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Adaptation of transport infrastructures and networks to climate change

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Abstract

Climate, with no remaining scientific uncertainties is changing. First impacts of climate change are already felt in several fields, such as transport energy, agriculture and are expected to increase in the near future. Notably, transport networks are essential for economy and society: their adaptation is necessary. Therefore, the French National Climate Change Adaptation Plan has defined actions in its field "transport infrastructures and systems". Transversal working groups with experts of various transport infrastructures were established in 2011 and have developed a strong cooperation to address this issue. They published: *i)* a thorough review of technical, regulatory and normative standards that require an update to adapt construction, maintenance and operation of infrastructures and networks to climate trends and *ii)* a risk assessment framework to prevent future extreme weather events on transport. Aim of this paper is to present methodologies and results of both publications.

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Keywords: Transport infrastructure; transport network; adaptation; climate change; risk assessment.

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1. Aim of this article

Aim of this article is to present a major collaborative initiative of the French administration. Experts and managers worked together to address the rising issue of climate change impacts on transport infrastructures. The methodologies developed and the results obtained are discussed.

2. Introduction

Transport infrastructures are highly valuable assets designed for a long period of use. Moreover, they play a major socio-economic role. Climate change put them at risk (see e.g.: ONERC, 2008; 2009). Therefore, their adaptation to future climate trends is necessary. It is an international increasing issue, which is in France addressed by the National Climate Change Adaptation Plan (MEDDE, 2011) - PNACC[1]. The Plan is aimed at anticipating climate changes in mainland France and its overseas territories. Published first in 2011 for a five years period, renewable, it covers 20 fields such as transport infrastructures, health, energy and industry, agriculture, etc. The field "transport infrastructures and systems" deals with goods and passengers transport and anticipation of climate change impacts on transport infrastructures and mobility. It plans to develop tools and strategies to enhance infrastructures adaptation capacity. The following actions have been defined:

- Action 1: review and adapt technical standards for construction, maintenance and operation of transport networks (infrastructures and equipment) in continental France and French overseas territories;
- Action 2: study the impact of climate change on transport demand and the consequences for reshaping transport offer;
- Action 3: define a harmonized methodology to diagnose the vulnerability of land, sea and airport infrastructures;
- Action 4: map out the vulnerabilities of land, sea and air transport networks in continental France and in French overseas territories, and prepare appropriate and phased response strategies to local and global climate change issues.

Transversal working groups, at the request of the Directorate General for Infrastructure, Transport and Sea[2] of the French Ministry of Ecology, Sustainable Development and Energy and under its supervision, were established in 2011. Under direction of the Cerema[3], experts of all transport systems from different technical services of the French government: territorial and technical entities of the Cerema, CETU[4], STAC[5], STRMTG[6], from various public transport managers: VNF[7], RFF[8], SNCF[9], and from a non-profit organization: IFRECOR[10], have developed a close collaboration to address these four issues.

Amongst others, they delivered in 2015 a technical report (Cerema, 2015a) covering potential impacts of climate change on transportation infrastructures and systems, on their design, maintenance and operation standards, and the need for detailed climate projections for their adaptation (Action 1). They also published a methodology[11] entitled

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[1] Plan National d'Adaptation au Changement Climatique.

[2] DGITM: Direction Générale des Infrastructures, des Transports et de la Mer.

[3] Centre d'études et d'expertise sur les risques, l'environnement, la mobilité et l'aménagement (Center for studies and expertise on risks, environment, mobility and urban and country planing).

[4] Centre d'étude des tunnels (Tunnel engineering center).

[5] Service technique de l'aviation civile (Civil aviation technical center).

[6] Service technique des remontées mécaniques et des transports guides (Ropeway and guided transport technical center).

[7] Voies navigables de France (Navigable waterways of France).

[8] Réseau Ferré de France (French rail network).

[9] Société nationale des chemins de fer français (French national railway company).

[10] Initiative française pour les récifs coralliens (French coral reef initiative).

[11] This methodology is still under development, therefore qualified as interim report, however already useable.