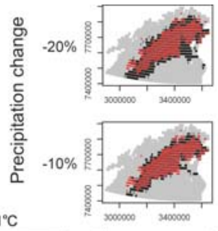
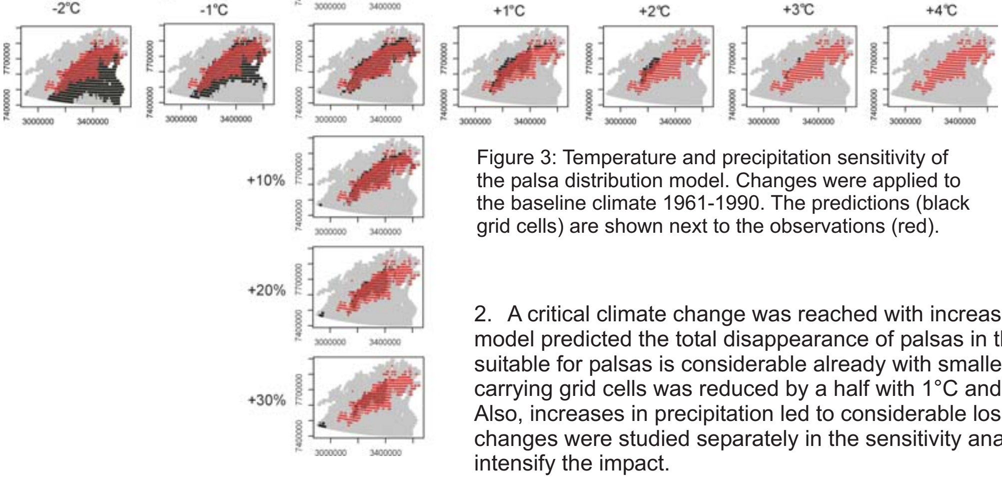
Results

The multiple logistic regression model based solely on climatological variables explained more than 87% of the palsa distribution (80% of the observed present grid cells and 90% of the absent grid cells were predicted correctly). The predicted distribution map therefore satisfactory matches the observed palsa distribution; cp. the map in the centre of figure 3 for the baseline climate.

Figure 3: Temperature and precipitation sensitivity of the palsa distribution model. Changes were applied to the baseline climate 1961-1990. The predictions (black grid cells) are shown next to the observations (red).

1. The sensitivity analysis showed considerable impacts of changes in temperature and precipitation on the distribution of palsas (figure 3). Decreasing precipitation expanded the areas with predicted palsas in all directions, whereas the decreasing temperatures of -2°C resulted in an expansion to south-eastern directions of the current distribution only. An imposed warming, on the other hand, reduced the palsa distribution from north-eastern and southern directions towards the centre of the current distribution with increasing temperatures. The negative effect of increased precipitation was similar from the margin of the palsa distribution in all directions.

2. A critical climate change was reached with increased temperatures of more than 3°C, for which our model predicted the total disappearance of palsas in the study area. However, the reduction in areas suitable for palsas is considerable already with smaller temperature changes: the number of palsa carrying grid cells was reduced by a half with 1°C and to less than one fifth with 2°C warming (figure 4). Also, increases in precipitation led to considerable loss of palsa. Temperature and precipitation changes were studied separately in the sensitivity analysis; a combination of both changes might still intensify the impact.

3. GCM-based scenarios showed reductions to less than half of the current palsa areas already by the 2020s for all seven GCMs in both SRES A2 and B2 emission scenarios (figures 5 and 6). Two scenarios predicted the total disappearance of palsas by the 2050s; for the 2080s, only one scenario showed areas with palsas.

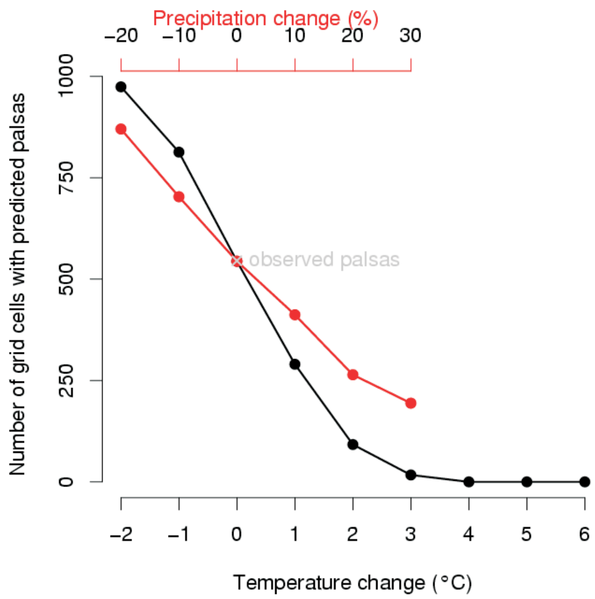


Figure 4: Modelled number of grid cells with palsa occurrence for changes in temperature and precipitation.

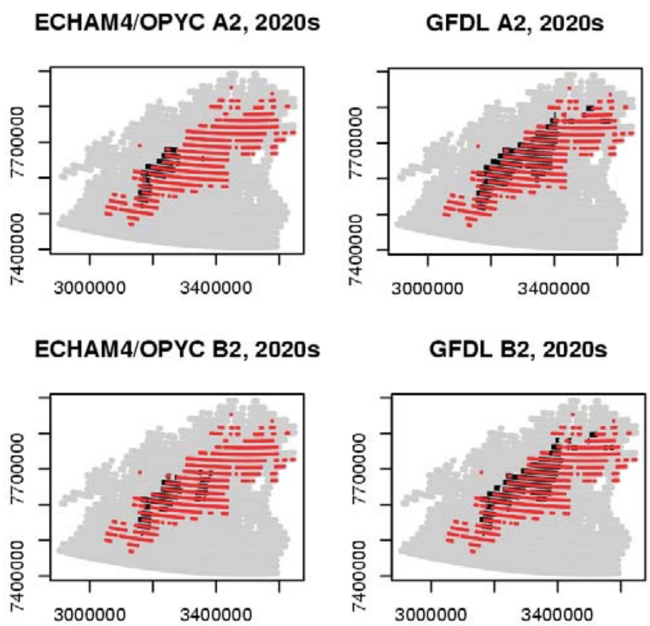


Figure 5: Palsa prediction for the 2020s according to four GCM-based climate scenarios, ECHAM4/OPYC and GFDL both for SRES A2 and B2 emission scenarios. The predictions (black grid cells) are shown next to the observations (red).

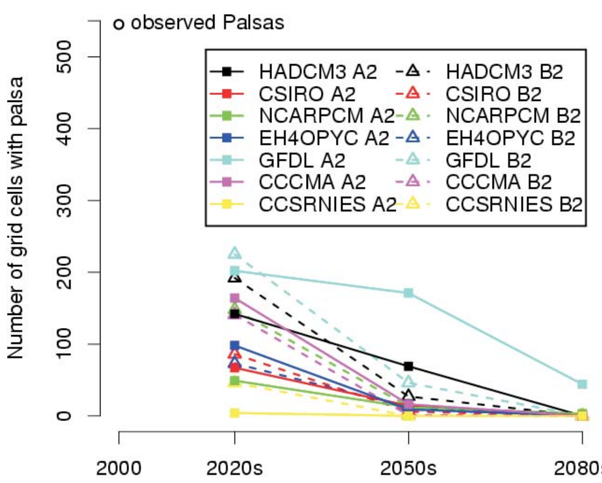


Figure 6: Modelled number of grid cells with palsa occurrences according to climate changes scenarios of 7 GCMs, SRES A2 and B2 scenarios, for the 2020s, 2050s and 2080s.

References

[1] Anisimov, O., Fitzharris, B., Hagen, J.O. et al., 2001: Polar Regions (Arctic and Antarctic). Chapter 16 in IPCC: Climate Change 2001: Impacts, Adaptation and Vulnerability. Cambridge Press.

[2] Nelson, F.E., Anisimov, O.E. & Shiklomanov, N.I., 2001: Subsidence risk from thawing permafrost. Nature 410, 889.

[3] Seppälä, M., 1988: Palsas and related forms. In: M.J. Clark (Ed.), Advances in Periglacial Geomorphology. John Wiley and Sons, Chichester, 247-278.

[4] Sollid, J.L. & Sørbel, L., 1998: Palsa bogs as a climatic indicator - examples from Dovrefjell, Southern Norway. Ambio 27: 287-291.

[5] Zuidhoff, F.S. and E. Kolstrup, 2000: Changes in palsa distribution in relation to climate change in Laivadalen, northern Sweden, especially 1960-1997. Permafr. and Perigl. Proc. 11, 55-69.

[6] Luoto, M. & Seppälä, M., 2003: Thermokarst ponds indicating former distribution of palsas in Finnish Lapland. Permafr. and Perigl. Proc. 14, 19-27.

[7] Laberge, M.J. and Payette, S., 1995: Long-term monitoring of permafrost change in a palsa peatland in northern Quebec, Canada: 1983-1993. Arctic and Alpine Res., 27(2), 167-171.

[8] Beilman, D.W., Vitt, D.H. & Halsey, L.A. (2001) Localized permafrost peatlands in western Canada: definition, distributions and degradation. Arctic, Antarctic, and Alpine Res. 33, 70-77.

[9] Tuomenvirta, H., 2001: Homogeneity adjustments of temperature and precipitation series - Finnish and Nordic data. Int. J. Climatol., 21, 495-506.

[10] Hanssen-Bauer, I. and Førland, E.J., 2000: Temperature and precipitation variations in Norway 1900-1994 and their links to atmospheric circulation. Int. J. Climatol. 20, 1693-1708.

[11] Alexandersson, H., 2001: Homogenisation of climate data, difficult but necessary. In: India, M. B. and López, D. (eds.): Detecting and Modelling Regional Climate Change. Springer, 3-12.

[12] Jylhä, K., Tuomenvirta, H. and Ruosteenoja, K., 2003: Climate change projections for Finland during the 21st century. Boreal Environmental Research (submitted).