

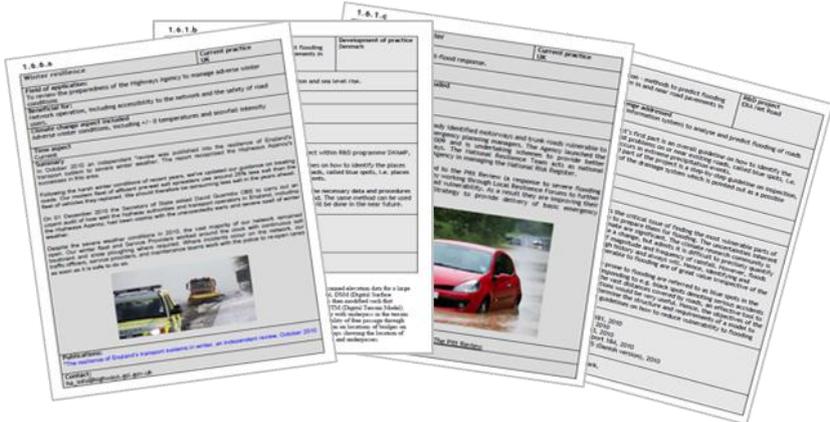
## **CEDR’s Work on Adaptation to Climate Change**

Conference of European Road Directors, CEDR, initiated work on studying the effects of climate change on roads. The work belongs to Strategic Plan 2 (2009-2013), Thematic Domain Operation and is organised as twin tasks dealing with adaptation to climate change (task 16) and mitigation of climate change (task 17). The mandate of the adaptation task group was to outline the main consequences of climate change for road infrastructures and to propose actions for adapting the road network to climate change. The report was presented to the road directors in October 2011.

Europe can roughly be divided in two parts, with respect to climate change. In northern and eastern Europe, warmer and wetter winter seasons will impose the main challenges. In southern, western and central Europe, climate change challenge will be dominated by warmer and dryer summers.

Climate change, as described by the projections from global and regional models, will bring about a number of challenges for the road network in Europe. In most cases this will be today’s challenges, but on a larger scale, occurring more frequently and at other locations than expected. In addition, we may experience more of unusual weather combinations, e.g. winter floods. In some cases climate change may be beneficial for the road owners, e.g. in places where less snow can be expected.

The work in the CEDR task group on adaptation to climate change started by performing two important surveys. The aim of the first survey was to map the awareness of the NRAs about climate change issues: Which specific problems are already observed? Are the NRAs prepared to deal with them? The second survey was performed to obtain an overview of ongoing work concerning adaptation to climate change.



*Fig. 1. Report for CEDR contains a thematic collection of examples demonstrating adaptation work in the participating countries*

The road administrations seem to be well aware of the possible consequences of climate change. Adaptation efforts have started, as is demonstrated by a compilation of examples of ongoing adaptation work. Some of the examples refer to R&D programmes. Others describe current practice in one country that may be useful and relevant for application in another country.

In preparing for a wetter climate, the most important issues to address are:

- Risks of flood and erosion – a challenge for drainage systems, erosion protection and for the design and maintenance of culverts and bridges,
- Landslides and avalanches: occurring more frequently, at new locations and with a higher share of “wet” landslide types, such as slush avalanches and debris flow,
- Droughts and high summer temperatures may impose problems for the asphalt surfacing, due to softening, but also for runoff conditions, due to lower permeability. Risk of wildfires may also increase in the southernmost regions.
- Deterioration of roads and pavements – i.e. increased rutting and reduced service life, mostly in cases where the drainage is insufficient,
- Effects of sea level rise on coastal stability and importance of ensuring sufficient elevation for roads, quays, and bridges, as well as sub-sea tunnel portals,
- Heavy snowfall in mountain areas of northern Europe, causing trouble for winter maintenance and operation,
- Risk management and efficient procedures for initiating remedial actions after an unwanted event occurs – due to the fact that present protective measures may not be sufficient and that the planning of remedial measures requires time.



*Fig. 2. After the storm “Dagmar”, Aurland, Norway 2011 (Foto: Arne Veum)*

Effect of climate change can be recognised in all phases of road management: planning, design, construction, maintenance and operation. The challenges should be addressed as early as possible. Here are the main issues:

**Planning:** alignment of roads avoiding excessive exposure, comprehensive plans for management of runoff water, early considering implications on maintenance;

**Design and construction:** ensuring sufficient drainage capacity and sufficient erosion protection, revising design rules for adaptation to higher climate loads, developing models for more analytical risk assessment for landslides, designing robust pavements resistant to high temperatures, taking care of environmental issues: pollution control, fauna etc, considering implications of road design on maintenance, taking care of climate issues in construction contracts;

**Maintenance and operation:** risk assessment in all phases, at all levels (identifying the most vulnerable assets according to predicted climate change, mitigating damage, prioritising needs), risk management related to unwanted events (preventive measures following forecast,

preparedness and emergency plans for managing situations after unwanted events), taking care of maintenance backlog – a drawback for road management in general, preparing for more demanding conditions for winter operation (by good contracts, emergency plans etc.), efficient traffic management (communication of risks under unwanted events and rerouting, use of good monitoring systems for traffic control), improved contracts (better definition of standard vs. exceptional condition, methods for sharing risk, robust requirements for inspection routines and documentation).

**The knowledge base for adaptation** should be developed by improved monitoring, mapping, and documentation of events on the road network. Further research is necessary for obtaining more knowledge on the effects of climate change on the road network, developing ways of defining acceptable risk and risk-based specifications. Raising awareness of stakeholders and the general public on the importance of adaptation is also important.

**Prioritising:** Adaptation to climate change should begin already in the planning phase of a road project and should be included in all other working procedures. For existing infrastructure, adaptation measures should be carried out as a part of planned maintenance or repair. The measures have to be chosen in a way that sufficient safety is achieved during the (remaining) service life of the structure. Postponing action is advisable only if it is followed up by monitoring the condition of the structure and the development of the most important climate factors. In some cases, accepting damage and the costs of repair may be the best solution.

However, defining the acceptable level of risk is a difficult task. It is also difficult to define the standard or “normal” climate valid for the service life of a structure or for the duration of a maintenance contract. This accentuates the need for good contact with expert offices in meteorology and hydrology and for good contracts for maintenance and operation.

The following **no-regret actions** are pointed out: reducing the maintenance backlog; improving the knowledge base through research, communication of needs, documentation of events and performed maintenance or repair; improving preparedness; and formulating maintenance and operation contracts which include better information about risks, improved monitoring, inventory and emergency plans.

## **Acknowledgements**

The report to CEDR is the result of the work of a task group consisting of: Christian Mlinar (Austria), Michael Kenneth Quist and Michael Larsen (Denmark), Janne Lintilä (Finland), Yves Dantec /Raphaël Jannot /Anne-Laure Badin (France), Simon Attila and Jozsef Zsidakovits (Hungary), Mary Bowe (Ireland), Giovanni Magaró (Italy), Eva Ruiz-Ayucar and Alberto Compte (Spain), and Dean Kerwick-Crisp (United Kingdom), in addition to the author of the paper. The co-author of the paper was engaged by the NPRA to assist in the production of the report. The leader of the joint group for mitigation and adaptation has been Gyda Grendstad, NPRA.