# CLIMRAIL

## Climate adaptation of railway infrastructure maintenance

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### Nyttor och effekter

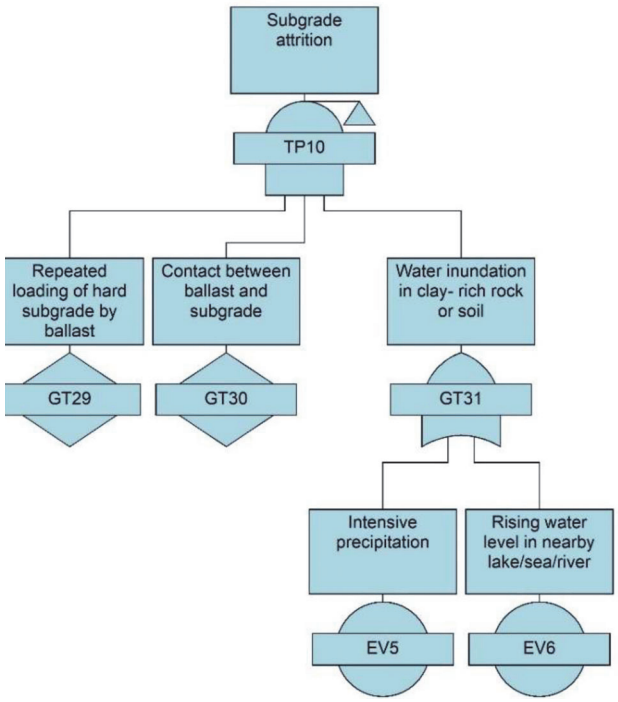
ClimRail developed an RCM-based decision-support framework for climate-adaptive railway maintenance, integrating multi-hazard knowledge, climate-sensitive Fault Tree Analysis (FTA), Critical Track Section assessment, and consequence-oriented maintenance strategies. The outputs provide Trafikverket and railway infrastructure managers with a structured basis for identifying vulnerable sections, understanding climate-induced failure mechanisms, prioritizing maintenance and monitoring resources, and adapting maintenance programmes to improve railway resilience and sustainability.

### Leveranser

A comprehensive RCM-based decision-support framework for climate-resilient railway maintenance, comprising a multi-hazard knowledge base, climate-sensitive Fault Tree Analysis (FTA), Critical Track Section (CTS) assessment methodology, and maintenance adaptation guidelines. The deliverable provides railway infrastructure managers with a structured methodology to identify climate-vulnerable sections, analyse failure mechanisms, prioritize inspection and maintenance resources, and adapt maintenance strategies to changing climatic conditions.

### Innovationsstatus

The key innovation of ClimRail is the integration of climate-change hazards with Reliability-Centered Maintenance (RCM) into a systematic railway maintenance decision-support framework. It combines multi-hazard deterioration knowledge, climate-sensitive Fault Tree Analysis (FTA), Critical Track Section prioritization, and consequence-based maintenance adaptation, enabling infrastructure managers to move from reactive maintenance toward risk-informed, climate-resilient and resource-efficient maintenance planning.




### Vidareutveckling och implementering

Future development will focus on validating and applying the ClimRail methodology at corridor scale, with enhanced integration of real-time monitoring, geotechnical/geophysical data, and early-warning indicators for climate-sensitive deterioration. The framework should progressively evolve toward quantitative risk and probability updating and be embedded in railway asset-management practices to support evidence-based prioritization of maintenance and resilience measures under climate uncertainty and resource constraints.

### Målbild 2040

If the result from the study is implemented systematically, by 2040, railway maintenance will be climate-resilient, predictive and risk-informed, with every railway corridor continuously assessed according to its climate exposure, condition, failure mechanisms and consequences.

Maintenance actions will be integrated and aligned to climate change ensuring resilient reliable and sustainable railway system.

### Aktörskonstellation

LTU, Traffikverket, LKAB, BDX Rail AB, SAAB Aerotech, IIT Kanpur, India & The University of Maryland, USA

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