figure 2: *Volume of total fellings (left scale, columns, in thousand m^3) and area of clear-cuts (right scale, curve, in ha) in the Czech Republic in 2012 – 2021*

The forestry sector was reacting very actively. Since 2022, the regenerated area has been overgrowing due to the increase in clear-cuts. The progress in forest regeneration was possible due to the increase in planting material, from 110 – 150 million pcs in 2010 – 2018 to 286 million in 2021, with an increasing tendency (Table 1).

Table 1: *Clear. cut area (1), clear-cut area increment (2), and clear-cut area decrease (3) in particular years (ha)*

Year	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
1	22,144	21,795	21,393	24,151	35,761	54,497	70,912	76,592	67,720	54,194
2						51,745	55,631	54,367	39,904	30,276
3						33,009	39,216	48,687	48,775	43,803

Moreover, relatively large areas were left for spontaneous, natural commercial, and preparatory species regeneration. It was used and verified a range of historical, as well as newly developed methods and technologies, such as:

- Underplanting of shade-tolerant species in the loosened stands,
- Seed tree methods using the survivors – more tolerant or resistant individuals and tolerant admixture of other species than spruce,
- Double plantings of different species, usually conifer and broad-leaved individuals,
- Two-phase regeneration: after a natural or artificial regeneration of preparatory species, the introduction of commercial/climax species (Figure 3),
- Newly, the interest in using non-native (exotic, introduced) tree species increased intensively.

Figure 3: The spontaneous regeneration of preparatory species can be used in the forest restoration, followed or completed by artificial regeneration of other species

An essential adaptation strategy is establishing new stands with structures able to increase the vitality and stability of future forests. This consists of the regeneration and thinning, in general, silvicultural approaches aimed at:

- Diversification of spatial and simultaneous age diversity. This is crucial in surviving even-aged stands and is connected with continuing thinning treatments. It also runs together with forest regeneration and the application of structural thinning and a longer-lasting shelter silvicultural system.
- For age diversification, the underplanting method can also be used, prolonging the regeneration period.
- Age diversification treatments will be vital in newly regenerated stands originating at large clear-cuts. This will represent considerable management problems in the coming decades.
- Species diversification is another vital task for more stable forest ecosystems. Site-corresponding species are supposed to convene this target. Primarily, the site native species should be used, but forestry research is oriented partly on introducing tree species and species; we can speak about "assisted transfer" from more southern and climatically extreme regions of Europe.

Forest stands are more diversified in age, space, and species structure, which are considered the main adaptive factors of the climate challenge and forest stability. Their forests can also contribute to mitigating the adverse effects of any future environmental change.

As reported by Prof. Ing. Vilém Podrázský, CSc., vice-president of the Czech Academy of Agricultural Sciences