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Vulnerability of Central Europe's transport infrastructure to climate driven changes in rutting and landslide events

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Assessing the vulnerability of transport infrastructure to adverse, weather driven events is of major importance for Europe's economic prosperity and social wellbeing in a changing climate. Robust and reliable information on the extent of climate change and its projected future impacts on transport infrastructure is essential for proactive planning and for implementing protective measures.

Here we present potential, climate change driven, developments in landslide events and the occurrence of conditions favouring rutting of asphalted roads. Both hazards are jeopardizing the functional effectivity and structural integrity of land-bound transport systems, as they not only cause expensive repair works but also long-lasting downtimes resulting in economic loss.

In this study we analyze so-called Climate Indices (CIs) - quantifying weather events potentially (i) triggering landslides as well as (ii) causing rutting of Central European roads - until the end of this century. This investigation is based on an ensemble of dynamically downscaled and bias-corrected climate change projections forced by the IPCC SRES A1B socio-economic scenario. Resulting regional-scale climate change projections are concatenated with Europe's road and railway network.

Concerning landslides results show an overall increase in 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.

Rutting events develop differently. While in the near future increases of about four more occurrences emerge mainly across flat, low laying areas, changes in the remote future affect the entire region under investigation. Areas at low altitudes – especially those within the Upper Rhine Valley show largest increases of up to 20 more potential rutting occurrences.

Attained results offer information on which parts of Europe's transport network are likely to experience largest changes in the occurrence of landslides and rutting events over the next decades. As such our findings shall be of help in the development of guidelines for climate proofing concerning design, maintenance and reinforcement of transport networks as well as foresightedly setting up intermodal transport logistics.