Living with instead of tackling Grand Challenges: the forest planning routine in light of climate change

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Résumé :

Cette communication explore la manière dont les acteurs gèrent leurs routines face à l'imprévisibilité des rythmes. Cette question s'inscrit dans le contexte du changement climatique, où les rythmes écosystémiques précédemment considérés comme acquis ne sont plus valables et réinterrogent les routines qui y sont associées. Pour explorer cette question, nous mobilisons le concept de dynamique des routines que nous croisons avec la rythmanalyse de Lefebvre. Nous nous appuyons sur un cas singulier mais représentatif : la routine de renouvellement de planification forestière locale dans une forêt domaniale française, confrontée aux conséquences du changement climatique. Nous montrons que les forestiers font face à des situations d'arythmie, c'est-à-dire à des situations où les rythmes ne sont plus synchronisés et peuvent conduire à l'effondrement de la routine. Pour surmonter ces risques, les acteurs locaux redéfinissent leur routine d'une manière plus agile, non pas pour résoudre l'imprévisibilité des rythmes, mais pour la reconnaître et faire avec à l'arythmie.

Mots-clés : routines dynamiques, grand challenges, rythmanalyse, changement climatique, planification forestière

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Abstract:

This paper explores how do actors cope with their routines in the face of rhythms unpredictability. This question takes place within the context of climate change where previous taken-for-granted ecosystem rhythms are not anymore and interrogated the routines associated. To explore this question, we mobilize the concept of routine dynamics that we cross with the Lefebvre Rhythmanalysis. The we draw on a singular but representative case: the local forest planning renewing routine in a French state forest, facing current and future but still largely unknown consequences of climate change. We show that foresters are facing situation of arrhythmia, meaning situations where rhythms are not in sync and might lead the routine to collapse. To overcome those risks, the local actors are redesigning the routine in a more agile way, not to solve the rhythms' unpredictability, but acknowledging it and coping with arrhythmia.

Keywords: routines dynamics, grand challenges, rhythmanalysis, climate change, forest planning

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INTRODUCTION

As one of the greatest challenges we confront in the 21st century (Howard-Grenville et al., 2014; IPCC, 2022), climate change strikes our world in ways we have not experienced before, warning us that the current way of doing things is no longer a valid path (Howard-Grenville & Lahneman, 2021; Linnenluecke & Griffiths, 2010; Shove & Spurling, 2014; Steffen et al., 2015).

Over the past years, a distinct body of literature aimed at a better understanding of what grand challenges are (Brammer et al., 2019; Seelos et al., 2022) and how they may be tackled through a variety of strategies (Bowen et al., 2018; Ferraro et al., 2015; Kaufmann & Danner-Schröder, 2022; Mair et al., 2016), has emerged. While many studies consider grand challenges as complex macro entities, several scholars have started to explore how they are constituted and maintained through everyday actions (Dittrich, 2022; Sele et al., 2024). Defined as a repetitive, recognizable pattern of interdependent actions (Feldman & Pentland, 2003, p. 96), we understand that organizational routines played a significant role in sustaining grand challenges by the repetition of actions (Feldman & Pentland, 2022).

However, if routines are the "locus" where actions are sustained, then the same routines are also a place where actions and their outcomes can potentially be changed. This phenomenon has been highlighted by research elucidating the endogenous dynamics of routines (Feldman, 2000; Feldman & Pentland, 2003; Feldman et al, 2021a). Recent advances show how this dynamic is the result of a mutually constitutive circle of performing and patterning. Whereas the former consists of enacting of specific actions, by specific people, in specific circumstances (Feldman, 2016), the latter points to the (re)creation of patterns as guides for further performances (Danner-Schröder & Geiger, 2016; Feldman, 2016).

While those dynamics have been highlighted in several situations such as crisis and disruption contexts (Cohendet & Simon, 2016; Danner-Schröder & Geiger, 2016), it remains in delineated

temporal settings where a go back to stability is implied. However, grand challenges, in particular climate change, are not temporally delineated but enduring and prolonged phenomena. Accordingly, it raises the issue of how to organize in the face of such uncertainty. In this regard, Geiger et al. (2020) showed how firefighters rely and anticipate on each other specifically to gain "temporal autonomy" against the interventions, especially fires. Moreover, the authors highlight the importance of rhythms to "protect" their routine performances from disturbances and temporal uncertainty. Yet, the interventions considered in their study, e.g. fires apartment buildings, are still somehow delineated. Wildfires however, such as the Australian "Black Summer" in 2019/2020 raise a different perspective regarding the magnitude of the event and the way to manage it (Danner-Schröder & Sele, 2023). In this case, the situation goes way beyond what the firefighters have been trained for, confronting them with the unknown. Firefighters had to fundamentally change their action patterns (Ibid.).

Building up on this focus, we are interested in how do organizations change their routines to cope with prolonged uncertainty?

To explore this question, we mobilize Lefebvre's (2004) rhythmanalyis as a theoretical and analytical lens. Empirically, we study the forest planning renewing routine in France and focus on how a local agency deals with renewing a forest management plan while facing current and future, but largely unknown consequences of climate change. This case is particularly relevant because of the long-term tree growing rhythm facing a huge range of possible biotic (insects, diseases, etc) and abiotic (storms, fires, etc) hazards which can reduce the forest to none. We show how actors' realization that they cannot solve but only live with the issue of prolonged uncertainty led them to: redesign their routine in order to re-adjust in a more continuous way. Our study contributes to our understanding on how routines are designed and performed under prolonged uncertainty. Further, it joins the conversation on grand challenges by implying that tackling grand challenges is not just about solving them, but also living with them.

1 THEORETICAL BACKGROUND

1.1 CLIMATE CHANGE AS A FAR-REACHING AND UNCERTAIN GRAND CHALLENGE

Grand challenges are complex, uncertain and evaluative problems (Ferraro et al, 2015) posing threats to the planet and society with far-reaching effects (Grodal & O'Mahony, 2017). As such,

climate change is one of the greater as it exacerbates every other issue such as poverty and social development, land use issues, water quality and supply, and so on.

To illustrate how this grand challenge translate for forests, let's keep in mind that in Europe, the average disturbance impacts on forests due to climate change has increased by 17% between the period 1950-2000 and 2001-2019 (Patacca et al., 2023; Seidl et al., 2017). Just in France, trees mortality has simply doubled between the period 2005-2013 and 2012-2020 (IGN, 2022). As these disturbances threat the ecosystems health, they are also threatening all the sectors and activities depending on forests, in particular rural populations (FAO, 2022).

In this context, while facing current and future but still largely unknown consequences of climate change, we questioned how do actors adapt their routines to cope with prolonged uncertainty.

1.2 ROUTINE DYNAMICS FACING RHYTHM UNPREDICTABILITY

Consisting in predictable patterns of actions and pre-established interrelations (Cyert & March, 1963; Nelson & Winter, 1982; Simon, 1947; Stene, 1940), organizational routines allow anticipation. This regularity rests on rhythms: « *By examining past, recurring work rhythms, one can predict future presence based on current events* » (Su et al., 2013, p. 296). However, predictability find its direct limits in situations that are both unstable and uncertain (Feldman & Sengupta, 2020). Such contexts might even lead to the collapse of routines due to the lack of predictability and coordination (LeBaron et al., 2016; Weick, 1993). Accordingly, those properties raise the question of how do the actors cope with situation of unpredictable rhythms?

This question has raised a vivid interest of routines scholars and number of studies have been achieved to better understand those situations. Among those, Bechky and Okhuysen (2011) looked at how SWAT teams, and a film production crew, deal with unexpected events. The authors show that where film production crew implement their routine with significant flexibility, SWAT teams stick strictly to the routine they learned during training. Improvisation is then done by recombining the different routines they are trained for. In the same logic of handling uncertainty, Patriotta and Gruber (2015) studied the way in which a local American news channel manages information and, in particular, breaking news. The authors show that actors rely on expectancy frameworks, defined as "shared baseline expectations about the

temporal progression of the news day." (Ibid., p.1575). These frameworks take the form of a pre-program at the beginning of the day of what is "normally" expected. By defining a pre-program, "expectation frames" allow presenters to make sense of the emerging news and prioritize it over what was originally planned. Prioritization and adaptation have more recently been grasped by Geiger et al. (2020): following the same logic regarding the SWAT teams, they studied how firefighters temporally coordinate their routines in the face of temporal uncertainty. They show that firefighters are able to cope with uncertainty by relying on the temporal sequences of routines acquired during training. The authors emphasize the importance of pre-trained rhythms of routines as a condition for flexible performance. Indeed, by sharing pre-trained routines, firefighters are then able to adjust (accelerate or change, for instance) their actions according to the evolving situations they face, and among themselves according to their actions. Geiger et al. emphasize that dissociating actions from situational contingencies allows firefighters to be flexible regardless the evolution encountered. In a different vein, Feldman et al. (2021b), drawing on the case of psychological and psychiatric care during and after the disruptions caused by Hurricane Katrina (2005, New Orleans), examined how actors continue to serve specific objectives or goals when they experience temporal disruptions. The authors show that actors are able to maintain routine coordination despite rhythms disruptions by relying on different strategies: provisional adjustment, path creation, and pattern creation based on multiple paths.

Those studies offer first promising leads on how the actors deal with rhythms unpredictability. Nevertheless, those studies remain relatively delineate in space and time, and mostly in crisis context, i.e. with a go back to normal after the event. However, the rhythms unpredictability due to climate change is a situation which is already happening and will be prolonged over centuries (IPCC, 2022). Accordingly, it raises the question of how do actors cope with their routines in a context of prolonged rhythms unpredictability?

1.3 USING RHYTHMANALYSIS AS A LENS TO GRASP ROUTINE RHYTHMS

To further the question of rhythm under prolonged uncertainty, we build on Lefebvre's (2004) rhythmanalyis as a theoretical and analytical lens.

According to Lefebvre, a rhythm comes from the "*interaction between a place, a time and an expenditure of energy*" (Lefebvre, 2004, p. 15). Lefebvre emphasizes the importance of linking

time and space: "*all rhythms imply the relation of a time to a space, a localised time, or, if one prefers, a temporalised space*" (Ibid., p.89). This conception connect with the notion of "*situated action*" characterizing practice-based and routine dynamics theories (Feldman et al., 2021; Langley & Tsoukas, 2017; Nicolini & Monteiro, 2016).

In a rhythmanalysis perspective, "*the rhythms of everyday life reflect the patterning of social practices and the dynamic relations of which these web-like patterns are made.*" (Pantzar & Shove, 2010, p. 27). As rhythm and practice are mutually constituted (Blue, 2019; Lefebvre, 2004; Pantzar & Shove, 2010), it can be advanced that routines could be seen as polyrhythmic assemblages, encompassing multiple actors, human as well as non-human.

In a rhythmanalysis lens, rhythms refer to two states: eurhythmia and arrhythmia. Eurhythmia consists to the association of different rhythms, that is "*rhythms unite with one another in the state of health*" (Lefebvre, 2004, p. 16). In short, in this situation, rhythms are in sync, healthy, and 'normed' (Blue, 2019, p. 940), coordination is maintained. They mutually depend on, support, and reinforce each other (ibid). In the musical metaphor, it is like everyone follows its own score, but in harmony with others. Then, there is arrhythmia where rhythms break apart, the coordination collapses (Lefebvre, 2004, p.16). In short, if no musicians realign with each other, there is a risk of cacophony. It happens when eurhythmic situations cannot keep them in "metastable equilibrium" and which "*sooner or later become illness (the pathological state).*" (Lefebvre, 2004, p.37).

Crossing routine dynamics with rhythmanalysis is insightful. Calling back the previous examples of research works studying how do routines cope with uncertainty, we might understand the situations explored as mainly arrhythmia context: even if it varies from one year to another in terms of students, the housing routine at the university is based on the regularities of the end of year and summer period (Feldman, 2000). In the same idea, one could advance as well that a fire follows some kind of regularities: ignition, flashover, decay. Accordingly, the firefighters' routines (Geiger et al., 2020) are indexed on the basis of those regularities. However, to follow with the fire example, in the case of large wildfires the magnitude is such that it disrupts the usual rhythms (Danner-Schröder & Sele, 2023). Usual actions, then, do not apply anymore, leading to a state of arrhythmia.

We are facing the same kind of situation due to climate change and our routines to manage ecosystems. Firstly, it should be pointed out that one of the main factors in the evolution of ecosystems is climate, the other being soil. Accordingly, when the climate changes, so do the rhythms of the ecosystems that depend on it, as the figure 1 shows.

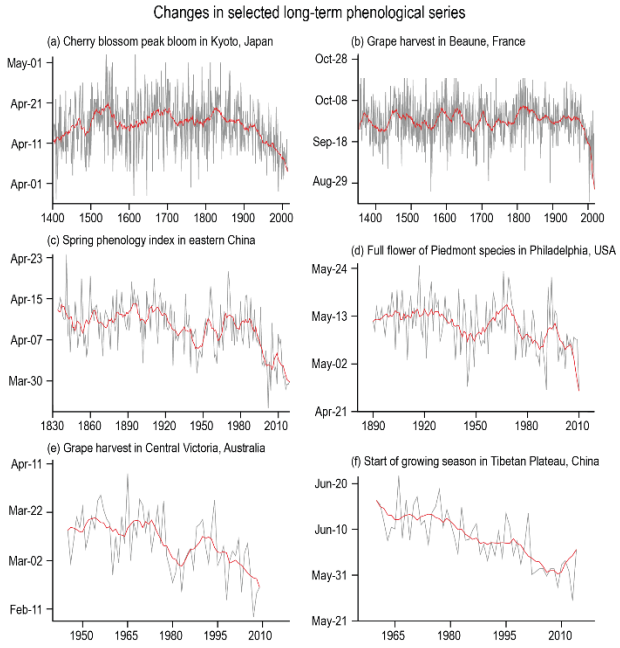

Figure 1 : Phenological indicators of changes in growing season (source: from Figure 2.32, AR6 WG1 IPCC, 2021). (a) Cherry blossom peak bloom in Kyoto, Japan; (b) grape harvest in Beaune, France; (c) spring phenology index in eastern China; (d) full flower of Piedmont species in Philadelphia, USA; (e) grape harvest in Central Victoria, Australia; (f) start of growing season in Tibetan Plateau, China. Red lines depict the 25-year moving average (top row) or the nine-year moving average (middle and bottom rows) with the minimum roughness boundary constraint of Mann (2004).

However, as climate is still evolving, the climatic scenarios are still uncertain and so are the ecosystem rhythms. As a consequence of climate change, taken-for-granted rhythms' regularities are not anymore, leading to disturb the routines indexed on those previous rhythms, and reinterrogating what the very dynamics of routines to ensure continuity (Feldman et al., 2021b). In all cases, natural rhythms hitherto taken for granted are evolving in an uncertain manner and are, as a result, unpredictable. Those prolonged uncertainties might lead the routines to arhythmic situations. Accordingly, we explore how do the actors cope with their routines to face arrhythmia and prevent the collapse of their routines?

2 METHODOLOGY

2.1 RESEARCH SETTING: A LOCAL FOREST FACING RHYTHMS DISRUPTION WHEN RENEWING THE LOCAL FOREST PLANNING

We opted for a case in which the phenomenon of interest is not only present to a high degree but also salient to those observing it (Pettigrew, 1990). In particular, we draw on a longitudinal study of the local forest planning renewing routine in a French state forest called "ForInnov". Forest planning consists of articulating how to use forests in a sustainable way across time and space and together with different stakeholders (Mermet & Farcy, 2011). In France, the management of public forests is entrusted to a single public administration, the National Forestry Office (ONF). The logic of forest planning is traditionally based on a deterministic approach under the assumption of regular forest rhythms, which have been taken for granted for centuries under climate stability, as shown by the figure 2.

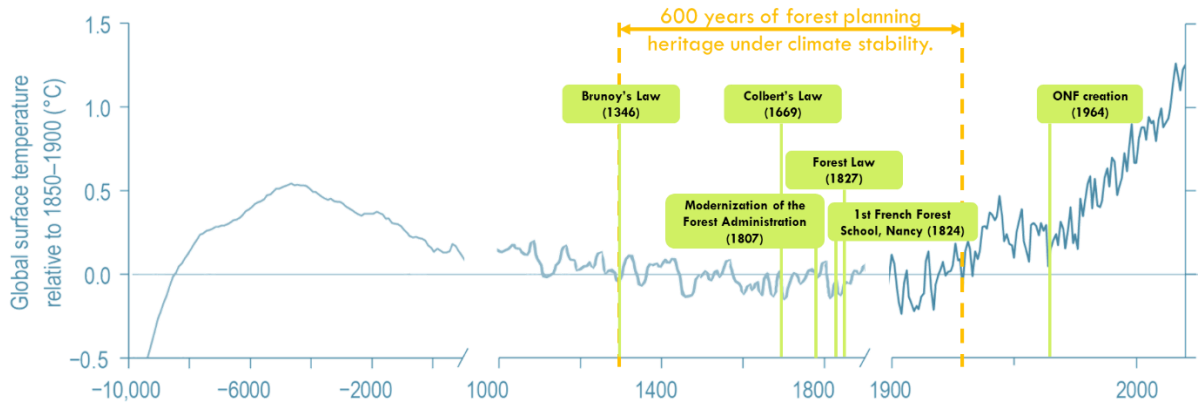

Figure 2: Climate change in perspective of the main historical landmarks in the development of French forestry planning. It can be seen that most of the history of forestry planning has taken place under stable climatic conditions, and therefore stable rhythms. (Adapted from: IPCC 6AR, WG 1: The Physical Science Basis. Figure 2.11 Earth's surface temperature history.)

This principle of forest management is traditionally reflected in a management document drawn up for a 20-year period, which sets out the actions to be taken in the forest. This document is typically made up of 3 parts: 1) inventory, 2) objectives and 3) action program.

However, with climate change, rhythms are no longer taken-for-granted. Thus, as we are interested in how the ONF deal with the prolonged uncertainty of climate change, we focus on

the ongoing renewal of ForInnov's forest planning which has to deal with these unknown forests' rhythms.

2.2 DATA COLLECTION

As the first author has been trained as a forest engineer and an organizational scholar, we capitalized on this background to overcome general understanding questions. Accordingly, we carried out our data collection according to the sensitive aspects of forest planning. In particular for the observation, we have been able to "save" time to understand what the foresters were actually to doing, to focus instead on the specific moment where the change happens. For example, while spending time with the foresters might has been instructive regarding their feelings, or their actions, we knew the very moment where the routine is discussed and changed happens during workshops with the stakeholders. Accordingly, we choose then to focus our time on these particular moments.

With this in mind, we mobilized several sources of data. First of all, interviews, but also observation, in particular to capture moments of recomposition of the routine. Then, we collected documents, in particular artefacts (charters, strategy, management plan) which emerged from the recomposition process and, in so doing, form as many traces of performing.

2.2.1 Interviews

The familiarity of one of the two authors with the forestry environment saved time in discovering this world and its actors. An initial series of interviews took place to gain an understanding of the situation, identify the issues faced by the actors, identify the landscape of actors involved, and the adaptations underway. It was on this occasion in particular that we were able to identify the initiative for a shared strategy for ForInnov forest management between the various stakeholders, and were introduced to its process. A second series of interviews was carried out during this shared strategy process (table 23), in order to discuss with each of the actors involved (local councilors, mayors, ONF managers, local authority associations, presidents of users' associations, etc.), and gather their experience of the situation, the issues that forest planning represents for them, their expectations, their role in the past, and the role they now wish to play. Finally, additional interviews with ONF management enabled us to place the local situation in its national context. In particular, we were able to identify that,

despite having a strategy for these situations, they are very recent for the ONF, in a way catching national actors off guard, and taking advantage of local situations to identify what works.

Tableau 1 : Interviews carried out

Position	Duration	Modalities
Director of a local government association	00:55:34	Face-to-face
External consultant	00:53:00	Video
Mayor city 2	00:41:05	Face-to-face
Mayor city 3	01:10:00	Face-to-face
Official elected city 1	01:10:00	Face-to-face
ONF – local director	01:25:59	Video
ONF – local manager A	01:11:58	Video
ONF – local manager A	00:37:47	Call
ONF – local manager B	00:35:00	Face-to-face
ONF – national manager 1	01:40:20	Video
ONF – national manager 2	01:12:40	Video
ONF – national manager 3	01:39:11	Video
ONF - planner	00:25:00	Face-to-face
ONF - planner	01:08:00	Video
ONF – planner	00:53:50	Face-to-face
ONF- local manager A	01:11:00	Video

2.2.2 Observation

Observations were limited by the lack of access to the field, and by the fact that data collection took place mainly during the Covid period. We therefore adopted a different strategy, concentrating on the moments of exchange and negotiation between the stakeholders to elaborate the shared forest management strategy. We were able to carry out all these observations face-to-face, providing us with the opportunity for informal exchanges with stakeholders and additional interviews. These observations were an ideal opportunity not only to understand the definition of a new pattern of routine governance, but also to observe the performance of this pattern through the construction of new roles and interactions between actors (Groleau, 2003).

In addition, we had the opportunity to take part in several field trips with ONF actors to identify the damage caused in the forest and their difficulties in pursuing the classic planning approach. These observations (table 24), coupled with interviews, enabled us to identify the beginnings of technical adaptations to forest planning.

Tableau 2 : observations conducted

Observations	Duration
Preparatory meeting for the ForInnov partnership initiative. Participants: branch manager, territorial unit manager, director of the ForInnov local association.	17/08/21 1h30
Meeting with mayor to prepare communal workshop and discuss wood-cutting.	17/08/21 1h
Participation in the kick-off day: plenary discussion in the morning, co-construction workshop in the afternoon. We were able to hold a number of interviews and informal discussions on this occasion. Stakeholders present: mayors and elected representatives of the local authorities concerned, user and nature associations, manufacturers, inter-professions, think tanks, etc. More than forty actors.	25/09/21 8h
Video-conference feedback from the first two series of workshops. Twenty actors present.	30/05/22 1h30
Participation in the entirety of co-construction workshop 3, aimed at translating the objectives into actions, identifying the task leaders and the a priori necessary budget. This was a particularly informal moment, with all the actors divided into groups of 4-5 participants to draw up action sheets by theme. Each time, we had the chance to take part in a group and thus participate in the elaboration of an action sheet. Although these were short sessions, they were particularly rich in content, since we were working with a mayor or local elected official, a representative of an association, and sometimes an industrialist or forest user; the points of view were therefore very varied, but had to end up agreeing on a common axis. Between 15 and 25 actors per workshop.	Du 08/06/22 au 15/06/22 4 x 2h30-3h00
ONF Team meeting: all sector topics (hunting, planting, social issues, etc.); opportunity for informal exchanges with the pool of technicians.	13/06/22 2h00
Field tour with the territorial unit manager and sector technicians to test the new health monitoring protocol.	15/06/22 3h
Sector meeting; main topic on the state of the plate in a health crisis context.	15/06/22 1h30
Communal workshop meeting (1 mayor, 2 elected representatives, 1 technician, 1 territorial unit manager)	15/06/22 2h

2.2.3 Secondary data

As a "substitute", in a way, for the impossibility of going into the field, we have largely mobilized secondary data to acquire knowledge of the cases. Of course, this knowledge is mediated and has already been transformed at least once by its author(s). But with this vigilance in mind, this data is a particularly important resource for our research, and offers significant advantages: relatively abundant, varied and often precise, free, easy to access, and covid-friendly.

Accordingly, we paid particular attention to the artifacts produced during this shared strategy development by stakeholders. Indeed, as products of the process, we see them as traces left by the actors' performance, enabling us to reconstruct the latter, albeit *a posteriori*, but with elements derived from action. In particular, we relied on the minutes and deliverables of the co-construction workshops. In addition to these artifacts, we mobilized the media (press, social networks) to enrich our understanding of the context.

With the support of our secondary data, we were able to corroborate our primary data, in line with a logic of triangulation (Denzin & Flick, 2017).

2.3 DATA ANALYSIS

Our data analysis followed an abductive approach (Gehman et al., 2018; Timmermans & Tavory, 2012), iterating back and forth between our empirical data and the existing literature on routine dynamics and rhythmanalysis. First, we wrote descriptions of the forest planning routine as well as extended narratives of the case study, identifying the involved actors over time and their role in the renewal process (Langley, 1999). In a second step, building on Opperman et al. (2020), we aim to specify the rhythms' constellation (Chen, 2016) of the renewing routine. Thirdly, we explore what arrhythmia and uncertainty mean for the renewing routine. Finally, we identified categories to answer how the actors were trying to live with arrhythmia and compared the polyrhythmic assemblage of the renewing routine over time.

Following Geiger et al. (2020), we firstly aimed at identifying who (both actors and actants) do what? at what rhythm? and what is the nature of this rhythm? To do so, the first author wrote a case narrative (Langley, 1999) to describe as precise as possible the renewing routine of forest planning. To build this narrative, the first author relied on its previous experience in forest planning, as well as on the interviews and materials collected. In this step, we were interested in both the actors and actants composing the rhythms' constellation (Bastian & Bayliss Hawitt, 2022; Gan & Tsing, 2018; Phillips, 2020; Tsing, 2015) of the forest planning routine. Yet, as we could not have direct interviews with cockchafers or trees, for communication reasons mainly, we bypass this issue by relying on spokesmen (Callon, 1986): scientists and their artefacts (inventory, qualitative and quantitative data, maps…). At the end, we were able to qualify the actions and rhythms of the actors and actants composing the forest planning routine (fig. 3).

Actors/actants		Description of their doings	Rhythms of their doings	Nature of their rhythm
ONF	Managers	Implement forest planning	During 20 years	Institutional (based on natural)
	Planner	Craft a forest management plan	Every 20 years for 20 years	
Forest-based sector		Process wood for goods and services business	All year long, but mainly at fall and winter as sap is low.	Natural and consumer-driven
Mayors and official elected		Express their opinions regarding the management plan	Every 20 years officially	Political
NGOs & Users		Enjoy the different forest's services Express their opinion	All the year along Every 20 years officially	Activity-based
Oaks		Growth and perpetuate	During the growing season for about 120-140 years	Natural and seasonal
Beeches		Growth and perpetuate	During the growing season for about 100-120 years	Natural and seasonal
Cockchafers		Growth (by eating trees' roots and leaves) and perpetuate	During 3 years underground and 1 year above	Natural and seasonal

Figure 3: Actions and rhythms of the actors and actants composing the forest planning routine

This analysis showed was how human and nonhuman rhythms are interrelated, and specifically that the humans one's are indexed, thus dependent, on the nonhuman rhythms such as tree growth and seasonal rhythms. Accordingly, it is then obvious that all the forest socio-ecological system is indexed on ecological rhythms and those are directly indexed on climatic rhythms. Thus, climate uncertainty is threatening all the directly and indirectly rhythms related.

In the third step, we explore what uncertainty means for the renewing routine. We start an open coding, to identify underlying dynamics, through our interviews and documents. After that, we go back to our narrative and enrich it with the excerpts from our coded data. We then initiated a second-order coding to spot where arrhythmia emerged and what were its consequences regarding the polyrhythmy of the renewing routine.

Finally, we identified categories to answer how the actors were trying to avoid arrhythmia, and get back to eurhythmia. Through this process, we also went back to our narrative network in order to compare the previous polyrhythmic assemblage of the renewing routine, with the new one, sketched to keep up with uncertainty.

3 FINDINGS

3.1 THE COLLAPSE OF THE TRADITIONAL FOREST PLANNING ROUTINE

Since its early days, the planning routine at ForInnov was a well-established and relatively stable part within the larger forest management approach. As illustrated in figure 4, the life

cycle of each plot and thus how each stand is 'raised' from the stage of planting to that of thinning (like carrots in the garden) to the final harvesting not only follows a linear logic but is temporally structured along the known rhythms of the trees.

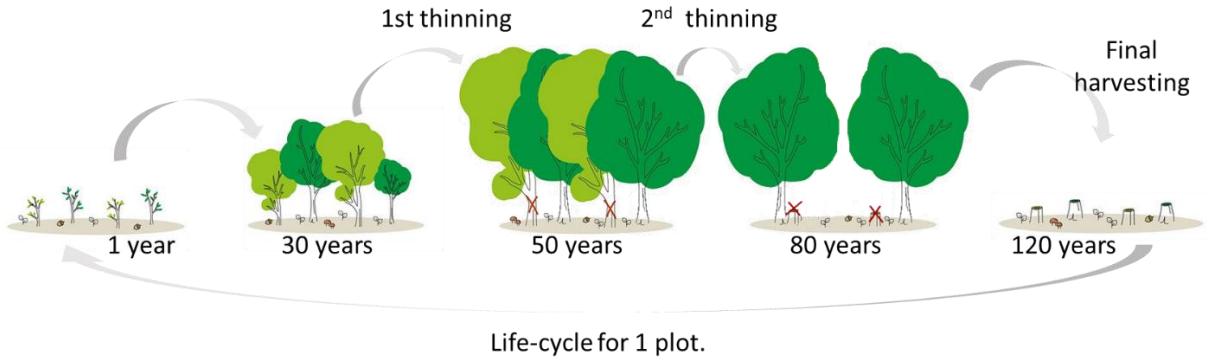

Figure 4: life-cycle of a forest plot

However, starting in the 2000s the planning routine was facing an increased amount of issues which could no longer be intercepted by small and ad hoc changes to the routine. When renewing the planning routine in 2012, foresters at ForInnov mainly focused on anticipating diebacks due to climate change induced draught. In particular, they decided to replace the pedunculate oaks by planting sessile oaks, which are more tolerant of water shortages:

> *"The management plan dates from 2012. It planned to transform the old pedunculate oak forest into sessile oak in replanting, and then to bet on the natural renewal of beech to complement." [ForInnov_ONF_Local Director]*

Despite these adaptations to the planning routine, foresters were alarmed in 2014 by an unprecedented mortality rate of trees that they saw happening; an issue which further accelerated as the surface affected by diebacks continued to increase from 10% in 2016 to over 60% in 2022, as shown in figure 5.

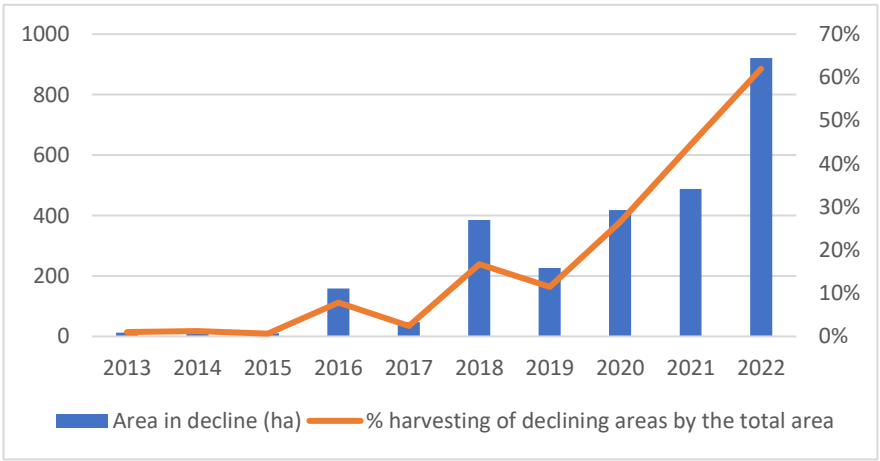

Figure 5 : Evolution of the declining forest surface of

In addition to the increasing diebacks, forest regeneration start showing alarming signs of failure. After further investigations, they discovered that the threat was coming from the underground: the cockchafer. This insect is naturally present in forest, but here, because of the warming conditions due to climate change, it developed at high speed. During its 3 years underground, the larva feeds on tree roots. On its fourth year the larvae emerge from the ground and eat the tree's leaves; basically, cockchafers eat a tree from head to toe. While trees might resist to cockchafers when their density is up to 2 larvae per m², foresters actually find concentrations sometimes 7 times higher to what a tree can resist. In those cases, the roots are almost completely consumed (fig. 6), the regeneration can no longer draw what it needs from the soil and eventually dies.

Figure 6: left picture = normal roots ; right picture = roots eaten

All in all, while the warming conditions are causing diebacks of mature trees, cockchafers are impeding forest regeneration. As a result, ForInnov situation is highly critical regarding its futur.

At this point, foresters faced several questions, chief among them: how to plan something on several years when you even do not know if the next year trees will be still alive? Indeed, the uncertainty of both climate (will the trees adapt and survive the new conditions with less water and more droughts?) and biotic challenges (will the cockchafers persist? will regeneration be able to resist them?) blurred completely the traditional decision-making process. The foresters were facing an insolvable situation according to the traditional way of forest planning.

> *"Prior we could say to ourselves in 20 years the climate will be the same, the species will still be adapted, and in addition it was with production periods which were over 120 years or 160 years for the oaks, we had things very well drawn, very well written, well, that's no longer possible" [ForInnov_Local director]*

3.2 LIVING WITH INSTEAD OF TACKLING UNPREDICTABILITY

Instead of trying to solve these insolvable questions, the foresters initiate a different pattern of the forest planning routine.

> *"The normal management design did not seem suitable to us, not applicable in the conditions that we encountered, the design did not give us the flexibility we needed, for example in a normal design, we must already define the surfaces to be regenerated, we must define a lot of things, and we were faced with a situation that made us unable to make these decisions. Also, regarding the choice of target species, in "classic" management, each plot must have its single target species, and we are proposing to put a set of species from which we can choose, for each plot, and get away from this logic of one species per plot. So to overcome that, we decided to propose our own design. » [ForInnov_ONF_Planner]*

3.2.1 Shortening the time-scale to re-adjust more quickly

In the "old" forest planning routine, renewing took place every 20 years. In the face of arrhythmia and uncertainty, the foresters started to turn in a 10-year rhythm, which is more adapted to a fast-changing context, as it is more quickly renewed.

> *"So we quickly said to ourselves that 20 years is very ambitious because the system is still unstable, so 10 years might not be bad, and it could hardly be shorter. The principle, by also discussing with the head office which tells us "yes yes, classically we wait to get out of the crisis to rest the question of the management plan" well but here, are we going to get out of it one day, we don't know, maybe we'll have to learn to live with it; the chafer in particular, the climatic drift definitely." [ForInnov_ONF_Local director]*

3.2.2 Leaving a determinist management style for an adaptive one

In order "to live with it; the chafer in particular, the climatic drift definitely" as this actor pointed out, it is interesting to see that they also started to leave the previous and centuries-long "regular forestry" way of managing ForInnov, based on a very deterministic way, particularly inadequate with arrhythmia. On the contrary, they started to implement a management specifically designed for handling arrhythmia, the so-called "forest mosaic".

> *"What we are seeing today is going much faster than expected... the situation is moving forward very quickly with a high degree of uncertainty... So our strategy is not to put all our eggs in the same basket. This is what we try to do with the concept of mosaic forest, by seeking diversity in species, structure, environments, etc. So we introduce new species, we mix young trees with older ones, that's what we try to do with several things at the same time. […] Of course, this changes a lot of our practices. It's a forest that won't have much to do with the one that previous generations have known, with the high forests of ForInnov that made our reputation." [ForInnov_ONF_Local Director]*

Complementary to a shorter rhythm of planning, the mosaic forest is intended to be more easily reorientable over time according to the rhythms evolution of climate change, trees, as well as cockchafers. Contrary to the regular forest, which consists in doing one thing at a time (a plot in regeneration, a plot in thinning, a plot in cutting), the mosaic forest consists of doing a little bit of everything everywhere (see Figure 7). This way, if there is an insect attack on the oak, for example, only the oak patch in the plot will be affected, not the whole plot. It is then easier to replace the oak patch by another species.

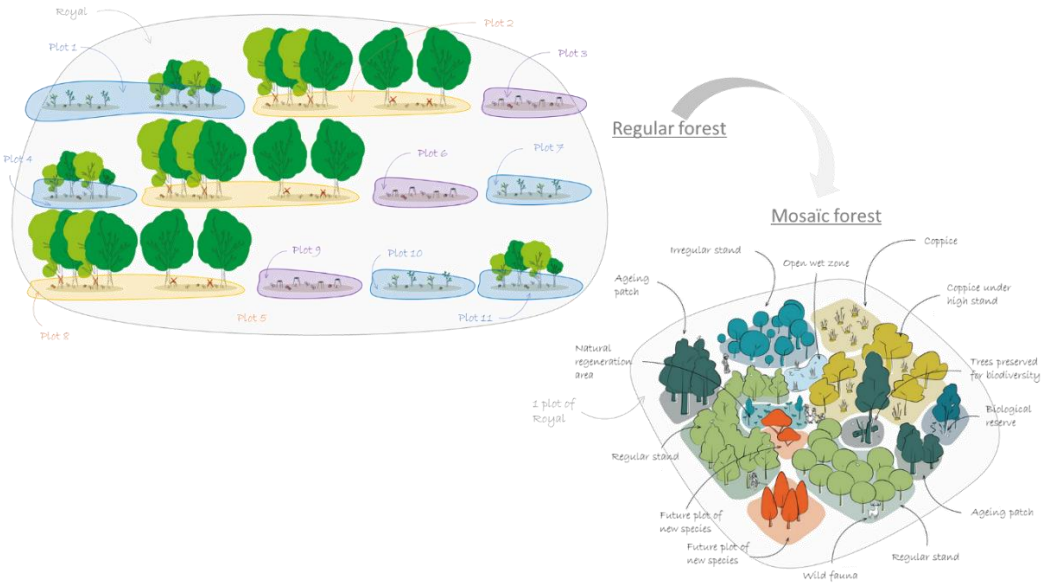

Figure 7: left = regular forest ; right = mosaïc forest

3.2.3 Opening-up the routine to share understanding and uncertainty

Finally, beside the technical issues of forest planning, the situation of ForInnov raises important social questions. First, due to the massive diebacks growing up through the forest, the local

inhabitants and users, for whom the forest is their daily landscape, have been moved and seized the local elected officials, as one mayor explained:

> *"Our inhabitants feel very concerned but at the same time very helpless. The population is waiting for that, to understand what is going on. Everyone loves this forest, and it is open to everyone. The general public, our inhabitants, need to understand what the future of this forest is. People see trees being cut down, they don't quite understand why. So we have to explain it in the simplest way possible." [ForInnov_Mayor_Town2]*

Facing incomprehension and, sometimes, contestations, the foresters had to act differently. Indeed, so far, the traditional routine of forest planning in addition to a very determinist and cartesian way, was also implemented in a very "in silo" way. In short, forest affairs were the hegemonic domain of the ONF. With climate change, and the rhythms of forest landscape mutations, this traditional way is no longer possible. The foresters of ForInnov, then, engaged in opening-up the routine to users and stakeholders, through a participative way from the decision-marking to the implementation of the decisions. In return, what foresters win is sharing uncertainty and risks, as the forest Director of ForInnov pointed out:

> *"What seemed most urgent to us, […] was to renew a dialogue with the communities, the associations, etc. because if we went very quickly on our crisis management plan, we would have been on our own, and that's really what we do not want. We want to co-construct with the communities, what they expect from the forest, and how we can work together to uh, to write the story together." [ForInnov_ONF_Local Director]*

But they also win legitimacy. Indeed, as users and inhabitants, involved in the process of forest planning, developed a shared understanding of the ForInnov's situation, they make sense of the clear-cutting going on, which participates to defuse conflicts between the forests and the stakeholders:

> *"So the audience is generally happy, especially since there were militant associations which had big differences with the ONF, which attacked them publicly*

> *via the press etc., even in recent months. And since the process [of the shared strategy] was initiated, in fact, there is another vision, and these people have managed to come to an agreement with the ONF, have had some explanations, as well as the elected officials have both advances and avenues, but sometimes still want to go further. […] But it shows that there is a need to understand each other on a certain number of subjects, and to learn from both sides, and it is also good that the voice of the communities is expressed, because finally before it we had very few opportunities to discuss this type of thing." [ForInnov_Director of an association of municipalities, member of the steering committee]*

4 DISCUSSION

4.1 ARRHYTHMIA MUST REINTERROGATE OUR PATTERNS

We show that a modification/variation of the rhythm of one or more actors/actants of the routine might impede its functioning. Specifically, here with non-humans at the heart of the routine synchronization is crucial, leading otherwise to arrhythmia, as exemplified by Gan and Tsing (2018). What our case highlights is that due to the prolonged uncertainty of climate change, which by ripple-effect modify trees' rhythms, the centuries-old routine of forest planning just failed. Based on a determinist logic, considering forest's rhythms as taken-for-granted, applying such logic in a dynamic and uncertain context is no longer an option. This situation generates a routine arrhythmia, i.e. rhythms break apart and coordination between actions and actors collapse. The culmination of it was reached when, due to the diebacks increase, the foresters had to freeze the fresh two years old management plan of ForInnov, initially established for 20 years.

4.2 DEVELOPING ROUTINES ACKNOWLEDGING INDETERMINACY AND ARRHYTHMIA

Somehow, the routine adaptations undertake by the foresters are similar to what the firefighters studied by Geiger et al. (2020), or the SWAT teams studied by Bechky and Okhuysen (2011), develop: facing the impossibility to pursue their traditional routine, the foresters initiated to redesigned it in order to, not solving the indeterminacy, but actually acknowledging it and coping with arrhythmia. In addition to the opening-up of the routine, they initiated a redesign of the routine that can handle arrhythmia through a shorten timescale, meaning a quicker update, as well as implementing a new forest management more reorientable and based on a "no-regrets" strategy. Indeed, while by the past, the implemented a determinist regular management,

very efficient in stable context, doing the same in face of uncertainty is too much risks. By contrast, the "mosaic forest", by doing "a bit of everything everywhere" prevent the risk of putting all the eggs in the same basket. That way, if oaks are dying, beeches might survive. So doing, the foresters do not solve arrhythmia, but they adapt the routine in order to live with it. While it is expected that most of the routine's actants will act on their own as the climate change is striking ForInnov, the foresters manage somehow to adapt their routine in order to find harmony through the cacophony, to follow the musical metaphor of Lefebvre. These adaptations, we believe, might be insightful as well for other grand challenges.

4.3 A COMPLEMENTARY WAY OF TACKLING THEM: LIVING WITH GRAND CHALLENGES

A large part of the grand challenges literature has developed with the target to tackling grand challenges, solve the problems, particularly relying on institutional and top-down approaches (Ferraro et al., 2015; Howard-Grenville & Spengler, 2022). While we should try to solve grand challenges as far as possible, we should also, in a complementary way, adapt our practices and routines in order to live with. Indeed, the forest planning case shows us that climate change is already impacting ecosystems such as forests, whereas trees growth broadly for a century. On the other hand, the consequences of climate change are launched at least for two to three centuries (IPCC, 2022), even by stopping all our activities tomorrow. How will be the forest of ForInnov in 50 years, 100 years, 200 years is then an insolvable equation. Furthermore, forest planning in this case is not contributing to climate change, but the subject of it. Yet, according to the way actors respond to these consequences might aggravate or attenuate them. By adapting their forest planning routine toward uncertainty and arrhythmia, the foresters of ForInnov attenuate climate change consequences as well as ensure the continuity of sustainable management and ecosystem services. We believe that this case leave a promising room to the way we respond to climate change, as well as the way we manage socio-ecological systems (Berkes & Folke, 1998; Gunderson & Holling, 2002) toward a management a bit more agile and a bit less deterministic.

CONCLUSION

While a substantial and growing literature has developed along the concept of grand challenges, it has been mainly with the target of tackling them. Although we should indeed try to tackle them as far as possible, some of them are really far-reaching issues, such as climate change, which will last at least for two to three centuries. A complementary way then is to be able to

live with it. In the "modern world", eurhythmia was the norm, things were simple and known, and managed through a determinist logic (Latour, 2010). With climate change, we are entering in a "post-modern world" where things act on their own, and indeterminacy is the rule (Ibid.). Accordingly, arrhythmia is somehow a new characteristic of this context and should be kept in mind for adapting our routines, through a more open and reorientable patterns.

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