Stand history in a mixed and multilayered forest in the Upper Susa Valley (Piedmont, Italy)

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Introduction

Human land-use has been an important driving force in shaping the landscape in the European Alps. Due to this fact, a detailed comprehension of how past land-use has affected population structure, composition and processes is required in order to gain a better understanding of the present forest dynamics.

Dendroecology is a solid approach for understanding the origin and past dynamics of forest stands. Since biological archives do not provide a sufficiently accurate reconstruction of the history of stands which have undergone heavy anthropogenic disturbances, it is necessary to look at historical documentary records and other independent sources of data as well.

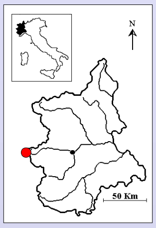
The present study integrates dendroecology and land-use history to investigate the origin, establishment, disturbances and spatio-temporal development of a mixed, multilayered forest stand located in the upper mountain belt in the Susa Valley (Piedmont, Italy).

Study area

TEPPAS FOREST
(45°04.62N; 6°67.60E)

Altitude: 1720 m
Slope: 22°
Aspect: North-North West
Rainfall: 778 mm/year
Av. annual temperature: 5.5°C (at 1260 m a.s.l)
Bedrock: calcschists
Soil: deep and well drained

The forest is multilayered and mixed with **silver fir** (*Abies alba* Mill.), **Norway spruce** (*Picea abies* (L.) Karts.), **Swiss mountain pine** (*Pinus uncinata* Mill.) and **larch** (*Larix decidua* Mill.).



Methods

1. Inside a 100x100 m plot, live and dead standing individuals with diameter at 50 cm height >4 cm, logs and stumps were identified, measured, labeled and mapped.
2. Two cores at breast height (the first upslope and the others at 90-120° from this) were taken from 20 dominant firs and 22 dominant spruces in order to build a site chronology for each species. An increment core was then taken from all the live and dead individuals (991 cores), upslope at a height of 50 cm. Individual ring series were crossdated against site chronologies.
3. Disturbances were analyzed by detecting releases from suppression in radial growth in increment cores.
4. Spatial patterns were analyzed by using univariate K(t) and bivariate K_{12}(t) Ripley's point patterns functions.
5. Tree age and releases data were elaborated chronologically by means of GIS. Available documentary archives (e.g., chronicles, diaries, land surveys, maps, plot measurements, weather observations) were analysed.

Results

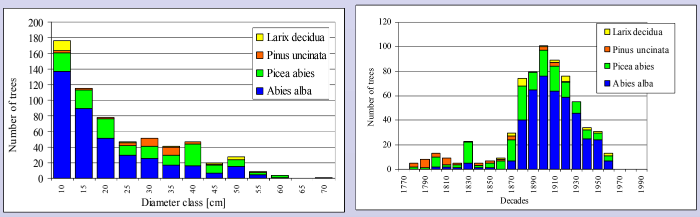


Fig. 1. The dbh size (on the left) and age structure (on the right) for the four main species in the Teppas permanent plot. Age structure by 10-year age classes at 50 cm height for the four species. Value on the x axis represent the class midpoint.

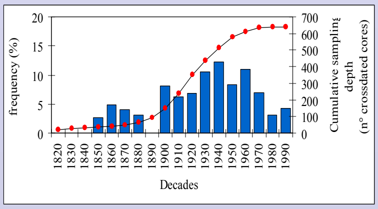


Fig. 2. Frequency of silver fir and Norway spruce released per decade (only period with more than 20 live trees). Cumulative sampling depth (number of trees) on the right. The decade-by-decade tallies of establishment show no correspondence with the frequency of growth release.

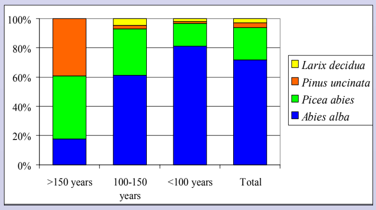
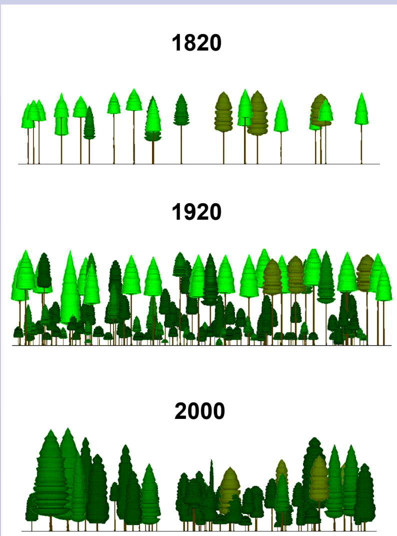


Fig. 3. Percentage species mixture of three different age classes of the present stand.



Period	Local history	Forest management and land use	Forest dynamic and forest structure
1750 - 1800	Establishment and transit of troops. Heavy anthropogenic pressure on the forest (grazing).	Clearcutting for military needs (fort construction, winter heating and cooking) and/or intense grazing in open forest associated with cuts for forest privileges	Open forest with *Larix decidua, Pinus uncinata, Picea abies* and scattered *Abies alba*
1801 - 1850	Heavy anthropogenic pressure on the forest (grazing)	Single tree selection for forest privileges and intense grazing	Open forest with *Larix decidua, Pinus uncinata, Picea abies* and scattered *Abies alba*
1851 - 1900	Construction of the Frejus railway tunnel. Beginning of emigration	Single tree selection for forest privileges and grazing (reduced during last two decades)	Forest with *Larix decidua, Picea abies, Pinus uncinata* and scattered *Abies alba.* The stand density begin to increase
1901 - 1950	Massive emigration. Beginning of tourism development	Single tree selection for forest privileges. Impact of grazing of the domestic animals greatly reduces.	Mixed forest with *Picea abies, Abies alba, Larix decidua,*and scattered *Pinus uncinata*. Forest density increases.
1951 - 2000	Agricultural activities drops off sharply in mountain areas. Intense development of tourism. Forest Management plans for all public forests	Selection cuts (single trees or small groups) for forest privileges mainly on *Larix decidua*. Over the past 20 years an exponential increase in wild ungulate density	The forest canopy closes; *Abies alba* becomes the dominant species. *Larix decidua* sharply decreases. Selective wild ungulate impact on the regeneration

Tab. 1. Synoptic table of the stand history in the forest of Teppas.

Discussion

The changes in composition and structure over the last two hundred years have generally been the result of human action rather than of natural disturbances. Forest development has been driven more by long-term trends in economic and cultural history rather than by autogenic or allogenic succession. The earliest trees in the present stand established at the end of the 18th century under conditions that were quite different from those present today, i.e. an open, intensively grazed larch stand (probably no more than 150 trees/ha) with some mountain pine and Norway spruce. Between the end of the 19th century and the beginning of the 20th, establishment on a massive scale of silver fir and, to a lesser extent, Norway Spruce, began, mainly as a result of the abandonment of the traditional agricultural activities; this trend continued until the end of the 20th century. The Teppas forest gradually became denser, so that the silver fir has become the predominant species, overtaking the light tolerant species and the Norway spruce. Silver fir regeneration occurs preferentially under the shelter of Norway spruce than under the shelter of the old silver fir individuals, as observed in several other forests in Europe. Nevertheless, there have been enough small disturbances, i.e. single tree or group selection and/or small windthrows to allow limited but continuous establishment of light-demanding early-seral species like larch and mountain pine, which would not have been possible in a denser forest. As a result of the stand history the present structure is multilayered and clumped.

Using modelling, paleo archives, historical and contemporary information to assess present and future ecosystem dynamics.