



HAL
open science

An experimental workshop to question the implications of an increase in extreme weather events frequency on the organization of French railways system

Vivian Dépoues, Jean-Paul Vanderlinden, Tommaso Venturini, Aglaé Jézéquel

► **To cite this version:**

Vivian Dépoues, Jean-Paul Vanderlinden, Tommaso Venturini, Aglaé Jézéquel. An experimental workshop to question the implications of an increase in extreme weather events frequency on the organization of French railways system. 2018. hal-01835393

HAL Id: hal-01835393

<https://hal.science/hal-01835393v1>

Preprint submitted on 11 Jul 2018

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

An experimental workshop to question the implications of an increase in extreme weather events frequency on the organization of French railways system

Vivian Dépoues^{1, 2, 3}

Jean-Paul Vanderlinden¹

Tommaso Venturini⁴

Aglaé Jézéquel⁵

1 CEARC/OVSQ, Université de Versailles Saint-Quentin-en-Yvelines, 11 Boulevard d'Alembert, 78280 Guyancourt, France ;

2 I4CE - Institute for Climate Economics, 24 Avenue Marceau, 75008 Paris, France

3 ADEME, 20 Avenue du *Grésillé*, 49000 Angers, France.

4 Institut Rhônalpin des Systèmes Complexes, École Normale Supérieure de Lyon, 46 Allée d'Italie, 69007 Lyon, France

5 LSCE - Laboratoire des Sciences du Climat et de l'Environnement ; 91190, Gif-sur-Yvette, France.

Abstract: Entangled in a complex socioeconomic environment, SNCF, the French national state-owned railway organization, is a good example of a company currently favoring reactive incremental adaptation to climate change over anticipated transformations. We designed and organized an experimental workshop to test how opening an exploratory space to discuss about the possible consequences of climate change may challenge this status-quo. Based on our previous work with SNCF, we decided to focus on increased climate variability in summer and extreme heat as potential disruptive characteristics of climate change. This article reports about this experiment and analyzes its outcomes, revealing that exploratory thinking can effectively raise original questions. Through the discussion, participants questioned management practices (e.g. vegetation management), but also management policies and guidelines (e.g. crisis management) and strategic investments. Moving from internal management concerns to social issues, they unveil critical governance challenges. At the end of the day, each institutional actor within the railway system - i.e. the infrastructure manager, mobility services providers, and traffic authorities - have to choose among several possible attitudes towards adaptation. Our discussions shows that these choices will especially depends on the overall market structure, which is different from one service to another and rapidly evolving. Collective adaption is therefore not self-evident and will only happen as the result of combined strategic decisions.

Keywords : railways, infrastructure planning, climate variability, exploratory, adaptation, governance

1. Introduction

This article presents the results of a research designed to investigate the consequences of an increased climate variability on the strategies of a major mobility company. The company is SNCF, the French national state-owned railway organization. It encompasses both the management of the network (SNCF Réseau) and the largest part of the operation of this network from regional transit to high-speed routes (SNCF Mobilités¹).

During two years, we conducted a research in collaboration with SNCF to describe the effects of scientific discourses about climate change impacts on this organization. We studied its existing adaptation efforts: as institutional processes, autonomous initiatives (*exploration communities, innovation projects, etc.*) (Dépoues, 2017) and more decentralized reactions (Dépoues, Vanderlinden, & Venturini, 2017). Both at an institutional level and within management teams, SNCF is aware of climate change and understands its consequences. Nevertheless, this understanding does not appear to lead to any major transformational change. People working for SNCF draw a clear picture of their company as a sociotechnical system with many structural and conjectural constraints. Any technical or organizational innovation is thus necessarily the negotiated outcome of interactions among multiple legacies and various ongoing changes: “Our network is 150 years old [...] Everything has changed in 150 years [...] the climate has changed, but also the population, the means, the practice, etc.”²

The company is entangled in a complex socio-economic environment with cross interactions with regulatory bodies, local authorities, other providers of public transportation and users. This creates a complex situation with internal (industrial processes, fixed-circulations schedules³, etc.) and external (norms, political choices, etc.) constraints.

Railway in France is also a system at the crossroads facing major changes both on the supply (new technologies, connected services, rise of intermodal offers, markets liberalization and new entrants to the market, etc.) and on the demand sides (evolving mobility preferences, etc.). After years of underinvestment, strategic choices need to be done to renew the network and modernize the service. It is therefore SNCF top priorities⁴ to improve dramatically its cost-performance, to succeed in its digital transformation, to develop its customer culture, and to improve its relationship with both users and transit authorities. Climate change comes as an additional concern among many

¹ SNCF Réseau and SNCF Mobilité are two publicly-owned companies both placed under the control of a “holding” called SNCF.

² Quotes are parts of the workshop discussions (2018-10-30), translated into English.

³ Ex. “ an organization 2 years in advance for train paths, 6 months for schedules “

⁴ Cf. <http://www.sncf.com/fr/groupe> (accessed 2018-2-2)

parameters of this rapidly changing environment. As a result, the company favors progressive adjustments, incremental and reactive adaptation.

Through anticipation and adaptive management, SNCF could better manage climate risks and take opportunities to offer an adapted and resilient mobility service. Yet, in line with our observations (Dépoues, 2017) and with the literature (Berkhout, 2012; Rotter, Hoffmann, Pechan, & Stecker, 2016; Surminski, 2013; WBCSD, 2014), a more transformative adaptation to climate change can only happen through a proactive uptake process (Rotter et al., 2016). Such a process requires dedicated deliberation spaces and times to clarify the relevant consequences of climate change in this particular context.

2. Research process: designing a workshop

To move further in this direction, we designed and organized an experimental workshop with SNCF in October 2017. This workshop intended to test how effective the opening of an alternative discussion space may be. It was designed to foster exchanges about the impacts of climate change for SNCF and the issues that could be raised, then to identify which discussions could emerge.

2.1 Workshops' objective and methods

Workshops and focus groups are common research devices to enable group interaction and reveal collective dynamics (Chambers, 2002). They provoke reactions between individual actors; make connections between issues. They make attitudes more apparent and create moments of reflexivity (Blanchard, 2011). Among researches on climate adaptation, workshops are frequently used to explore climate change consequences (Colombert, 2016; Corre, Dandin, L'Hôte, & Besson, 2015; Tissot et al., 2016)⁵; to facilitate the dialogue between scientists and decisions makers (Kane, Vanderlinden, Baztan, Touili, & Claus, 2014; Porter & Dessai, 2017) and even to co-design adaptation strategies (Haasnoot et al., 2013). Some of the workshops reported in the literature⁶ are action-research devices; they intend to provoke changes in the system studied. They do so by intervening at particular moment to feed actual decision-making. For instance, (Malekpour et al., 2017) “put

⁵ Cf. http://www.gip-ecofor.org/doc/drupal/gicc/Lettre_GICC_numero21_1.pdf (accessed 2018-01-5)

⁶ Bertrand et al. (2017) for instance created animation devices to build a common knowledge and overcome the “mismatch between supply and demand for climate knowledge”. According to them, “the important thing is that people anticipate environmental situations and transform them into shared images and expectations that enable social action”. Malekpour et al. (2016) proposed a model for “a diagnostic intervention in the ongoing process of strategic infrastructure planning, as a way of revealing context-specific impediments [...] tested in water infrastructure planning for one of the world's largest urban renewal areas in Melbourne, Australia”. Their goal is “enabling reflexivity within the ongoing planning process [...] about the development of processes and tools that support the widespread adoption and successful implementation of those solutions in the face of wide-ranging impediments”. Similarly, Malekpour et al. (2017) tested a strategic planning intervention format as an alternative to predict-then-act approaches, to cope with uncertainties and complexities.

forward a planning intervention, which can be plugged into conventional planning processes”. As such, we did not go so far: our workshop served a research purpose and aimed at producing original knowledge through interaction. However, the description we got of how climate change may question the system is an insight potentially very useful to shape and share visions for the future of rail in France.

If we were able to set up a successful workshop, it was because we prepared it through several months of fieldwork and interaction with SNCF teams. SNCF has been a key partner of this research allowing a privileged access to people working all across the organization and to internal working-groups on climate change. Thanks to this cooperation we could develop sustained relationships with several executives and have rolling discussions about how the organization deals with climate change. We met many of the participants before the workshop and we could count on their understanding of the research objectives and process. We also received a strong support from high-level executives in the company who helped us to select the participants and encouraged people to take part to the workshop. This allowed us to gather representatives from various SNCF activities ranging from infrastructure management to a variety of traffic services (Table 1).

Table 1: SNCF participants to the workshop

Representatives of*
SNCF Headquarter (n=4): sustainability and climate officers, normalization and standards
SNCF Mobilités (n=3): <ul style="list-style-type: none"> • Intercités (classical national lines), regional sustainability manager, regional communication officer & digitalization project manager
SNCF Réseau (n=4): <ul style="list-style-type: none"> • Regional sustainability managers, Engeneering department - LNMP and Nîmes-Manduel projects (new High speed line and new railway station)

**Because of strong internal turnover within SNCF, many of the participants brought experiences coming from more than just one position. Nevertheless, participants regretted the absence of people directly involved in the maintenance.*

We decided to keep the workshop closed to external stakeholders to allow participants to express themselves freely, though this prevented us to debate questions involving external stakeholders. The workshop was held in SNCF buildings in the regional operations department of Montpellier, previously chosen for a detailed case study (Dépoues et al., 2017).

During four hours, it offered a space to engage in exploratory discussions on the consequences of climate change for SNCF activities. Following a research protocol agreed with participants, we recorded the whole workshop. Participants also received “participant’s workbooks⁷” with specific questions and blank spaces to express their ideas and feedback (Blanchard & Vanderlinden, 2012). Nine participants returned their completed workbook. We analyzed the content of these workbooks and the complete transcript of the discussion according to a grounded-approach (Herpin, 2010; Lejeune, 2014), conducting a thematic analysis of our corpuses.

2.2. Workshop focus

Drawing on our previous interactions with SNCF staff and our knowledge of the company environment, we adjusted the proposed discussion framing and chose how and at which stage to introduce scientific inputs and raised different questions (Figure 1). Being able to include a climate-scientist in the research team was also a key ingredient of the experience.

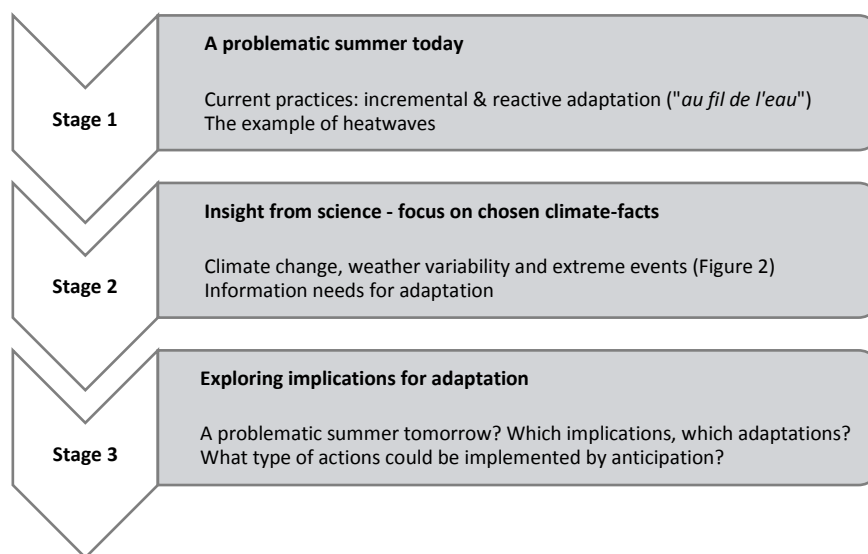


Figure 1: three stages of the workshop as it was built and items on the discussion agenda (Source: authors)

We hypothesized that some characteristics of climate change, might be major disruptive factors in spite of not always being immediately mentioned by the actors nor stressed in reference reports on climate change (Cattiaux, 2017a, 2017b; IPCC, 2014; Jouzel et al., 2014). Those characteristics are an increased climate variability, possible new extreme events and multiple uncertainties. We took the

⁷ Participant’s workbook “is a methodological tool that optimizes the time we spend together. This optimization falls into two orders. First by formalizing break times, with writing breaks, we anchor our deliberations better in what each and every one of us brings. Secondly, the participant workbook enables us to collect some data in the form of your writings.” (Blanchard & Vanderlinden, 2012).

apparent gap between how the company is adapting and those characteristics - recalled at the beginning of the session (Figure 2) – as the workshop starting point.

Take-home messages

- Talking about climate is talking about all possible weather situations
- The climate is changing and will change even more
- A changing climate enable unprecedented weather situations...
- ...all around the world, including in Languedoc Roussillon
- It especially means more heat waves, longer, more intense ... which may happen at unexpected moments in the year,



What is extreme today may be normal tomorrow ...
we may wonder what the extremes of tomorrow will look like!

Figure 2: wrap-up slide on climate science presented during the workshop (Source: authors, translated)

Our goal was to draw all the consequences of this increased climate variability and uncertainty for the railway system: technical concerns but also non-technical, for instance consequences regarding the business model or the service delivered.

In a context of deep uncertainty, many authors suggest to favor exploratory approaches of adaptation rather than predict-then-act deterministic procedures (Dessai et al., 2009; Dittrich, Wreford, & Moran, 2016; Hallegatte, Shah, Brown, Lempert, & Gill, 2012). Formulating questions based on triggering issue, discovering alternative courses of action, testing current practices and planned actions against a variety of futures are among the first steps of such approaches. We subscribed to this type of frameworks. (Wardekker, de Jong, Knoop, & van der Sluijs, 2010) used “wildcards” (i.e. imaginable surprises) to stress test adaptation options for coastal-management. In a similar fashion, we intended to question the current representations and ways of doing. As Malekpour, de Haan, & Brown (2016), we explicitly raised the question “what could go wrong with current SNCF approach and strategy with regards to climate change?”. We wanted the discussion to focus on the organization, its management practices, guidelines and its strategy more than available scientific information and uncertainties. The next sections report our findings.

3. Results

3.1 Questions raised by the focus on an increased climate variability, seasonal variation and extremes

We chose to discuss climate change with a seasonal approach, focusing on the current management of summer heatwaves and possible future hot seasons. This entry point drove the discussion towards the critical issue of increased inter-annual climate variability and seasonality (Cassou & Cattiaux,

2016; Fischer & Schär, 2009; Vrac, Vaittinada Ayar, & Yiou, 2014). Changes that were experienced by the workshop participants in the past did open conversations on the limits of current, well established, management practices. For instance, participants involved in the maintenance of the permanent way rose the issue of vegetation control along the tracks. Up to now, vegetation is managed through a centralized heavy process, relying on a national train operating all around the country to weed the tracks. This train has a very precise working-program planned up to three years in advance. This way of doing can only work if weeds lifecycle is foreseeable and stable enough. With an increase in variability, there may be early or late weed germination. Consequently, the train might miss the efficient treatment period. Alternative processes, maybe less centralized and more flexible, might therefore be implemented:

“For two years we have not weeded at the right moments. [...] The leaves fall in December and there are droughts in February. [...] So, when we do a treatment in April it's useless. It would be necessary to do it after the rains of June whereas the national trains is planned for April-May, it is too early. [...]. But we cannot program differently. With current industrial process of vegetation control with weeding trains set at the national level, we cannot fine-tune, we cannot do it case by case. Maybe we should work at the regional level to deal with it. The vegetation cannot be managed at the national level anymore with weather hazards and variations in seasonality we perceive, at least in Languedoc Roussillon. [...] It's been three years, that our regional train has to make a second pass because the first was useless. [...] We spread tons of glyphosate, it costs money and we are not very effective in Languedoc Roussillon at the moment.”

This example shows, that sometimes, it is when focusing on variability more than trends that climate change really starts questioning current management processes.

Summer heatwaves are one of the extreme events with the most serious implications for SNCF activities. They have technical consequences – e.g. rails buckling implying to temporary reduce trains' speed (European Environment Agency, 2014; Ferranti, Chapman, Lee, Jaroszweski, & Lowe, 2017; Jaroszweski, Baker, Chapman, & Quinn, 2013). They also have more organizational and human consequences affecting both workers and users comfort and health. They are a potential source of perturbation and crisis. For instance, Dubost describes how, because of unbearable heat onboard during a short traffic interruption in a suburban train near the city of Paris, travelers got off the train causing a prolonged traffic interruption for safety reasons (Abramovici, 2011; Dubost, 2017). Discussing about the possible recurrence of situations that are currently considered as exceptional questioned the ability of current crisis management guidelines to withstand the test of time. Here are some of the questions risen during the workshop:

“It is up to the company to decide if we must have trains running as scheduled despite exceptional conditions? At some point we must be able to answer no. When trains cannot circulate they cannot. I think we need to integrate this parameter in our operations. It's like that. This summer when it was

60°C in the US, planes did not take off. What do you want to do? Is it worth doing research to run engines at 60°C for only a couple of days or it is better not to take off for 3 days. These are all the questions we need to think about”

“Even in the case of a weather alert we send out the trains - as long as it is only an alert, we send them out. But today we know that for some alerts, we should perhaps consider alternatives.”

“At least on secondary routes we can generalize replacement options. If we know we will be annoyed the whole summer because of heat, rather than waiting for the incident, we could anticipate and implement in advance an alternative bus transport.”

Going in the same direction was the discussion about worst-case events. We did not want the debate to be limited only to imagine “most probable changes.” Narratives of possible future weather situation can “provide complementary, more realistic and more physically consistent representations of what future weather might look like” (Hazeleger et al., 2015). Going in this direction, we proposed an example of high-end but plausible scenario built on the existing literature in climate science (Bador et al., 2017; Berry, Betts, Harrison, & Sanchez-Arcilla, 2017; Dubuisson, 2017; IPCC, 2014; Jouzel et al., 2014; Quesada, Vautard, Yiou, Hirschi, & Seneviratne, 2012; Stott, Stone, & Allen, 2004). This possible future was made of a succession of several subsequent extremes events in a summer sometimes between 2035 and 2050: a dry spring, an early but short heatwave in May, a longer even if not extreme heatwave from July to September when the Cévenol⁸ season begins. We chose those events to be representative of various categories of climate evolution: changes in seasonality, changes in duration of heatwaves, and possible conjunction with disruptive climate events.

This exposé did not lead to a precise discussion on the responses to address to these particular cases. Participants more generally wondered what it could mean to cross these thresholds (ex. temperatures up to 50°C in summer becoming realistic (Bador et al., 2017)). It appeared very clearly that this could challenge some of the choices made today and particularly the viability of certain lines. This is particularly salient for lines exposed to climate hazard or dependent on seasonal flows (beach tourism in this region, ski elsewhere): “I wonder if in 2050-2100, the most structuring routes will be the same as today with this heat”. In other words, climate change questions investment policies and strategic choices. In particular, contexts combining an enhanced climate vulnerability and evolving socioeconomic reality may lower the overall relevance of railroads.

“-In case of heat, because of the risk of rails dilation you slow-down from 90 to 60 mph, but doing so, you disturb the whole traffic [...] -Such a deterioration of the performance questions the relevance of this mode of transport”.

⁸ A “Cevennes storm” or “Mediterranean episode” is a particular type of rain which mainly affects the Cevennes region, in the south of France and often cause severe flooding. They result from hot, humid and unstable air coming from the Mediterranean, which can generate violent and sometimes stationary storms. They occur mainly in autumn, when the sea is the warmest and evaporation strong. <http://www.meteofrance.fr/actualites/28475438-dossier-episode-mediterranee> (accessed 2018-2-2)

“If tomorrow, every summer you cannot take the train for 10, 20 or 30 days because the rails, the catenary or the air conditioning ... it questions the durability of the rail system in general. Maybe there are modes of transportation currently developed that will be more adapted. Adaptation is perhaps just a question of survival of the rail system.”

“There are lines with few customers and very expensive to maintain: should we continue to operate them? We have the case with Intercités routes, for instance in Lozère, with a purely economic perspective, we should not circulate anymore. Maybe that's where we go for tomorrow, if in addition there is more problems because of the weather”.

This discussion ranged from consequences of climate change to the railways installations themselves - which did not appear controversial - to more open-ended questions regarding management practices and policies or strategic investments. Moving from internal management concerns to social concerns, participants eventually reached issues that questioned current roles and opened up discussions on responsibilities and governance (Figure 3).

3.2 Discussing roles distribution, responsibility and governance

The responsibilities of the company were clear only for some of the issues that were raised. For instance, when it comes to vegetation control, there is no ambiguity regarding how to define and address the problem. Changing seasonal patterns becomes a source of inefficiency for those in charge of the maintenance of the network (namely SNCF Réseau and even more precisely the *M&T*⁹ department for the maintenance planning and regional *Infrapôles* for the implementation). When detected, this inefficiency becomes a salient item on the company agenda. Consistency with its objectives, priorities and performance indicators is pursued. Making this inefficiency visible and measurable is therefore the main lever for climate adaptation. As Network Rail (SNCF Réseau counterparts in the UK, (Network Rail, 2017)) did, SNCF could implement an action plan to monitor the relationships between climatic conditions and maintenance operations. This may allow for the definition of targets to improve the management of these relationships. Emerging adaptation initiatives previously observed (Dépoues, 2017) already go in this direction. They combine new weather indicators in partnership with the national meteorological service and an improved monitoring of the network. Implementing the relevant changes, moving for instance towards decentralized weed-control, is then a classical challenge for change-management. This is also an R&D challenge with a major technical aspect consistent with SNCF innovation strategy (SNCF, 2017). New

⁹ “Maintenance operations, surveillance of railway installations, organization, work site supply chains, implementation of works ... 24/7 Maintenance & Works staff ensure the maintenance and modernization of the railway network. [...] To guarantee a high level of performance, innovation and safety, Maintenance & Works defines priority renewal projects, especially within the framework of the Network Modernisation Plan. It also organises maintenance actions tailored as closely as possible to railway needs”: routine maintenance works, special maintenance works including renewal of the railway and grouped worked. <https://www.sncf-reseau.fr/en/about/our-business/maintenance-works> (accessed 2018-2-2)

IT solutions like smart-network monitoring offer new options for efficiency. Localized, predictive, agile maintenance based on sensor-data could effectively replace systematic centralized planning and could at least partially address this type of climate evolutions (““At the time leaves were falling in October ... it used to be like that. It is not the case anymore, so, [...] we may set up different processes to deal with that, there are plenty of innovations we can use, digital, connected, there is plenty to do”).

For other issues, however, adaptation is not as straightforward. Responsibilities are not as clearly defined. For instance, when climate change challenges crisis management, it opens questions ranging from acceptability of preventive train cancellations to availability and systematization of alternative options (ex. buses) or messages sent to users¹⁰. Who is responsible for addressing these questions remains unclear, because of their multiple consequences in terms of service quality, efficiency, image of the company (we talked about SNCF perception in the media, especially in the new social media era¹¹), but also in terms of public security. Mobility being a public service and railways being critical socio-economic infrastructures, such consequences go beyond SNCF itself. These questions involve many stakeholders both within SNCF and among public authorities. This part of the discussion on climate change impacts lead to a debate around costs, risks and responsibilities: “in the dialogue with traffic authorities, as soon as it comes to responsibilities and costs issues, discussions become like a ping pong game. Everyone is putting the responsibility on the others. We need to clarify who is in charge of what.”

SNCF Mobilités is often pointed as an easily identifiable culprit. It is on the front line, interacting on a daily basis with users of rails and directly blamed in case of disruption (“we are still the company that is quickly pointed out”; “in customers’ mind today, if we are forced to close a line, even because of a climate emergency, SNCF is still responsible”). However, the company does not necessarily control all the levers to address the issue. As a mobility provider, it has first to deal with shorter time horizons: it operates with the existing infrastructure and in case of crisis has to follow SNCF Réseau instructions (SNCF, 2016)¹². This situation will most likely be complexified by the opening of the rail

¹⁰ How to integrate this issue of adaptation into the information delivered to passengers? Is it a State responsibility or should it be delegated to SNCF? Are passengers ready to postpone their planned trips? ““A train-user book his ticket months in advance or even buy an annual transit pass. This means that from his perspective the trip is already promised, it is due. When there is an interruption it’s intolerable because he perceived it as a broken contract”.

¹¹ “Customer’s expectations are changing, becoming even more demanding and visible with social medias. In case of a crisis, cancelling a train may be very impacting for the company image. At the end of the day, whatever the initial cause, the message broadcasted is that “SNCF trains are not circulating”.”

¹² “SNCF Réseau is in charge, as Infrastructure Manager, of the management of operations related to the return to a nominal railway production on the National Rail Network” (translated from (SNCF, 2016)

transportation market: “In an opened-market, we just has to respond to the requirements of the authority in charge of the mobility policy¹³”. SNCF Réseau, as a long-life assets manager, is more long-term oriented (CEDD, 2015) – and thus is a less visible potential “culprit”. Yet, because of its natural monopoly on the infrastructure, it remains the unique and legitimate interlocutor for public authorities. Finally, public authorities have a duty to take care of public security¹⁴. They also enforce free-competition rules defined at the EU level for liberalized part of the service (freight, high-speed lines, international lines and soon regional traffic). Moreover, they design and financially support public mobility policies. Since the 2016 law¹⁵, there are two important public levels of governance regarding railway transport: the national State and Regional councils¹⁶. The national State is the traffic authority for Intercités services, i.e. middle-distance trains operating classical lines¹⁷. Regional councils are the traffic authorities for regional trains (so-called TER).

Taking into account those heterogeneous contexts and constraints, discussion around roles and responsibilities is critical for designing and implementing an efficient adaptation strategy (Preston, Westaway, & Yuen, 2011): “a recent study shows that demarcations of responsibilities are often lacking in adaptation policy documents”¹⁸. As noticed in (European Environment Agency, 2014, p. 14), “the responsibility for adaptation action in the transport sector is often not clear. [...] in the event that adaptation related to transport would happen only spontaneously, conflicting and ineffective strategies could follow”.

This rapid overview of actor’s relationships shows that the conditions may exist for a constructive dialogue on climate adaptation, at least between public authorities and SNCF Réseau (“Being the unique manager of the Infrastructure, SNCF Réseau will perhaps remain as the good interlocutor. It is also responsible for what happens on its network”). Mobility providers for their part can choose to remain silent or to share information with the authorities. Among participants, both options were defended. SNCF Mobilités has the legitimacy of experience but the dialogue may become more difficult in a competitive setting:

¹³ As noted, it is already the case in urban areas “Keolis is not defining the mobility Policy of Bordeaux Metropolis, it just operates the service”

¹⁴ Décret n° 2017-1071 du 24 mai 2017 relatif aux attributions du ministre d'Etat, ministre de la transition écologique et solidaire, cf. <https://www.ecologique-solidaire.gouv.fr/direction-generale-des-infrastructures-des-transport-et-mer-dgitm> (accessed 2018-02-05)

¹⁵ Loi n°2015-991 du 7 août 2015 portant nouvelle organisation territoriale de la République (Loi NOTRe)

¹⁶ Metropolitan France is divided into 13 administrative regions

¹⁷ « Trains d'équilibre du territoire »

¹⁸ Scholars proposed analytical framework to design comprehensive governance systems for adaptation. For instance (Huitema et al., 2016) provided a typology of options addressing the following dimensions problem choices, level choices, timing choices, choices concerning modes of governance and instruments, norms and principles choices and eventually implementation and enforcement choices.

“We are still in a situation of monopoly, but soon we will not be the only ones on the market. If we raise this topic but our new competitors do not, our clients will think that there are people able to manage it more efficiently than we do. At the end of the day, which legitimacy will we have to talk about these issues more than any other?”

“I still think that we must not remain totally silent. Precisely because of this new market situation. It would be too easy for traffic authorities to blame us for not alerting them. The new entrants encountering problems will explain that they are legacy of the past. As we know the risks we may gain from being irreproachable and transparent in the information we deliver to authorities.”

3.3 A variety of potential adaptation postures

Throughout these discussions, participants did not hesitate to consider a wide spectrum of adaptation options. They went quite far in questioning the implications of climate change, behind the usual veil of institutional postures. Without any representatives of public authorities, we could not fully compare everyone’s viewpoints during the workshop. However, even within SNCF we note that adaptation strategies can be very different depending on the actor’s constraints and interests:

- From an asset manager perspective, adaptation means in the first place to improve the infrastructure – making it more robust or more resilient - to assure it will be able to cope with climate changes. The issue at stake is to make sure that railway as a mobility option will survive in the coming years.
- From a mobility-policy perspective, adaptation is about making the relevant investments and prioritize choices to assure durable and qualitative services to users. Favored routes and transport techniques are considered variables in this equation, sometimes as favored modes. This is consistent with ongoing evolutions that drive historical players such as SNCF Mobilités to redefine their identity from a railway company to mobility-services providers: “Our partners only consider the railway option. We have to say that SNCF is now an intermodal company. [...] There is a pedagogical aspect to make our customers understand that global warming can change how we can fulfill our mission. And our mission is not to operate railroads; it is to carry people, to offer mobility services. ”Their challenge is to meet policy-makers requirements in the most cost-efficient and satisfying way: “In some places, the most adapted train line may be a bus line [...]”.
- From a commercial perspective (e.g. for TGV operating high-speed lines which are not subsidized as regional lines are) considering climate change means adapting the company value proposition¹⁹ (managing risks and seizing opportunities) to keep or improve a

¹⁹ i.e. what it offers to its customers, the promise of benefits to be delivered to users.

competitive advantage over other transport alternative. Adaptation therefore becomes part of an efficient marketing strategy wondering how customers' expectations will evolve regarding e.g. heat-comfort, top seasonal destinations or travel-priorities (will speed remain as important compared to reliability with more weather hazards especially for freight? (Dépoues, 2016)). As one participant said, "there are other companies entering the market both for travelers and freight, and [...] if Veolia trains are better air-conditioned, then more people will chose them, the comfort will become a criterion of competition"

This short description shows how, even within a "single" company such as SNCF Mobilités, several attitudes are possible and rational. Various economic configurations live together. Depending on the context, adaptation may be beneficial simultaneously, or not, to the interest of the state owned SNCF and to the interest of private operators²⁰. It very strongly depends on the overall market structure, which is different from one service to another and rapidly evolving. For instance, regarding TER, the current liberalization phase makes any long-term planning very difficult. A participant testified: "I lived the opening of market for freight, in the beginning the competitors did not talk about societal problems, it is only about the economics, the price, how to manage costs, how to go faster. [...] Our competitors will be much more concentrated on market shares than on climate issues". However, with time, this type of configurations may evolve: - towards an oligopoly in which adaptation may become a collective problem addressed through sectoral agreements²¹, or -towards monopolistic competition in which adaptation becomes part of a differentiation strategy (fostering adaptation as an innovation policy). The situation is already different for TGV or Fret SNCF (freight) which are commercial services engaged in an intermodal competition (against planes, coaches, trucks, etc.). In this context, adaptation can participate to the (re)definition of the benefits offered by SNCF to its customers: focusing for instance on user's comfort for TGV or reliability for the freight²².

4 Conclusion

Railway services are part of a social contract and SNCF is a major actor of French mobility. It is a very well known organization with which users have an "affective" relationship (Opinion Way pour Trainline, 2018; Regniault, 2017). As a result, when we present climate change as a potential game-

²⁰ about the public-private debate on adaptation see (Duit & Galaz, 2008; Klein, Juhola, & Landauer, 2017; Mees, Driessen, & Runhaar, 2012; Tompkins & Eakin, 2012).

²¹ A participant who worked for the water industry before described this type of configuration between major companies in this sector.

²² Conducting a foresight exercise, DHL, the German logistics company, for instance imagined a future in which vulnerability mitigation and resilience of transports becomes more important than speed and efficiency maximization because more numerous extreme weather events (DHL, 2012). Scenario 5: Global Resilience – Local Adaptation

changer, debates go far beyond technical adjustments or internal reorganization. Very quickly, they move towards bigger social questions regarding risk culture, mobility and travel expectations and habits (for work, for holidays²³).

"-Can we imagine to adapt daily transport plans? -It raises the question of working hours because people take the train too to go to work. -If tomorrow we have days with +8°C people will not work between 10:00 and 16:00, so there will be natural evolutions that will affect mobility-demand."

"When you think that the school holidays begin on the same day for everyone and so you have 15 million people heading to the train stations, it's an aberration in terms of transport organization".

At the end of the day, there is no unequivocal adaptation response to these wicked problems (Rittel & Webber, 1973) but a plurality of possible attitudes. This included the acknowledgement that foreseeing change is not sufficient to act. Costs and technological challenges must be factored in, and sometimes prevent anticipatory adaptation. "Wait and see," is thus an option, thus accepting to suffer the consequences. For some key factors such as SNCF Mobilités or traffic authorities, many alternative strategic choices are still open-ended.

SNCF is facing a dual challenge: adapting its activities to maintain a viable service but also taking part to the adaptation of society more broadly. To what extent this is SNCF's responsibility is open for discussion and may depend on which branch of the company we are talking about. Nevertheless, one could defend that as the historic, national player SNCF may have a strategic interest to be proactive and contribute to the adaptation of the economy and society.

This discussion needs to keep going, involving more stakeholders. The original interaction experimented here was successful in giving flesh to theoretical questions about adaptation. What do we really want to adapt a mode of transportation, a mobility service, a company? For participants, this is not an abstract discussion anymore. As expressed in their workbooks, many participants in the room had this discussion together for the very first time (e.g. "I knew, 4 or 5 of the participants, I appreciated such occasions to meet and talk [...] especially since SNCF Mobilités and SNCF Réseau are two different companies"; "What I appreciated was to get this transversal view thanks to the diversity of participants"). The workshop offered them a unique deliberative space to start thinking

²³ For school holidays, France is divided in zones/regions made to handle the holiday rush better. A national schedule sets every year holiday's periods. These fixed dates are key determinant of train- passenger flows (what we call "grands departs"). For instance see, http://www.sncf.com/ressources/cp_27_-_grands_departs_2017.pdf

about this issue while providing a unique insight on the complexity of envisioning adaptation under deep and multi-source uncertainty.

Questioning management practices	Questioning management guidelines	Questioning strategic choices	Questioning societal habits
Ex. vegetation control	Ex. crisis management	Ex. investment décisions & prioritisations	Ex. work and holidays organization
→ New technologies, procedures changes (ex. decentralization of weeding)	→ New cancelling policy, substitution options, changes in users communication	→ Reconsidering routes viability, permanent mode switch, favoring strategic redundancies	→ Working and travelling differently, accepting to lower expectations (ex. losing in speed for security/reliability)
An internal issue			A societal issue
Clear roles and responsibility distribution.	Issues of public security + infrastructure availability: a discussion to set up between SNCF Réseau and public authorities?	-Mobility as a public service: designing mobility policies; role of regional and national traffic authorities (SNCF Mobilités – TER/Intercité: service-provider implementing public requirement) -Mobility as a commercial service, TGV or Fret: commercial services, adaptation as an added-value proposition	A broad societal issue in which SNCF might play a role, for instance doing pedagogy with train-users, participating in a collective dialogue on the necessary evolutions of the « contract » between users, authorities and mobility providers

Figure 3: synthetic mapping of adaptation issues as expressed during the workshop

Acknowledgements

This research was funded by the French National Energy and Environment Agency (ADEME), the Institute for Climate Economics (I4CE) and SNCF. We are especially grateful to Christian Dubost, Bernard Torrin, Antoine Rothey, Claire Rousselet and Jean-François Ruiz (SNCF and SNCF Réseau) for their valuable support to access the relevant material in the company and to organize the workshop. We thank Benoit Leguet and Bruno Lafitte for constructive feedback.

References

- Abramovici, M. (2011). Attention, un client peut en cacher un autre » Gérer les clients en situation perturbée. *Gérer & Comprendre*, 105(3), 71. <http://doi.org/10.3917/geco.105.0071>
- Bador, M., Terray, L., Boé, J., Somot, S., Alias, A., Gibelin, A. L., & Dubuisson, B. (2017). Future summer mega-heatwave and record-breaking temperatures in a warmer France climate. *Environmental Research Letters*, 12(7). <http://doi.org/10.1088/1748-9326/aa751c>
- Berkhout, F. (2012). Adaptation to climate change by organizations. *Wiley Interdisciplinary Reviews-Climate Change*, 3(1), 91–106. <http://doi.org/10.1002/wcc.154>

- Berry, P., Betts, R., Harrison, P., & Sanchez-Arcilla, A. (2017). *High-End Climate Change in Europe*.
- Blanchard, A., & Vanderlinden, J.-P. (2012). Interdisciplinarité et outils réflexifs : vers une approche globale des trames vertes urbaines. *Vertigo*, (Hors-série 12).
<http://doi.org/10.4000/vertigo.11798>
- Cassou, C., & Cattiaux, J. (2016). Disruption of the European climate seasonal clock in a warming world. *Nature Climate Change*, (April), 1–6. <http://doi.org/10.1038/nclimate2969>
- Cattiaux, J. (2017a). Cours Changement climatique - ENM.
- Cattiaux, J. (2017b). Quel temps fera-t-il dans 59 ans ?
- CEDD. (2015). *La gestion des infrastructures de réseaux*. Retrieved from <https://www.ecologique-solidaire.gouv.fr/sites/default/files/CEDD - La gestion des infrastructures de réseaux - Résumé.pdf>
- Chambers, R. (2002). Participatory workshops. A source of 21 sets of ideas and activities. *London, England: Earthscan.*, 220 p. <http://doi.org/10.1108/et.2002.00444had.006>
- Colombert, M. (2016). *ADAPTATIO Rapport Final*.
- Corre, L., Dandin, P., L'Hôte, D., & Besson, F. (2015). The VIADUC project: innovation in climate adaptation through service design. *Advances in Science and Research*, 12(1), 199–205.
<http://doi.org/10.5194/asr-12-199-2015>
- Dépoues, V. (2017). Organisational uptake of scientific information about climate change by infrastructure managers: the case of adaptation of the French railway company. *Climatic Change*, 143(3–4), 473–486. <http://doi.org/10.1007/s10584-017-2016-y>
- Dépoues, V., Vanderlinden, J.-P., & Venturini, T. (2017). *Entre dire et faire : discours scientifique sur le changement climatique et adaptation du système ferroviaire français*.
- Dessai, S., Hulme, M., Lempert, R. J., Pielke, R., Dessai, S., & Hulme, M. (2009). Climate prediction: a limit to adaptation. Adapting to climate change: thresholds, values, governance. In *Adapting to climate change: thresholds, values, governance*. (pp. 64–78).
<http://doi.org/http://dx.doi.org/10.1017/CBO9780511596667.006>
- Dittrich, R., Wreford, A., & Moran, D. (2016). A survey of decision-making approaches for climate change adaptation: Are robust methods the way forward? *Ecological Economics*.
<http://doi.org/10.1016/j.ecolecon.2015.12.006>
- Dubost, C. (2017). SNCF: face to face with climate change. In B. Laville, A. Euzen, & S. Thiébaud (Eds.), *Adapting to Climate Change: a question for our societies* (CNRS Editi).
- Dubuisson, M. B. and L. T. and J. B. and S. S. and A. A. and A.-L. G. and B. (2017). Future summer mega-heatwave and record-breaking temperatures in a warmer France climate. *Environmental Research Letters*, 12(7), 74025. <http://doi.org/10.1088/1748-9326/aa751c>
- Duit, A., & Galaz, V. (2008). Governance and Complexity—Emerging Issues for Governance Theory. *Governance*, 21(3), 311–335. <http://doi.org/10.1111/j.1468-0491.2008.00402.x>
- European Environment Agency. (2014). *Adaptation of transport to climate change in Europe: challenges and options across transport modes and stakeholders*.
- Ferranti, E., Chapman, L., Lee, S., Jaroszweski, D., & Lowe, C. (2017). The hottest July day on the railway network : insights and thoughts. <http://doi.org/10.1002/met.1681>
- Fischer, E. M., & Schär, C. (2009). Future changes in daily summer temperature variability: Driving processes and role for temperature extremes. *Climate Dynamics*, 33(7–8), 917–935.
<http://doi.org/10.1007/s00382-008-0473-8>
- Haasnoot, M., Kwakkel H, J., Walker, W. E., ter Maat, J., Kwakkel, J. H., Walker, W. E., ... ter Maat, J. (2013). Dynamic adaptive policy pathways: A method for crafting robust decisions for a deeply uncertain world. *Global Environmental Change*, 23(2), 485–498.
<http://doi.org/10.1016/j.gloenvcha.2012.12.006>

- Hallegatte, S., Shah, A., Brown, C., Lempert, R., & Gill, S. (2012). Investment Decision Making Under Deep Uncertainty: Application to Climate Change. *Policy Research Working Paper*, (6193), 41. <http://doi.org/doi:10.1596/1813-9450-6193>
- Hazeleger, W., van den Hurk, B. J. J. M., Min, E., van Oldenborgh, G. J., Petersen, A. C., Stainforth, D. A., ... Smith, L. A. (2015). Tales of future weather. *Nature Climate Change*, 5(2), 107–113. <http://doi.org/10.1038/nclimate2450>
- Herpin, N. (2010). Barney G. Glaser, Anselm Strauss, La découverte de la théorie ancrée. Stratégies pour la recherche qualitative. *Lectures*. Retrieved from <http://lectures.revues.org/1357>
- Huiteima, D., Adger, W. N., Berkhout, F., Massey, E., Mazmanian, D., Munaretto, S., ... Termeer, C. C. J. A. M. (2016). The governance of adaptation: Choices, reasons, and effects. Introduction to the special feature. *Ecology and Society*, 21(3). <http://doi.org/10.5751/ES-08797-210337>
- IPCC. (2014). Working Group II Contribution to the IPCC Fifth Assessment Report, Climate Change 2014: Impacts, Adaptation and Vulnerability. *Ippc, AR5(2014)*.
- Jaroszweski, D., Baker, C., Chapman, L., & Quinn, A. (2013). The impact of cc on transports: current progress and future requirements.
- Jouzel, J., Ouzeau, G., Déqué, M., Jouini, M., Planton, S., & Vautard, R. (2014). Le climat de la France au {XXIe} siècle Volume 4 Scénarios régionalisés: édition 2014 pour la métropole et les régions d'outre-mer.
- Kane, I. O., Vanderlinden, J.-P., Baztan, J., Touili, N., & Claus, S. (2014). Communicating risk through a DSS: A coastal risk centred empirical analysis. *Coastal Engineering*, 87, 240–248. <http://doi.org/10.1016/j.coastaleng.2014.01.007>
- Klein, J., Juhola, S., & Landauer, M. (2017). Local authorities and the engagement of private actors in climate change adaptation. *Environment and Planning C: Politics and Space*, 35(6), 1055–1074. <http://doi.org/10.1177/0263774X16680819>
- Lejeune, C. (2014). *Manuel d'analyse qualitative Analyser sans compter ni classer*. De Boeck Supérieur.
- Mees, H., Driessen, P., & Runhaar, H. (2012). Who governs climate adaptation adaptation? Exploring the scope for public and private responsibilities. *Journal of Environmental Policy & Planning*, 14(3), 305–330.
- Network Rail. (2017). *Network Rail Weather Resilience and Climate Change Adaptation Strategy 2017-2019*.
- Opinion Way pour Trainline. (2018). Les Français et l'ouverture à la concurrence du secteur ferroviaire.
- Porter, J. J., & Dessai, S. (2017). *Mini- me : Climate scientists ' (mis) perceptions of users and their needs. Working Paper No . 12 SRI PAPERS (Vol. Paper No .)*.
- Preston, B. L., Westaway, R. M., & Yuen, E. J. (2011). Climate adaptation planning in practice: An evaluation of adaptation plans from three developed nations. *Mitigation and Adaptation Strategies for Global Change*, 16(4), 407–438. <http://doi.org/10.1007/s11027-010-9270-x>
- Quesada, B., Vautard, R., Yiou, P., Hirschi, M., & Seneviratne, S. I. (2012). Asymmetric European summer heat predictability from wet and dry southern winters and springs. *Nature Climate Change*, 2(10), 736–741. <http://doi.org/10.1038/nclimate1536>
- Regniault, F. (2017). *La SNCF Pour les Nuls*. (First, Ed.) (First). Paris: Pour Les Nuls.
- Rittel, H. W. J., & Webber, M. M. (1973). Dilemmas in a general theory of planning., 4(2), 155–169.
- Rotter, M., Hoffmann, E., Pechan, A., & Stecker, R. (2016). Competing priorities: how actors and institutions influence adaptation of the German railway system. *Climatic Change*, 137(3–4), 609–623. <http://doi.org/10.1007/s10584-016-1702-5>
- SNCF. (2016). *Document de référence : Coordination de la gestion des situations de crise du système*

ferroviaire. Evolution.

SNCF. (2017). *Innovation & recherche 2016.*

Stott, P. A., Stone, D. A., & Allen, M. R. (2004). Human contribution to the European heatwave of 2003. *Nature*, 432(7017), 610–614. <http://doi.org/10.1038/nature03089>

Surminski, S. (2013). Private-sector adaptation to climate risk. *Nature Climate Change*, 3(11), 943–945. <http://doi.org/10.1038/nclimate2040>

Tissot, A.-C., Amiotte-suchet, P., Brulebois, E., Castel, T., Ponnou-delaffon, V., Richard, Y., ... Bertrand, F. (2016). *Projet HYCCARE Bourgogne, Rapport Final.*

Tompkins, E. L., & Eakin, H. (2012). Managing private and public adaptation to climate change.

Global Environmental Change, 3(11), 3–11. <http://doi.org/10.1016/j.gloenvcha.2011.09.010>

Vrac, M., Vaittinada Ayar, P., & Yiou, P. (2014). Trends and variability of seasonal weather regimes.

International Journal of Climatology, 34(2), 472–480. <http://doi.org/10.1002/joc.3700>

Wardekker, J. A., de Jong, A., Knoop, J. M., & van der Sluijs, J. P. (2010). Operationalising a resilience approach to adapting an urban delta to uncertain climate changes. *Technological Forecasting and Social Change*, 77(6), 987–998. <http://doi.org/10.1016/j.techfore.2009.11.005>

WBCSD. (2014). *Building a Resilient Power Sector.*