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A compilation of biotic and abiotic threats toward the future production of Norway spruce *(Picea abies)* and Scott's pine *(Pinus sylvestris)* in Sweden.

Climate observations are showing that air temperatures are constantly increasing, and modelled data indicates that temperatures will continue rising in the future. Changes in the climate will affect ecosystems and consequentially, the ecosystem services we depend upon. In Sweden, forests are among the most important ecosystems for humans. The forest is a major part of the Swedish economy. Currently, several different types of damage, or risk, affect Swedish forests annually. These damages can be biotic or abiotic. The threat that these damage types pose, will only increase with climate change.

This study investigated which types of damage pose the greatest threat to spruce and pine in Sweden, and how these damage types will be affected by climate change. Firstly, a literature study determined what the threat scenario looks like today and which damage types can be affected by changes in temperature and precipitation. Biotic threat groups that were identified were insects, fungi and game species. Abiotic threat groups that were identified were droughts and storms. Secondly, a quantitative analysis was conducted on selected biotic and abiotic damage types, using climate data that follows IPCC's RCP 8.5 and 2.6 scenarios. Biotic factors used for quantitative analysis were bark beetles, pine weevils, pine shoot beetles, root rot and scleroderris cankers. The Abiotic factor used was drought.

Finally, maps were constructed, illustrating that most damage groups that pose the largest threat to spruce and pine in Sweden will be favoured by increasing temperatures and changes in precipitation patterns. The results showed that all insect outbreaks studied will be favoured by temperature increase, with annual swarming occurring earlier by up to 30 days for bark beetles and pine weevils in the RCP 8.5 scenario. Earlier swarming days may lead to multiple insect generations in one season leading to even further damage on forests. The RCP 2.6 scenario entails earlier swarming, although with a much smaller difference to present day. Similarly, damage caused by root rot will be much greater in the 8.5 scenario compared to the 2.6 scenario. Root rot will be bolstered by increasing temperatures, causing the number of days with infection risk to rise by an average of 20% by 2099 for all of Sweden in the 8.5 scenario. The results for scleroderris cankers showed that outbreaks increase during the middle of the century, yet decrease toward 2099, which can be attributed to the alteration of precipitation patterns caused by climate change, since this fungus requires a damp environment for infection to occur. The results for drought show that during periods of an increase in scleroderris outbreaks, periods of drought decrease, indicating precipitation increase toward the end of the century.

The study is general, yet comprehensive, and can be used as a starting point for future studies regarding the effect of climate change on threats to Swedish forests.

Keywords: Physical Geography and Ecosystem analysis, Forest industry, Bark beetle, Pine weevil, Root rot, Scleroderris canker, Drought.

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