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Potential Risk of Wood Decay

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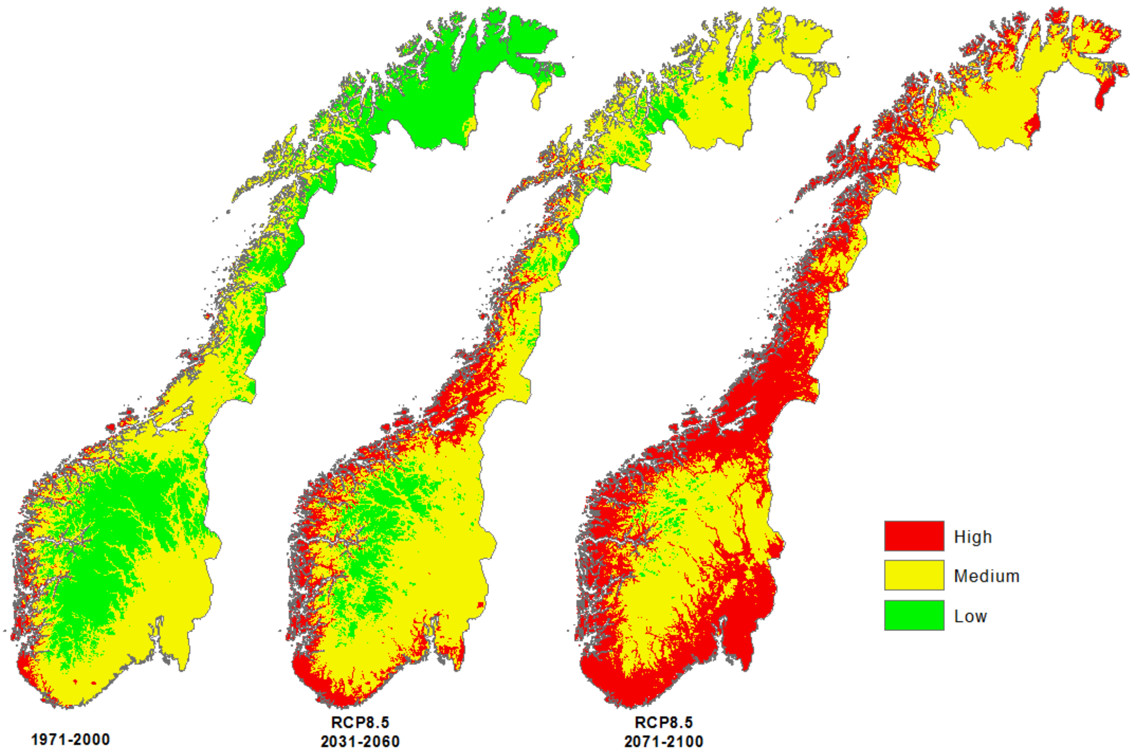

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Abstract

In Norway the weather changes a lot and varies throughout our elongated country. Wood structures are exposed to weather and climate conditions. Precipitation and temperature are two basic elements for greater or lesser fungi growth. The risk of wood decay throughout Norway is described.

The potential risk of wood decay is separated in low, medium and high potential danger of wood decay. The development in Norway from the historic grid in period 1971-2000 and for two future periods, mid-century, 2031-2060, and end of century 2071-2100 is described. It shows that high risk of wood decay is expanding thorough out Norway inland from the coastal areas.

In a wetter and warmer climate, the risk of wood decay is increasing in most areas. To the end of the century low risk of wood decay is limited to mountain areas in South Norway and some areas in northern Norway, only a few areas are left in the business-as-usual scenario RCP8.5 in the low risk range. In RCP4.5, scenario with reductions, most of Norway ends up in medium risk areas to the end of the century, while for RCP8.5 most areas end up in the range for high risk of wood decay.

Keywords

wood decay, normal, vulnerability, climate scenario, climate index

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Responsible signature

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1 Introduction

Weather and climate in Norway is characterized by large regional and local gradients. In the coastal areas the climate is maritime, warm and moist, and with relatively small diurnal, seasonal and annual fluctuations. The eastern and inner parts experience a more continental climate with large temperature amplitudes and generally less precipitation. This is effects of large-scale atmospheric circulation, local radiation budgets and the complexity of terrain. Precipitation and temperature are two basic elements for greater or lesser fungi growth. Since the climate scenarios shows more precipitation in the future, especially on the western coast of Norway, this region will be more exposed to wood decay than current. Wood structures are exposed to weather and climate conditions. Approximately two million buildings will move from potential medium to high risk of wood decay (Kvande et. al., 2012).

This report was written within the ongoing Center for Researched-based Innovation (SFI) Klima 2050[1]. An aim for Klima 2050 is; "... reduce the societal risks associated with climate changes and enhanced precipitation and flood water exposure within the built environment."

Potential risk of wood decay is described with a climate index formula from Scheffer (1971) and Lisø et.al. (2006). The index is dependent on both precipitation and temperature. Potential decay in wood structures above ground for Norway is divided in low, medium and high risk of wood decay. This report consists of maps, historic and future, with potential risk of wood decay based on the climate index formula. Grids with a 1*1 km^2 resolution are used in the calculations, for the historic period 1971-2000 (Tveito et.al., 2005) and for future scenarios in period 2031-2060 and 2071-2100 (Wong et.al., 2016).

[1] klima2050.no

2 Data and Method

Scheffer (1971) developed a formula to “yield an index of the relative potential of a climate to promote decay of off-the-ground wood structures” and presented a climate index map of the US with three index zones. The formula is later developed for Norway by Lisø et.al. (2006). The climate index (Equation 1) consist of a temperature and moisture factor which is the two most important climate elements for potential of wood decay due to fungal attack:

$$Climate\ index = \frac{\sum_{January}^{December}(T_{mean}-2)(D-3)}{16.7} \qquad (1)$$

Where T_{mean} is the monthly mean temperature (°C) and D is the mean number of days in the month where the daily precipitation exceeds 0.254 mm (i.e. 0.01 inch). For practical purpose has 0.3 mm been applied as threshold, since the observed precipitation/grid has 0.1 mm precision. The product is the sum from January to December and is divided by 16.7 to get a range from 0 – 100 for the US (Scheffer, 1971). For the grids used in this study the denominator would be about 12 to get the same range, but to be able to compare with previous studies, no alterations are done in the formula.

In this study grids of historic and future temperature and precipitation are used to calculate potential risk of wood decay for Norway. As a part of their operational service the Norwegian Meteorological Institute (MET Norway) produce a daily interpolated data set of 1*1 km^2 resolution for precipitation and temperature (Tveito et.al., 2005, Jansson et.al., 2007 and Mohr, 2009). This dataset is covering the period from 1957 up to present.

For future scenarios data from IPCC 5^{th} assessment report are used (IPCC, 2013). Representative concentration pathways (RCP) describe future scenarios for greenhouse gas emission. RCP4.5 describes a world with increasing emissions to the midcentury and thereafter reductions. While RCP8.5 describes a world with continuous increase of climate gas emission, a business-as-usual scenario. For these two scenarios the risk of wood decay is calculated for the mid-century, the period 2031-2060, and for the end of the century, 2071-2100.

The report “Klima i Norge 2100” (Hansen-Bauer et.al., 2015) use 10 regional climate projections from Euro-CORDEX (Jacob et.al., 2014) for precipitation and temperature maps for Norway. 9 of these models are used in this study (MPI_SMHI-RCA4 was withdrawn due to error). The downscaled maps for Norway with daily 1*1 km^2 resolution are used (Wong et.al., 2016). For all 9 models the climate index are calculated for the historic reference period (1971-2000), as a control run, and for the scenarios (RCP4.5 and RCP8.5) in the two future periods. To correct the models, when temperature and precipitation are combined, the control run where subtracted from the historical reference period. The difference was added to the future scenario/projection to get a corrected model run. We found that the control runs and the historic grid for the normal period (1971-2000) where very similar. Hence the corrected projections had minor changes, but they are used further in the results.

The potential risk of wood decay for the two scenarios RCP4.5 and RCP8.5 in the future periods 2031-2060 and 2071-2100 for all 9 models are shown in Appendix A. From all 9 models the mean and median was calculated. The result of the mean is shown in Figure 2 and Figure 3, while the median is in Appendix B.

3 Results

Wood decay is dependent on both precipitation and temperature and will develop in accordance with these elements. In Norway the largest normal annual precipitation are along the western part and the highest normal annual temperatures are in the coastal areas in the South.

For the historic period (1971-2000) the climate index for wood decay range from 1 - 73. The index is divided in thirds to get low, medium and high potential risk of wood decay:

- low decay risk (equal to or less than 24, the least favorable conditions for decay)
- medium decay risk (25 – 48)
- high decay risk (values above 48, favorable conditions for decay)

3.1 Historic period 1971-2000

Risk of wood decay for the historic normal period 1971-2000 is shown in Figure 1. The map illustrates low, medium and high potential danger of wood decay respectively in green, yellow and red. Low risk of wood decay is typically present in the colder and drier parts of Norway, like in the mountain areas in South Norway and in the northernmost areas. The medium risk areas are mostly lower elevation parts of Eastern, Southern and Central Norway. The coastal areas of Southern, Western and Central Norway are highly exposed of wood decay due to many days of precipitation and favorable temperatures for fungi growth.

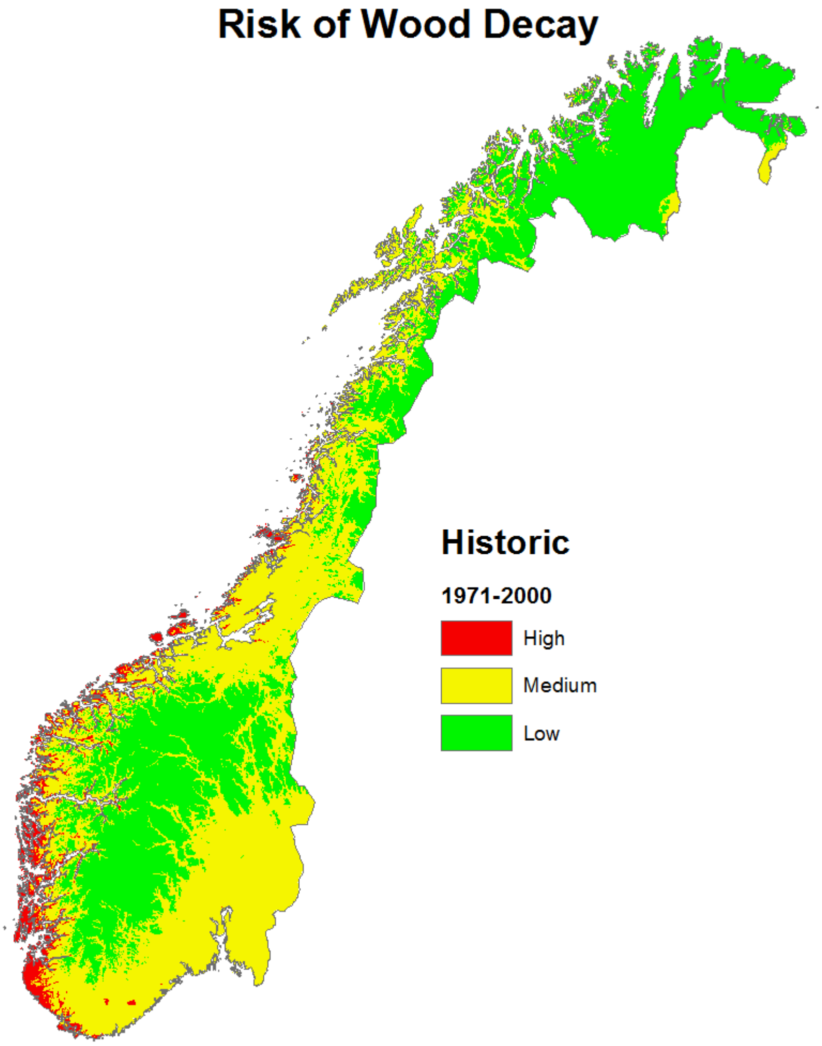

Figure 1: Risk of wood decay in historic normal period 1971-2000.

3.2 Risk of wood decay in future scenarios

Figure 2 and Figure 3 shows the risk of wood decay (the mean of 9 climate models) for two future scenarios (RCP4.5 and RCP8.5) for mid-century, the period 2031-2060, and for the end of the century, 2071-2100. (For median of the models see Appendix B.) The potential risk of wood decay is clearly expanding in the two different periods and for both future scenarios. High risk of wood decay extends around the coastline and expanding further inland Norway and further north. This is not surprising since the scenarios show warmer climate and more precipitation in the future.

For RCP4.5 will areas with low risk of wood decay be reduced mostly to mountain areas in South Norway and a few areas in Northern Norway. The areas with low risk of wood decay shrinks further towards the end of the century compared to the mid-century. For both periods most areas ends up in the medium risk range. While areas with favorable conditions for wood decay are clearly expanding around the coastline and further inland Norway. High risk areas extend further north and inland for the latest period.

For the RCP8.5 shows the development until the mid-century similar pattern as for the end of the century RCP4.5 scenario. Most areas are within the medium risk range of wood decay. Mountain areas in South Norway and some areas in northern Norway are in low risk range, while high risk areas are expanding around the coast and further inland Norway. For the end of the century in RCP8.5 there are just a few areas with low risk of wood decay left. Some parts of Norway will have medium risk of wood decay, mainly in Finnmark County and in higher elevated parts of South Norway. The majority of Norway end up with high risk of wood decay. This is a difference from the RCP4.5 where most areas end up in the medium risk range.

For comparison of all 9 model ensembles the dispersion in connection to wood decay is large. The most conservative model run is CNRM-CM5_CCLM where high risk areas are not so prominent like several other models for the end of the century both for RCP4.5 and RCP8.5. In the most extreme model run for wood decay, HADGEM2_SMHI-RCA4, almost all of Norway ends up in high risk areas for the end of the century in RCP8.5. For the period 2071-2100 and RCP4.5 the same model shows that the high risk areas are more extended than in the most conservative model for RCP8.5 for the same period. The dispersion between the models in the two different RCP's is large and lies within each other's span. See appendix A for maps from all 9 model ensembles for both scenarios in both periods.

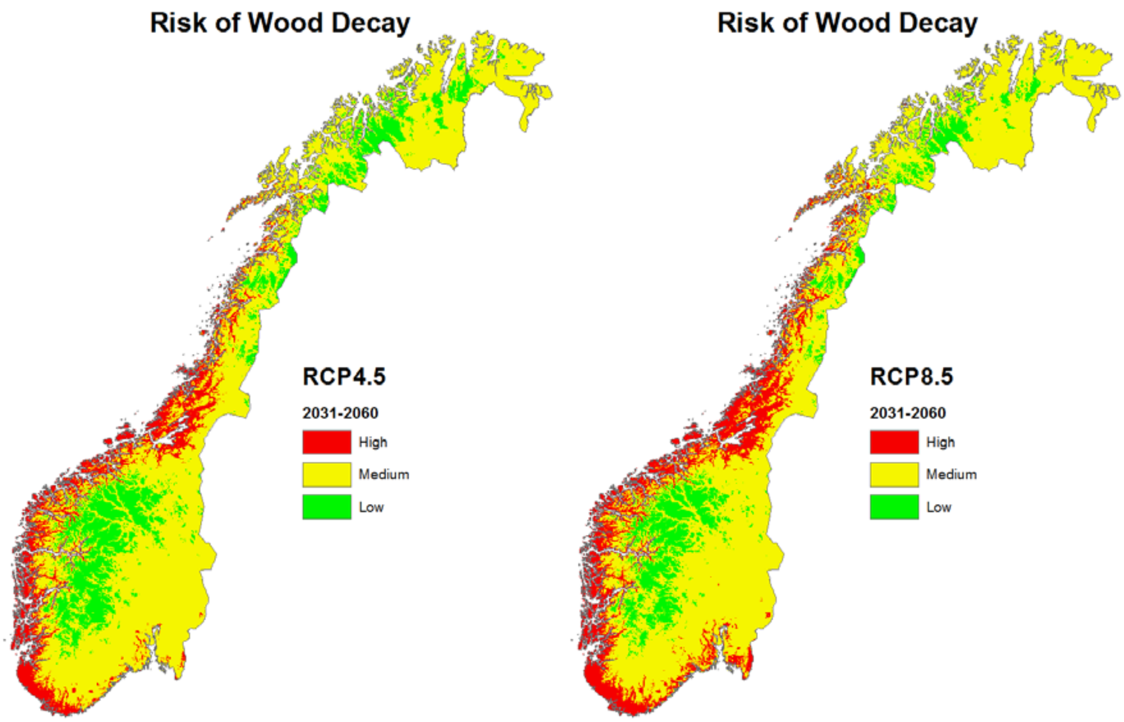

Figure 2: Risk of wood decay in scenarios RCP4.5 and RCP8.5 for future period 2031-2060. The map is a mean of 9 climate models.

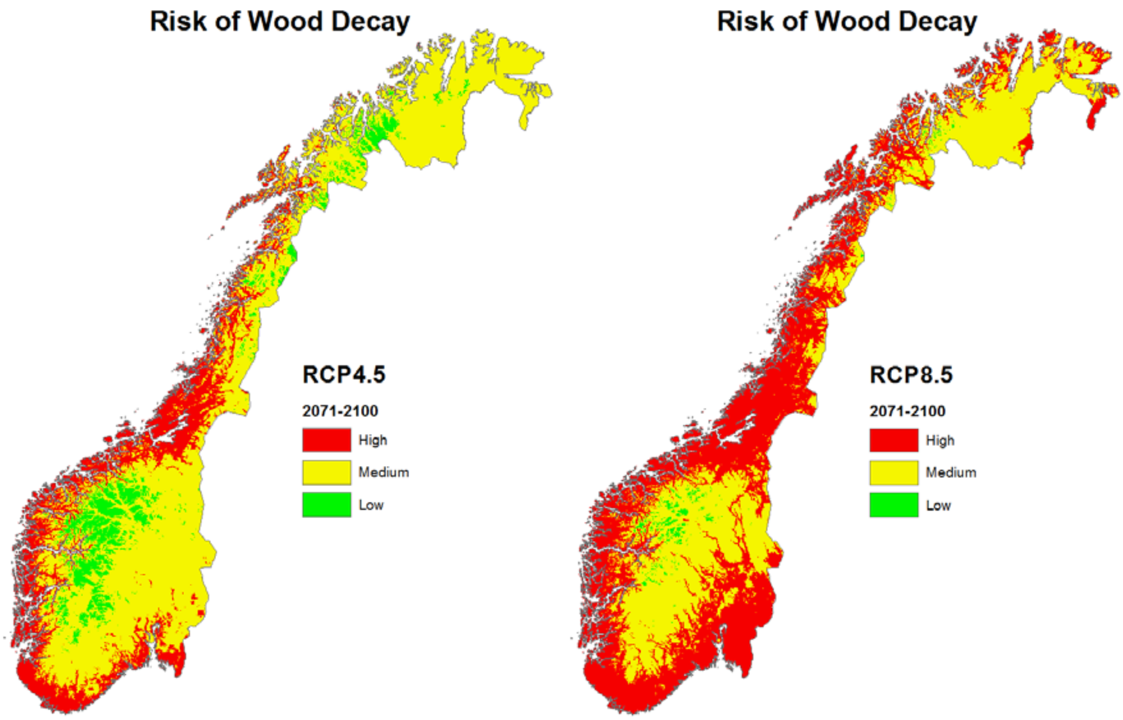

Figure 3: Risk of wood decay in scenarios RCP4.5 and RCP8.5 for future period 2071-2100. The map is a mean of 9 climate models.

As described the climate index is divided in thirds to get low, medium and high risk of wood decay, and ranges up to 73 in the historic grid, see bullet points above. For the period 2031-2060 the climate index range up to 84 in RCP4.5 and up to 87 in RCP8.5 for the mean of the 9 climate models (median; 85 and 91). For the end of the century, 2071-2100, the climate index range up to 90 in RCP4.5 and 108 in RCP8.5 for the mean of the models (96 and 114 for median). The legend is the same as for the historic period to see the wood decay development. Climate index above 48 is high risk of wood decay.

4 Summary

The potential risk of wood decay is separated in low, medium and high potential danger of wood decay. In a wetter and warmer climate, the risk of wood decay is increasing. The development in Norway from the historic grid to two future periods shows that high risk of wood decay is expanding into continental parts of Norway inland from the coastal areas. To the end of the century low risk of wood decay is limited to mountain areas in South Norway and some areas in northern Norway, only a few areas are left in the business-as-usual scenario RCP8.5. In RCP4.5 most of Norway ends up in medium risk areas to the end of the century, while for RCP8.5 most areas end up in high risk of wood decay for the mean of 9 model runs.

Comparison of the results all 9 RCM models show large dispersion for the projected wood decay. This illustrates the uncertainties in the development of wood decay for the future throughout Norway. In the most extreme model run for RCP8.5 almost all of Norway ends up in high risk of wood decay at the end of the century, except a few areas in northern Norway and in the South Norway mountains. For the most conservative model in the same scenario medium risk of wood decay is most prominent in Norway. This model run have less risk of wood decay than for the most extreme run in RCP8.5 in mid-century and RCP4.5 to the end of the century.

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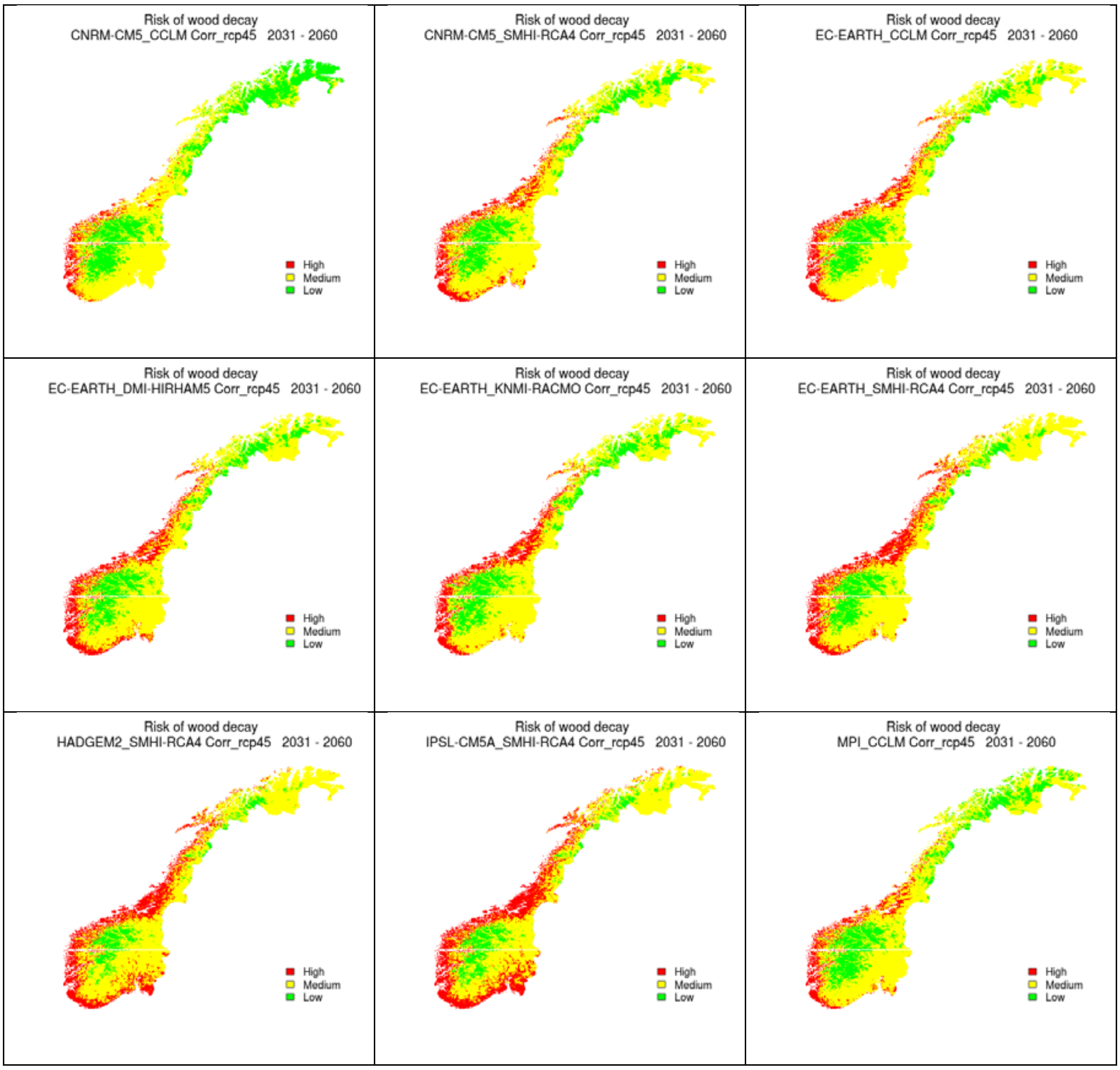
5 Appendix A

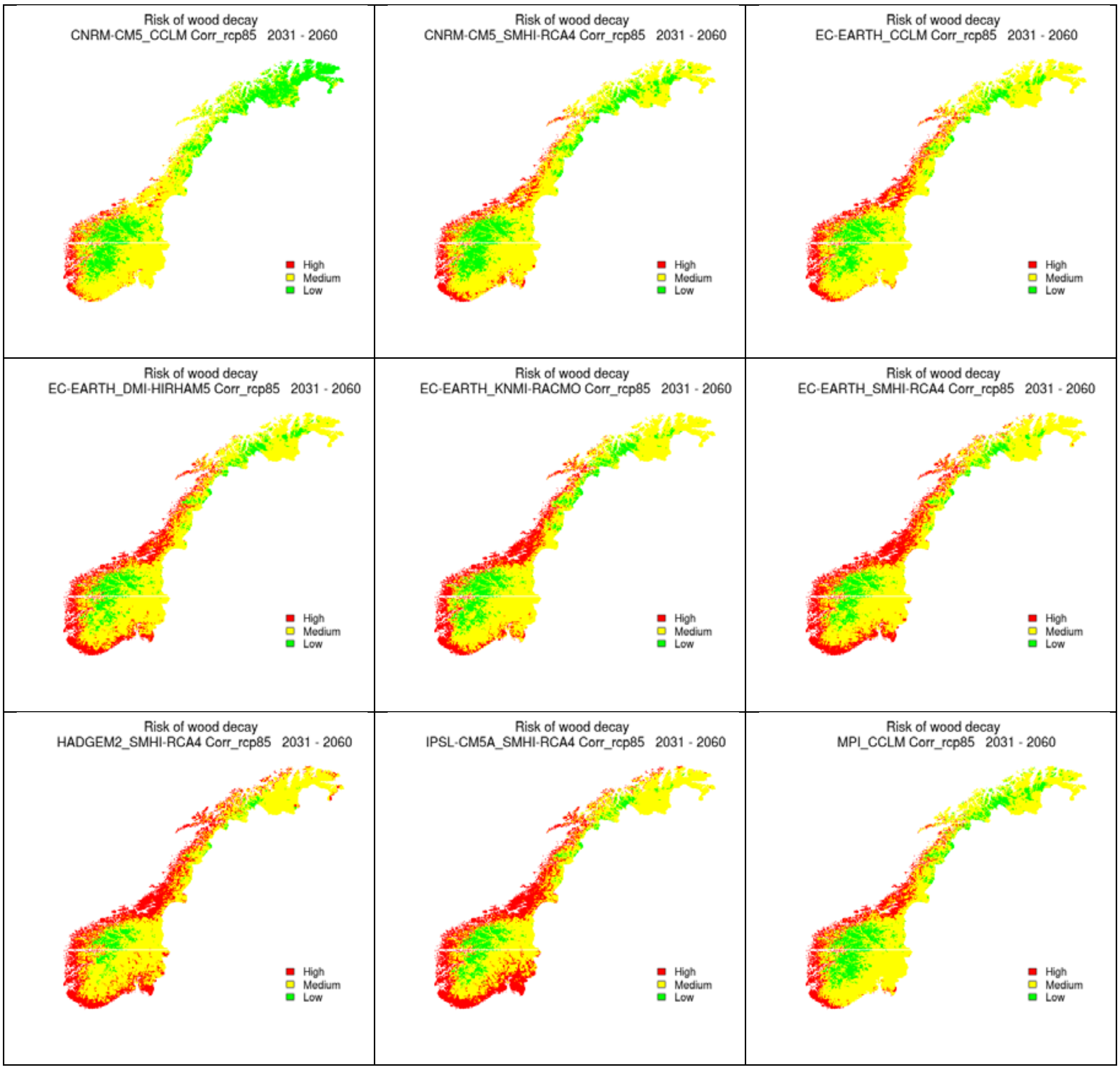
In this Appendix risk of wood decay from all 9 models are presented. First is the mid-century, 1931-1960, with both scenarios in 5.1 and 5.2. Then for the end of the century, 2071-2100, with both scenarios RCP4.5 and RCP8.5 in 5.3 and 5.4.

5.1 RCP4.5 – 2031-2060



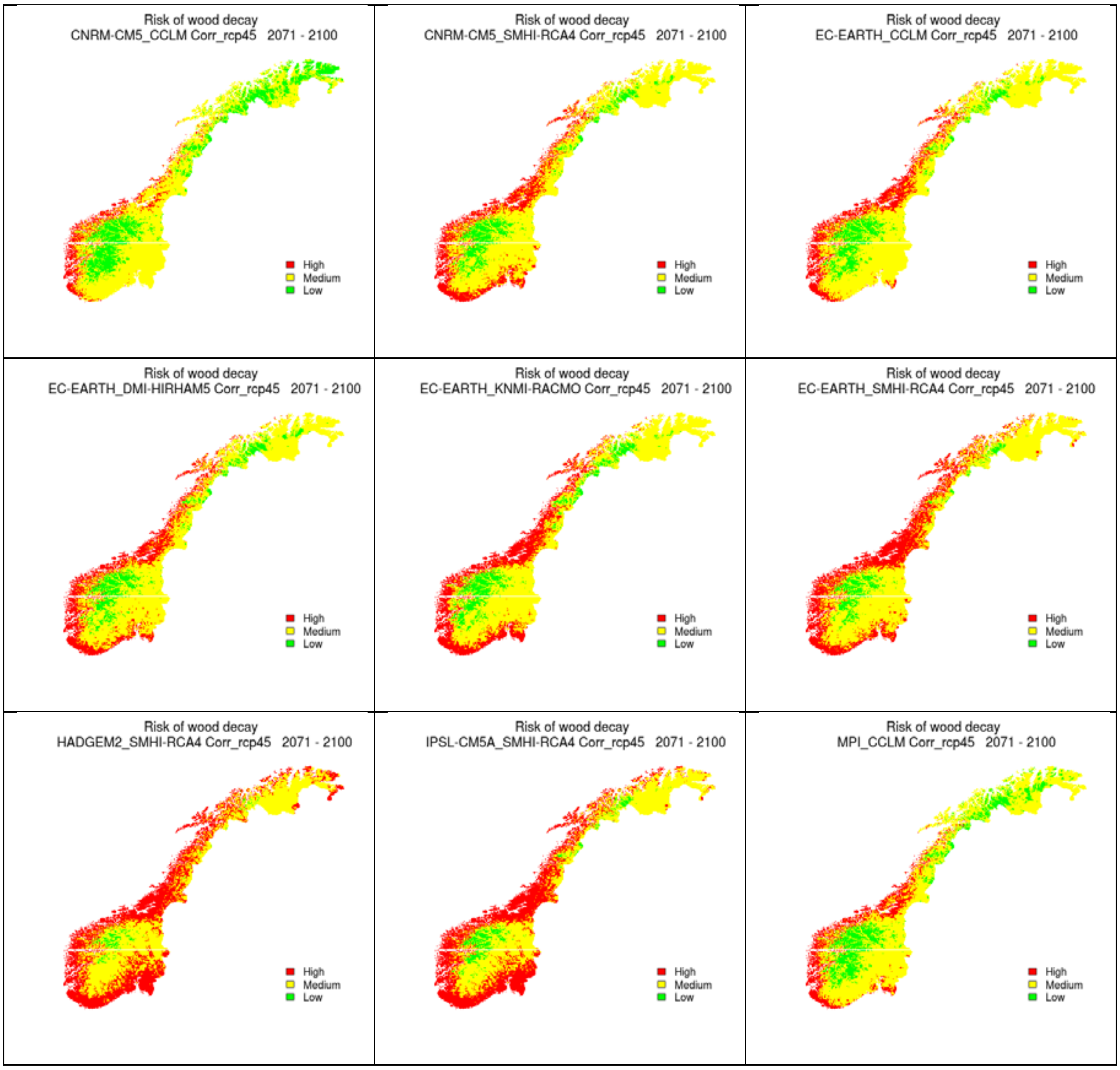
Risk of wood decay for scenario RCP 4.5 for the mid-century (2031-2060).

5.2 RCP8.5 – 2031-2060



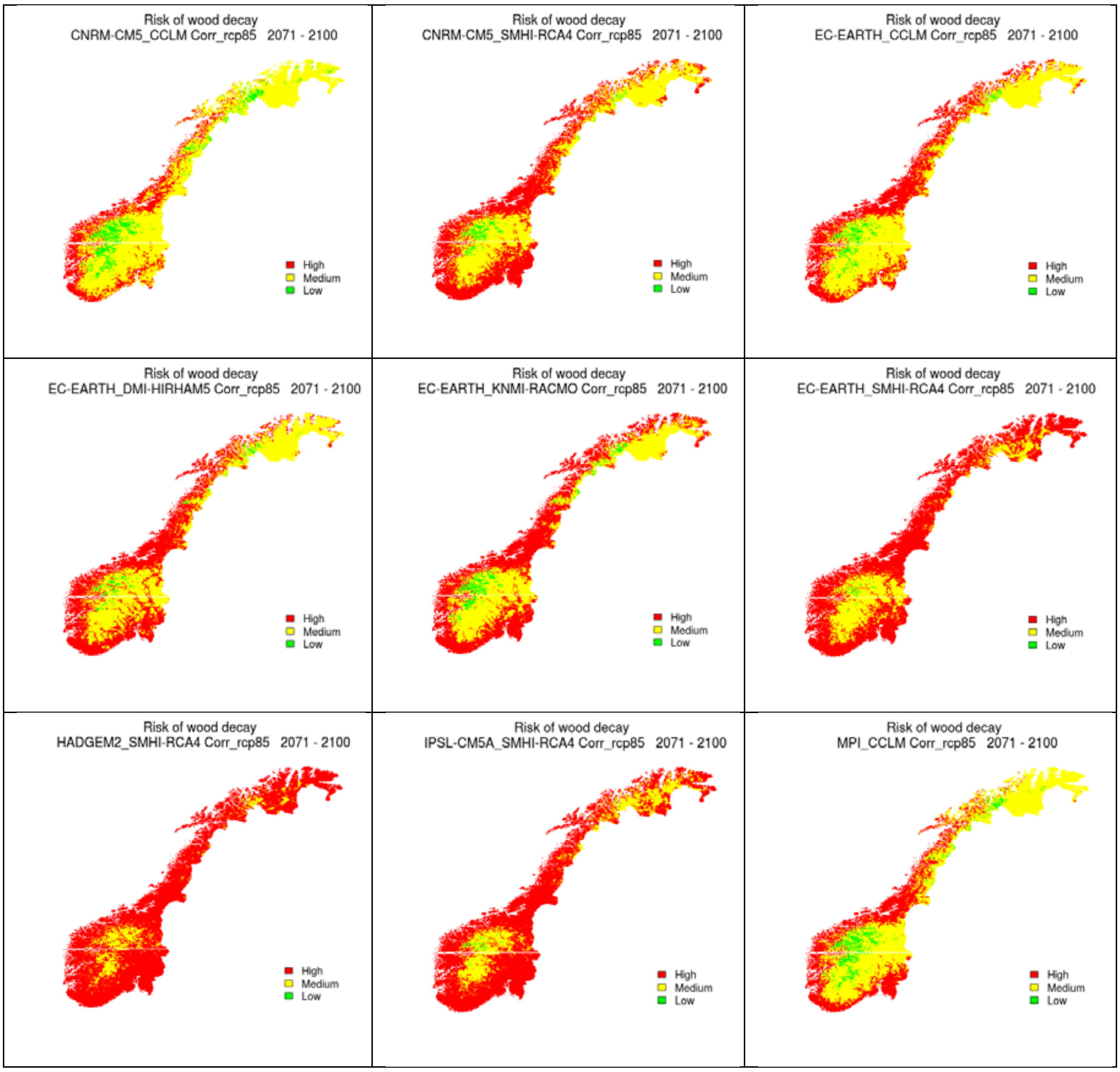
Risk of wood decay for scenario RCP 8.5 for the mid-century (2031-2060).

5.3 RCP4.5 – 2071-2100



Risk of wood decay for scenario RCP 4.5 for the end of the century (2071-2100).

5.4 RCP8.5 – 2071-2100

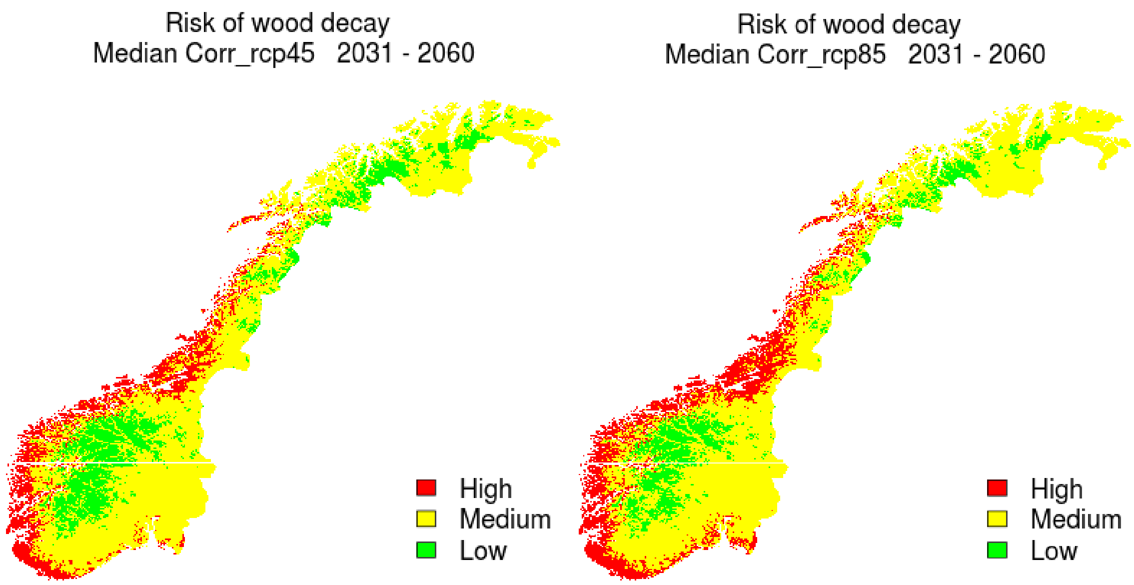


Risk of wood decay for scenario RCP 8.5 for the end of the century (2071-2100).

6 Appendix B

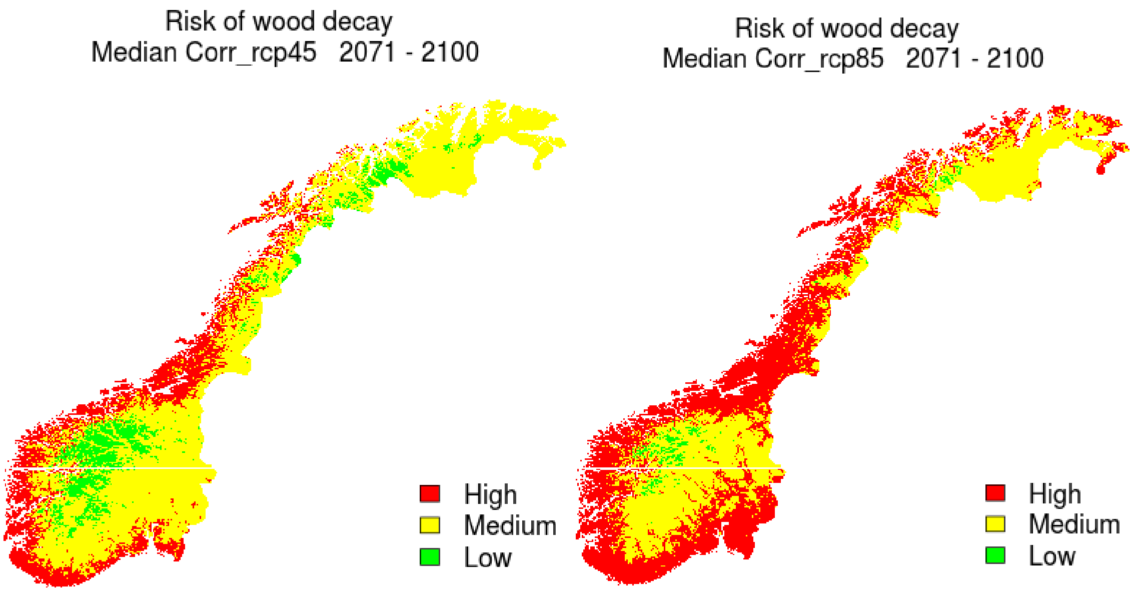
In this Appendix risk of wood decay for the median of the 9 climate models is presented. For both future scenarios RCP4.5 and RCP8.5 for the mid-century, 2031-2060, and for the end of the century, 2071-2100.

6.1 Median RCP4.5 and RCP8.5 – 2031-2060



Risk of wood decay for future scenarios RCP4.5 and RCP8.5 for the mid-century, 2031-2060. The maps show the median of 9 climate models.

6.2 Median RCP4.5 and RCP8.5 – 2071-2100



Risk of wood decay for future scenarios RCP4.5 and RCP8.5 for the end of the century, 2071-2100. The maps show the median of 9 climate models.