

**Auxometric growth data of exotic tree species in the  
experimental plantation of Copera (San Antonino):  
estimating the potential in the light of climate change**

**Report**

WSL Swiss Federal Institute for Forest, snow and Landscape Research  
Insubric Ecosystem Research Group, Cadenazzo

Dr. Gianni Boris Pezzatti ([boris.pezzatti@wsl.ch](mailto:boris.pezzatti@wsl.ch))

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## ***Rationale and project aims***

In the frame of the ongoing climate change and the potential consequences on forests, several options for ensuring stable forests that can fulfill the multiple ecosystem services as production, protection, biodiversity and recreation are discussed and evaluated. Among those also the possibility of considering the integration in forest management of non-invasive exotic forest tree species that may be well adapted to the future climate challenges. To this goal, several experimental facilities have been recently set up. Management-proof results may however be yield in a couple of decades at the earliest. In this context, information from past trials and experiments on the growth behaviour and the health conditions of exotic woody species in Switzerland may substantially current silvicultural choices towards the forests of the future.

Following the arrival of the chestnut blight in Switzerland, a major tree planting experiment was set up 70 years ago in Copera (municipality of San Antonino, Ticino) on an area of 29 ha, by the former WSL. The goal was to evaluate the suitability of 71 tree species (49 exotic and 22 indigenous species) as a replacement of the threatened European chestnut (*Castanea sativa*). The north-facing position of the plantations on slopes between 500 and 800 m asl makes it an interesting case for conditions which could occur in the future at the lower altitudinal ranges North of the Alps. The experiment was however not following a structured design. In particular plot sizes were very different and rather low (i.e., from 140 to 3900 m<sup>2</sup>). Several plots were already abandoned in the 80ties or 90ties, whereas the full experimental area was transferred to the forest service of Canton Ticino in 2005. Data on plant growth are in paper format in the WSL physical archives in Birmensdorf, and only a part was recorded in digital format in the auxometric database of WSL. Among the planted species some are currently getting attention in the discussion about potential climate-proof trees, like the Douglas fir (*Pseudotsuga menziesii*).

The goal of the present project was to determine which and to which extent of the collected data can be exploited for evaluating the suitability of exotic tree species potentially interesting in the frame of the ongoing climate change.

## ***Changes to the planned activities***

The project originally planned 3 tasks: a) the exploration of the WSL physical archive in Birmensdorf; b) the search for interventions operated by the forest service of Canton Ticino since 2005 in the plantation; and c) the selection of the plots of potential interest.

However, only 1/3 of the surface of the experimental plantation had some data in digital format in the auxometric database of WSL. Most information on the majority of the plots were only on paper. Although many experiments were abandoned before 2000, the information on the development of the stands in their first decades is a relevant information in the evaluation of the growth of exotic tree species.

In order to exploit this potential and to already start to digitize the most relevant information during 2024, an additional grant of 48'952 CHF in the frame of a WSL-internal project (*Das "Copera-Archiv": Erschliessung historischer Dokumente eines grossflächigen und einzigartigen Anbauversuchs zu verschiedenen Baumarten im Kanton Tessin*) lead by the WSL research group Stand Dynamics and Silviculture (PI Jonas Glatthorn) was requested and obtained.

A first digitization effort has however already been performed in 2023, in the frame of the development of the DokuTool (*Dokumentations-Tool Zukunftsbaumarten*) application (a project co-financed by the Wald- und Holzforschungsförderung Schweiz WHFF-CH), with the goal of providing some test datasets.

In order to optimally link these 3 projects and avoid overlapping efforts, we modified the originally planned tasks, focusing on the creation a common digital foundation, that will allow a structured and geo-referenced storage of the information to be digitized in the next months.

## Results

### Documents in the physical archive

#### Maps

Several maps in big format with the position of the experimental parcels were found (*Übersichtsplan 1:1'000*), some of which reporting also the planned silvicultural treatments at certain points in time (*Pflegeplan*). We selected and digitized 3 maps reporting the date of 18.8.1966 (which presumably is the date of the base map used) with a professional scanner: a map reporting some corrections to parcels possibly done in 1966, a version after the correction, and a map reporting the *Pflegeplan 1972/76*. The last one was georeferenced in ArcMap according to the position of the buildings and of the road/paths, since the reference points (crosses) drawn on the map were not accurate (Fig. 1).

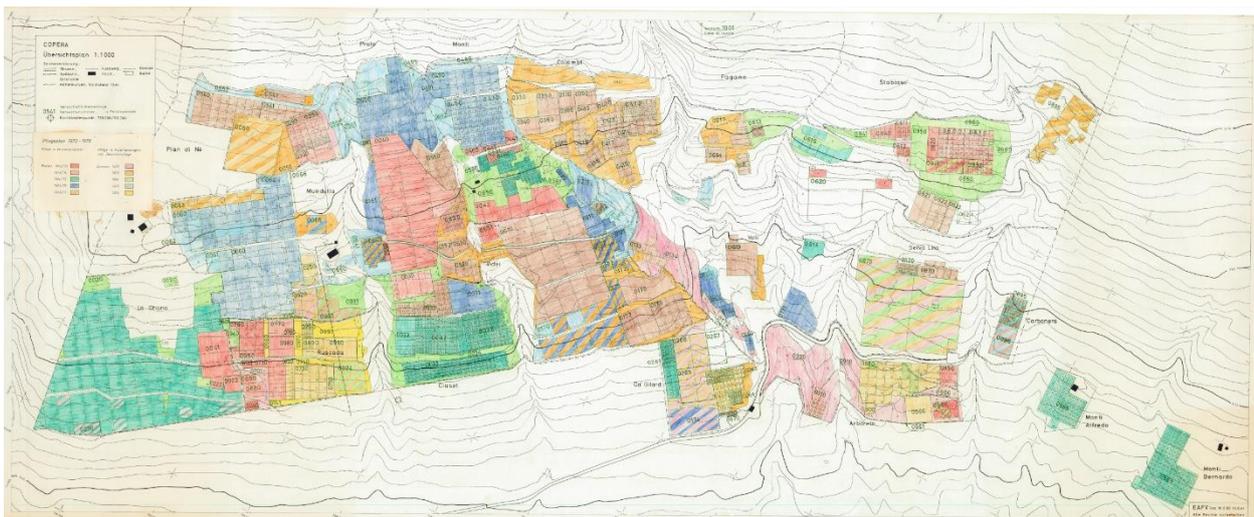


Figure 1: Scanned and georeferenced plan of the Copera experimental setup (*Übersichtsplan 1:1000* of 1966, *Pflegeplan 1972/76*).

Finally, a more recent map of 1992 with a lower resolution (based on a *Übersichtsplan 1:2'000*) reporting the last *Pflegeplan* of the parcels that were last actively maintained was scanned. It is to remark that those parcels are the ones also recorded in the WSL auxometric database (referred to parcels called *Teilflächen*), but do not always correspond to those formerly present (subplots). At some points in time only a selection of parcels was carried on, sometimes by joining together older parcels (Fig. 2)



Figure 2: Scanned and georeferenced plan of the Copera experimental setup (Überischsplan 1:2000, Pflegeplan 1992).

On the base of the georeferenced plans all parcels were manually digitized, at the plot and at the single parcel (subplot) level, ending in 183 polygons for the plots and 2'363 polygons for the subplots. Also a third layer containing the 87 polygons of the *Teilflächen* was digitized.

### **Other documents**

Several different types of documents are present in the physical archive in Birmensdorf (Table 1).

Table 1: Different document types to be found in the Copera physical archive located in Birmensdorf.

Document type	Information	Period
<i>Lieferscheine</i>	Provenances of the original material (seeds, seedlings)	
<i>Anlageprotokolle</i>	Original setup of the experiment, as well as following plantings ( <i>Nachpflanzungen</i> )	
<i>Situierungspläne</i>	Spatial location of each tree (identified by an id) inside the parcel	
<i>Meldungen</i>	Descriptions, measurements, silvicultural treatments, experimental goals	until 1980
<i>Karteikarten</i>	Same as <i>Meldungen</i>	starting from 1972
<i>Inhaltsverzeichnisse</i>	Listing for each year with summaries of measurements, treatments and plans	
<i>Hängemappen</i>	Contains plans, measurements and <i>Inhaltsverzeichnisse</i>	

Several documents have been scanned and part of the information digitized in order to provide some test -dataset for the DokuTool project.

## Documents of the forest service of Canton Ticino

A first search of the documents present at the *Ufficio della selvicoltura e degli organismi pericolosi* on sylvicultural interventions operated since 2005 in Copera by the forest service of Canton Ticino has been performed. Several digital documents were provided for past interventions. However the description detail do not currently allow the precise localization and the extent of the treatments, often performed for training purposes of apprentices. The forest services is currently digging further to retrieve this information detail.

## Database

We developed database a relational PostgreSQL database that can also handle geographic data like polygons, by using the postGIS extension. We created a web application built on top of the WSL BOX framework (<https://www.boxframework.com/>), which is also used for the national Swissfire forest fire database and the new WSS (Waldschutz Schweiz) platform. The database is currently password protected and accessible online at <https://webapps.wsl.ch/copera/> (Fig. 3).

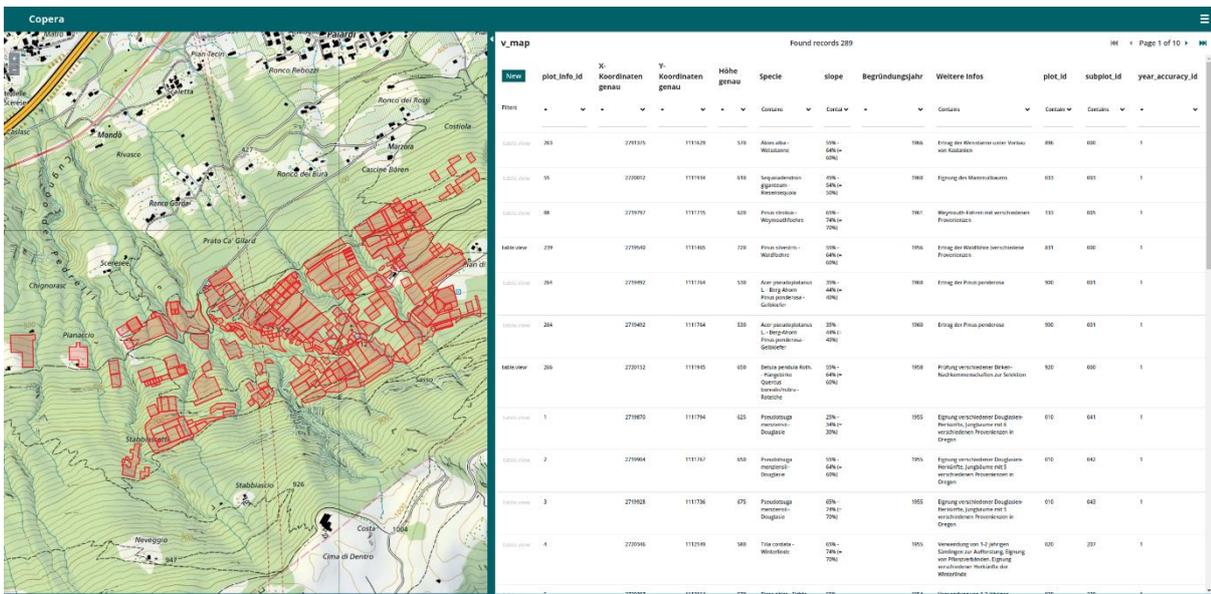


Figure 3. Screenshot of the beta version of the Copera web application showing a georeferenced access mask.

The database holds a hierarchical structure (Fig. 4) and currently contains all the digitized polygons of the parcels, the scanned documents, as well as all the test dataset created for the DokuTool and the partial information about provenances (on for the data present in the auxometric database).

The database structure is however a work in progress and still needs to be improved in order to be able to locate the present information to the most precise georeferenced information. This refinement process will be performed in the first months of 2024, in parallel to the digitization foreseen by the WSL internal project.

Copera

plot\_info plot\_info\_id 239

Save Save and back to table Save and insert next New Copy Delete Revert

plot\_info\_id requires 239

X-Koordinaten genau 2719540

Y-Koordinaten genau 1111465

Höhe genau 720

Standortstyp kantonal 33a/42c

Quelle Standortstyp Beurteilung beschränkte Zun

Exposition Nordwest

slope 55% - 64% (= 60%)

Begründungsjahr 1956

Weitere infos Ertrag der Waldföhre (verschr)

plot\_id requires 831

subplot\_id requires 000

year\_accuracy\_id 1-2J

### Species

plot_specie_id	Baumart DE	Baumart FR	Baumart Lat.	specie_id	herkunft	Anzahl bei Start	Pflanzenverband DE	regeneration_id
508	Waldföhre	Pin sylvestre	Pinus sylvestris L.	Pinus sylvestris - Waldföhre	Schweiz/Deutschland	555	1,5m x 1,5m	Nacktwurster

plot\_specie +

### Interventions

plot_intervention_id	month	Datum	Stammzahl (absolut)	Maximaler BHD (cm)	Nachpflanzungen	Massnahmen Konkurrenzvegetation	Übrige Massnahmen	Bemerkungen zu Zustand und Schäden	Dokumentation der Zustände/Massnahmen	development_stage_id
3103	Oktober	1963				Buchen im Vorbau: alle alten Erlen und Birken entfernt (sehr viel Material)				
3097	Dezember	1965				Buchen im Vorbau: Buchen mit schlechter Qualität wurden entfernt oder gekippt/geastet	Föhren wurden von Buchen eingepackt gelöst			
3098	Juli	1967				Buchen im Vorbau	bei der Parzelle mit der alten Nummerierung 832 wurde eine normale Ausleседurchforstung vorgenommen ausser bei den Feldern 1-3/10-15 (als negatives Beispiel)			
3104	Oktober	1967				Buchen im Vorbau	bei der Parzelle mit der alten Nummerierung 832 wurde in den Feldern 4-9/16-18 geastet			
3102	November	1971				Buchen im Vorbau	auf 2 Quirle geastete in Feld 4-9, 15, 16			
3106		1972				Buchen im Vorbau				
3107		1973				Buchen im Vorbau: starke Dichtungspflege, besonders hinsichtlich der Buchen, die zu Gunsten der Föhren dezimiert werden, Buchen sollen aber im Nebenbestand bleiben	Parzelle 831: oben möglichst alle Föhren befreien, sonst starke Dichtungspflege, unten eventuell grabastige Föhren entfernen; Parzelle 832: starke Dichtungspflege, besonders hinsichtlich der Buchen, die zu Gunsten der Föhren dezimiert werden, Buchen sollen aber im Nebenbestand bleiben			
3100	Juni	1974				Buchen im Vorbau	Durchforstung (Buche wurde stark reduziert)			
3101	Juni	1982				Buchen im Vorbau	Ausleседurchforstung	ein Teil der Fläche weist Schneedruckschäden auf		
3105	Oktober	1988				Buchen im Vorbau	normale Ausleседurchforstung	vereinzelt Schneebruch und Schneedruck		schwaches Baumholz (d60m 30-40 cm)
3099	Juli	1994				Buchen im Vorbau	normale Ausleседurchforstung			

plot\_intervention +

### Documents

document_id
70831000_Metadaten.pdf
70831000_Übersichtsplän.pdf
70832000_Metadaten.pdf

Copera - Box Framework - 1.11.10 - box-copera 0.0.8

Figure 4. Screenshot of the beta version of the Copera web application showing the details at plot level.

## Next steps

The next months we will work in tight collaboration with the WSL research group Stand Dynamics and Silviculture in order to provide a final database structure that can hold all the information to be digitized. It is planned to have all the relevant information stored in the database in the second half of the year, allowing then a first analysis of the data and the identification of the most interesting cases in the light of the ongoing climate change.

Kind regards

Dr. Gianni Boris Pezzatti  
Insubric ecosystems research group - WSL