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Three visions of the futures of forests in a changing climate: the epistemic commitments of forest scientists

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Introduction

Nowadays two major contrasting narratives are shaping forests futures: one of forests under threat from global change (increasing temperatures and droughts, proliferation of pathogens, etc.) and the other of forests bearing hope in the struggle against climate change (carbon sinks and more broadly bio-economy). However, anticipating the impacts of climate change on forests does not produce a unanimous discourse shared by all forest scientists. This paper aims to analyze how forest scientists are envisioning forest futures and how they are pre-empting the impacts of climate change on forest dynamics. To do so, I draw on the sociology of epistemic commitments[1] to examine how forest scientists understand the anticipation of forest futures in a changing climate, i.e. what knowledge, what technologies and what knowledge infrastructures should be developed and financed in order to adapt French forests to climate change. This paper is based on a sociological inquiry carried out in forest research laboratories[2] and among French forest scientists.

Drawing on Ben Anderson's thoughts on "statement of the future"[3], I suggest that how scientists understand and know forests futures is at the core of their epistemic commitments:

> "Each of these different types of action is accompanied by a series of statements about how 'the future' relates to the past and the present. Of course, much more needs to be said about the differences in how 'the future' is figured. For the purpose of this paper, all I want to stress is that statements problematize 'the future' in particular ways, conditioning how it may be anticipated and acted on." (Anderson, 2010, p.780)

According to the geographer, these statements shape the way in which scientists are foreknowing forest futures – a project of knowledge – and the way in which they try to make them happen or not – a solution to solve the problem. We find thus what underpins the notion of "epistemic commitments": a way of framing and knowing a problem and a solution to deal with it. Forest futures visions therefore articulate a way of pre-empting climate change as well as a set of actions to be taken to ensure that desirable futures occur and to avoid threatening ones.

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[1] Granjou C and Arpin I (2015) "Epistemic commitments. Making relevant science" *Science, Technology and Human Values*, 40(6): 1022-1046.
[2] The National Research Institute for Agriculture, Food and Environment (INRAE), the Center for functional and evolutionary ecology (CEFE) and the Research & Development department of the French National Forests Office (ONF).
[3] Anderson B (2010) "Preemption, precaution, preparedness: Anticipatory action and future geographies" *Progress in Human Geography*, 34(6): 777-798.

The three visions of forests futures combine four elements:

1/ a way of conceiving the temporality of the future and its relations to the past and the present (linear or disruptive, predictable or unpredictable)

2/ a conception of the forest to be known and the ‘ideal forest’ to be shaped. This entails both a knowledge project and an action project

3/ a commitment to the knowledge and technologies that need to be developed to better understand and manage forests

4/ an ‘*ethos* of anticipation’: how forest scientists perceive their ways of doing science, both as the creation of objective knowledge and as a profession and a cultural, social and technical practice.

This approach thus offers a sociological and socio-political understanding of the current organization of forest research, with an emphasis on the alliances and conflicts that arise from the scientists’ ways of conceiving their practices. Because of their scientific and social careers, their involvement in forest management, and their understanding of the ‘science that matters’ and of what futures and forests are – what I describe as “epistemic commitment” – forest scientists subscribe to one of the three visions of forest futures: the ‘Risky Future’, the ‘Disruptive Future’ and the ‘Historicized Future’.

A/ the ‘Risky Future’: monitoring, anticipating and managing forests as techno-political devices to reduce climate change

B/ the ‘Disruptive Future’ of the impacts of global change on forests, which are considered as non-linear and stochastic ecosystems

C/ the ‘Historicized Future’ of forests as a result of historical processes and accidents with long-term dynamics

The main characteristics of those three visions are summarized in Table 1.

A. The ‘Risky Future’: monitoring, anticipating and managing forests as techno-political devices to reduce climate change

- General description

Within the “Risky Future”, scientists aim to monitor, forecast and take action in order to reduce future risks threatening forests. However these risks are also perceived as opportunities to develop “Forest-Infrastructures” which are understood as socio-political and technological devices for fighting climate change. Here, scientists are sharing an *ethos* of trust towards models, increasing computing power and new technologies for data collection (LIDAR) and processing (Big Data).

- Envisioning forest futures toward the risk concept

In this case, the key notion is risk. Many risks are threatening forest futures. Scientists have thus to identify them in order to reduce them. To this end, forest scientists and experts are relying on socio-technical arrangements designed to monitor French forests: simulation models backed up with extensive databases fuelled by forest monitoring networks. Technologies such as remote sensing and modeling hold out the promise to better know and mitigate the risks. However risks are also understood as opportunities for actions such as the implementation of new forest policies. Forests are not only threatened by climate change, they also provide ways of mitigating it (wood energy and carbon sinks) or of adapting to it (assisted migration of species, non-native species introduction). "Forest-Infrastructures" that stock carbon and produce energy are then considered as a key element in climate change mitigation and adaptation. Risks have here a dual nature: they are both threats and hazards that need to be contained and opportunities to implement new technologies and to strengthen forest ecosystem services such as carbon sink. Forests are then understood as techno-political devices – a way of governing environment – in line with studies that have already analyzed the political dimensions of "measurability"[4] or "datafication"[5] processes and practices. In this perspective forests transformed into data are thus globally governable. Risk is therefore understood as a compass helping decision-making amid uncertainty. The 'Risky Future' is line with the security paradigm tied to a particular understanding of complexity – complex adaptative systems – as described by the Australian philosopher of science Jeremy Walker[6].

- An *ethos* of trust towards the promises of new technologies

New technologies play therefore a crucial role in forest knowledge and management. From this standpoint, for example, LIDAR technology allows precise information to be obtained on the geographical location of different forest stands as well as their exploitation conditions. In a scenario where wood production is expected to be boosted by wood energy and where 'carbon sinks' are expected to play an increasingly significant role, remote sensing offers the potential for a more accurate resource assessment that would enable the forests to be managed strategically, for example by keeping hard-to-reach wood stocks for carbon storage, while more accessible ones would be used for productive functions. Remote sensing promises are in line with those of environmental monitoring as it is being promoted in international projects and networks such as the COPERNICUS project, the European version of the Global Earth Observation System of Systems, which seeks to use monitoring technologies of the Earth System (satellites, remote sensing, etc.) to produce useful data for environmental governance.

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[4] Turnhout E, Neves K and De Lijster E (2014) "'Measurementality' in biodiversity governance: knowledge, transparency, and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES)" *Environment and Planning A*, 46: 581-597.

[5] Devictor V and Bensaude-Vincent B (2016) "From ecological records to big data: the invention of global biodiversity" *History and Philosophy of the Life Sciences*, 38(4): 13.

[6] Walker J (2020) *More Heat than Life: The Tangled Roots of Ecology, Energy and Economics*, Singapore: Palgrave Macmillan. See the chapter 14: "Genealogies of Resilience: From Conservation to Disaster Adaptation".

Modeling, simulation and the development of the computing power of the computers associated with them are the cornerstone of what this first vision of the future of forests calls ‘intelligent forest management’. Scientists trust the idea that forests could help us struggle climate change and more precisely with the use of those new technologies that will improve forest knowledge and management.

However the “Risky Future” is also criticized by some authors, notably the Canadian philosopher Jean-Baptiste Vidalou[7] who condemns the “unearthed” approach of forest monitoring technologies and of ‘Forests-Infrastructures’ opposed to forests as environments. French forester Frédéric Le Play had already put forward the same argument in the 19th century when he challenged the official forestry doctrine that sought to deprive mountain populations of their property. Moreover, cartographies are never neutral: relying on precise information and socio-ecological and economic indicators may thus be interpreted as a technocratic approach to forest policy.

“Risky Future” is neither an apocalyptic nor a catastrophic future, but quite the opposite. This future thus contains certain optimism. The discourse about the risks affecting forests is backed up by an optimistic discourse about new technologies and the need for reorganizing forest management and ownership.

B. The ‘Disruptive Future’ of climate change: forests as non-linear and stochastic ecosystems

- General description

Within the “Disruptive Future” improving our fundamental knowledge of forest ecosystems is the key issue to understand and anticipate climate change effects on forests. For this reason, forest scientists should focus on uncovering ecosystem processes in borderline conditions and thus on linking both experimental and modeling approaches. Unlike the “Risky Future”, new technologies are not meant to be at the core of forest research. Here, forest scientists are sharing an *ethos* of giving up anticipative practices: there are currently too many uncertainties about forest future dynamics to act now on the basis of model forecasts.

- A critical look at forecast model and new technologies

Forest scientists criticize the long-term time-scale projections – the so-called “maps at horizon 2100” – according to the following idea: scientists would be encouraged by funding agencies to produce these maps despite their scientific irrelevance, since the future they seek to anticipate will differ essentially from what is known today. The projection of past trends into future conditions is not relevant if we hold future as disruptive. Therefore, scientists strongly disagree with the promises of remote sensing and increasing computing power. To them, accumulation of data documenting past or current trends might conceal the truly different and disruptive nature of future trends. Acquiring more spatially precise data through

[7] Vidalou JB (2017) *Être forêts. Habiter des territoires en lutte*. Paris : La Découverte.

remote sensing or aggregating an ever-increasing number of sub-models thanks Big Data will not allow us to better anticipate forest futures.

LIDAR technology could also lead to changes field agents work, as they collect forest data, carry out inventories and tag trees to be cut. Technological choices are always political and social ones: technological infrastructures generate "path dependences"[8] (Edwards et al. 2017) meaning that some futures are more likely occur than others. Scientists who disagree with the technological and technocratic "Risky Future" vision are well aware of this.

- Facing the disruptive future: giving up anticipative practices

Improving forest ecosystem fundamental knowledge is should be put on top of forest research agenda. One senior ecologist, Jacques, told me: *"Modeling is not interesting when all goes well. What is rather important is this: I've got three months without rain, what's going to happen? Under those circumstances, if we simply have a model running in optimal conditions, it is useless"* … *"Models are not useful if they seek to reproduce reality but if they allow us to manipulate the system's regulation"*. This modeling approach is conceived as a heuristic one and should be backed up with other approaches such as experimental observations – Puéchabon observation sites – or experimental devices such as ecotrons allowing experimenters to study the functioning of ecosystems in conditions not currently observed but which are presumed to be those of climate change.

Facing the "Disruptive Future" of forest ecosystems, scientists such as Maxim decided to stop making projections: *"I have lost interest in doing this; I have even lost interest in reading publications on this subject"*. Consequently scientists decide either to give up anticipating the effects of climate change on forests or to slow down their modeling activities and return to the field or to experimentation. They also are cautious about anticipative management practices that could lead to catastrophic consequences, such as the introduction of non-native species supposedly better suited to future climatic conditions

C. The 'Historicized Future' of forests as a result of historical processes and accidents with long-term dynamics

- General description

Within the "Historicized Future", scientists consider forests as socio-ecological and historicized environments. To anticipate forest futures, we first need a precise knowledge of forest past dynamics based on long-term data. Forest scientists thus emphasize interdisciplinary approaches – for example with archeology or with history – so as to rebuild forest socio-historical trends: the so-called 'forest memory'. Here forest scientists are sharing an *ethos* of responsibility: despite the many uncertainties, forest scientists should still try to

[8] Edwards P, Jackson S, Bowker G and Knobel C (2007) *Understanding Infrastructure: Dynamics, Tensions, and Design*. Report of a workshop on "History & Theory of Infrastructure: Lessons for New Scientific Cyberinfrastructures", January.

anticipate future trends as well as they can, otherwise they run the risk of leaving this expertise to other actors.

- Knowing the past to anticipate the future

A forest modeler, Charles, told me: "Yes, I'm interested by the future in my research, but most of the time it is the past that I study". Therefore understanding forest past dynamics to anticipate the future is at the core of the 'Historicized Future' research agenda. It also leans on the fact that French forest productivity has changed due to climate modifications. Until 1980s forest trends were considered to be stable, so scientists lack long-term data about productivity changes. They thus try to collect past long-term data – forest research and management data – in order to reconstruct forest past trends. Knowing the long-term past dynamic so as to anticipate the futures is not something specific to forest research. Sociologist Martin Skrydstrup[9] has made similar observations when he studied the paleoclimatologist community attempting to understand past climate states to anticipate future environmental changes.

Ecological, eco-physiological or statistical approaches are not sufficient to know forest past trends. Scientists promote therefore interdisciplinary work with for example history and archeology. Productivity changes have rendered obsolete correlative models that extrapolate future trends from past and present data. This is why these scientists exhort a better knowledge of forest past and advocate that this approach be put on the core of forest research agenda, despite the fact that it is opposed to new technologies and to the process of scientization and technologization of forest research during the last fifty years

- Anticipating and communicating forest futures despite uncertainties

Despite the uncertainties and biases inherent in their work, forest modelers and ecologists do not renounce prediction. Form them, ecologists have to be heard in the debates concerning climate change. They acknowledge that ecologists have a major social and political role to play: *"ecology has a historical opportunity to become a major actor in the development of a sustainable human society"*[10]. Mathieu, an ecologist, thinks that forecasting is important although he considers that understanding fundamental ecological processes are the major challenge for forest research: *"if we ecologists don't speak, someone else will speak for us"*.

Ecologists' expertises give them a responsibility to be part of the climate change debate. This is the meaning of this *ethos* of anticipation. Despite the uncertainties, ecologists have to get into the public arena to report major trends of global changes. This idea is in line with views from certain ecologists reported in an article in *Le Monde*[11] in which they insist on the

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[9] Skrydstrup M (2017) "Envisioning the future by predicting the past: Proxies, praxis and prognosis in paleoclimatology" *Futures*, 92: 70-79.

[10] Mouquet N, Lagadeuc Y, Devictor V, Doyen L, Duputié A, Eveillard D, Faure D, Garnier E, Gimenez O, Huneman P, Jabot F, Jarne P, Joly D, Julliard R, Kéfi S, Kergoat G, Lavorel S, Le Gall L, Meslin L, Morin X, Morand S, Morlon H, Pinay G, Pradel R, Schurr F, Thuiller W et Loreau M "Predictive ecology in a changing world" *Journal of Applied Ecology*, 52(5): 1293-1310.

[11] Garric A (2020, mars) « Savants ou militants ? Le dilemme des chercheurs face à la crise écologique » Le Monde [online] [https://www.lemonde.fr/sciences/article/2020/03/09/savants-ou-militants-le-dilemme-des-chercheurs-face-a-la-crise-ecologique_6032394_1650684.html].

importance of voicing their opinions in debates concerning climate change and biodiversity loss.

Table 1: Three visions of forest futures

	Risky Future	Disruptive Future	Historicized Future
Understanding of the future and the actions to be taken	• Current and future risks are both threats and opportunities to take action. •Preparedness paradigm : containing risks and reacting urgently •Technoscientific promises offer an optimistic future (the « Progress arrow »)	• Climate change has disruptive effects on forests: the future is not only uncertain, it is unknowable in present times • It is not possible to project future with past and current trends • We must act with caution	• Understanding forest futures requires first of all knowing their past • Long-term data is crucial, every effort must be made to preserve and update it • Old-growth forests should be studied and preserved
Understanding of what forests are	• Forest-Infrastructure for tackling climate change • 'Intelligent' control and piloting of forest socio-ecological functions	• Complex ecosystem featuring non-linear and stochastic processes	•sociological and historicized environment : sylvosystem • forest have 'memory'
« Science that matters »	• New technologies (Big Data, Lidar) • Modeling and simulation are crucial for forest management • Developing surveillance and monitoring networks, conserving genetic resources • Assisted migration of forest species	• Modeling forest dynamics under « borderline conditions » • Linking modeling and experimental approach (like Ecotrons) • Criticism against new technologies used in data collection and processing, and criticism against species distribution models and maps	•Promote interdisciplinary approaches (archaeology, history, etc.) • Harmonize older data •Develop historical approaches of forest trends: forest scientists are all above historians.
Anticipation *ethos*	• Ethos of trust : pre-empting future risks to act now • Technology and precise information legitimate political actions	• Ethos of renouncement : phenomena are too complex to be anticipated	• Ethos of responsability : forest scientist has a part to play in the framing of ecological, socio-economic and political future trends • Forest scientists should play this role, otherwise others will speak in their place
Actors and institutions that support and promote this vision	• Institutional discourse (Academy of Agriculture, Ministry) • Stakeholders in the wood sector • Forest modeler having a hybrid profile (between research and management)	• Forest ecologists (CEFE, INRAE)	• Forest modelers • Hybrid profile (INRAE, ONF)