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Landslide exposure of Europe's road and rail infrastructure in a changing climate

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In the face of climate change, the assessment of land transport infrastructure exposure towards adverse climate events is of major importance for Europe's economic prosperity and social wellbeing. Robust and reliable information on the extent of climate change and its projected future impacts on roads and railways are of prime importance for proactive planning and the implementation of adaptation strategies. Among various menacing natural hazards, landslides stand out as extremely severe hazards jeopardizing the functional effectivity and structural integrity of land-bound transport systems, as they can cause long-lasting downtimes and exceedingly expensive repair works.

Landslides are known to be driven by heavy precipitation events that persist over several days. Along with climate change, such events are expected to increase in frequency, duration and intensity over the decades to come. In this study a climate index picturing rainfall patterns which trigger landslides in Central Europe is analyzed until the end of this century and compared to present day conditions. The analysis of potential future developments is based on an ensemble of dynamically downscaled and bias-corrected climate change projections that are forced by the SRES A1B socio-economic scenario. Resulting regional scale climate change projections across Central Europe are concatenated with Europe's road and railway network.

Results indicate overall increases of landslide occurrences. While flat terrain at low altitudes exhibits an increase of about one more potentially landslide-inducing rainfall event per year until the end of this century, higher elevated regions are more affected showing potential increases of up to 14 additional events. This general distribution emerges already in the near future (2021-2050) but gets more pronounced in the remote future (2071-2100). Largest increases are to be found around the Upper Rhine Valley. Consequently, potential impacts of increasing landslide events are discussed through a case study covering the Black Forest mountain range in Baden-Württemberg.

Findings derived in this study are designed to support political decision-makers and European authorities in transport, freight and logistics by offering detailed information on which parts of Europe's land-bound transport network are at particular risk concerning landslides. In order to safeguard this essential backbone of Europe's economic prosperity, the development of guidelines for climate proofing regarding the design, maintenance and reinforcement of transport networks as well as intermodal logistics is certainly of high significance.