OF TRAINS AND CLIMATE

In the field of rail transport, climate change raises very concrete challenges. The infrastructure is already under heavy stress and suffers from waves of heat that distort the rails and from floods that can disrupt traffic. Passenger comfort raises additional problems. How can we adapt to these changes? How can we anticipate them? Major rail companies have been thinking about these problems for several years and are beginning to design new strategies of action on the short, medium and long term.

In the report commissioned by the World Bank, published in late 2012, one could read the following statement: “A rise of 4°C in temperatures will lead to unprecedented waves of heat, severe droughts and floods in many areas. These natural disasters will have a serious impact on ecosystems and on the services associated with them.” The report also stated that: “The world has recently experienced a series of events that highlight the extreme vulnerability of developing countries but also of rich industrialized countries.”

The prospect of a substantial climate change by the end of the century is now a certainty. Updated forecasts will be presented by the Intergovernmental Panel on Climate Change in its fifth report. In February 2012, French research teams had already submitted their own contribution (PDF, in French) to these new estimates. The current projections forecast an increase of average temperatures of 2 to 6°C by 2100.

We are slowly beginning to take the measure of this global impact. In the United States today, one fourth of the surface transportation delays are due to bad weather and it is expected that droughts and storms will increase in frequency, strength and duration in the coming years.

The different types of consequences induced by climate change on weather conditions in Europe are already well identified. Nevertheless, we still don't have a clear vision about their intensity nor their exact location. For a country like France, the evidence suggests an increase in the number of extreme weather events: heavy rainfall leading to floods, heat waves in summer, periods of extreme cold.

To reduce the vulnerability of the rail system and, more generally, of the mobility system, large transport companies and governments have begun to develop a strategy for adapting their activities. In the United Kingdom, for example, 550 billion pounds (611 billion euros) need to be spent by 2050 to adapt the infrastructure to climate change; one billion pounds will be spent on the protection against floods by 2035, an increase of over 80% compared with the current expenditure in this area.

But it is not only a matter of figures. The very manner in which mobility is conceived and organized will undergo dramatic changes. Such major issues trigger a specific need of reflection.

Issues and Methods

What are the challenges for a mobility integrator? From the industrial and commercial point of view, climate change will have an impact on the comfort of passengers and employees, flow of goods, rolling stock (technical specifications, maintenance cycles, cleaning, air conditioning...), stations (choice of location, design and renovation) or infrastructure (roads, vegetation...) and on the offer of mobility services that transport operators can provide from start to finish. Logically, this also has an impact on the choice of multi-year investments in different parts of the production tool.

Basically, the challenge is to adapt to the new conditions. The Third Assessment Report of the IPCC http://www.ipcc.ch/index.htm#.UYI_moIWjJw specifically mentions the “adaptation of natural or human systems in response to climatic stimuli or to their impacts, to reduce adverse effects and take advantage of beneficial opportunities.”

Strategic reflection of this magnitude needs to be developed with the public authorities. In France, a decisive step was made with the so-called Grenelle de l’Environnement, a governmental summit organized in 2007 involving NGOs and other players. It was decided to develop a National Plan for Adaptation to Climate Change (PNACC, in French) for various sectors, including transport.

The PNACC identifies various actions. These include anticipating and minimizing potential damage by an ex ante intervention on the factors that will determine the extent of damage (e.g. urbanization of areas at risk). But the challenge is also to organize the rapid repair of the equipment that has suffered the impacts of climate change (e.g. quickly restore electrical distribution after an extreme event).

The SNCF has taken part in this reflection by creating a working group that brings together specialists from different areas of the firm while involving external professionals and experts.

Rather than making a specific study for each of the components of the rail system, they have chosen to implement a systemic approach.

A central issue was to define strategic directions for the adaptation of activities. The six key steps described in Économie de l’adaptation au changement climatique by Christian de Pertuis et al (The Economics of Adaptation to Climate Change, 2010) served as reference. After an initial phase of identification of the impacts of climate change, their timeframe and of the vulnerability of zones, it was necessary to identify priority adaptation measures based on the identified impacts. An assessment of the priority measures and the selection of these measures, consistently with the overall strategy, helped finalize the study phase before moving to the operational phase.

A work of this magnitude cannot be made alone: special attention has been paid to foreign experiences. What do they teach us?

New vulnerabilities: the Spanish, British and Japanese lessons

"In some scenarios, Paris will need to learn how to live with a climate similar to that of Seville, in southern Spain," according to the researcher Stéphane Hallegatte. To compare the results of our studies on the heat waves issue with ground realities, we shared our experience with Spanish Railways (RENFE) on the operating conditions of mobility operators in southern Europe.

The air conditioning units installed on board the AVE, the Spanish high-speed trains, have better specifications than those installed in similar trains in other countries. Design specifications for the air conditioning of AVE are the following: with an outside temperature of 40°C and a relative humidity of 43%, the temperature inside the passenger cars must not exceed 25°C in temperature and 40% of relative humidity.

Air conditioning equipment must be designed to always work whatever the temperature or humidity outside. Financial compensation is provided to passengers in case of failure.

But passenger comfort is only part of the picture. The infrastructure is also involved and from this point of view, decisions may have serious consequences. Since these facilities are capital intensive and have very long life cycles, the decisions that are made today concerning transport infrastructure will have an impact during the 30, 50 or even 100 coming years, from their conception until the end of their life.

The ADIF, the Spanish railway infrastructure manager, has sought to identify and assess the risks involved by the increased frequency of flooding due to climate change as well as determine the urgency of corrective actions, if necessary. Eleven studies of flooding risks were carried out in different Spanish regions: in each case, a flood risk zoning was established to provide an a priori knowledge of the sections of rail tracks affected by the increased risk of flooding or drainage basin movements. A parametric analysis of risks was performed by taking into account the degree of probability of the onset of a disaster by landslides and other disasters involving water, as well as the severity of damage. Then, a detailed study of the elements of railway infrastructure (earthworks, bridges, tunnels) was undertaken to examine the impact of flooding on the status of each of these structures and to implement various strategies and measures to prevent or mitigate the impacts, without forgetting to maintain the natural balance of the hydrological system.

The ADIF concluded there would be a decrease in rainfall due to climate change and a probable increase of storms in critical areas, which could affect the developed infrastructures as far as reducing or suppressing rail capacity and therefore, the movement of trains. The ultimate goal of the study was to produce a document in which the problems due to geological and hydrological phenomena, likely to be encountered by the infrastructure, are identified and evaluated; additionally, to determine the urgency of any corrective action.

Heat waves appear clearly as a priority threat. Particularly interesting measures are being implemented or under development by Japan Railways (JR). JR Central has observed an increase in the temperature of the rails during the recent years (over 60°C). To prevent track buckling, the maintenance of continuous welded rail and rail joints should be reinforced. Measurement procedures and maintenance methods during the specific time of year when temperatures are very high are implemented by the operator. To achieve “zero accidents” due to track buckling, the track structures requiring maintenance are identified and strengthened as well as the type of maintenance to be performed. The estimated maximum temperature, which was set to 60°C, was raised to 65°C. Changes in the management of long welded rails regarding this temperature rise are studied by JR East. The analysis of the degree of safety of rail fastening systems is also being revised. JR West also implements measures to prevent track buckling. A maintenance vehicle with a CCD camera to detect the opening of joints has also been developed. Devices for measuring the gauge of the track were also tested. JR Shikoku and JR Kyushu have also implemented optimizations for the operations involved in changing rails to reduce accidents during very hot, but also very cold periods.

Under completely different climatic conditions, Network Rail – the manager of the British infrastructure – identified a range of impacts and their consequences.

Infrastructure vulnerabilities and their effects

Climate impact	Field	Effects
Heat	Rails	Buckling risk management
Heat	Rails	Reduction of the window of opportunity for maintenance employees (too much heat in the workplace)
Heat	People	Health of passengers (prolonged train stops during situations of extreme temperature)
Heat	People	Impact on freight of prolonged train stops under extreme temperatures circumstances
Heat	People	Working staff conditions
Heat	Signaling, electricity and telecommunications	Catenary loosening
Heat	Signaling, electricity and telecommunications	Impact of heat on the tracks circuit
Heat	Signaling, electricity and telecommunications	Damage on the tracks and tracks equipment failure
Precipitation	Watercourse	Damage on the tracks and tracks equipment failure
Precipitation	Groundwater	Damage on the tracks and tracks equipment failure
Precipitation	Watercourse	Erosion and water effects on bridges
Precipitation	Watercourse	Deepening of embankments (high water level)
Precipitation	Watercourse	Security of staff carrying out inspections during extreme floods
Sun exposure/ heat/ rainfall/ wind	Vegetation	Changing the type of plants, poor adhesion, deactivation of track circuits
Sun exposure/ heat/ rainfall/ wind	Vegetation	Falling trees causing obstructions
Rise in sea level, storms	Defenses of coasts and estuaries	Flooding of coastal tracks, waves crossing the tracks

(Source: Network Rail, October 2010)

Apart from the rail network and trains, there is also the issue of buildings which, even if less crucial, are also part of the agenda. For example, over the last years, the Blackfriars Station in London has undergone major reconstruction works, for a total cost of 550 million pounds (633 million euros). This station is part of the Thameslink connecting Bedford to Brighton via Gatwick. The redevelopment program was developed by taking into account the long-term implications of climate change, including regulatory constraints. The new station will be equipped with systems for collecting rainwater as well as thermal and photovoltaic solar panels to reduce the dependence of the station to water and electricity networks. The station will produce about 50% of its electricity needs on site. Network Rail considers the implementation of these panels as a scale test which will help evaluate the benefits of this technology and its application to other infrastructure in the future.

The SNCF Strategy

By taking into account these different examples, the SNCF has built its adaptation strategy. The heart of this strategy is based on a series of “no regret” measures, that is to say measures whose cost/benefit balance remains positive independently from the pace of climate change.

The whole set of measures is divided into three parts. The first is dedicated to the creation of a knowledge base to refine the measurement of risks and associated losses to assess better the feasibility and cost of technical solutions. The second is dedicated to the development of tools for support to the different relevant timeframes: crisis management in emergency situations, prevention plans and investments on the medium term. The third part is dedicated to the mobilization of internal and external stakeholders without which the SNCF cannot take action: staff, organizing authorities, public authorities, customers.

Technical solutions are already known – although newer, and more efficient, solutions could emerge thanks to technological advances. These solutions are already implemented by the operators present in countries with a harsher climate than ours; they are also implemented as crisis management solutions by the SNCF during extreme weather events.

A multiple response to heat waves: technical solutions

Climate risk	Impacts on the SNCF	Possible adaptation measures
Overheating of the air in cars	Discomfort, uneasiness of staff and passengers	Longer preconditioning of trains
		More demanding specifications of the air conditioning device
		Improve ventilation (based on dual-flow ventilation models)
		On vehicles traveling at moderate speed (eg trams), install ventilation without air conditioning (cf. tramway La Réunion)
Alteration or premature wear of the electronics or the rail signaling equipment	Loss of reliability	More frequent maintenance
		Harden the specifications
Engine overheat	Loss of tractive power of engines	Slowing down of traffic
Vegetation dryness	Slope fires, fires along the railway	Choice of less flammable plant species
		Preventive coordination with civil security
	Presence of animals along the railway, in search of pasture	Fences along the tracks
		Impact shields in the front of the locomotives
Under the effect of global warming, the habitat areas of certain insects unknown in France moves north.	Invasion of these insects in cars (ventilation systems, sleeper trains ...)	

(Source: SNCF 2012)

SNCF, who is a long-term investor, should consider taking "decisions without regret" concerning the industrial elements that will still be used in the period from 2030 to 2050. To this end, different solutions are proposed.

The first step is to develop and update a regionalized map of climate vulnerabilities based on 30-year forecasts from Météo-France models (Arpège) and IPSL/Jussieu. This work must be shared with RFF concerning infrastructure vulnerability. The second step is to update the construction and maintenance standards of the infrastructure in cooperation with the national manager (RFF), guidelines for restoring vegetation in rail corridors, recommendations and specifications for the European or international resilience of rolling stock, insurance clauses of the haulier regarding climate risk. Third step, initiate a reflection on the management of a long-term climate crisis involving many players (actors, decision-making process, public information, alternative plans, “climate emergency plan”). Fourth step, stimulate innovation concerning the ecodesign of components of the rail ecosystem.

Source : http://www.paristechreview.com/2013/05/02/trains-and-climate/