



Original map of the location of a network of 477 floristic plots installed in 1971 and 1972 in Amance forest. Based on this map, the surveys were redone in 1990 and 2022.

Are long-term vegetation dynamics determined by silvicultural disturbances? The case of the Amance forest.

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Thematic action concerned: WP2

Context:

Ongoing environmental changes are impacting forests. The major concern is the future effects of climate change on forest production. But what are the real changes taking place? Long-term observation networks help answer this question.

Objectives:

To resample a network of plots previously sampled in 1971 and 1990 in order to characterize changes in forest herbaceous vegetation. Specific questions were:

- Has the eutrophication of vegetation (i.e. enrichment in nitrophilic species) observed between 1971 and 1990 continued, increased, or slowed since then?
- Is the current global warming already having a visible impact on the composition of plant communities?
- are there other factors that impact vegetation dynamics?

Approaches:

Resampling of 164 sites in the forest of Amance (Meurthe-et-Moselle, France). Circular surveys of 400 m² of all species present (39 on average per site), at the same date as in 1990. A strong particularity of the approach is **to have made separate surveys, within the 400 m², in each micro-habitat related to the visible disturbances in the plot (gaps, trails, wheel ruts, pits and mounds...)**. Species movement along multivariate analysis factorial axes, and changes in indicator values for nitrogen availability, soil acidity and moisture, and mean temperature are analyzed.

Key results:

. **Vegetation change between 1990 and 2022 is dominated by a new factor, soil compaction due to mechanisation.**

Species associated with logging roads and wheel ruts (*Juncus spp.*, *Carex pendula*, *Glyceria spp.*, *Rumex sanguineus*...) increased strongly in frequency throughout the forest. Indicator values for soil moisture and soil compaction increased significantly. Ancient woodland species species, which avoid disturbance, declined.

. Eutrophication is still occurring. A significant thermophilization appears. But these two phenomena are secondary in the dynamics of the vegetation compared to the previous one.

Main conclusions:

. Soil compaction was already known, through experimental studies, to have a strong impact on soils and biodiversity, and consequently on woody regeneration. But this knowledge was limited to experimental sites. We show here for the first time that **this disturbance is a new factor that has acted *in situ*, over the last 30 years and on the scale of an entire massif.**

. Causes of eutrophication: the current levels of nitrogen deposition measured in the Northeast region (7.2 kg.ha⁻¹.yr⁻¹ excluding dry deposition) may still be above critical loads, or the observed eutrophication of vegetation may also be a consequence of mechanization.

. Thermophilization: while atmospheric temperatures measured in the Amance forest have increased by 1.5°C between 1990 and 2022, the vegetation bioindicates only a tenfold increase, of 0.15°C. Thus, **a strong climatic debt is currently being created in the dynamics of the vegetation.**

Perspectives:

- Explore national databases (National Forest Inventory, RENECOFOR) to test whether this impact of mechanization is found in other regions, or even on a national scale.
- Revisit the few (two?) soil compaction experiments in France, to analyze the dynamics of the vegetation.
- Better characterize the effects of compaction on soils and vegetation. To analyze in particular the dynamics of nitrogen at the level of micro-sites created by compaction.
- To set up a **monitoring system for forest mechanization, current and past, completely absent today.**

Valorization:

- Vennin S., Montpied P., Behr P., Thimonier A., Dupouey J.L., 2023, Mechanisation of forest operations drives long-term changes in plant communities, **submitted to Journal of Applied Ecology**.

- Vennin S., Montpied P., Behr P., Thimonier A., Dupouey J.L., 2022, Mechanized forest operations as an emerging driver of understory vegetation change - 50 years of plant communities' composition in the Amance forest (France), **poster, International conference in Ecology & Evolution** (SFE2, GfÖ, EEF), Metz, 21-25/11/2022

- Seminars for the dissemination of results organized with forest managers: ONF-recherche national (16/12/2022), CNPF-CRPF (05/12/2022), ONF région Grand-Est (02/12/2022).

- Presentation of the results to the FRB (30/12/2022).

Leveraging effect of the project: None for the moment. No time or means to continue this theme.