

# Dendrochronological dating and provenancing of timber used as foundation piles under historic buildings in The Netherlands

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Received 10 December 2006; received in revised form 15 February 2007; accepted 23 July 2007

Available online 19 November 2007

## Abstract

In this study, we investigated whether dendrochronology can be used to determine the felling dates and origin of the trees that were used as wooden pile foundations under historic buildings. Dating and dendroprovenancing of the timber was possible for eight out of nine buildings. This is due mainly to the availability of newly constructed tree-ring chronologies of pine for the Netherlands and was of particular value in three of the investigated buildings where local timber had been used. Problems with the analysis of short time series from local timber are discussed. Detection of the felling date and origin of the trees used as piles allowed determination of the time lag between felling of the tree and implementation of the timber. Any possible effects of storage and/or transportation time on the susceptibility of the timber to bacterial degradation are considered.

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**Keywords:** Dendrochronology; Dendroprovenancing; Foundation piles; Pine; Spruce

## 1. Introduction

### 1.1. Background

For many centuries, wooden foundation piles have been used in the Netherlands for the establishment of (monumental) buildings on unstable ground (Klaassen, 2007). From the 16th century onwards, besides oak and alder, mainly softwoods such as Scots pine (*Pinus sylvestris*) and European spruce (*Picea abies*) were used. Recently, problems were encountered with the stability of pile foundations under historic buildings. In the context of the EU-BACPOLES project (EVK4-CT-2001-00043) an interdisciplinary approach was used to evaluate the state of preservation of wooden foundation piles and possible mechanisms of (bacterial) degradation.

In this context, questions arose about the age and origin of the building timber and its possible influence on the performance of the foundation piles. The felling date of a

tree that is used as a foundation pile can be determined by using dendrochronology, i.e., tree-ring analysis. In this way, dendrochronology can give an indication about the construction date of a building (see Fig. 1). In the case of precise documentation of the construction date, information about the length of the transportation and/or storage time between felling of the tree and the implementation as a pile can be deduced. Knowledge about the origin of the timber, an approach called dendroprovenancing (Fig. 1), also enables us to study differences in wood quality related to the growing regions of the trees.

### 1.2. Dendrochronology and dendroprovenancing

In the Netherlands, dendrochronology is normally applied to the dating of oak wood in archaeology, building history, art history, and palaeoecology (Jansma, 1995, 1996; Vernimmen and Sass-Klaassen, 2004; Sass-Klaassen and Hanraets, 2006). The potential for dating softwoods from Dutch monuments is described in Sass-Klaassen (2000), but little is known about the felling date and origin

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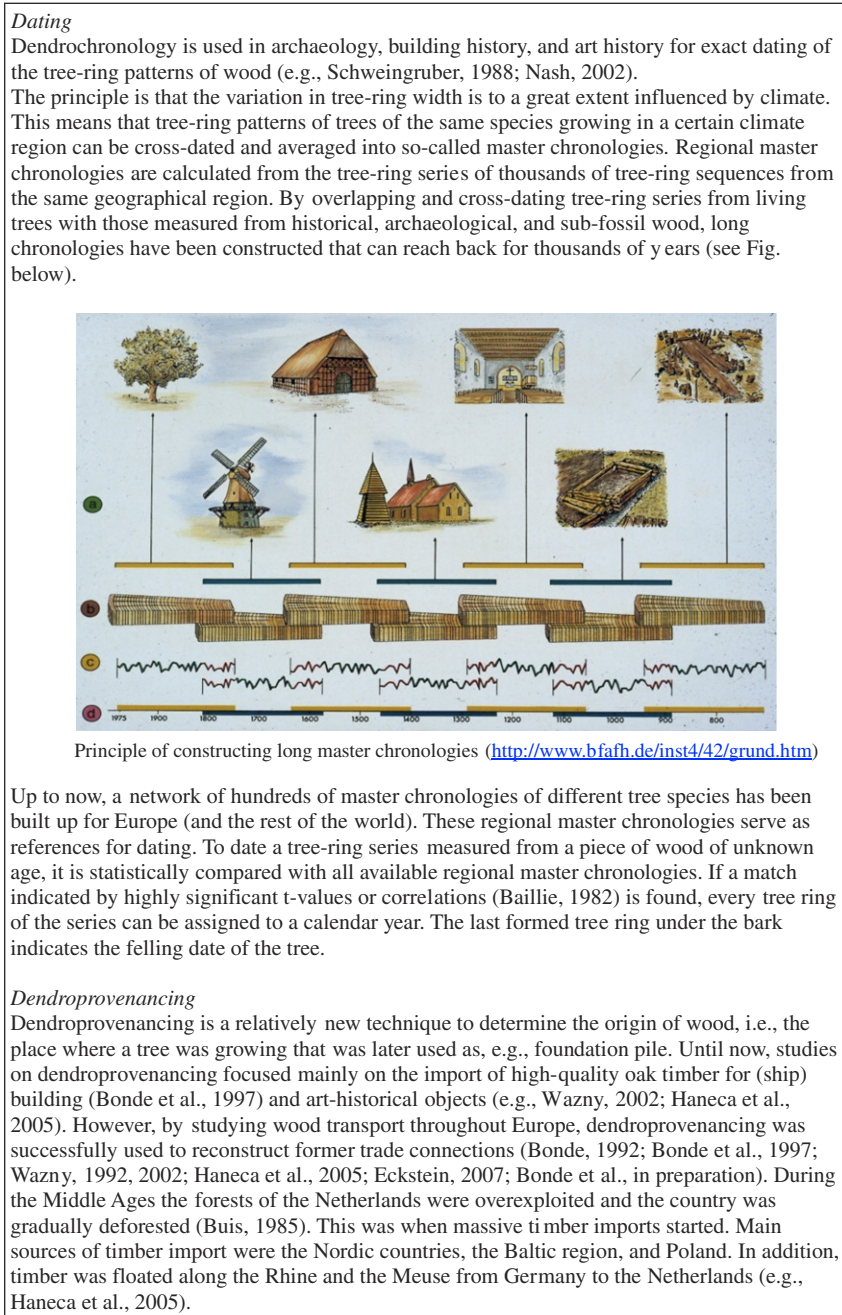


Fig. 1. Principles of dendrochronological dating and dendroprovenancing (Bonde, 1992; Bonde et al., 1997; Eckstein, 2007; Nash, 2002; Wazny, 1992, 2002).

of the (softwood) timber that was used for foundations piles under historic buildings.

During Roman times, but especially in the Middle Ages, the forests of the Netherlands were overexploited and the country was gradually deforested (Buis, 1985). It was at this time that massive timber imports began, with the main sources of timber being the Nordic and Baltic countries and Poland. In addition, timber was floated along the Rhine and the Meuse from Germany to the Netherlands (Haneca et al., 2005). Pine is the only softwood species used for foundation piles that grows naturally and was planted on sandy soils in the Netherlands, whereas spruce had to be

imported from elsewhere, most likely from southern Germany, or the Nordic countries. Until now, no Dutch pine chronologies were available for the dating of wood from historic buildings.

### 1.3. Approach

To determine the felling date and the origin of the timber used as foundation piles under Dutch historic buildings, a network of regional tree-ring width chronologies of pine and spruce from different parts of Europe was required. The chronologies included in this study should at least

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