

Larix decidua

Description of model and ensemble projections

The current distribution of *Larix decidua* is simulated to colonize most of subalpine forests in the Interior and Southern Alps. In addition, the species also is modelled to find suitable habitats in some few parts North of the Alps such as in the Gastern Valley or in the Southern-most parts of the Lauterbrunnen valley (Stechelberg) and in the subalpine forests in the Rhine valley, mostly around Chur. Some parts like the Reuss uppermost valley and the Posterior Rhine valley are simulated to be suitable, despite having no (or not much) observations of the species being distributed there. On the other hand, the Anterior Rhine valley and some neighbouring valleys harbor significant portions of the species' distribution North of the Alps, and are well modelled. Underestimated are also some parts North of the Alps in Western Switzerland. All low elevation plantings on the Swiss Plateau and Jura Mountains are not modelled to be suitable habitats from the set of occurrences and absences used for this model.

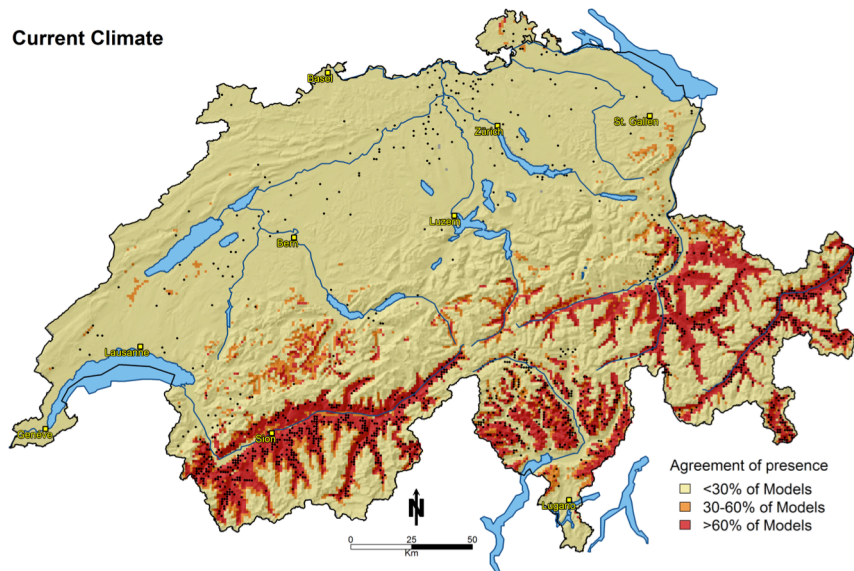


Figure 1. Current distribution (black dots) from the Swiss National Forest inventory (LFI 1) and simulated habitat suitability under current climate as calibrated from LFI forest inventory data of Switzerland.

Under expected climate change using the A1B scenario, most combinations of statistical and regional climate models predict a clear shift to higher altitudes of *L. decidua*, which leads to a stronger connection of the currently somewhat disconnected distribution range. This means that these regions represent soon climate conditions, under which presence of *L. decidua* is currently being observed. The species is expected to colonize all future subalpine zones, but still is expected to largely be absent in subalpine forests North of the Alps, with the exception of the Gotthard regions and - to a less certain degree - mountains in the Southern Simmen, Diemtig and Kander valley, where a moderate spread is projected.

Synthesis and Conclusions

The model projects the distribution of *Larix decidua* comparably well, and can be considered a credible model to project the future habitat suitability of *Larix*. The ensemble models project a 60% overlap between the current and the future range in Switzerland and a lower overlap (38%) in Europe. While in Switzerland (+45%) the species can be expected to expand its range of suitable habitats, it is projected to lose significant suitable habitat area (-61%) compared to its current range. Usually, species growing in high mountain environments tend to lose considerable range with increasing temperatures (Engler *et al.* 2011). However, *Larix decidua* is likely profiting from the projected decrease in summer precipitations throughout the Alps and Southern/Central Europe by expanding into regions that were too wet before. By this, *Larix* is expected to find more suitable habitats in by the end of the Century compared to today in the Alps, but not in the rest of Europe.

Larix decidua inhabits sub-continental forests in the upper subalpine belt throughout the Alps, and best grows on step slopes on a range of different soil types. *Larix* is very light demanding, and the currently large distribution and local dominance may partly be a result of management (Alpine pasturing) effects. More shade tolerant species would have likely outcompeted *Larix* locally, if these hadn't been removed by man in order to increase the pasturing potential of the subalpine belt. Under a slowly decreasing (sub-) alpine pasturing regime, *Larix* might decrease somewhat its abundance and range.

Range change statistics

	CH	Europe
Current range size [km²]	5'596	57'482
Future (2080) range size	8'137	22'394
Range Change 2080/2000 [%]	145.4%	38.9%
Overlap 2000/2080 [km²]	3'386	21'758
Overlap/current range [%]	60.5%	37.8%

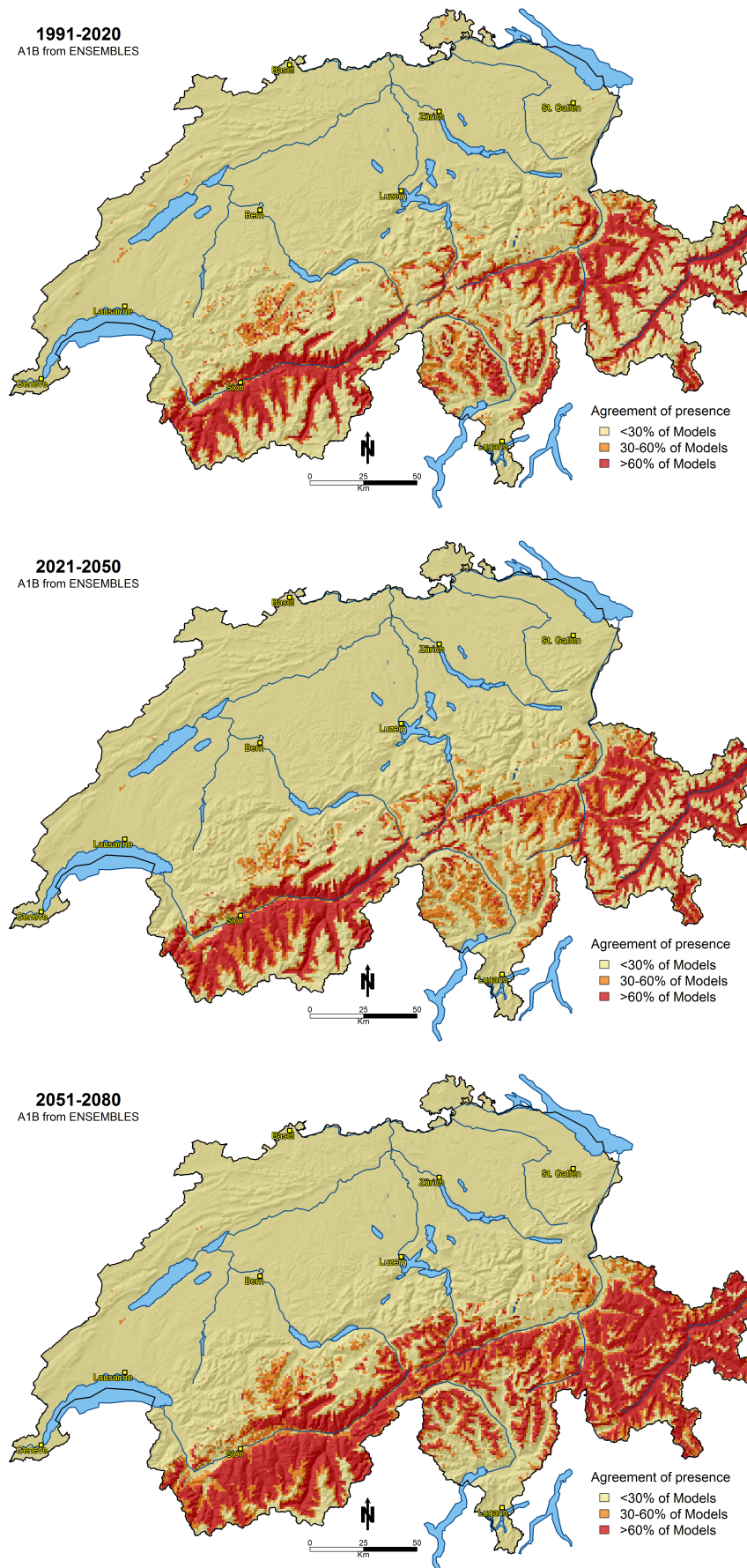


Figure 2: Ensemble of projected future ranges of suitable habitat as modeled from six RCMs and six statistical models. Light yellow colors indicate that all climate & statistical model combinations project absence of the species, while dark red colors indicate presence. Orange colors indicate uncertainty regarding habitat suitability.

In addition, *Larix* is +/- regularly (7-10 yrs) attacked by the larch totrix (*Zei-rapthera griseana*), a moth that has its distribution range throughout the boreal regions of Eurasia. Other pests are also reported. These might in addition limit the capacity of the species to adapt rapidly to new habitats under climate change. On the other hand, the species is considered early successional, grows fast (and is therefore also planted widely at low altitudes), and reaches maturation rapidly. It also grows sufficiently well on mineral soils, though it prefers more loamy soils to grow best. As a consequence of these life history characteristics, the species' migration capacity should be well adapted to climate and land use change (Meier *et al.* 2012).

References

- Engler R, Randin CF, Thuiller W, *et al.* (2011) 21st century climate change threatens mountain flora unequally across Europe. *Global Change Biology* **17**, 2330-2341.
- Meier ES, Lischke H, Schmatz DR, Zimmermann NE (2012) Climate, competition and connectivity affect future migration and ranges of European trees. *Global Ecology and Biogeography* **21**, 164-178.