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Maintaining carbon in the forest soils of the Morvan (France): Spatial and knowledge competition around the evolution of practices

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Abstract

Purpose: This paper deals with a specific form of carbon-centred rationale aimed at maintaining carbon stocks in forest soils by promoting certain practices and discouraging others, primarily clearcutting. The goal is to explore recategorisations and realignments within the forestry sector brought about as a result of increased awareness of this rationale in the public debate within France.

Methods: To do this, I conducted a qualitative case study (observations, interviews, and document analysis) in the Morvan region, which plays a role in the French national media as a hotspot of opposition between contrasting forestry models.

Results and Conclusions: The global issue of maintaining carbon in forest soils is translated into the local context mainly by environmental NGOs and their allies, who redefine older critiques of clearcutting. Knowledge on the topic circulates in three parallel networks of stakeholders in the Morvan, due to a polarised setting where the PNRM has difficulty acting as an interface. Beyond the committed decarbonisation agendas of citizen-led forestry groups, a more general loss of legitimacy of clearcutting is tangible within the forestry sector, with some operators favouring other models, such as natural regeneration. Greened forms of clearcutting are also justified with merely strategic uses of carbon arguments. Paradoxically, these various positions about maintaining carbon in forest soils can lead to a similar interest for less productive areas of forest. Another weak signal of the revival of forestry production in the name of carbon is the increasing implementation of the *Label bas carbone* scheme.

Keywords: climate change mitigation, forestry models, knowledge circulation, *Label bas carbone*, legitimisation process

1. Introduction

As in other countries, in France, the forestry sector is reorganising along two simultaneous greening and relocation processes (Lenglet and Caurla, 2020), disrupting the original sectoral logic (Sergent, 2010). In this context, renewed environmental threats are raising more and more attention, particularly regarding the adaptation of forest management (Banos and Deuffic, 2020). In the face of climate change, foresters and forest science are focusing on topics relating to adaptation strategies (Dolez et al., 2019; Fouqueray et al., 2020), such as fire risk management (Moura da Veiga and Nikolakis, 2022) and assisted migration (Sansilvestri et al., 2016), while mitigation issues command less attention. Against this backdrop, carbon sequestration, which is one of the major mitigation levers, is usually approached through the lens of aerial biomass, such as trunks, branches, and leaves, or of wood products, such as furniture (Roux et al., 2019). Soils and their capacity to be carbon sinks appear to be relatively poor relations, at least in France, where soil formation is a smaller forest ecosystem service than, for example, in northern Europe (Orsi et al., 2020). Nevertheless, thinking about forest soils as carbon sinks is increasingly seen as a way to reconsider the opposition between old-growth and plantation forests (Taerøe et al., 2017; Luysaert et al., 2021).

This discussion should be seen in the context of a large body of scientific work on the evolution of forest cover, particularly in the Global South with a focus on deforestation, but also in the Global

North with a focus on agricultural decline. Beyond the mere spatial patterns, such land cover trends are often analysed from the perspective of conflict, for instance, when voluntary large-scale afforestation undermines local uses and landscapes (Temple, 2011) or because specific tree species are rejected (Robert and Tebonou, 2020), but also when conflictual uses coexist intensely, such as in periurban forests (Decoville, 2007). Indeed, as emphasised by Kull (2017), it is difficult to analytically detach forest cover from forest composition, socio-political processes and relationships producing forest spaces, and forest ideologies and discourses. Therefore, forest multifunctionality (Barthod, 2015) including wood production, nature conservation, hunting, leisure, and, more recently, energy transition (Banos and Dehez, 2017), is the subject of many debates. This calls into question the property (Nichiforel et al., 2018) and management regimes (Schlueter, 2008; Sourdril et al., 2012) of forests, as well as their public regulation (Nichiforel et al., 2020).

Traditionally, foresters have perceived soils as a central component of the forest station, i.e., as an element of the physical and biological environment framing the development of trees. More recently, soils have also been understood from a care perspective, as elements to be respected when forestry works are undertaken, particularly to minimise soil compaction. Both ways of considering soils see them first as physical-chemical materials, rather than living ecosystems or carbon sinks. Recent research has focused on a more systemic understanding of forest management impacts on soils, recontextualising forestry works within the range of decisions that affect forests and their soil carbon (Augusto et al., 2019).

Currently, social debates focus on clearcutting and its environmental impacts. The French Ministries of Agriculture and of Environment, the French Agency for Ecological Transition (ADEME), and the French Biodiversity Agency (OFB) commissioned two major applied science consortia of the French forestry sector (GIP Ecofor and RMT Aforce, 2022) to produce an expertise report on the state of knowledge. This report offers an original overview of the impacts of clearcutting on soil carbon: after a forest plot is cut, years to decade-long soil carbon losses are observed, particularly in the topsoil, in fine textured soils and when the soil is prepared before plantation. Less than three weeks after these results were presented, in December 2022, the Minister of Agriculture however stated that his “priority is that the forest meets the carbon storage objectives set to achieve carbon neutrality by 2050. To do this, we must plant. [...] If we put constraints everywhere, [...] as] on clearcutting, we create the conditions for nothing to happen”¹.

In this rather tense context, the article focuses on a specific form of carbon-centred rationale aimed at maintaining carbon stocks in forest soils by promoting certain practices and discouraging others, primarily clearcutting. This rationale reconfigures the classic, purely landscape-related, critique of clearcutting (Barthod et al., 1999) and plays a part in the reconsideration of forestry standardisation and heavy-mechanisation trends. It is supported through the advocacy of environmental NGOs which, in France, condemn the apparent “industrialisation” of forestry, which leads to what they refer to as “bad forestation” (Nageleisen et al., 2020). This use of such a rationale thus appears original for two reasons. Firstly, it focuses on soils and not on trees or wood products, as previously explained. Secondly, it is used by national and local NGOs against the practices of economic operators, unlike many uses of carbon rationales in carbon forestry projects (which usually aim to reduce deforestation in tropical and equatorial settings: Corbera and Brown, 2010). These carbon rationales are used by external stakeholders who impact “local land management strategies [...] intimately linked with livelihoods and well-being in ways that are easily left unaccounted for in globally scaled assessments of carbon capture” (Krzywoszynska and Marchesi, 2020).

The objective of the article is to explore the recategorisations and realignments brought about within the forestry sector as a result of the rapidly increasing awareness of this rationale in the public debate in France. In parallel, foresters justify their practices with competing carbon-related arguments. I consider how this original use of a carbon-centred rationale plays a role in attracting stakeholders considered as alternative into a process of reassessment and requalification of activities and redistribution of resources and capital that may also lead to more productivist strategies. In terms of

¹ My own translation from <https://www.forestopic.com/fr/foret/les-acteurs/1510-foret-bois-priorite-stockage-carbone-marc-fesneau-ministre-agriculture>, retrieved February 28, 2023.

forest management, this would particularly imply that the entire forest-timber-paper sector would be understood from a carbon sink perspective.

My argumentation is based on a case study of the Morvan, a French region where controversies surrounding clearcutting are among the fiercest in the country (GIP Ecofor and RMT Aforce, 2022), leading all stakeholders to take a stance on the issue. This makes the region a very suitable field to explore the social construction, uses, and impacts on practices and forests of the rationale studied. How and by whom is the global objective of maintaining carbon stocks in forest soils locally understood and implemented or contested, and what consequences are there on the evolution of forest composition?

After focusing on the area to be studied, and materials and methods, the remainder of the paper will examine discourses and knowledge, practices and agendas, and finally spaces. It first analyses by which means and by whom the carbon-centred rationale studied is translated to the Morvan context and contested. It then questions what role the rationale plays in the evolution of forestry practices, as the basis of decarbonisation agendas or fostering merely strategic uses of carbon arguments. Lastly, it shows that forestry models referring to competing carbon-centred rationales simultaneously reconfigure the forests of the Morvan through differing forms of revival of production in the name of carbon.

2. Study area, materials, and methods

This article focuses on the Morvan, a forest massif and mountainous region (reaching an elevation of 901 m) located at the northern end of the *Massif Central* highlands. It is sparsely populated (21 inhabitants/km²) and comprises the most rural extremities of the four *départements* of the ex-administrative region of Burgundy (Nièvre, Saône-et-Loire, Côte-d'Or, and Yonne). Historically, the Morvan was an area of emigration and underwent a mass rural exodus and agricultural decline during the 20th century (Cossart, 2021). As a result, it became highly forested, particularly by the resinous plantations developed under the incentive of the French National Forest Fund (a public-sector scheme to fund forest plantations) up until the end of the last century.

Nowadays, although it is not the area with the most active forestry in France (Levers et al., 2014), the Morvan plays a role in the media as a hotspot of opposition between contrasting forestry models, with a particular focus on clearcutting and Douglas fir plantations (Marage, 2020). In recent years, the number and surface area of clearcutting operations have increased significantly, fuelling the polarisation of local debates. This sharp increase in clearcutting is due to a convergence of three factors: resinous plantations from the post-war era reaching structural maturity; a bark beetle invasion affecting spruce plantations since 2018; and lastly, the continued clearcutting of deciduous coppices, often grown on former agricultural wasteland.

The argumentation builds on three sets of data. First, I collected grey literature primarily produced between 2019 and 2022: national and local press reviews, planning documents, and other leaflets produced by the *Parc naturel régional du Morvan*² (PNRM) that document the local context; position statements contributing to the local debate on forestry; and the funding application files of seven *Label bas carbone*³ projects. I then carried out fieldwork from autumn 2021 to autumn 2022, with five stays in the Morvan. During these stays, I conducted 42 semi-structured interviews, with government

² (Regional Nature Park of the Morvan): A chartered local authority with rural development goals, created in 1970 and covering an area of 3,290 km². It brings together rural municipalities and the departmental and regional councils to which they belong.

³ (Low-carbon certification): An incentive policy from the Ministry for Environment. It authenticates carbon credits linked to forest plantation or improvement.

departments and agencies (7)⁴; local authorities (13)⁵; civil society groups (10)⁶ and employees in the forestry sector (12)⁷. In addition, I collected notes from three participative sessions: one accompanying a forestry company head to his meetings with forest owners, timbers, and skidder operators over a half-day; the second, a trade fair dedicated to the cultivation of Christmas trees; and the third, a session of the forest-wood working group of the PNRM, during which I presented a cartographic analysis of clearcutting.

To analyse these data, I first fully transcribed the interviews and structured their content under headings (between 10 and 20 per transcription). I then collected relevant quotes from the transcriptions, the documents, and my notes from the participative sessions. I put them together in a spreadsheet with 14 entries (corresponding to the questions of the interview grid and the main points of the article's structure, which were identified throughout the transcriptions), which filled 65 cells. The analyses build on the comparison of these ordered data, section by section.

3. New discourses and knowledge on the role of clearcutting in forestry decarbonisation widen already polarised debates on forest management

This first section of results focuses on how the global issue of maintaining carbon in forest soils is understood in the Morvan and adapted to the local context by a series of stakeholders in their discourses. To understand how non-expert rural people come to refer to a “carbon ontology of soils, in which soils are primarily understood through their capacity to hold on to atmospheric carbon” (Krzywoszynska and Marchesi, 2020) in their struggle against clearcutting, I reformulated the way knowledge on clearcutting's impacts on soils circulates – from national level to the remote hamlets of the Morvan. As there is currently no widely accepted scientific consensus, each stakeholder builds on what they have learned over the years in formal or informal contexts, but also, directly or indirectly, on

⁴ Three forest rangers and the head of the local unit of the *Office national des forêts* (National Forest Office – ONF): a government agency managing all national and municipal forests in France, accounting for 25 percent of all forest surface area); officials from the decentralised Department for Environment, Planning and Housing in Burgundy, including the former forest policy officer; and the head of the section in charge of forestry at the decentralised Department for Agriculture, Food and Forest in Burgundy.

⁵ A PNRM employee, its President and a member of its board; four communal councillors in charge of forestry issues in their respective municipalities; two rural mayors experimenting with democratic or alternative management of their respective municipal forests; the mayor of a village involved in building new forest roads; the president of a departmental council and some of its employees; and a member of the board of the *Bibracte Grand Site de France* (Major Site of France: a label for France's best-managed, classified natural sites that are very well known and receive large numbers of visitors).

⁶ Interviewees from eight local environmental NGOs: founders of Autun Morvan Ecologie (AME, created in 1989 in the city of Autun, covering the south of the Morvan, recognised as an institutional player) and Adret Morvan (created in 2012 to campaign against a planned industrial sawmill, covering the north of the Morvan, more activist-oriented), which are both bridging local oppositions with national advocacies; two managers, a forest advisor, and a member of the scientific committee of two so-called “citizen-led and ecological” forestry groups (the Morvan Deciduous-Trees Safeguarding Group, which is linked to AME, and the Wild Cat Group, linked to Adret Morvan); members of local groups campaigning against specific forestry projects: Amis de notre forêt au duc, Collectif Lavault-de-Frétoy, Sauvegarde du massif d'Uchon and la Bresseille.

⁷ An employee and an elected representative of owners from the *Centre régional de la propriété forestière* (Regional Centre of Forest Ownership – CRPF): an equivalent to the Chamber of Agriculture for the forestry sector, with a council of elected representatives of forest owners and a team of technical advisors – it also validates forest management plans; the heads of two local forestry companies who also own large tracts of forest (one of them being also involved in sawing activities); the local heads of a national forest management company and of a tree planting company; employees of two forest cooperatives; a large landowner managing his forest on his own, the SAFER (Land Use and Rural Settlement Corporation: a semi-public body which controls rural land ownership through a preemptive right on farmland. It also intervenes on forest land transactions, but in a mediation role); a forestry advisor for the Morvan; an employee in charge of the relations with local authorities; and the CEO of a start-up carrying out *Label bas carbone* projects.

the growing amount of literature review reports and papers (e.g., Mayer et al., 2020) published since 2020 on the topic.

I identified three coexisting multiscale and cross-sectoral knowledge-circulation channels highlighting, respectively, soil carbon, aerial biomass carbon, and a lack of knowledge on carbon. Each is structured around relatively like-minded networks of stakeholders (respectively, environmentalists, scientists and forest rangers; forestry operators; public-sector stakeholders), whose entrenched positions limit the discussion with the networks of other channels. Three kinds of stakeholders coalesce in such channels: those used to synthesise or produce knowledge, who review literature or carry out experiments; those used to disseminate information; and those who adopt the general opinion of their peers.

3.1. Rapidly growing opposition to clearcutting is reconfigured by networks of local and national NGOs, former scientists and forest rangers highlighting soil carbon

Opposition to clearcutting has a decades-long history in the Morvan. It was initially (1970s) integrated into a landscape-centred critique of forestry by local NGOs opposed to the introduction of resinous species through the clearcutting of deciduous plots and replantation. The NGO AME was the first to document the trend, to fight against large-scale clearcutting, and to try to influence regional forestry regulations by joining various committees.

New stakeholders, such as the NGO Adret Morvan, have emerged in the last decade, during a period marked by increased climate change awareness, and are putting forward narratives closely linked to climate change mitigation. Some of them also want to respond to the legitimisation of forestry intensification with climate-centred arguments. Consequently, they promote old-growth forests as a solution to store as much carbon as possible, as highlighted by a manager of a citizen-led forestry group: “silviculture methods make the difference: when you clearcut, when you stir up the soil as [the largest forestry operators] do with their machines, all the carbon in the soil is oxidised, so you release it all” (interview, September 2021). In the face of this renewed context, old stakeholders tend to adopt these new narratives and, at the beginning of our interview, the founder of the NGO AME, a retired secretary, exclaimed: “Clearcutting, it’s a massive greenhouse gas emitter!” (interview, June 2022).

Local environmental NGOs pay particular attention to deep soil and root carbon in line with allies from other sectors (science, forestry public service, journalism) and scales (national), evoking Eden et al. (2006)’s conclusions, which gives a reticular form to this first knowledge circulation channel. Three cooperations can be underlined in this sense.

A first cross-sectoral cooperation is the participation of F. Ponge, a retired professor in ecology, from the French National Museum of Natural History, on the scientific board of a citizen-led forestry group, bringing to mind Frickel’s remarks (2004) on scientist activism. In May 2019, he wrote a popular science text for the French Society for Ecology and Evolution, presenting the Morvan as a case study for the future of French forests (Ponge, 2019). Building on this and other contributions, in 2020, the NGO AME, acting as a knowledge broker, published a leaflet entitled *When the Morvan is covered with Douglas fir plantations, will there still be time to talk about the contribution of forests to global warming?* (Haese et al., 2020). As the professor recalls, “the founder of AME wanted to respond [... to the idea that] shortening stand life and rotation length [...] would fix more carbon. She said to me, ‘What do you think about that idea?’ I looked around a bit and I came across a study that had been published in *Nature* (Stephenson et al., 2014) [...] that showed, using [...] replicates at different locations, [...] that, in fact, when the tree was old, well that’s when it stored the most carbon because all the previous calculations didn’t consider the root mass. [...] When I sent her this article, she said, ‘We have to make a brochure’” (interview, May 2022).

A second multiscale cooperation is between the local NGO Adret Morvan and the new national environmental NGO Canopée (Canopy), which has been involved since 2018 in campaigns aimed at countering both imported deforestation from tropical forests and clearcutting in French forests, with a particular emphasis on the Morvan during the advocacy work. As early as 2019, S. Angerand, the coordinator of Canopée, a forest engineer, was underlining arguments regarding CO₂ emissions related to clearcutting. In 2020, as part of a partnership between two French NGOs and an EU-wide NGO focusing on forests (FERN), he collaborated with an independent forest advisor with a PhD in forest

science and links to French alternative forestry organisations. They co-authored a literature review report on the climatic impacts of forest management (Angerand and du Bus de Warnaffe, 2020). The founder of the NGO Adret Morvan draws on this report to build his argumentation for advocacy (illustrating the moral entrepreneurship role of Canopée), as he says: “international studies have been carried out on the subject. And they explain that it’s buffered, [...] most of the time, there is more carbon in the soil, in a well-balanced forest, than in the trees” (interview, September 2021).

In both cases, the location of the debate on the relatively recent topic of soil carbon provides three main advantages for the advocacy of NGOs. Firstly, although most stakeholders are not very familiar with it, carbon storage is a legitimate issue that offers a window of opportunity to frame the debate through literature reports and to shape public opinion with campaigns. Secondly, focusing on this specific component of the forest-timber sector is a way to focus the discussion on carbon storage in forests and on forestry practices (including clearcutting), without taking into consideration the wood products. Thirdly, the novelty of carbon-centred arguments helps to get around the countering by the forestry sector of former more biodiversity-centred arguments. Nevertheless, weakness of this strategy is that soil carbon is not only physically but also often socially invisible: for many stakeholders, it is not an everyday matter of concern, or it appears to be inherent to forestry, making it merely a supplementary argument in many local disputes.

Thirdly, in the late 2010s, the leftist majority union of the ONF forest rangers, SNUPFEN, coalesced with local environmental NGOs, forming the *SOS Forêts Bourgogne* alliance, and enabling scientific and empirical knowledge to percolate. Activists interviewed reported how their participation to this coalition helped them to upgrade their understanding of forestry.

Lastly, as in other channels, some activists did not read the science popularisation leaflets and reports, or did not discuss the issue with forest rangers, but are aware of the carbon-centred rationale put forward by their peers, calling to mind Eden et al.’s (2016) remarks on the pragmatism of knowledge dissemination by environmental NGOs. They thus also refer to more common-sense arguments when developing their advocacy: one me that “nobody disputes that ploughing a permanent grassland releases carbon. I don’t see why it would be any different in a forest” (interview, September 2021).

3.2. Following their professional organisations, most forestry operators highlight aerial biomass carbon

Local stakeholders in the forestry sector, including forest cooperatives and tree nursery, planting, logging, and sawmill companies, call into doubt the importance given to soil carbon and focus on aerial biomass carbon. They advocate for carbon storage based on energy substitution and wood products, by connecting with bodies in the research sector other than the first network’s organisations.

For them, carbon storage and mitigation issues are less salient than adaptation issues: they feel more concerned by the rise of drought and woodfire risks and fear that storing carbon in old-growth forests could lead to massive carbon loss if trees die back or burn. In that clearcutting is for them a lever to store carbon outside soils, they tend to empirically discredit its impacts on soil carbon by appealing to observations of the fertility of different types of forest soils, in a conflation of carbon and fertility dimensions. As the head of a local company says, “We give more weight, as far as carbon capture is concerned, to the production of wood than to the storage in the soil. [...] We don’t think that the limited clearcutting operations that can be undertaken remove that much carbon from the soil. With the recovery of the vegetation, which is so fast...” (interview, March 2022).

This knowledge circulation channel takes the more traditional form of the dissemination of research and development results to members of an economic sector. Indeed, a large Douglas fir plantation owner, who is also a forestry company head and a sawyer, claims that “maybe there are interesting things to learn [from environmental NGOs], but I don’t know which ones are not already being offered by *our* scientists” (interview, March 2022). The scientists he refers to with a possessive pronoun are engineers of the technological research centre of the forest, wood, paper, and furniture sectors (FCBA) and of the CRPF, who are structurally involved in applied research programmes (often with researchers of the French National Research Institute for Agriculture, Food and the Environment

(INRAE)). The knowledge at stake here is not popularised through literature review reports but transferred through good practice guides or other less formal means.

However, it should be noted that forest advisors working on their own or for national forest management companies keep their knowledge up-to-date through other means (continued training sessions organised by their professional association, and in situ experiments on forest plots they manage, in partnership with an association promoting uneven-aged high-stand) and focus more on soils in their rationale.

One of the key arguments on carbon of the stakeholders of this network is that of a lack of scientific evidence, as when the head of a national forest plantation fund states that “there are many reports coming out, which look here and there for studies... that allow them to argue the idea they had at the beginning! [...] There is still a lot to learn and confirm about soil carbon. The studies available focus on intertropical forests. But for our climates, it remains to be seen and therefore the criticisms of clearcutting are not entirely accurate” (interview, June 2022). This is a classic “merchant of doubt” strategy in this kind of environmental struggle. The national expertise report of GIP Ecofor and RMT Aforce (2022) reviewed dozens of studies on cases from temperate and boreal climate zones and, back in 2018, the Forest-Wood Regional Pact in Burgundy referred to four scientific works on the same climate zones dating back to the beginning of the century (in particular, see Nave et al., 2010) to highlight that clearcutting implied carbon release (p. 194-198).

As in other channels, some interviewees put forward only common sense arguments which are presented as assumptions: “I have the *impression* that the quantity of carbon stored in the soil is a fraction of that of the wood on the plot” (interview, January 2022, CRPF employee), and, “Under two hectares, I *believe* that clearcutting doesn't have a big impact on the soil” (interview, June 2022, elected representative of owners at the CRPF).

3.3. Local public stakeholders cite the scientific committee of the PNRM, while the PNRM does not manage to play an interface role

In this context, the PNRM could arbitrate the debates, especially since it created a scientific committee bringing together scholars with field expertise in the Morvan. In 2018, the President of the PNRM asked the committee to work on the impacts of clearcutting on the environment, to legitimise his political agenda of strengthening local clearcutting regulation. Two members were assigned specific missions: an emeritus researcher at INRAE (collaborating with an experimental forest station in the Morvan) and an employee of the *Institut national de l'information géographique et forestière*⁸ (IGN). They carried out a literature review (Ranger et al., 2021) focusing on biological, physical, and chemical impacts (e.g., nutrient leaching and other forms of erosion, such as those shown in Fig. 1), without taking into account carbon storage, because of what they considered to be a lack of robust results in a still-emerging subject area. Research on carbon flows in forest soils is currently being conducted in the Bibracte *Grand Site de France* to fulfil this need for in situ knowledge. Eventually, the scientific committee concluded that clearcutting should be limited to old stands of less than 1.5 hectares, on gentle slopes and outside environmentally sensitive areas, with cable logging, no slash export, and no swathing.

This report is a valuable source of information, particularly for the decentralised government Departments and local authorities. The President of the PNRM justifies his agenda on clearcutting with carbon-centred arguments explicitly taken from an expertise report on climate change mitigation in the forestry sector, released by INRAE and IGN two years earlier (Roux et al., 2020): “the problem with global warming is that it is a race against time: our CO₂ emissions count right now. [...] So if we look at 500 years from now, the industry will be right [saying forests should be cut and replanted with fast-growing tree species], but in the next 50 years they are wrong. [...] This is one more argument to say that we must [...] keep our capital as much as possible, especially the carbon capital in the soil” (interview, November 2022). He also cites the national expertise report on the impacts of clearcutting (GIP Ecofor and RMT Aforce, 2022) as a solid basis for argument, emphasising that “now we have a

⁸ (National Institute for Geographic and Forest Information): Originally a producer of the topographical maps of France, it has also been responsible for the National Forest Inventory since 2012.

solid scientific basis. [...] Because it is the GIP Ecofor that says it and not only the scientific committee of the PNRM” (interview, November 2022).

As such, the PNRM is considered by many operators of the forestry sector as too close to the NGOs’ opinion to be able to play an interface role, even if it coordinates a network of local stakeholders relating to forestry issues under the banner of a Territorial Forest Charter. An elected representative of forest owners at the CRPF stated that “anything that comes from the PNRM is usually very unpopular with foresters. I’m not sure if everyone has read the report of the scientific committee ” (interview, June 2022). On the other hand, NGOs are aware of the existence of the report, but their activists have not necessarily read it, with one of them commenting, “the Park's scientist, a soil specialist, says that Canopée is talking rubbish, but I don't know why” (interview, September 2021).

This shows the extent to which the three circulation channels do not hybridise but develop within separate networks of stakeholders. Foresters consider clearcutting more from the pragmatic perspective of its (health or economical) reasons and locate its carbon impacts at the sector scale because of their wood products activities, while opponents tend to focus on the (landscape and environmental) consequences and the carbon impacts at the forest scale because of their focus on clearcutting. The current lack of communication is recognised by local stakeholders, who regret how strongly the positions of organisations are entrenched, even if inter-individual conversation is said to still be possible. For instance, during the session of the forest-wood working group of the PNRM I attended, a vice-president of the PNRM urged that the forestry companies undertaking the most questionable clearcuttings be “named and shamed”, which led the director of CRPF to say she was shocked by such impudent intentions. Effectively, the first area of work of the Territorial Forest Charter focuses on establishing a “constructive and peaceful local dialogue”.

More broadly, this situation can be explained in part because the Morvan has been repeatedly presented in the national media over the last five years as a hotspot of clearcutting, with many programmes supporting the advocacy of NGOs and covering their spectacular non-violent actions while giving less voice to other stakeholders. In this regard, an elected representative of owners at the CRPF highlights that “bark beetle clearcutting is not desirable; it’s a disaster. But NGOs use it as an argument against forestry in general” (interview, June 2022). During separate interviews, two members of the forestry sector even came to express doubts on supposedly hidden goals of the environmentalist sector, showing how mistrustful the relations are: “I’m not going to join the conspiracy movement, but some NGOs... we don't really know where their funding comes from. [French forests] have very significant competitive advantages, and this does not necessarily please everyone” (interview, March 2022).

4. In practice, the loss of legitimacy of clearcutting is only partially linked to decarbonisation agendas

This second section of results focuses on the evolution of practices (particularly clearcutting) of the main forestry operators working in the Morvan, by exploring their decarbonisation agendas (citizen-led forestry groups, public-sector stakeholders) and the merely strategic uses of carbon rationales in their wider forestry agendas (other forestry operators). While they tend to analyse their practices through the prism of a continuous transition, each of these stakeholders promotes specific types of forest and forestry models, which coexist. Six of these models repeatedly appear in the interviews, reminding some of the five typical forest management approaches along an intensity gradient defined by Duncker et al. (2012) (Fig. 2): regeneration or implantation of resinous (almost) monoculture, by clearcutting; natural regeneration of resinous monoculture, which can lead to tree species diversification; ProSilva close-to-nature forestry of deciduous plots; deciduous forest for firewood; non-management of deciduous plots (on former agricultural wasteland or short-rotation coppice), which is particularly common due to the significant land fragmentation; and spontaneous forest evolution (differing from non-management by its voluntary nature, sometimes close to rewilding initiatives), which is still in its beginning. Only some are at the heart of decarbonisation agendas.

4.1. Two citizen-led forestry groups promote a committed decarbonisation agenda

In 2003 and 2015, local environmental activists linked to the NGOs AME and Adret Morvan, respectively, created two forestry groups that they consider to be citizen-led and ecological. Their aim is to purchase deciduous forest plots to protect them from clearcutting and from being planted with resinous trees. Between them, they own 450 hectares, or 0.3 percent of the forested area of the Morvan, which is divided into nearly 30 different locations. Their management guidelines follow ProSilva close-to-nature forestry, the goal of which is to cultivate an irregular mixed forest with continuous cover to balance economic revenues and environmental conservation. Implementing these guidelines, including cable logging, is sometimes rather difficult in a region where not all forestry companies are familiar with these alternative methods.

These forestry groups present the most significant decarbonisation agendas, highlighting that they “have this great awareness of the amount of carbon that is present in the soil, and everything is done, effectively, not to release it” (interview, September 2021). The presentation leaflet of one of the groups compares clearcutting to a “traumatism” and the manager of the other group says that her “leitmotiv is that, once the forestry work has been carried out [...], within three years, there should be no trace of human passage. So, the logging paths are thought out for each cutting campaign” (interview, September 2022).

However, both groups have their own version of this committed decarbonisation agenda. Both focus on maintaining the most carbon in soils, but they differ slightly on where to place the cursor in the continuum between storage only in old-growth forests and only in wood products. The oldest group (the Morvan Deciduous Trees Safeguarding Group) has a more managerial approach and follows, quite strictly, the recommendations of the ProSilva-certified forest advisor it works with. It is linked to the NGO AME, had to legitimise itself over two decades and manages a large surface area (350 hectares).

The most recent group (the Wild Cat Group) is a little more activist-oriented, somewhere between close-to-nature forestry and spontaneous forest development. Its leader states that “wood is one of the services provided by the forest: there is no reason to manage forests only in terms of wood production” (interview, September 2022). The leader of the NGO Adret Morvan, linked to this group, even states that “the optimal carbon storage in a forest is between 400 and 700 years. This means that if we wanted to capture carbon at large scale, the only thing we would have to do would be to stop exploiting forests” (interview, September 2021).

4.2. Voluntary public-sector stakeholders lack means and look to upscale

The ONF’s employees are also aware of decarbonisation issues, which are integrated into some instructions given by their national headquarters, such as the “mosaic forest” model that includes patches of old-growth forests. However, they point out the discrepancy between goals and means, in that the ONF is required by the government to reduce its expenditure. The head of the local unit recalls: “What happens is that the government, the nation, issues strong instructions, but what does it pay us for carbon? Nothing!” (interview, September 2021). The vast majority of the ONF’s income in fact comes from the sale of wood, particularly in the framework of supply contracts with sawmills. Thus, one of the national forests in the Morvan, the *forêt au duc*, has been partly clearcut over the past decade to plant resinous species of interest to the downstream industry.

Other stakeholders in the public sector highlight that, to decarbonise forestry, payment schemes could be introduced to reward the carbon storage services provided by rural territories such as the Morvan: the president of a departmental council states “when we absorb carbon, we cover the contributions that other areas should make; today this is not valued” (interview, November 2021). Nevertheless, the only payment scheme created (in 2018) by the government, the *Label bas carbone* (see Section 5.3), does not subsidise carbon storage but defines a framework for private stakeholders to agree on voluntary compensation.

The ONF manages national forests, and also those of municipalities, and each village or town council should provide its own instructions to the local ranger. Only in one of the villages did the mayor

pursue a decarbonisation agenda, highlighting, however, that rural villages need knowledge and frames of reference to implement such policies – documentation he could not find in the advice booklets of the forestry institutions (such as the CRPF).

As for the CRPF, it is limited in its effort to decarbonise forestry by three obstacles. Firstly, the regional regulation must follow national frameworks, which have been moving towards forest exploitation since the 2008 “harvesting turn” (Sergent, 2014) in French forest policy. For instance, the criteria for refusing a clearcutting authorisation request, or a forest management plan that includes clearcutting, are limited to the highest slope inclinations, regardless of other considerations. Secondly, the CRPF approves private estate forest management plans for 10 to 20 years, which means that current clearcutting has been authorised from the beginning of the century onwards, and that owners willing to execute plans cannot be blamed for doing so. Thirdly, even though CRPF employees popularise practices that are alternatives to clearcutting, the diversity of owner involvement in their forests limits the dissemination of guidelines to a small group. An elected representative of owners explains that “we are trying to identify the at-risk management plans to get them to evolve, especially regarding large-scale clearcutting. But it is more difficult with owners of former agricultural wastelands, who are often not in the CRPF, than with the heirs of former landowning families, who are attached to their deciduous forests” (interview, June 2022).

4.3. Forestry operators progressively adopt greened forms of clearcutting or abandon it, but with merely strategic uses of carbon rationales

The largest forestry operators active in the Morvan are two cooperatives, four local independent companies, and two sawmills. In the face of the environmental critique targeting the CO₂ emissions of clearcutting, they do not try to implement genuine decarbonisation agendas but merely justify some developments (such as “eco-reafforestation” or the natural regeneration of Douglas fir) with carbon arguments, alongside other more biodiversity-oriented reasons.

4.3.1. The undeniable impacts of clearcutting are designed to be limited by new practices

Clearcutting is presented as an integral part of cultivated forests, to whom foresters should be accountable, in that they created them. Consequently, it is still a part of the landscape in the Morvan: the plots can most often be recognised by the parallel windrows of slash and, when the replanting has already taken place, by seedlings aligned in the interrows, and equipped with stakes and anti-herbivore meshes (Fig. 3). Despite this, forestry operators cannot easily deny the critiques of environmentalists. A forest advisor of a cooperative states, “the entire life of the soil was nevertheless shaken by the clearcutting which preceded the reforestation...” (interview, June 2022). Those most attached to clearcutting engage in a discursive turn, stating that they limit, as much as they can, the impact of a necessary practice.

This line of argumentation tends to highlight the errors of past practices and the improvements achieved since then. A forestry advisor from a cooperative explains that “at one time [...] we would rip out the branches, burn them, then arrange them. Today, we try to avoid as far as possible arriving at bare ground, especially on slopes. [...] It has been ten years since I stumped up a plot, for example. [...] We try to keep all the root system in place and just get to the level. I'm still doing [windrows ... But] we're careful about the spacing of the tines so that there's a minimum of soil in there and only wood, for example” (interview, June 2022).

Another way to make clearcutting more acceptable is not related to carbon storage but is to increase the biodiversity of the plantation that follows, which is a more visible argument. Moreover, some forms of incomplete clearcutting have appeared, as shown in Fig. 4: trees of minor species, or rows of trees, can be left on the plot to limit the impacts.

4.3.2. CFBL's “eco-reafforestation”: a tentative form of environmental-friendlier clearcutting

Some clearcutting operations of the *Coopérative forestière Bourgogne Limousin* (CFBL)⁹ do not follow this pattern, as shown on Fig. 4. In line with what are considered permaculture principles, slashes are plotted out on the ground, which is entirely covered, and seedlings are planted in individual holes, which reduces the surface area of ploughed soil. Deciduous trees are spared during the cut. Eco-reafforestation is designed to work as a mulch: “it maintains homogeneity [of organic matter] in the plantation. [...] It has a protective role against weeds and soil erosion. [...] It also allows lighter machines [5 tonnes rather than 30] to pass through, so it respects the soil” (interview, June 2022).

As later recognised by the advisor, “it is not, in fact, against clearcutting. That's another debate” (interview, June 2022). The construction of an environmental-friendly reputation, financial opportunism and forestry pragmatism jointly explain this innovation. On one hand, the not quite justified comparison with permaculture, the use of an “eco” prefix and the in-situ promotion of the practice through panels (Fig. 4) indicate that eco-reafforestation was probably developed to counter critiques by re-legitimising the existing norm of clearcutting from an environmental, and more specifically pedological, perspective. This kind of greened clearcutting also allowed the cooperative to gain access to “an attractive budget for our members from the French post-Covid economic recovery plan, which was a springboard for this technique” (interview, June 2022), explains a forest advisor. On the other hand, forest advisors of the CFBL also use results-oriented arguments on the competitive advantage of the practice: it improves the growth efficiency of tree seedlings, which reaches 80 percent (compared to 60 percent), due to fertility management reasons, but also to the more limited access of game to seedlings.

The practice nevertheless does not exist outside the CFBL, for practical reasons, as the maintenance of such plantations must be carried out by manual workers and not by motorised machines.

4.3.3. Beyond clearcutting, natural regeneration as a new horizon for Douglas fir forestry

Finally, only two independent forestry companies and, to a lesser extent, one cooperative, have moved away from clearcutting and now tend toward prioritising natural regeneration. They highlight the positive consequences of the new best practices they have implemented: the technical evolution of forestry machinery (more axletrees, wider tyres, and more extended swivel arms) helps to reduce soil compaction, which is spatially condensed by the systematic use of the same logging paths (Fig. 5) from one harvesting campaign to another.

For these forestry operators, clearcutting still exists, but is limited to failed natural regeneration, localised forest dieback and resinous implantation on coppices or wasteland that welcomes new plantations. As the head of a forestry company stated, “now, the massif is mature for natural regeneration” (interview, March 2022), implying that clearcutting was initially necessary to set up Douglas fir plantations instead of the oak and beech forests that once covered the Morvan. Consequently, although some forest advisors are aware of the positive consequences of natural regeneration on the soil carbon stock and are able to justify the evolution of practices from a carbon perspective (“when we can, we will try to limit clearcutting and start with irregular stands, precisely so as not to have this bare land, with the associated release of carbon”, interview, June 2022), this moving away from clearcutting does not rely primarily on an explicit decarbonisation agenda.

The progressive loss of legitimacy of clearcutting is, above all, to be understood from a technical point of view. Firstly, the idea of implementing natural regeneration was not the result of a voluntary experiment to decarbonise forestry, but an observation after the 1999 storm. Secondly, from a results-oriented perspective, clearcutting is criticised for annihilating soils’ biodiversity which can be crucial to tree growth: “there is always a lot of symbiont fungi in the soil. Either they are alive because they are associated with adult trees and will benefit young plants, or you have extracted all your trees and [...] they died and when you install new plants, they do not benefit from it” (interview, October 2022). Thirdly, natural regeneration is presented as a better strategy to adapt to climate change than clearcutting: preserving higher trees in a plot helps to protect seedlings from the drier spring wind, the warmer summer evening sunshine, and the heavier winter snow.

⁹ (Burgundy Limousin Forest Cooperative): One of the six major forest cooperatives, active in the centre and centre-east of France.

5. Parallel spatial reconfigurations of forests are fuelled by opposed carbon rationales and agendas

This third section of results focuses on the spatial dimension of the various decarbonisation agendas and strategic uses of carbon-centred rationales in the Morvan. I question how both can lead to a revival of production in the less productive areas of forest.

5.1. Two opposed forestry models justify the intensified management of non-managed forests in the name of carbon

The main land-use change dynamics inside the forestry sector reported by the interviewees are the spatial expansion of clearcutting-replantation and close-to-nature forestry (ProSilva) models, in particular at the expense of the non-managed plots, and the parallel expansion of natural regeneration from already existing monocultures (Fig. 2). Both types of conversion from non-management to soft or intense exploitation are made in the name of carbon, even if the practices differ, in a sense reminiscent of the “schizophrenic forests” studied by Robbins and Fraser (2003) in Scotland.

5.1.1. The energisation of non-managed forests through small-scale clearcutting is presented as a way to secure carbon stocks

Non-managed deciduous forests are framed by forestry operators as underused resources with distant owners unable to increase their value, which, in a sense, echoes the framing of collective farmlands as nobody’s lands (Li, 2014). One of them comments that “the deciduous forests in the Morvan are currently either unknown to their owners, who have inherited them without knowing where they are or what they are, or used for firewood, generally by older people” (interview, March 2022). Another adds that “better a coppice that is energised by a plantation than one that is dying out due to climate change and not harvested. In terms of landscape, it can be worse. And in terms of carbon footprint, it is not very clear” (interview, June 2022).

While large-scale clearcutting is most often condemned, even by some forest operators, small-scale clearcutting is still presented as necessary to begin the exploitation of former coppices or wastelands. A forest owner indicates that, “after all, there are plots on which we have no choice. We bought old wastelands [...] with hazelnut trees, ferns, and things like that. We had to clear the brush, clean it up, clear the land, and then replant. But where there were trees, we left them” (interview, June 2022). The forestry sector is, in fact, still developing in the Morvan; a forest advisor for a cooperative underlines that “for us, the recovery plan is a development booster. We have equipped ourselves with a mini excavator: now we have one per agency whereas before, we had to resort to service providers” (interview, June 2022).

5.1.2. Close-to-nature forestry as a mode of legitimising citizen-led forestry groups

Non-managed forests are not only targeted by operators willing to implant new resinous plantations; explicit decarbonisation agendas can also lead to a renewed attraction for production. The committed agendas of both citizen-led forestry groups indeed rely on ProSilva close-to-nature forestry, which is certainly softer on soils than clearcutting, but more active than non-management. In that the plots they purchase have usually not been exploited for decades, their decarbonisation agendas translate into a stimulation of wood production. The manager of one of them highlights that “the difficulty that our forest advisor often has is to find the right dosage of light input. And at the very first hammering, the first cut that he makes in a forest that has not been touched for 80 years, I get the impression that it’s always difficult for him to see with what intensity we’re going to make these holes in the canopy” (interview, September 2021).

This is due to a quest for legitimacy inside the forestry sector, as reported by the same manager: “from the beginning, we wanted to put ourselves on an equal footing with the industry, which criticised us for not knowing anything about it [...] It was important to be able to show that there was a forestry alternative that was economically profitable” (interview, September 2021). This is not the only way environmental NGOs fight for forests in France: outside the Morvan, other groups choose to buy forests to let them spontaneously develop, in a more rewilding-oriented vision¹⁰.

Finally, for some operators of the forestry sector, both citizen-led forestry groups of the Morvan do not threaten the legitimacy of clearcutting but will lead more people to accept it. The head of a national plantation fund, however, considers that “if these plots [of coppices and wastelands] are gradually acquired and managed by people living on the territory, even if their initial intention is in reaction to clearcutting that they do not understand well, I think that they will certainly understand forestry better, since they are going to become owners, with economic problems” (interview, June 2022).

5.2. The *Label bas carbone* supports strategic uses of carbon arguments to expand the spatial stock of the forestry revival

When asked about climate change mitigation in the forestry sector, the employee of the CRPF in charge of the Morvan answered that, “regarding this issue, the tool we have is the *Label bas carbone*” (interview, January 2022). To date, seven *Label bas carbone* forest projects have been recognised by the Ministry of Environment in the Morvan (compared to 365 in the rest of France).

Beyond the spatial strategies of private stakeholders analysed in section 5.2, these seven projects in particular show how institutional support for climate change mitigation can lead to a revival of production in the name of carbon through the integration of (structurally or conjuncturally) peripheral zones into managed forest spaces. One of the projects consist of former agricultural wasteland afforestation (8.1 hectares) and six of dieback or uprooted-forest improvements. The last six projects are directed by a forest cooperative, a forest management company and independent forest advisors to help clients who were affected by bark beetle invasions in spruce pine plots (50.2 hectares) or by storms or droughts in Silver fir plots (5.8 hectares). Most of the plots are replanted with pure or mixed Douglas fir plantations. In these cases, the *Label bas carbone* is nothing more than a complementary financing source for owners willing to increase the management of their forests, as one owner explains: “we chose it also because it is a much easier funding method to mobilise than the economic recovery plan or others: there are fewer administrative steps” (interview, Novembre 2022). For all interviewees, the scheme is above all a regulatory framework formalising that forests are storing carbon and giving funders the opportunity to subsidise owners for replanting their forests.

While the name “low carbon” would lead one to believe that the *Label bas carbone* promotes environmentally ambitious projects, this is not necessarily the case in that the eligibility criteria are easier to meet than those of the economic recovery plan, for example. The way the forestry works are conducted (including the impact on soil carbon) does not influence the calculation of the volume of carbon sequestered by a project but appears only in the determination of environmental “co-benefits”, which are supposed to be used as indicators by funders. The forest advisor of a cooperative summarises as follows the strategic logic of this tool: “The low carbon certification is essentially selective on the history of the plot, not on the objective of the replantation. [...] Its goal is to fund carbon storage through reforestation, rather than to let the forest develop spontaneously” (interview, October 2022). As a funding tool for the continuation of forestry production through the reconstitution of damaged economic assets, the *Label bas carbone* is also a lever for renewed practices of production optimisation, such as mixing tree species (usually two or three) to reduce pest risk or introducing more southern tree species (such as the maritime pine) to anticipate climate evolution.

An independent forest advisor criticises such “cognitive dissonance”, underlining that many clearcut forest plots whose replantation is financed within the framework of the *Label bas carbone* would have been replanted in any event, as imposed by the Forestry Law: “it’s not additional carbon

¹⁰ Such as *Forêts préservées*, in the Pyrenees (<https://foretspreservees.com/>), or *Etats sauvages* in the Massif Central and in the Vosges (<https://www.etatssauvages.org/>).

[...] It's just the funding channel that changes" (interview, October 2022). Foresters implementing *Label bas carbone* projects are also conscious that this tool stimulates production and justifies itself from a carbon perspective without a solid scientific basis. This is illustrated by the bias of the carbon storage calculation, as pointed out by a forest advisor for a cooperative: "Quite honestly, firstly, we have data that is not at all current; we're using growth curves that date back to the 1990s. Secondly, the data should be specific to each silvicultural region and that is not the case at all" (interview, June 2022). In a report, WWF France also criticised the fact that "the reference scenarios [...] ignore the carbon debt of the clearcutting operations which preceded some of the plantations funded. [...] The urgency of sequestering carbon should not justify prioritising the old techniques of the National Forest Fund" (Ollivier and Vallauri, 2021).

On one hand, however, the funding provided by the scheme sustains productivity improvements for plots that are already dynamically managed, but with a risk of a shift towards non-management due to economic losses. On the other hand, when agricultural wastelands are to be reforested, as in the last project taking place in the Morvan, the logic of converting *de facto* natural non-managed spaces into managed forests appears similar to that observed within the citizen-led forestry groups. In fact, in a region where agriculture is declining, this 8.1-hectare wasteland afforestation project with Douglas fir and larch was contested by local dwellers; and when he learned that the project had been certified, the PNRM President exclaimed: "It's unbelievable! You see there how the mechanisms can be perverse. Because the general interest was to keep these spaces open for agricultural activity!" (interview, November 2022).

6. Conclusion

The Morvan is the subject of intense controversy in terms of forestry, and more particularly concerning clearcutting which for some years has been contested from a new carbon-centred rationale. This article questions how the global objective of maintaining carbon stocks in forest soils is locally translated (or contested) in the discourses, what role it plays (or not) in the evolution of forestry practices, and what consequences this has on forest spaces.

On the one hand, local environmental NGOs reconfigure their critique of clearcutting by highlighting an emerging topic. They do this owing to several cooperations which give them a role of local knowledge broker: with national and European NGOs acting as moral entrepreneurs who can synthesise scientific literature to build advocacy strategies; but also, with retired scientists and forest ranger unions. Beyond this, local environmental NGOs have created two forestry groups to buy forest plots and implement the forestry model they support (ProSilva), with the final aim of legitimising their vision for the future of forests through practice. Their explicit decarbonisation agendas nevertheless lead to the exploitation of formerly non-managed forests, resulting in an extension of productive spaces in the name of carbon.

On the other hand, local forestry operators minimise the importance of soil carbon by presenting their carbon balance at the sector scale and by engaging in a merchant of doubt strategy against the NGOs' advocacy. The role of carbon storage is peripheral in the current evolution of their practices towards greened clearcutting and other forestry models, such as natural regeneration of monocultures. However, some of them strategically use carbon arguments. This is in particular the case when they extend resinous monoculture on non-managed forests or wasteland, the very kind of spaces also targeted by the alternative forestry groups (but with ostensibly opposite goals).

Lastly, public stakeholders put forward differing visions. The PNRM agenda is to regulate clearcutting more tightly, and it bases its advocacy among other things on carbon arguments, which prevents this local authority from fully playing an interface role between forestry operators and environmental NGOs. Few municipalities wish to decarbonise their public forest. The ONF regrets not being able to be subsidised for carbon storage. Furthermore, the decentralised government Department for Environment applies the *Label bas carbone* scheme policy, which in fact stimulates strategic uses of carbon rationales, more than decarbonisation agendas.

These trends can be considered from the theoretical perspective of the “forest transition” proposed by Kull (2017) as interrelated “ecological, socio-economic, and political processes and relationships” and “forest ideologies, discourses, and stories” that participate in the transformation of the forest composition. Here, what is at stake regarding forest composition is the place given to each forestry model (such as clearcutting-replantation, non-management or ProSilva) and practice (such as clearcutting). Discourses on maintaining carbon in forest soils emerge against the backdrop of increasing awareness of climate change but remain somewhat subsidiary, facing the main issue for foresters of adaptation to renewed risks (often implying carbon release). Choosing where to store carbon depends on many factors and visions (flows vs. stocks, e.g.) and is currently better documented by a growing number of scientific syntheses, such as that of GIP Ecofor and RMT Aforce (2022). These discourses fuel renewed but also pre-existing stories on the future of the forests of the Morvan. At the same time, socio-economic processes are gradually changing practices while political processes, in this case with the *Label bas carbone*, encourage the extension of managed forest spaces, sometimes to the detriment of other land covers already storing large amounts of carbon.

Finally, the Morvan was chosen for this study because it is the subject of rather in-depth disputes intersecting the issues of clearcutting and carbon storage, as compared to the rest of France. However, the intense mediatisation of this region and the apparent originality of the case study should not hide the fact that multiscale (in terms of knowledge transmission) and more general (regarding, e.g., the *Label bas carbone*) drivers have been brought to light. It could be expected that such dynamics are also present in similar forest massifs which have undergone resinous afforestation, and which have an active environmentalist sector.

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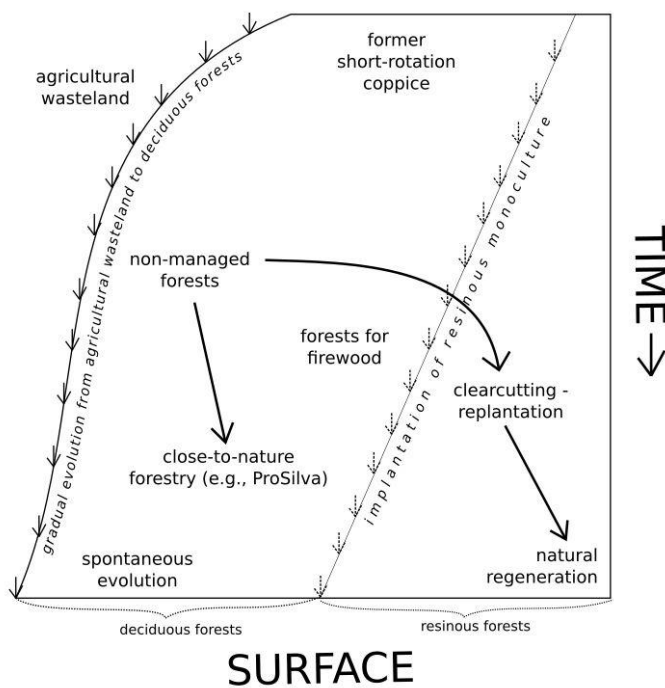
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Fig. 1 Traces of gully erosion at the bottom of a parcel clearcut some years ago (Commune of Dun-les-Places) © Author, September 2021



Fig. 2 Simplified spatio-temporal model of the diversification of forestry in the Morvan over the last decades © Author, 2023.



Notes to the reader:
 - Time and surface scales are not respected, but merely indicative of general trends.
 - Forestry models do not replace former models, but successively appear or diffuse, and finally coexist.
 - Bold arrows represent the main current land use change dynamics which are analyzed in the text.

Fig. 3 Replanted clearcut parcel (Commune of Planchez) © Author, June 2022



Fig. 4 Replanted clearcut parcel through the “eco-reforestation” method. The panel in the bottom left corner states “This is a CFBL Eco-reboisement® with the support of the post-Covid economic recovery plan” (Commune of Alligny-en-Morvan) © Author, March 2022



Fig. 5 Path recently used for forest works in a Douglas fir parcel (Commune of Sommant) © Author, March 2022

