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Predicting future windthrow susceptibility coupling forest growth and wind risk models: an application to a study area in the eastern Alps

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Research background

Windstorms is the main source of forest disturbances in the Alps

To identify the most vulnerable areas is crucial for hazard evaluation and assessment of forest stability

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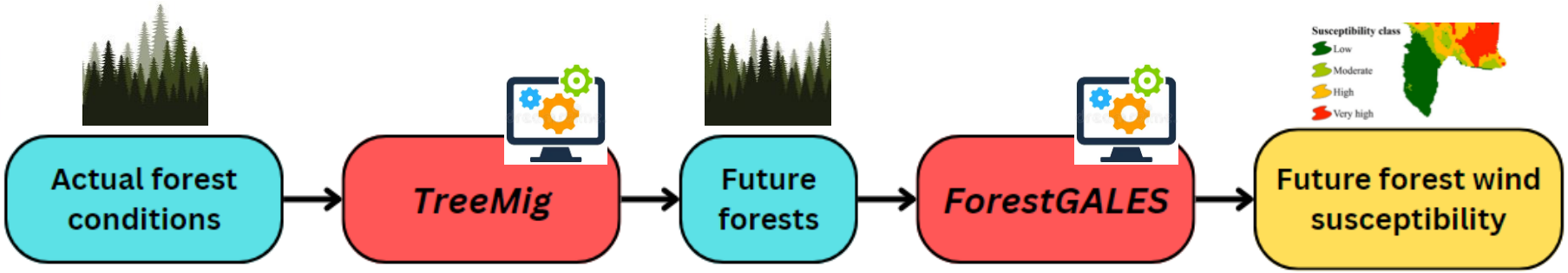
Motivation

Climate change is gradually modifying the structure and the species composition of actual forests

Natural disturbances are expected to increase.

What is the future forest wind vulnerability?



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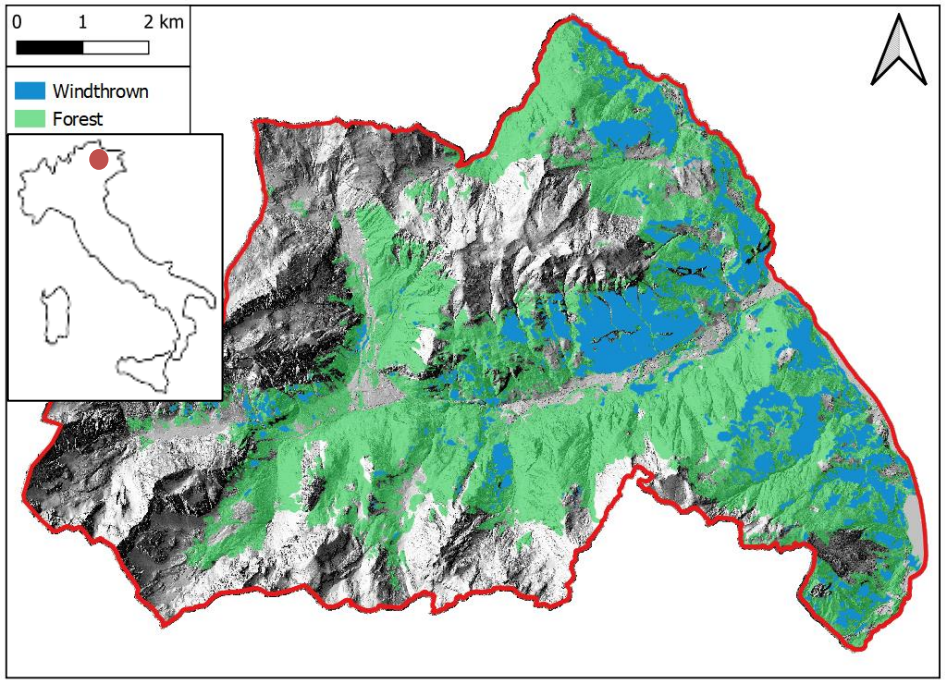

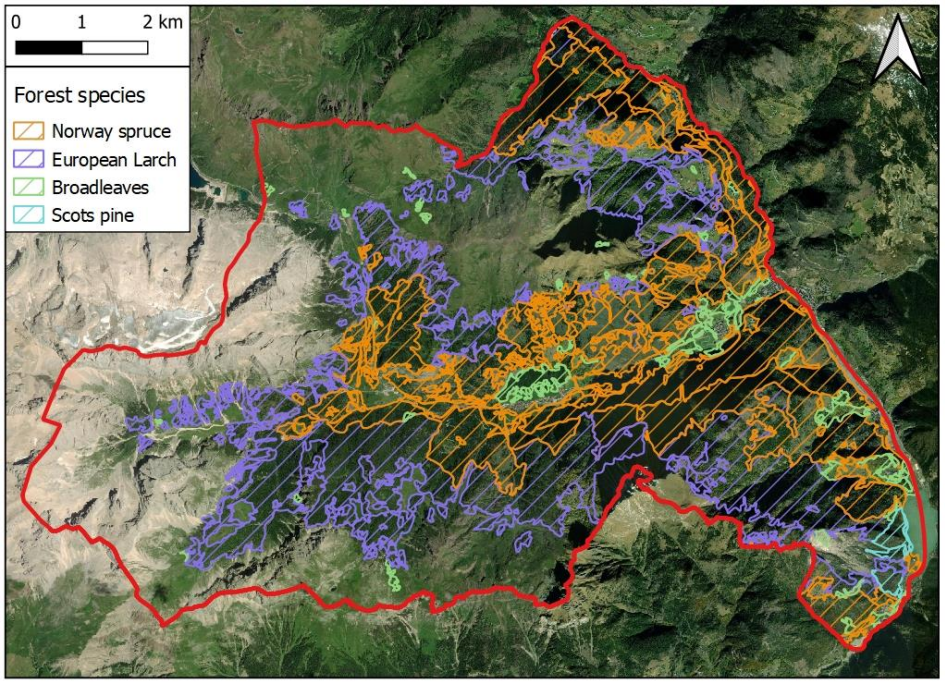

Study area

Rocca Pietore municipality, Veneto region (Italy)

Extent: 74 km^2

Elevation: 841 – 3343 m a.s.l

Forest area: 35 km^2

Forest area affected by Vaia: 7.3 km^2 (20%)

Species composition:

- Norway spruce (40%)
- European Larch (30%),
- Scots pine (5%)
- Broadleaves (25%)

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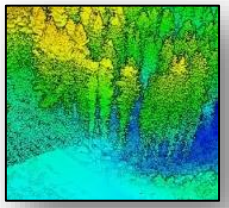
Methods – Forest growth



LiDAR survey 2019, cellsize

Weather station data 1926-2022

Soil water storage capacity: Map provided by the Veneto region

Forest characteristics:
- tree location
- species
- height

Climate data:
- Temperature -> linear increase
- Precipitation -> steady

DTM

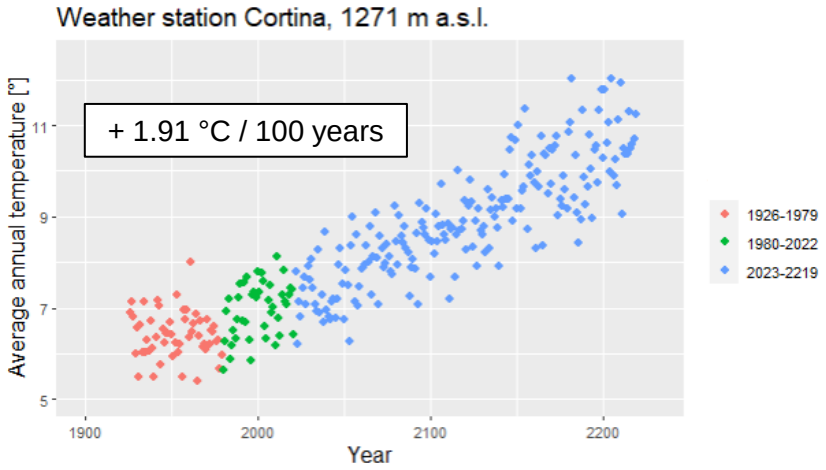
Start year: 2019

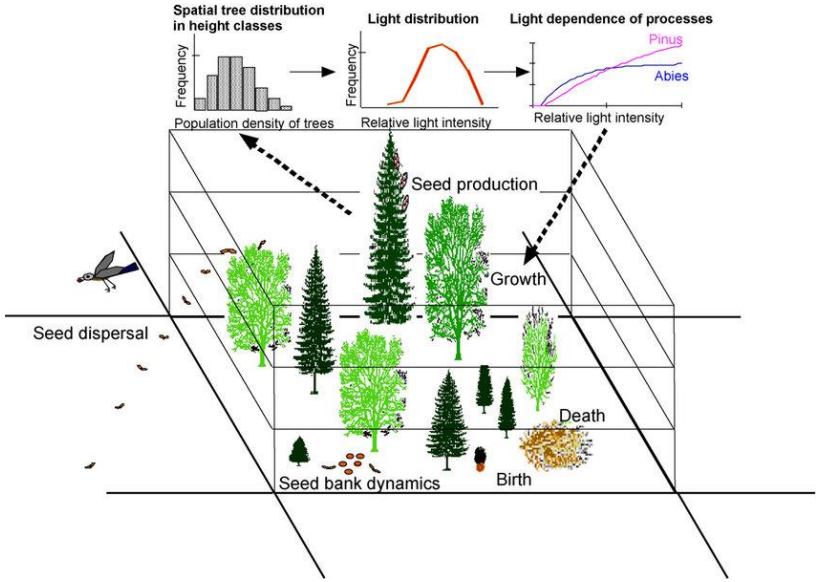
TreeMig
cellsize: 100 m

Altitudinal gradient

Scenarios: +50, +100, +150, +200 years

Number of trees per cell for height class and species





Source: Lischke et al., (2006)

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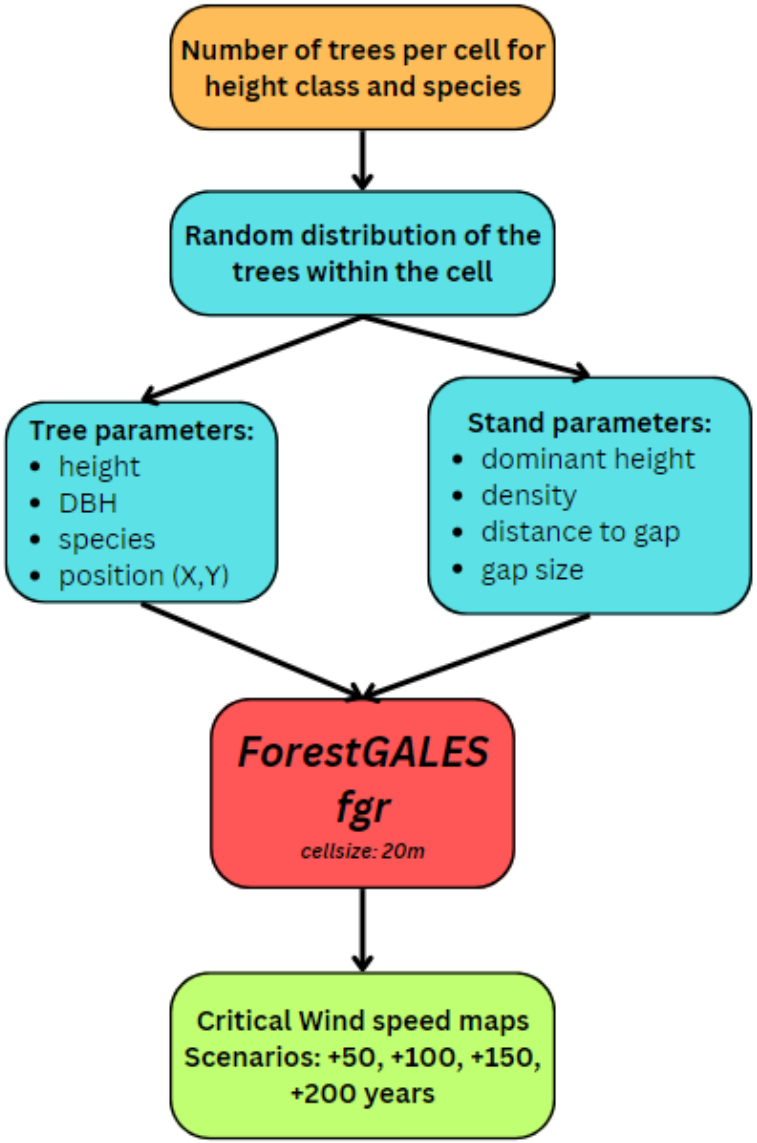
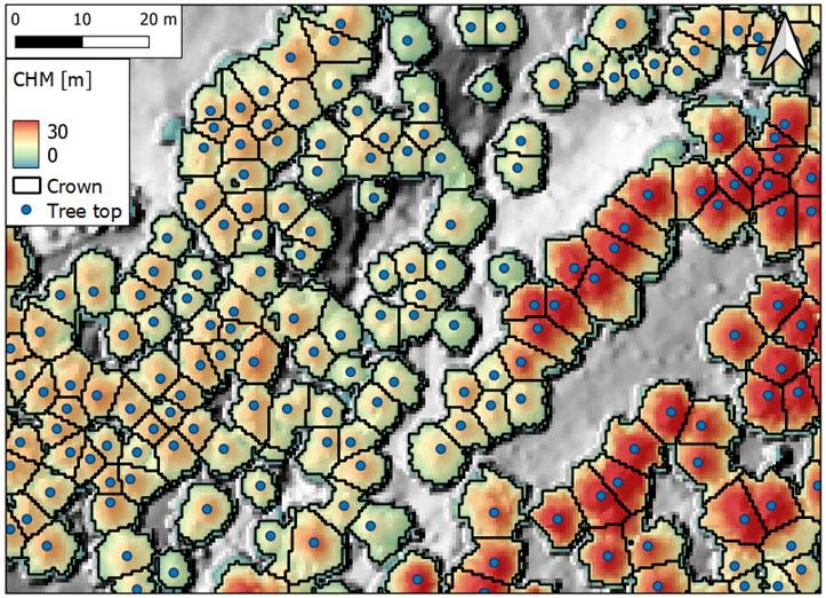
Methods – Wind susceptibility



Locatelli et al. (2017)

Semi-mechanistic model that calculate the Critical Wind Speeds (CWS) of overturning and breakage.



Calculation of input data for fgr, code release:

https://github.com/TommBagg/data_preparation_fgr

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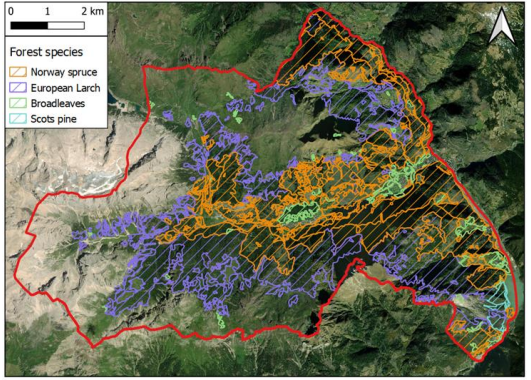
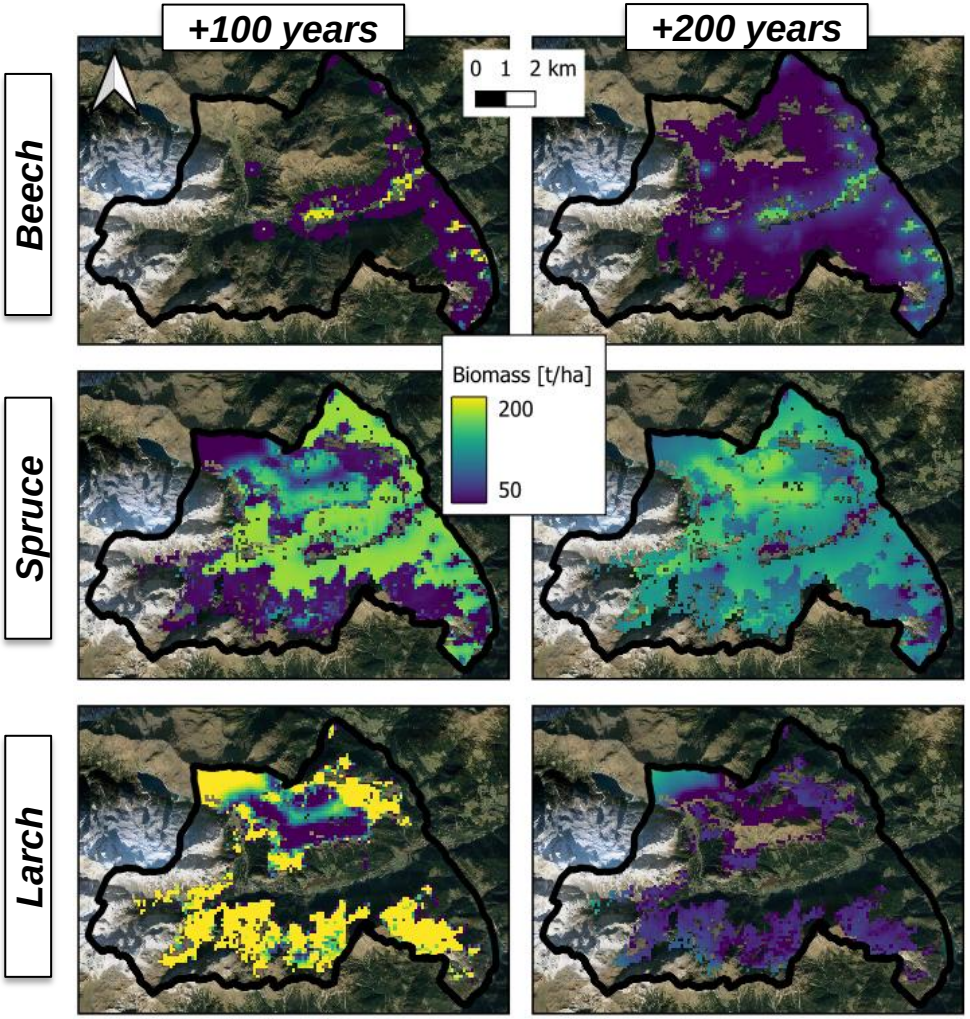
Results – TreeMig

- Norway spruce rises in elevation substituting forests of European larch
- Beech spreads at higher elevation composing mixed forests with spruce
- European larch tends to colonize new areas at high altitude

Outputs of TreeMig are every 50 years for a simulation time of 200 years.





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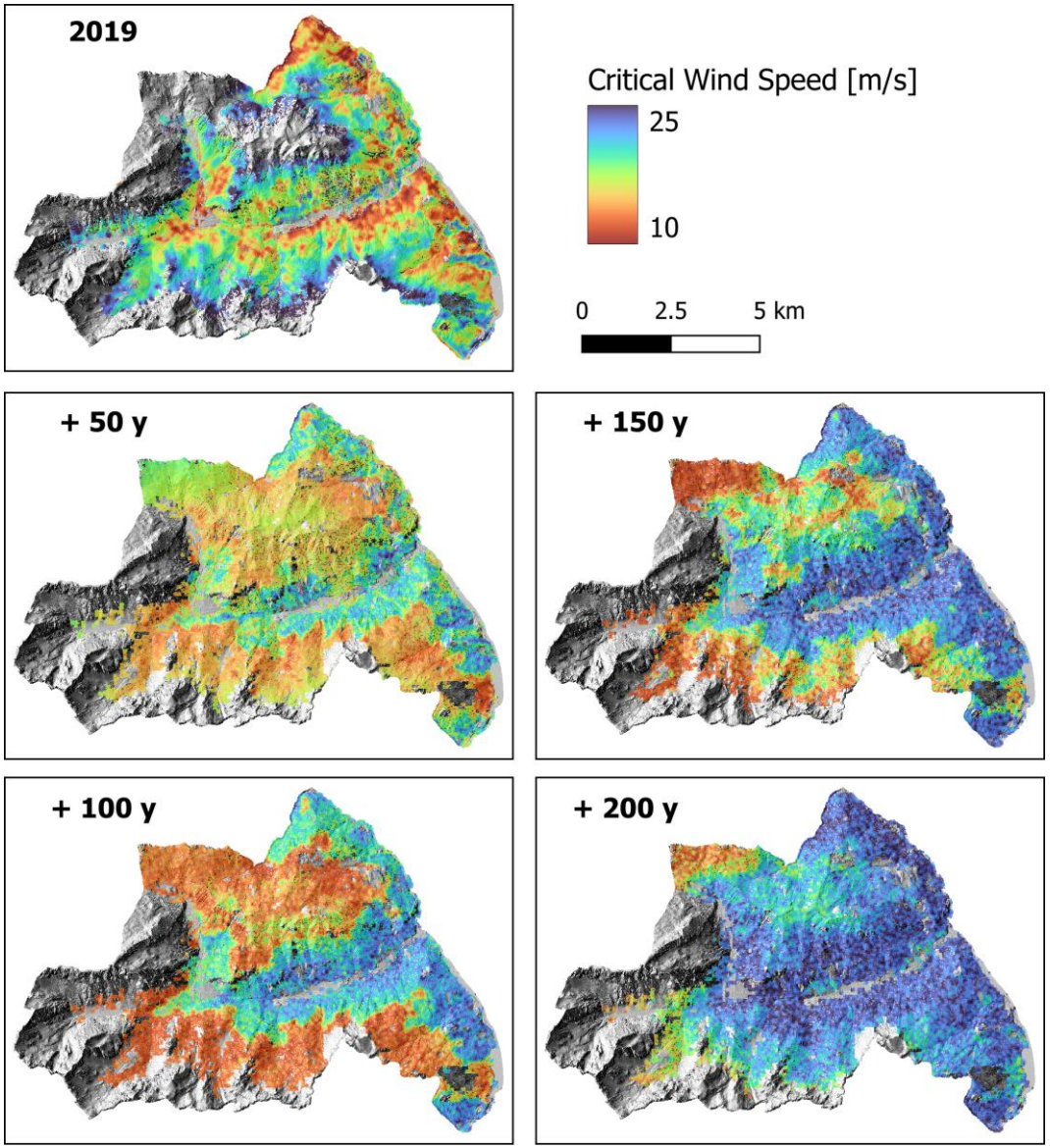
Results ForestGALES

- Critical Wind Speed (CWS) is strictly related to species composition
- Worst scenario is the +100 years where spruce replaces larch
- CWS will be higher at high elevation: the opposite of the actual situation -> beech will expand in the valley bottom



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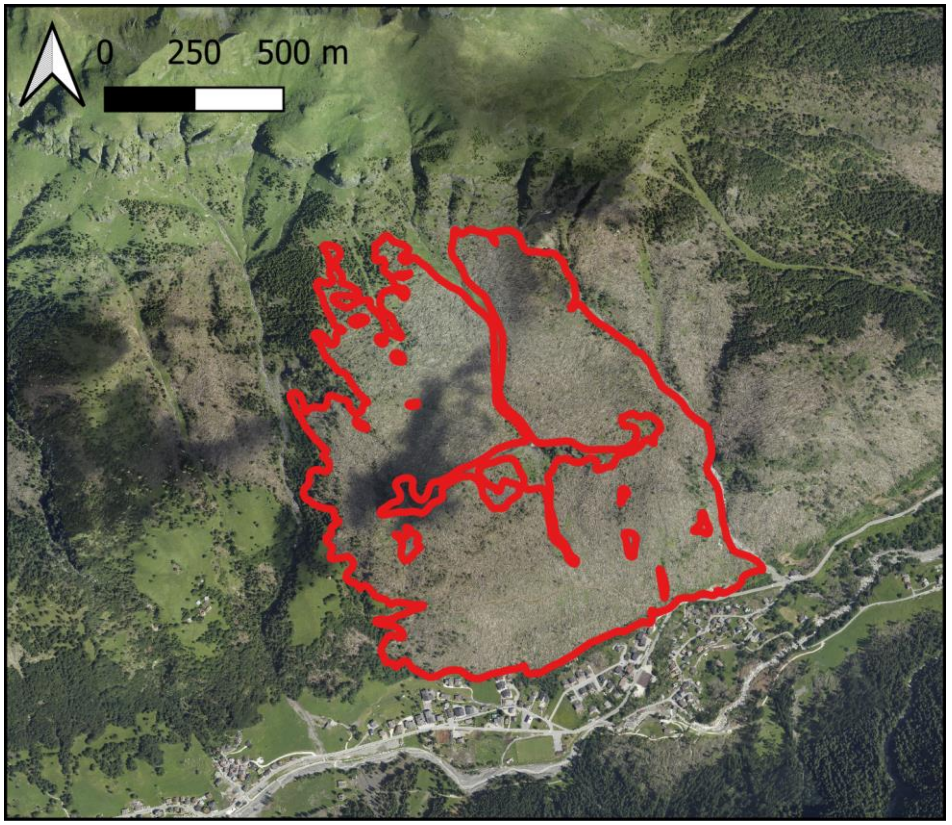
Results – windthrown areas

- Area severely affected by Vaia in 2018
- Worst moment is +50 years, where the forest is composed by an even-aged dense stand of spruce
- Since +100 years the CWS is higher due to presence of beech and less homogeneous structure



Scenario [years]	CWS [m/s]	SD [m/s]
2019	-	-
+ 50	17.15	1.66
+ 100	21.12	1.17
+ 150	23.27	0.95
+ 200	23.75	0.83

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Discussions - conclusions

- **Coupling TreeMig and ForestGALES can predict future forest wind vulnerability**
- **The proposed methodology can be used to identify most susceptible areas in the near and far future taking into account climate change**
- **Possibility to model the forest growth and wind damage potential after forest disturbances**
- **Development of future scenarios by tree planting (windthrown areas) and/or silvicultural operations**

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