Adaptation of road maintenance to climate change in Finland

E. Järviluoma, Centre for Economic Development, Transport and the Environment for Lapland
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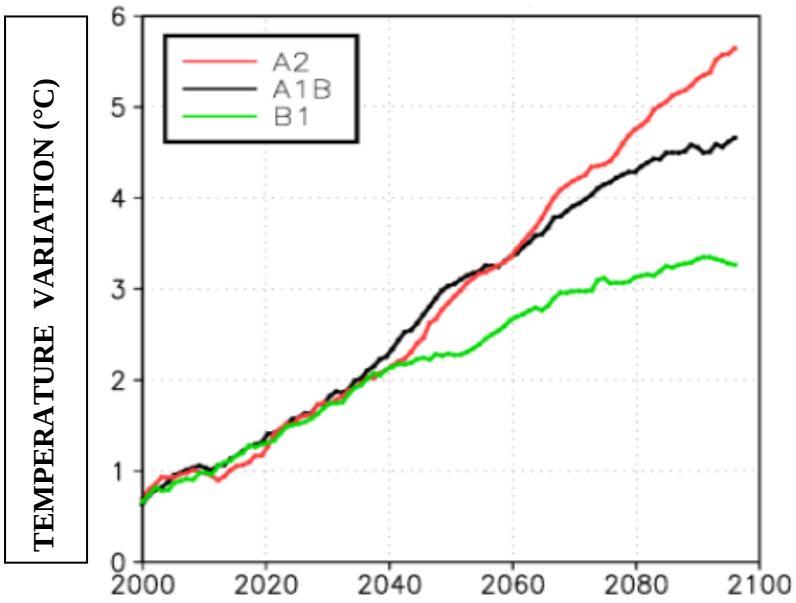
1. Climate change in Finland

In the course of the past century, temperature has increased by 0.74°C on Earth and by a bit more than one degree in Finland. The most significant increase in temperatures has been experienced in high latitudes of the Northern Hemisphere, and for this reason, the climate change in Northern Finland tends to be somewhat stronger than in Southern Finland. During the next few decades, the annual average temperature in Finland is expected to rise by about 0.4±0.1°C per decade (Figure 1). Winter temperatures are going to rise about two times more than summer temperatures.

The rise of average temperatures will have a significant impact on extreme weather conditions: the number and intensity of heat waves may increase dramatically, while the coldest spells in winter are expected to become clearly milder. As winters become less severe, this will have a significant effect on snow conditions.

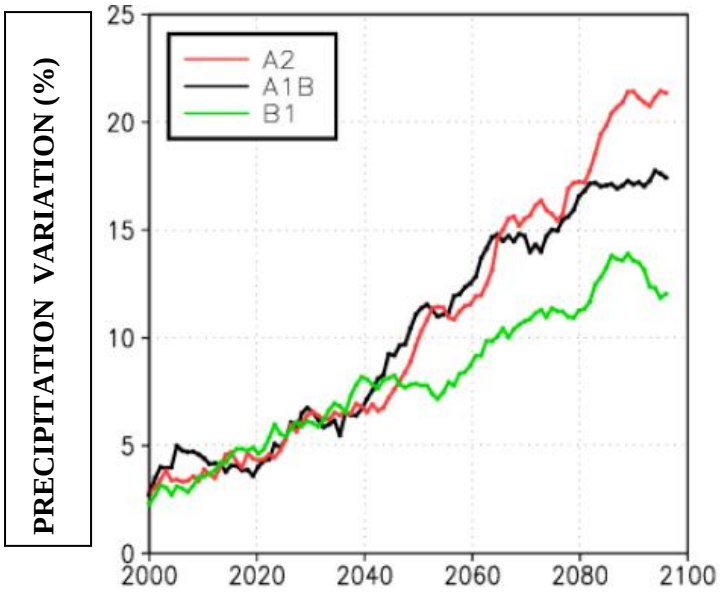


Change (°C) 2070 – 2099

Scenario	Temperature rise
A2	5,1 (3,1 – 7,0)
A1B	4,4 (2,5 – 6,3)
B1	3,2 (1,5 – 4,9)

Figure 1. Annual average temperature rise in Finland according to different climate scenarios. Reference period 1971 - 2000. Source: Finnish Meteorological Institute.

The annual rainfall in Finland is expected to increase in the current century (Figure 2). A larger share of precipitation will be rain instead of snow, and a major part of the increase in rainfall will take place in winter. In winter, the increasing rainfall will be manifest in the larger number of rainy days and in an increasing intensity of rain, while in summer, it is mostly visible in the precipitation maximums that will reach higher levels than before.



Change (%) 2070 – 2099	
Scenario	**Increase in rainfall**
A2	**19 (10 – 28)**
A1B	**17 (8 – 25)**
B1	**12 (5 – 19)**

Figure 2. Precipitation variations in percentages according to different climate scenarios. Source: Finnish Meteorological Institute.

Changes in the Finnish climate that are relevant for road maintenance include the following:

- shorter periods of temperatures below 0°C
- growing number of mild spells in between frost periods
- increasing number of days when temperatures fluctuate between freeze and thaw cycles
- fewer days with snow cover, shorter winters
- decreasing thickness of ground frost in surfaces not covered with snow
- maximum levels of daily precipitation increase in all seasons
- increased number of hot days in the summer
- winds may become stronger.

According to the latest ACCLIM research, it has been predicted that:

“If the temperature increase, as projected by the A1B scenario, will occur, the soil frost depth will decrease in the major part of central and southern Finland by 50–70% and in northern Finland by 30–40% in a century. In the next few decades alone, the depth of soil frost will decrease by 10–30%, and even more in the archipelago.” This may have an important impact on road building costs in the long run.

Estimates on the variation in wind strengths and the occurrence of storms that are based on different climate models tend to be different from each other. It is possible that decreasing levels of sea ice will contribute to an increase in the strength of coastal winds. However, there is no clear evidence that the number of storms in Finland would increase.

2. Impact of climate change

It is expected that the climate change will have the following impact on road maintenance:

- more need for anti-skid treatment in Northern Finland, less need for snow clearing in Southern Finland (Table 1)
- increased erosion and damage of road surfaces
- increasing periods of difficult road conditions on roads with a lower maintenance degree
- risk of flooding will increase
- more disturbance to transportation and telecommunication links.

Table 1. Variation (%) in the need for snow clearance and salt treatment in different parts of Finland; comparison between periods 1980-2010 and 2025-2055. Source: Klimator AB 2009: "Improved Local Winter Index to Assess Maintenance Needs and Adaptation Costs in Climate Change Scenarios".

	Snow clearance, variation (%)	**Salt treatment, variation (%)**
	1980-2010 and 2025-2055	**1980-2010 and 2025-2055**
Southwest Finland	**-9**	**3.4**
Southeast Finland	**-5.3**	**11.9**
Northeast Finland	**-1.9**	**12.2**

3. Cost effects of the changing climate

- costs of road maintenance during winter have been forecasted to increase
- erosion of road surfaces will be quicker than before and make costs increase
- repairing flood damage will cause additional costs
- disturbed transportation and telecommunication links will increase costs
- less provision for frost heaving may help diminish construction costs in the long run.

4. Adaptation to climate change

On the strategic level, issues to be highlighted in road maintenance include climate change mitigation and adaptation. Climate change adaptation strategies have been created also on the local level. Over the last few years, research activities linked to road maintenance have focused on climate change mitigation.

The key adaptation measures in road maintenance in Finland are related to the development of winter maintenance (anti-skid treatment, snow clearance), improvement of road surfaces, flood preparedness and risk management. Floods may be caused by increasing spring floods, rise of the sea level and rise of the groundwater level. However, in the Bothnian Bay, where the land uplift rates are the highest in Finland (between 8 and 9 mm annually), its impact will be enough to compensate the global rise of sea levels during the current century.

The Climate Change Policy 2009-2020 by the Ministry of Transport and Communications identifies the following key measures with respect to climate change adaptation in road maintenance:

- updating instructions dealing with construction, maintenance and road surfacing
- making plans for exceptional weather conditions
- financing research
- taking advantage of possible positive consequences of climate change.

These measures have been carried out in cooperation with other authorities. Road authorities have, for example, mapped flood sensitive areas in the road network on the basis of knowledge derived from experience. Instructions for the potential occurrence of floods have been drawn up and protection plans have been updated. In addition, joint flood protection exercises have been arranged with rescue authorities. Currently, in relation to implementation of the flood directive, environmental authorities are identifying urban areas that are sensitive to flood and drawing up flood action plans. At the same time, the road network and its height levels have been mapped.

Reports:

- **Finland's National Strategy for Adaptation to Climate Change in 2005**
- **Climate Change Adaptation Research Programme (ISTO)**
- **Climate Change Policy (ILPO). The Ministry of Transport and Communications 2009**
- ACCLIM project website: http://ilmatieteenlaitos.fi/acclim-hanke
- "Modelling and predictability of soil frost depths of snow-free ground under climate-model projections", https://helda.helsinki.fi/handle/10138/28455
- "The changing climate in Finland: estimates for adaptation studies. ACCLIM project report 2009", https://helda.helsinki.fi/handle/10138/15711