



DCCB Progress report version 1.1, July 2nd 2007
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1 INTRODUCTION

1.1 GENERAL

The project *Digitaal Collaboratorium Cultuurhistorische Boomtjkdkunde voor de Lage Landen* (DCCB; Digital Collaboration on Cultural-historical Dendrochronology in the Low Countries), is a pilot project in the category Investment Subsidy Medium subsidized by the Netherlands Organization for Scientific Research (NWO), section Humanities (GW). The practical goal of this pilot project is to set up a research and user network and to define the requirements for a digital data library on dendrochronology for the Low Countries, which can be used as a new data source for cultural historical and palaeo-environmental studies. The result will be a full proposal to NWO/GW in the category Investment Subsidy (Medium). More information about the project, including the original application, can be found at <http://www.archis.nl/RINGnieuw> and clicking on 'DCCB'.

1.2 THE DCCB PILOT PROJECT

1.2.1 Summary

The purpose of the DCCB pilot project is to outline the infrastructure for a multi-disciplinary archive in cultural historical dendrochronology (digital work places for and databases of information about archaeology, cultural landscape, architectural history and art history) for the Low Countries, based on the principle of *do ut des* ('I give that you may give'). The envisioned archive should be useful to develop and refine knowledge based on information in and inferred from cultural historical and 'natural' dendrochronological data about chronology, socio-economy, cultural landscapes, climatology, forestry and wood technology.

1.2.2 Project description

1.2.2.1 Framework

The growth patterns in wood can be read as accurate chronological records of biological, geological and climatological processes in the past. Not only the year that the tree was felled can be determined from the patterns detected in (pre-)historic wood, but also the location (country and region) and type of woods from where the tree came, the forest management and harvesting selections practiced at the time, and the climatic circumstances during the growth period. The ring patterns also contain information about individual trees and how they were used (it is for example easy to determine which pieces were sawn from a single tree). Moreover, measurements of the ring patterns are the building blocks for the reference calendars which are the basis for the dendrochronological dating method. Dendrochronological data are therefore an important source of information for cultural history about chronology, the social economy, cultural landscape, climate, forest management and wood technology.

Connections among digital data collections are necessary for relating dendrochronological information taken from different cultural and natural (pre)historic places and/or objects in order to address larger research questions. In the last two years the RACM and the Netherlands Centre for Dendrochronology (Foundation RING) have been involved in professionalizing dendrochronology as practised in the Netherlands. One of the results is a digital collection of dendrochronological data (at this moment 6000 dated ring patterns (number of observations (n) per measurement series: $40 < n < 300$)) and associated metadata stemming from materials found in the Netherlands and adjacent Northern Belgium (Flanders). This collection of archaeological, cultural landscape, architectural and to a lesser extent art historical data spans the period from 6025 BC to the present and contains, among other things, the source data of the calendars which were developed as references for dating wood from the Low Countries (Jansma & Hanraets 2004; Jansma *et al.* 2004; Jansma 2006). The collection has largely contributed to a new type of research (see below). In 2006 the digital structure has been adopted by companies who are involved in dendrochronology in the Netherlands (BAAC bv and Dendrolab NL¹) so that the data collections can be linked up later. The structure has also been made available to organizations in Flanders.

¹ Dendrolab NL has since ceased to exist. Its data are still available.

At present a predilection for synthetic research is on the rise in dendrochronology: measurements stored separately are being brought together in a framework of broader cultural historical research questions (Jansma 2006). This has already led to important new insights into the Roman Period:

- The Romans used locally grown trees for their building activities in the Netherlands until far into the Second Century. Organised transport of lumber over greater distances can only be shown in the context of Roman ship-building (Visser 2005). This falsifies the accepted hypothesis that the Romans built and maintained their infrastructure with German oak brought in via the Rhine;
- The Roman flat-bottomed barges excavated in the Netherlands were built from oak grown in the Netherlands (Vorst 2005; Jansma 2007a; Jansma 2007b). The accepted hypothesis has been that ships of this type were only built higher upstream along the Rhine River;
- At the end of the First Century in the Netherlands the Romans built flat-bottomed barges without considering wood-technological aspects (Jansma 2007a); in the Second Century the Romans had an established system for ship building; in this system even the *type* of oak was selected on the basis of growth patterns (mechanical characteristics, related to location) (Vorst 2005). This is new information.

That the aforementioned research concerns the Roman Period is because this period well represented in the digital archive. The National Research Agenda for Archaeology (Chapter 3; see www.noaa.nl) predicts important knowledge gains as this type of dendrochronological research is extended to other periods and cultural historical topics.

1.2.2.2 Statement of the problem

Wooden remains from the Middle Ages and later are found both in the subsoil and under water as well as above ground in movable and non-movable objects. Wood was simultaneously used in, for example, ships (archaeology), roofs (architectural history), and pulpits (art history). Because these types of objects belong to research domains of very different disciplines, a synthetic dendrochronological research approach is only possible with multi-disciplinary cooperation and data exchange. Frameworks regarding content, organization, management and technical aspects must be developed to this end.

1.2.2.3 Objectives of the DCCB

1. The project will organize and make available, within a dendrochronological 'collaboratory' of cultural historical organizations, a digital workplace and data library of the Low Countries oriented toward research, education, and commerce within the relevant cultural historical disciplines, which will be extendable internationally. Existing digital dendrochronological collections will be reconfigured and combined for this purpose as follows: (a) the collections will be organized according to the research agendas of the relevant disciplines; (b) important research results from these disciplines will be added; and (c) the collections will be made available for use by dendrochronologists and users of dendrochronology (based on project-oriented authorization by the authors of the data). In addition, the collections will be tested for adherence to valid digital standards and will be adapted to them where necessary. Linking to existing information systems should be a possibility.
2. The results of a synthetic dendrochronological collection incorporating research results and data of the (overlapping) disciplines of archaeology, cultural landscape, architectural history and art history will be:
 - new, high quality chronological data (reference calendars, spatial dating networks and dates) for examining complex historical phenomena;
 - high quality, quantitative socio-economic data for examining previous forest management and the trade and use of wood which will contribute to existing socio-economic interpretative frameworks;
 - high-quality climatic chronologies which will contribute to the current interpretive frameworks for examining large-scale cultural and socio-economic phenomena and changes.

1.2.3 Importance and value of the proposed collaboration

The DCCB pilot project is collaboration among representatives from the disciplines of archaeology, cultural landscape, architectural history and art history, as well organizations involved in maintenance of the cultural heritage, and their partners, for building a cultural historical digital collection. It is this collaboration which is significant for the development of interdisciplinary research questions and the treatment of data associated with them. The participation of universities provides input from areas of

fundamental research and education. The participation of Foundation RING guarantees that their newly developed digital dendrochronological collection of the Netherlands and Flanders will be part of the project and that the work will take place within a dendrochronological knowledge network and on the basis of thorough dendrochronological expertise. Interaction with commercial dendrochronology guarantees data exchange and knowledge sharing with this sector.

The planned dendrochronological collaboratory in the Low Countries represents a new, multi- and interdisciplinary approach to cultural historical dendrochronology based on exchange of knowledge. The planned collaboration will put us in the vanguard in Europe as far as the renewing and professionalization of this (disparate) specialty goes.

1.2.4 Relevance of the DCCB

The proposed DCCB archive for the Low Countries contains cultural as well as natural dendrochronological data and metadata relevant to cultural and environmental studies in the region and (with imported wood) beyond. The DCCB will enable research of former vegetation, forest management, wood provenance and climatology on a larger geographical scale and with more detail than is possible at present. With the DCCB, users outside of dendrochronology will be able to get fast overviews of the dendrochronological possibilities, data and interpretations. The DCCB furthermore serves as a data repository; entered data and metadata are safeguarded for the future. The content of the DCCB is expected to grow in time since the dendrochronological community outside the Low Countries has expressed a strong interest in the scientific and repository aspects of the archive and members of this community have in fact joined the DCCB-network (in the advisory board). Because of the data sharing that is possible with the DCCB, the collaboration within and between the cultural historical disciplines, the environmental disciplines and the dendrochronologists will improve both nationally and internationally and new research topics will be defined, as has become clear during phase 1 of this pilot project (see below). The DCCB will set international digital standards for archiving and data management in dendrochronology. The cultural historical and dendrochronological traditions as well as, more recently, the Treaty of Valetta, have led to a strong increase of commercial research mainly interested in 'cheap' dendrochronological results (dendrochronological cutting dates of wood), resulting in severe dispersal and loss of data. In this context, the DCCB will contribute to an overall increasing awareness of, and commitment to, a rational and cost-effective handling of the unique and 'expensive' dendrochronological data and metadata derived from commercial and other research. The commitment expressed by the DCCB regarding the safeguarding of these materials thus far has no parallels within Europe.

1.3 DCCB TIME FRAME 2007

Planning

Kick-off meeting DCCB	February 1st 2007
Phase 1 Inventory of users' wishes	Jan. – Apr. 2007
Phase 2 Formulation of Requirements Document	May – Jun. 2007
Phase 3 Formulation of the NWO Medium-sized Investment grant proposal	Jul. – Aug. 2007

Phase 1, the inventory of users' wishes, consists of the following activities:

Phase 1a Distribution of survey forms concerning the fields of cultural history, earth science and dendrochronology	Jan.-Feb. 2007
Phase 1b Conducting workshops on cultural history, earth science, dendrochronology and education	Mar. 2007
Phase 1c Personal interviews with representatives working in these fields of specialization	Apr. 2007

Presentation of the results of phase 1: April 26th 2007.

The deadline for the proposal is September 3rd 2007. NWO/GW communicates the results in March 2008.

1.4 THIS DOCUMENT

1.4.1 Progress Report DCCB version 1.1

This document reports the steps that were taken and the results that were obtained during phase 1 of the pilot project. In Chapter 2 the scientific and research-political rationale behind the DCCB initiative is described. Chapter 3 describes current digital archives in dendrochronology that can be consulted via the Internet. In chapter 4 the current data formats in dendrochronology are discussed. Chapter 5 describes the manner in which the DCCB network was created, the inventory of users' wishes was obtained and the initial content of the DCCB was defined. Chapter 6 contains the conclusions regarding the overall form and content of the DCCB. Chapter 7 outlines the research agenda based on the interdisciplinary data in the DCCB archive as defined by the DCCB network. Chapter 8 contains some preliminary remarks about the work plan of the proposed project.

1.4.2 Earlier and later versions of the 'DCCB Project formulation'

The first version (version 1.0) of the DCCB Project formulation was evaluated by the DCCB network in May 2007 by respondents to the survey, workshop participants and other contributors to the discussion.² This resulted in the current amended version 1.1, which was announced and distributed to the DCCB network in July 2007.³ Network participants who don't read Dutch and therefore were unable to read version 1.0, in July received this document in English.

Once phase 2 of the pilot project is completed and the Requirements Document has been formulated, the Requirements will be added to the current document. This will result in version 2.0, which will be distributed among the network participants during July-August. This 2nd version of the document will serve as a background and appendix of the definitive grant proposal, which will be submitted to NWO/GW as an application for an Investment Subsidy (Medium) toward the end of August.

2 SCIENTIFIC AND RESEARCH-POLITICAL BACKGROUND OF THE DCCB

2.1 DENDROCHRONOLOGY AND THE CULTURAL HERITAGE

The longer the time series that are used in dendrochronology, the longer the chronological intervals that can be studied. However, European deciduous trees are relatively short lived. In addition, no natural forests exist in the Low Countries; the majority of existing forests are planted and/or the result of centuries of forest use and management, which also involved thinning, the removal of dead trunks *et cetera*. This means that if we are to build collections of tree-ring records that span more than a few centuries and that are useful for cultural historical and environmental studies of the more remote past, we have to turn to the tree-growth archives contained in the wood previously used in man-made structures, such as buildings, objects and archaeological sites, and to the remains of dead forests preserved *in situ* in the soil.

The wood that is part of the cultural heritage is in majority not directly accessible for tree-ring research due to ownership of the structures, costs and restraints of sampling and other factors. Because of practical and financial reasons, tree-ring specialists working with pre-contemporary material as a rule use wood samples delivered to them by the cultural historical disciplines interested in dendrochronological dates (i.e., the determination of the year in which trees were felled).⁴ Research of sub-fossil forest remains in the Netherlands (which date no younger than AD 600) is enabled by archaeological organizations and in the past has received substantial funding by NWO (Jansma 1995; Leuschner *et al.* 2002; Poole *et al.* 2004; Sass-Klaassen *et al.* 2004a, 2004b; Sass-Klaassen & Hanraets 2006).⁵

² Version 1.0, which is written in Dutch and dates April 26th 2007, can be found at <http://www.archis.nl/RINGnieuw> and clicking on 'DCCB'.

³ The current version 1.1, dated June 25th 2007, can be found at <http://www.archis.nl/RINGnieuw> and clicking on 'DCCB'.

⁴ The demand for dates is one of the main factors causing the increase of dendrochronological activity in the Low Countries during the last decades.

⁵ NWO/GW contract numbers 280-151-040 and 250-51-072; NWO/ALW contract number 750-70-004.

The fact that European dendrochronology as far as studies on a longer time scale are concerned depends on the wood applied in the cultural heritage, has shaped the field to a considerable degree. In contrast to the US and parts of northern Eurasia, where natural forests are a ready source of century to millennia-long chronologies and where climate is the main research focus, the research questions asked in European dendrochronology have come to overlap with research questions asked in the cultural historical and landscape historical disciplines. Such questions are: (1) which traces of human behaviour do we find in the remains of former vegetations and to what extent were these vegetations shaped by human activity; (2) what does the growth behaviour recorded in wood from the cultural heritage tell us about the geographical origin of the wood and the specific characteristics of the original forest or woodland; (3) given the provenance of timber, in which way was it transported to its final destination; (4) what changes can we detect in the major transport lines of wood and which cultural factors determined these shifts; (5) what wood properties were important to the architects of the cultural heritage and why; (6) can we discern a technological rationale behind the order in which individual wooden objects were built and can we trace the roots of this rationale back in time; (7) can we discern other than economic motives behind wood use and which type of objects are involved; (8) what do the environmental and climate signals in the growth patterns of wood tell us about the (changing) environmental settings of cultural developments and change?

In order to answer these questions researchers have to look both within and outside the geographical region they work in, which in practise is defined by administration and language. This especially holds for the Netherlands with its long history of deforestation and its many relicts in the cultural heritage of former trade.

Former wood use in the Netherlands was shaped by the availability of the material and other factors such as political and socio-economic developments, wars and even plagues. Before ca. AD 1000 timbers in the Netherlands were largely derived locally: contrary to common assumptions in archaeology, dendrochronologists proved recently that the wood used in the Netherlands during the Roman Period was largely derived from local sources (Visser 2006), and earlier research on the so-called Utrecht Ship (ca. AD 1000; Centraal Museum, Utrecht) showed that its timber was derived from the vicinity of Tiel (central Netherlands).⁶ But already during the Roman Period wooden objects such as barrels and planks as well as ship's timbers were brought in from greater distances, such as the Mosel region (Vorst 2005; Jansma 2007b). After AD 1000 the origin of wood in our cultural heritage that is suited for dendrochronology most often is in current Germany (varying from Westphalia to regions in Lower Saxony and South Germany), but can also be in England (coffins, ship's timbers),⁷ Scandinavia (timbers in buildings and ships)⁸ and the Baltic countries (planks used in art, furniture and ships; e.g., Jansma *et al.* 2004).

With a few exceptions, the dendrochronological archives containing information about wood provenance and other important descriptive and interpretational data are managed locally by the authors/owners of the tree-ring studies, who individually have determined the level of detail of their measurements and metadata. Dendrochronological data and metadata from the Netherlands cultural heritage reside in laboratories in Amersfoort (NL), Deventer (NL), Gersten-am-Ems (BRD), Neu-Isenburg (BRD), Hamburg (BRD), Cologne (BRD), Trier (BRD) and Berlin (BRD). In order to increase our understanding of the complicated matter of forest management, timber trade and wood technology in the context of specific building industries before as well as after AD 1000, and in order to study long-term trends of environmental change and related cultural developments, these archives need to be updated to the current research agenda and combined into comprehensive collections on a larger geographical scale and with a higher spatial resolution than has been realized up to now. The importance of a dendrochronological archive such as the DCCB was recognized formally in the field of archaeology in 2006, in the National Research Agenda for Archaeology (NOA; www.noaa.nl; chapter 3).

2.2 COMMERCIAL DATING AND THE LOSS OF DATA

Since the 1970s and particularly since the 1980s the cultural historical disciplines in Low Countries have been using dendrochronology as a dating method. Once the method became accepted and the

⁶ RING Report numbers 1986013, 1997069 and 1997070.

⁷ RING Report number 2003049.

⁸ Buildings: e.g., Alkmaar (RING Report numbers 1997005), Hoorn (RING Report number 2001043) and Leiden (RING Report number 2003019); ships: e.g., the Sophia Albertina (RING Report number 2004066).

high chronological resolution of dendrochronological dates became a standard, the demand for dendrochronology increased. From this point onwards, the interaction between the commissioners and suppliers of dendrochronological dates became a matter of routine.

Dendrochronological dating in cultural history in general involves two parties: the one who commissions the work and the one who carries it out. De commissioners of dendrochronological dates are companies dealing with the cultural heritage (such as businesses in the fields of archaeology and building history), city administrations with archaeological and historical tasks, the cultural historical services of the national government, universities and museums. The suppliers of dendrochronology are specialists who usually work in settings where they are financed by the income generated by performing dating research (in companies, foundations and other constructions).

As a rule, these two parties make an agreement regarding the numbers of samples to be analysed and financial aspects. Practise shows that matters such as data and material management, the required level of dendrochronological metadata, the preservation of digital data and accessibility of the data for subsequent research are not covered in these agreements. The consequence is that many dendrochronological data have ended up, and still end up, outside any program of preservation and publicity of government-funded knowledge.⁹

The DCCB initiative is a tool to remedy the implicit loss of data resulting from this state of affairs. It will enable us to safeguard dendrochronological data and metadata and to make them available for further research, and to start asking research questions that cannot be answered in a context where many data are dispersed and inaccessible or even invisible, and/or are lost as the result of changing digital practices.

2.3 DUTCH AND FLEMISH DATA COLLECTIONS MANAGED OUTSIDE THE LOW COUNTRIES

2.3.1 Previously built laboratory collections

Overview

Until the end of the 1980s archaeological materials found in the Netherlands suitable for tree-ring research were sent to universities in Germany for study since the expertise did not exist in the Netherlands. Dutch collections from this period relevant for the DCCB reside in the dendrochronological laboratory of Hamburg University (authors of the data: Prof.dr. D. Eckstein (retired) and S. Wröbel). Smaller collections are in Cologne University (author of the data: B. Schmidt) and in the Trier Landesmuseum (author of the data: E. Hollstein (deceased)).

Since the 1980s and until recently the Hans Tisje company (Neu-Isenburg, BRD) has been investigating historical buildings in the Netherlands (author of the data: H. Tisje (retired)). An extensive collection of measurements taken from Dutch buildings is in the company's archive; an overview of the collection as well as the original wood samples can be found at RACM.¹⁰

Research of panel paintings by the University of Hamburg began during this period and until very recently still continued.¹¹ This university has developed a unique, very extensive collection of measurements taken from wood panels painted by Dutch and Flemish masters (author of the data: Prof.dr. P. Klein).¹² Other data collections regarding Dutch and Flemish art that are managed outside the Low Countries, reside with the CRNS in France (authors of the data: G. Lambert and C. Lavier),

⁹ In the meantime both politicians and scientists have come to recognize that results from research financed by the government ('public funding') must be made publicly available.

¹⁰ Prof.dr. D.J. de Vries (of Leiden University and RDMZ, which is now part of RACM) is an important commissioner of both Hans Tisje and the RING foundation and has maintained lists of the executors of contracted research, the research locations and the dendrochronological results.

¹¹ The dendrochronological observations were recorded in the Low Countries on initiative of museums, the Foundation Rembrandt Research Project and other parties and the analysis was done in Germany. Results in terms of dating and wood provenance were then communicated to the commissioners, but no measurement series were returned and no agreements were made about the future management and accessibility of these data.

¹² From the perspective of dendrochronologists working in the Low Countries this data collection is also one of the most 'invisible' since the author has not participated in international projects involving dendrochronological data sharing, such as EU projects *Temperature change over Northern Eurasia during the last 2500 years* (Project number CV5V-CT94-0050, 1994-1996) and *Analysis of dendrochronological variability and natural climates in Eurasia: the last 10,000 years* (Project number ENV4-CT95-0127, 1996-1998).

England (University of Sheffield; authors of the data: J. Pilcher (deceased), J. Hillam (retired) I. Tyers (now outside Sheffield University) and C. Groves) and other organisations throughout Europe.

Accessibility

There are good contacts with the Landesmuseum of Trier (M. Neysse) and Cologne University (B. Schmidt). Relevant data regarding the Roman Period will be made available by these organizations within months.¹³

With the exception of 270 measurement series from Medieval Dordrecht, which have been made available by S. Wröbel of Hamburg University to the RING Foundation in 2002, the number and quality of the Dutch dendrochronological data and metadata residing in the University of Hamburg cannot be assessed. The reason is that efforts to involve Hamburg University have all failed because the authors of the data are either retired (Prof.dr D. Eckstein), or they are not willing to join the DCCB initiative (S. Wröbel, Prof.dr. P. Klein). However, the number of fields of metadata registered for the Medieval Dordrecht collection is very low¹⁴ and possibly this is exemplary for the whole of the Hamburg collection on cultural heritage from the Low Countries. The Dutch collection of the business Hans Tisje also remains inaccessible, because the author (H. Tisje) has retired as well.

The conclusion is that most of the older, existing collections will not be directly available for the DCCB initiative.¹⁵ This regretful fact illustrates what happens when individual researchers in dendrochronology remain the sole possessors of their data and retire. It also shows the immense importance of good agreements in dendrochronology on data management and provisions for further scientific use. A clear policy and agreements on data management are especially important when dating research is carried out by organizations abroad which are operating outside the regional cultural-historical domain and outside the regional research traditions in which further use of the data can lead to new answers to prevailing research questions.¹⁶ Dendrochronological data represent larger financial investments than those expressed in the cost of the actual dating research: the costs of for example excavating and sampling of the wood. The loss of dendrochronological data therefore can be considered as a loss of financial investments (most often by governmental, 'public' funding) in the research leading to the demand for these data. By developing international digital standards for dendrochronological archiving, which is one of the goals of the DCCB initiative, we will prevent such losses in the future. Through the DCCB, we will also prevent the future loss of data that cannot be retrieved because they are derived from wood that is destroyed after the research is concluded.

2.3.2 Recent laboratory collections

The number of foreign companies and organisations conducting dating research in the Low Countries has increased since the Treaty of Valletta. Today the German company Pressler & Partner (E. Pressler; Gersten-am-Ems (BRD)) and the Archaeological Institute in Berlin (K.-U. Heußner; BRD)) are active in the Netherlands and are collecting data relevant for further study of the cultural heritage in the Low Countries.

3 DIGITAL ARCHIVES IN DENDROCHRONOLOGY

There exist five digital archives in dendrochronology that contain larger collections of data and that at first sight show some similarity with the DCCB initiative. But although these archives all contain raw

¹³ The data will be made available through data exchange with the RING Foundation as part of NWO/GW programme *Arts and crafts in Roman shipbuilding: raw materials management, construction technology, use and disposal of barges in the Lower Rhine region in the Roman period* (contract number PR-06-41).

¹⁴ In order to update this information, the excavation records will have to be consulted.

¹⁵ Hopefully, once the DCCB receives funding and gathers momentum, Hamburg University will be persuaded to open up their collection for (at least) a data survey.

¹⁶ For example many commercial dendrochronologists in Germany do not primarily ask research questions about the Dutch timber trade or Dutch ship's building industry, because their historical knowledge of the Netherlands and their overview of dendrochronological data from the Netherlands are such that it is very difficult for them to evaluate dendrochronological results in terms of this trade and industry. As a consequence, when they perform a dating on cultural heritage from the Netherlands it is not at all certain that they will generate and record the metadata needed to improve our knowledge about these topics.

and/or average numeric growth values of wood, they do not contain the larger part of the metadata needed for follow-up research in cultural history and palaeo-environmental research. In the following paragraphs the goal, structure and content of these archives is discussed and evaluated in the light of the goals of the DCCB.

3.1 THE INTERNATIONAL TREE-RING DATA BANK (ITRDB)

Since the 1980s, dendrochronologists have had at their disposal the *International Tree-Ring Data Bank* (ITRDB), maintained by the *NOAA Palaeoclimatology Program* and the *World Data Centre for Paleoclimatology* (Boulder, Colorado (US; fig. 1)).¹⁷ The ITRDB stores and preserves dendrochronological data. All users can upload individual series of measurements and average growth chronologies; the same data can be downloaded by any user (see appendix 1a for the format of the ITRDB).

A factor of the ITRDB which makes it less suitable for use by cultural dendrochronologists is the free public access to all the data. Researchers who want to protect their data from use without permission do not store it with the ITRDB. Because most cultural dendrochronologists in Europe generate their income with dating, and use their own data and chronologies as dating references, they are unwilling to publish their series in the public domain (publicizing could weaken their position, because other parties could use their data to compete with them on the open market). Consequently, dendrochronological measurements on cultural heritage in Europe are underrepresented in the ITRDB.

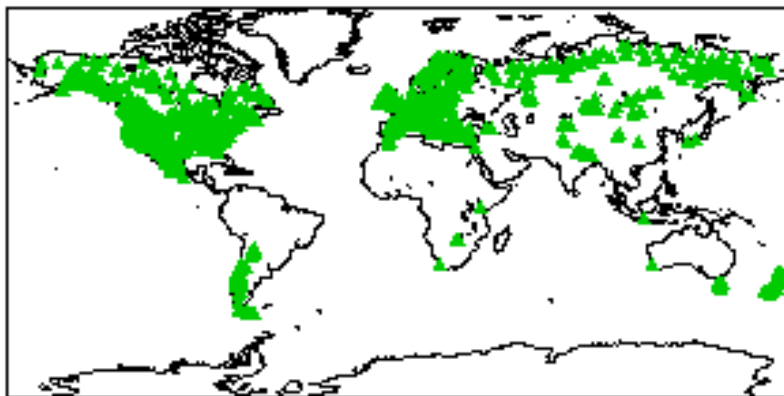


Figure 1 The origin of the data stored in the ITRDB
(source: <http://www.ncdc.noaa.gov/paleo/treering.html>).

The ITRDB was developed by dendroclimatologists who work mainly with measurements of modern tree rings. Cultural-historical, ecological and geological metadata are impossible to store in the system.¹⁸ The format in addition can not accommodate chronologies older than 999 BC (see 4.1). Unfortunately, the ITRDB system is not built to meet changing demands of data storage and since the 1980s it has not been adapted to the advancements of research questions and administration of data that have been made in the field. The result is that the ITRDB archive is not suitable for the data storage and applications which the DCCB proposes.

3.2 DENDRODB

The relational database DendroDB was set up to enable analyses related to climate and environment at the European level (fig. 1).¹⁹ The archive, available via the internet, contains series of

¹⁷ <http://www.ncdc.noaa.gov/paleo/treering.html>

¹⁸ For example the difference between the date of the last measured tree ring and the date the tree was cut down cannot be recorded in the ITRDB. The reason is that ring patterns of sampled living trees are always complete to the bark; therefore, the date of the last measured ring is always the same as the year the tree was sampled. The difference between the date of the last measured ring and a cropping date derived from this (date of the ring immediately under the bark) is, however, essential for the dendrochronologically interpretation of worked wood, which generally lacks the latest rings formed.

¹⁹ <http://servpal.cerege.fr/webdbdendro/>

measurements of ring widths and wood density and ecological information about the habitats of living trees (see appendix 1b for a description of the data in the archive). In contrast with the ITRDB, but conforming to the wishes of the European dendrochronological community, many data in the archive are protected and accessible only with permission from their authors.

The DendroDB was set up with dendroclimatology and dendroecology in mind, so that provision for information about cultural historical background and context is lacking (see appendix 1b). Part of the content of the DendroDB was taken over from the ITRDB; it is noticeable that only the dendrochronological series of measurements that continue to the present-day have been selected. Also absent are observations about historic objects and remains of previous forests and woodlands preserved in the soil.

The structure of the DendroDB is essentially well suited for registration of data from dendrochronological research using modern material (living trees). It is possible that its structure can be used in those parts of the DCCB that concern contemporary wood research. The structure, however, is not suitable for the culture historical and 'older' earth science applications that the DCCB will cover.

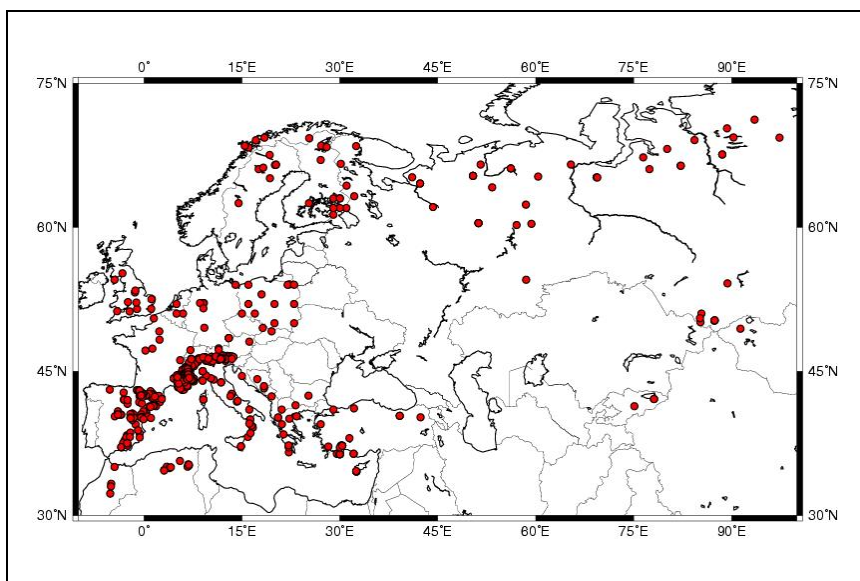


Figure 2 The origin of the data (ring width) in DendroDB.
(Source: <http://servpal.cerege.fr/webdbdendro/>)

3.3 HISTORICAL TREE-RING ARCHIVE HOHENHEIM 'HISTRA'

An extensive cultural-historical archive has been created in southern Germany using collections from the University of Hohenheim and several businesses in the area of Hohenheim in order to assist climatic and environmental research (fig. 3).²⁰ The archive, which has differential accessibility, is reachable via PANGAEA - *Publishing Network for Geoscientific & Environmental Data*.²¹ The aim of PANGAEA, a public digital library, is to archive, publish and distribute earth related data with an emphasis on basic research pertaining to landscape, oceanology and geology. HISTRA was mainly designed to guarantee the continued existence of a very large collection of dendrochronological data (but not metadata) and has not been organized with research questions in mind. The dendrochronological data are, aside from a global description, not accessible from outside the network (see appendix 1c for a table of general accessible metadata; the data have been stored as individual series of measurements). The collection does adhere to international ISO standards where possible. The project leader of HISTRA, M. Friedrich, will be on the advisory board of the DCCB.

²⁰ <http://www.uni-hohenheim.de/palaeobotanik/dendro/projects/histra/#Projekt>

²¹ <http://www.pangaea.de/>

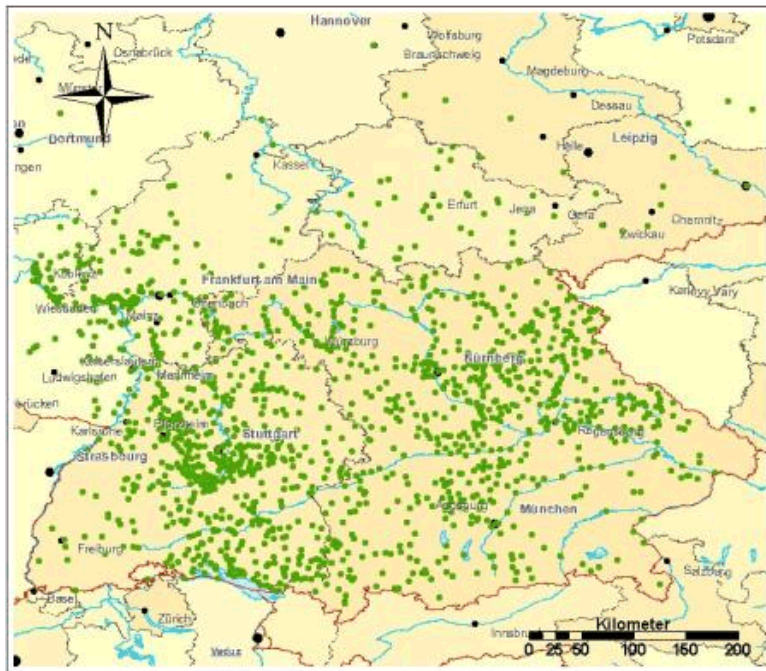


Figure 3 Provenance of the data stored in HISTRA (PANGAEA)
 (Source: <http://www.uni-hohenheim.de/palaeobotanik/dendro/projects/histra/>)

3.4 BASE DE DONNEES DENDROCHRONOLOGIQUES (CNRS)

The *Laboratoire de Chrono-Ecologie*, University of Franche-Comté/CNRS (FR) has set up a freely accessible digital dendrochronological archive which consists of average chronologies from the Iron Age onwards (see appendix 1d for the data format).²² This archive is a valuable source of average tree-growth chronologies. Compared to the proposed DCCB, the archive does however have some weaknesses. The meta-data are limited to the name of the site, the length and first and last year of the chronologies. No information is included regarding the signal strength of the chronologies. Because the database only contains average chronologies, it does not allow for repeating the ‘experiments’ by which the chronologies were created. Also, the database does not allow for regional presentations of the data, because coordinates are not included. Our contacts are J. Lambert (University of Franche-Comté/CNRS), C. Lavier (Ministry of Culture. Centre de Recherche et de Restauration des Musées de France/CNRS) and S. Durost (post doc at University of Franche-Comté (FR) and University of Liege (B)).

3.5 DENDROCHRONOLOGICAL DATABASE OF THE EidG. FORSCHUNGSANSTALT FÜR WALD, SCHNEE UND LANDSCHAFT WSL (CH)

This relational, Oracle-based tree-ring database contains contains radio-densitometric measurements from about 14,000 cores of more than 40 tree species at about 600 locations all over the northern hemisphere, as well as their documentation and spatial information.²³ Part of this information is also available via the ITRDB. More than 1000 x-ray films have been exposed from the samples. For each sample and each tree ring, several parameters were measured: (a) minimum density; (b) maximum density; (c) earlywood density; (d) latewood density; (e) earlywood width; (f) latewood width; (g) ring width; (h) approx. age of pith. The dendro data can be downloaded in TUCSON (ITRDB) format. The dendrochronological data can be accessed by two web-based and linked applications: the *Dendro Database Surfer*, a database browser which allows a search for all attribute data and enables users to browse through the database, and the *Dendrochronology GIS*, a GIS viewer, which serves to perform spatial queries on the database. All sample locations are plotted on a World Vegetation Cover Map.

²² <http://chrono-eco.univ-fcomte.fr/Public/DataBases/DendroTmp/DData/>

²³ <http://www.wsl.ch/dendro/dendrodb.html>; we suggest our readers to visit this beautiful website and to explore its options.

This database for information about living trees was developed in 2002 (Schmatz et al. 2001). Although this database is easier to search than the ITRDB, the database is not suited for storing cultural-historical metadata and the format of the data has the same limitations as the format stored in the ITRDB. The search applications are well suited for the DCCB.

3.6 CONCLUSIONS REGARDING PRESENT PUBLIC-DOMAIN ARCHIVING IN DENDROCHRONOLOGY

Three of the five existing digital dendrochronological archives that are accessible via the Internet have not been designed for data from the cultural heritage and from former vegetations. Of these three, only the ITRDB does contain some data from pre-contemporary contexts. The ITRDB is however unsuited for the preservation of the metadata that go with these older measurement series, such as building phase, type of timber, geological context *et cetera*. In addition, the ITRDB does not allow for storage of series dating before 999 BC and does not allow for the registration of felling dates that do not coincide with the date of the outer ring that was measured. Both other non-cultural archives, DendroDB and the dendrochronological database of the WSL (CH), also do not allow for registration of metadata that are important as a background for series from the cultural and natural past. The design of DendroDB is, however, well suited for the registration of research on living trees and could be used in the DCCB-project as a model or starting point for an international digital standard for archiving research on living trees. The WSL-database is Oracle based and has some search functions, such as a GIS application, which could serve as examples for the DCCB.

The two other archives have been designed with cultural history in mind. The first, HISTRA, is dedicated to the preservation of single tree-ring series and hardly contains metadata (M. Friedrich, personal communication), meaning that it cannot be used for interregional comparative studies regarding wood provenance, timber type *et cetera*. The second archive, the *Base de Données dendrochronologiques*, only contains average chronologies and therefore is not suited for interregional analyses of individual timbers.

None of these archives in their current form is suited as a core from which the DCCB can be built. The reason is that the goals of the DCCB differ strongly from those of the existing archives. In order to enable the types of studies outlined in this proposal, a new archive has to be built and filled with data relevant to the outlined research questions.

4 DATA FORMATS IN DENDROCHRONOLOGY

4.1 THE ITRDB FORMAT

The ITRDB-format was developed in the Laboratory for Tree-Ring Research of Arizona University (US). This format (plain text), also called the Tucson-format (*.tuc) or the Ring-Width List format (*.rwl), was developed by dendroclimatologists who work mainly with measurements of modern tree rings. Cultural-historical, ecological and geological metadata are impossible to store in the system.²⁴ The format does not provide for the registration of annual growth anomalies or other observations. In addition it can not accommodate chronologies older than 999 BC (see appendix 1a, *Format of average tree-ring calendars*). The reason is the fixed number of available digits for the code of single measurement series (column 1; 6 to 8 digits) and the year (column 2; 4 digits). In case the code is 8 digits long, which is common in European dendrochronology, there exists no space in column 2 for numbers lower than -999, because such numbers take up 5 digits. Dendrochronologists as a rule solve this problem by converting their 8-digit codes into 6-digit codes before contributing their data to the ITRDB. However, the problem is even more serious with the format of average chronologies. In this case, the calendar code (column 1) cannot be over 6 digits long and 4 digits are reserved for the years, meaning that with the year -999 all available digits are taken up. Because the ITRDB assumes codes of 6 digits, adaptations of the codes cannot solve this problem. The ITRDB therefore cannot be

²⁴ For example the difference between the date of the last measured tree ring and the date the tree was cut down cannot be recorded in the ITRDB. The reason is that ring patterns of sampled living trees are always complete to the bark; therefore, the date of the last measured ring is always the same as the year the tree was sampled. The difference between the date of the last measured ring and a cropping date derived from this (date of the ring immediately under the bark) is, however, essential for the dendrochronologically interpretation of worked wood, which generally lacks the latest rings formed.

used to store average chronologies dating before 999 BC. A final drawback is that this format reckons with the non-existing year zero (0), meaning that in chronologically coherent datasets of measurement series either the BC- or the AD-intervals of series are shifted one year relative to their actual date. This format is therefore not suited for the storage and applications which the DCCB proposes.

4.2 THE CNRS FORMAT

The CNRS-format (plain text) allows for a limited number of metadata and does not provide for the registration of annual growth anomalies (see appendix 1d). Although this format is well suited for the storage of measurement series, many metadata cannot be harvested from this format. In case the DCCB will contain provisions for this format, these metadata will have to be supplied by the authors of the data in separate files.

4.3 THE CATRAS FORMAT

Until recently the most common format used in European dendrochronology was the CATRAS format. This is a binary code for individual series that unlike ASCII (plain text) is inaccessible through text editors and cannot be imported to Microsoft environments. The format was created using the CATRAS program (Aniol 1983), which was also used for dating, editing and some statistical descriptions of measurement series.

Using the CATRAS software it is possible to convert individual series to ITRDB-format. With series dating BC, 8000 years are added to the date. The CATRAS format allows for registration of sapwood numbers; this information is lost when series are converted to ITRDB-format. It also allows for the registration of some growth anomalies (problematic rings). Its possibilities for storing metadata are however restricted to one short line (string). This format is therefore unsuited for harvesting metadata. In case CATRAS files (or files in other formats containing converted CATRAS-files) are added to the DCCB, the metadata will have to be supplied by users of the DCCB in separate files.

4.4 THE HEIDELBERG FORMAT

The Heidelberg format is created by software TSAP²⁵ and is one of the most common formats in current dendrochronology. In this format individual measurement series and their metadata as well as groups of data (including metadata) are stored in ASCII format (plain text; appendix 1e). The number of metadata is variable and determined by the author of the measurement. The format is well suited to store many kinds of metadata and can therefore be used to harvest these metadata. This format has been selected during the workshops as well suited for the DCCB.

4.5 THE PAST FORMAT

The PAST format is created by software PAST (SCIEM²⁶) that also is widely used in current dendrochronology. As with the Heidelberg format, the number of metadata in the header is variable and is determined by the author of the measurement (appendix 1f).

Most existing formats list 10 annual values per text row. However, in the Past format annual values are stored in columns, with each row giving the value(s) belonging to a specific year. This means that series in this format are easily imported into statistical and graphical software. Compared to the ITRDB, CNRS, Heidelberg and V-formats, which all have a maximum of only 3 digits separating the annual values in each text row, the 'column format' of PAST has much more space to add observations to particular years. With a column format it is also possible to add annual descriptive fields during a cycle of version management, such as the DCCB proposes. A format like PAST is therefore well suited for the DCCB.

²⁵ See <http://www.frankrinn.com/Products/Tsap.htm>.

²⁶ <http://www.sciem.com/>

4.6 THE V-FORMAT

The V-format was developed at Göttingen University (BRD). It was used as the prevailing format in past EU-projects regarding climatic change during the past two to ten millennia.²⁷ As a part of these projects many data gathered well into the 1990's in North-western European dendrochronology were converted to this format. The V-format is not widely used and unlike the Heidelberg and PAST formats it does not contain many metadata, making it unsuitable to harvest relevant metadata (appendix 1g). The V-format should, however, be included in the DCCB because this will enable the DCCB to store the international archives of the mentioned EU-projects and other data in this format. If data in V-format are to be used for further analyses, the metadata will have to be supplied by the authors of the data in separate files.

5 THE RESEARCH AND USERS' NETWORK OF THE DCCB

5.1 SHAPING THE DCCB NETWORK

5.1.1 Survey

In January 2007, survey forms were distributed among the target groups.²⁸ Altogether, some twenty reactions were received.²⁹ The results were incorporated in a paper entitled 'Achtergronddocument workshops Cultuurhistorie, Landschapsontwikkeling en Dataleveranciers' (Background document for workshops in cultural history, landscape development, and data collection).³⁰ This document, together with activity sheets adapted to the goals of the respective workshops, was used as a basis for the workshops.

5.1.2 Workshops

Three workshops, respectively in cultural history (archaeology, building history and the research of furniture and art), landscape development (geosciences, cultural geography, (palaeo-)ecology and forestry), and dendrochronology, were held on March 5 and March 8 of this year (see appendix 2 for the workshop programs and a list of participants). The purpose of the workshops was to further define the structure and content of the DCCB on the basis of the users' needs in the disciplines of cultural history, earth science, and dendrochronology.³¹ At the same time the workshops were used to determine where more knowledge could be gained by adapting or refining research goals and strategies and to inventory dendrochronological data existing in other countries that are important for the DCCB which could be made more accessible by extending the DCCB network.

Esther Jansma, leader of the project, began the workshops with a presentation about DCCB and an overview of the survey results. Afterwards the participants in the cultural history and landscape development workshops identified users' wishes and lacunae in knowledge in their respective fields. In the third workshop, consisting of dendrochronologists and therefore the data collectors for the DCCB, the desired form and content of the DCCB, including suggestions from dendrochronologists outside the Low Lands, was discussed.

A workshop for educators, which was planned for March 22 with the objective of defining desirable DCCB capabilities for teaching, had to be cancelled because too few people enrolled. It was decided to collect the information wanted by personally interviewing stakeholders.

²⁷ EU projects *Temperature change over Northern Eurasia during the last 2500 years* (Project number CV5V-CT94-0050, 1994-1996) and *Analysis of dendrochronological variability and natural climates in Eurasia: the last 10,000 years* (Project number ENV4-CT95-0127, 1996-1998).

²⁸ The target group consisted of members of the Foundation for Dutch Archaeology (SNA; cities, universities, and businesses), universities/faculties, businesses, museums and and restauration ateliers.

²⁹ Three completed survey forms were received during and after the weeks of the workshops; these were included in the current report.

³⁰ See <http://www.archis.nl/RINGnieuw/dccb.htm> under 'Voorgangs DCCB projectformulering 1.0' [sic].

³¹ *Ibid.*; Appendix 1 of this document lists the programs and participants of the workshops.

5.1.3 Personal interviews (national)

Geosciences

In May an interview took place with dr. H. Weerts of TNO regarding the possibilities of linking the DCCB to DINOshop, the central portal to Data and Information of the Subsurface of The Netherlands. The DINO system is the central storage site for geoscientific data on the shallow and deep Dutch subsurface. The archive contains shallow and deep borings, groundwater data, cone penetration tests, geo-electrical measurements, results from geological, geochemical and geomechanical sample analysis, borehole measurements and seismic data. DINOShop provides access only to DINO information available to the public.³² It was mutually agreed that this link is important and that the DCCB should be set up in such a manner that it facilitates this connection.

Art history

It was apparent at the kick-off meeting of the DCCB project that members of the art history world (restorers, curators, art historians, and program and project leaders in art history) were underrepresented in the contact list. P. van Duin (Rijksmuseum) recommended a number of prominent restorers and art historians. Prof.dr. E. van de Wetering of the Foundation *Rembrandt Research Project* agreed to an interview in May. During this interview, possible merits of the DCCB for art research have been identified and discussed in detail. Prof. van de Wetering, who in the past enabled a lot of dating research by Prof.dr. P.Klein (University of Hamburg) on so-called 'panel paintings' (paintings on wood), agreed to join the advisory board of the DCCB.

Education

Desirable features of the DCCB for education were assembled by interviewing professors and assistant professors from the VU, UvA, UL and UU in April. The discussions have concentrated on, first, the DCCB being a user-friendly *service* focussed on introducing dendrochronology³³ and, second, making parts of the DCCB available for educational projects.

5.1.4 International contacts in the field of dendrochronology

Low Countries

At the beginning of the project, the DCCB for the Low Countries already received active support from the dendrochronological community in the Netherlands and Flanders; the tree-ring specialists who are located in this area are all involved in the DCCB project as either grant applicants or project partners. In June, a meeting was held with Prof.dr. P. Hoffsummer (director) en J. Eeckhout of the dendrochronology laboratory at the University of Liège (Laboratoire de Dendrochronologie, Philosophie et Lettres, Département des Sciences Historiques, Université de Liège). This group has joined the project group as a partner. With this new addition the DCCB includes all organizations in the Low Countries that are professionally active in dendrochronology and located in the area.

Europe

It is important that the DCCB does not focus on the Low Countries exclusively. In the first place, the DCCB will fill a gap in current dendrochronological data archiving, because it focuses on research of the past in the overlapping domains of the cultural historical disciplines and the earth sciences and will be the first digital archive that contains the specific metadata necessary for this research. Second, the structure of the DCCB enables research in a wider region than the Low Countries, and this important fact has been picked up by the international dendrochronological community (see below). In order for the DCCB to function internationally, it should connect to various European research agenda's and traditions in registering research. In addition, national topics such as Dutch timber trade and ship's building cannot be tackled with an archive that excludes data from the forests outside the Low Countries from which the timber was derived.

There are countless organisations and businesses in Europe that are involved in dendrochronology. We decided on a *bottom up* approach by asking individual researchers (the authors of dendrochronological data and metadata) instead of organisations to participate. We invited dendrochronologists who have data relevant for the Low Countries at their disposal and/or play an internationally prominent role in the profession and have the capability and interest to participate in an international endeavour. These are:

³² Source: TNO, <http://dinolks01.nitg.tno.nl/dinoLks/about/whatIs/whatIsDINOLoket.jsp>.

³³ See also 2.2.3 *Information module*.

- Dr. A. Billamboz (Landesdenkmalamt Baden-Württemberg, Dendrocronologischisches Labor Hemmenhofen (BRD));
- Dr. N. Bonde (Research Lab for Natural Science and Dendrochronology, National Museum Copenhagen (DE));
- Dr. M. Friedrich (Jaarringlaboratorium Universiteit van Hohenheim (BRD); Data-archief HISTRA (see par. 2.1));
- Dr. P. Gassmann (Laboratoire de dendrochronologie, Freiburg University (BRD));
- C. Groves (University of Sheffield (UK));
- C. Lavier (Ministère de la Culture/CNRS Centre de Recherche et de Restauration des Musées de France, Paris, (FR));
- Prof.dr. P. Klein (Institut für Holzbiologie, Universiteit van Hamburg (BRD));
- Dr. G. Lambert (Laboratoire de Chrono-Ecology, Université de Franche-Comté, Becancon (FR))
- M. Neysses (Rheinisches Landesmuseum Trier (BRD));
- E. Pressler (Erhard Preßler und Partner, Planung und Bauforschung in der alten Stadt, Gersten/Emsland (BRD));
- Dr. B. Schmidt (Laboratory of Dendrochronology, University of Cologne (BRD));
- Dr. W. Tegel (University of Freiburg (BRD));
- H. Tisje (Neu-Isenburg (BRD); retired);
- S. Wröbel (Institut für Holzbiologie, Universiteit van Hamburg (BRD)).

European advisory board

Many of the invited scientists reacted enthusiastically to the project, because in their opinion the DCCB will provide a research setting that will enable the field to perform cultural and environmental studies on a larger scale than can be realized at present, and because the DCCB will provide a repository of data and metadata that has no parallels at present. Scientists among this group from the UK, France and Germany were invited to join the advisory board of the DCCB (see 5.2.1 *Advisory board of the DCCB*).

New project partners

The company Pressler & Partner (E. Pressler) reacted enthusiastically to participating in the DCCB as a partner. This is an important step since this concern has been active in the Netherlands for years and its large digital archive is in order.

Researcher C. Lavier of the Centre de Recherche et de Restauration des Musées de France (Ministry of Culture/CNRS) is very interested in a research collaboration with RACM and Foundation RING on Roman barges from archaeological contexts in the Netherlands and France as well as on Dutch and Flemish art represented in the data collections of these organizations. Ms. Lavier agreed to join the advisory board of the DCCB. In case the DCCB initiative receives funding, she will become a partner of the project and will contribute all data and metadata on the Dutch/Flemish works of art that are present in the CNRS archive to the DCCB. Research collaboration between the RACM and the CRNS on Roman barges and Dutch/Flemish art will take place in the NWO/GW program *Arts and crafts in Roman shipbuilding: raw materials management, construction technology, use and disposal of barges in the Lower Rhine region in the Roman period* (Contract number PR-06-41; 2007-2011) as well as in the context of ongoing and new art research projects.

5.2 RESULTS: NETWORK AND INITIAL CONTENT OF THE DCCB

5.2.1 The DCCB network

Dendrochronology

The DCCB initiative receives the support of all researchers involved in collecting and generating dendrochronological data and metadata in the Low Countries. These are: RING Foundation (Amersfoort; dr. E. Jansma (director) and M. Dominguez), the dendrochronological laboratory of the university of Liege (Prof.dr. P. Hoffsummer (director), J. Eeckhout), and the companies BAAC bv (Deventer/Den Bosch (NL); S. van Daalen), Dendrolab NL (M. Dominguez; this laboratory no longer exists but its legacy will be incorporated in the DCCB) and Pressler & Partners (Gersten-am-Ems (BRD); E. Pressler). In addition, it receives support of the French Ministry of Culture/CNRS (Paris; C. Lavier), which will as a pilot project contribute data on Dutch and Flemish cultural heritage. Individual researchers who work or recently worked in the Low Countries in temporary PhD and post doc projects on the cultural heritage and former climate have agreed to provide the DCCB with their data.

These are S. Durost (University of Franche-Compté/University of Liege; post doc); K. Haneca (University of Gent; post doc); R.M. Visser (Free University and RACM; PhD-student NWO/GW contract number PR-06-41) and Y.E. Vorst (Free University and RACM; PhD-student NWO/GW contract number PR-06-41)

Cultural History

The researchers, project leaders and research-policy makers in cultural history who have expressed interest in the DCCB-initiative are located at key institutes such as the National Service for Archaeology, Cultural Landscape and Built Monuments (RACM, part of the Dutch Ministry of Education, Culture and Science (OCW); J. Van Doesburg, B.J. Groenewoudt and H. Peeters), the Netherlands Institute for Cultural Heritage (ICN (OCW), Amsterdam; A. de Tagle (head of Research)), the Rijksmuseum (Sector Collections: R. Baarsen and A. Wallert; Restauration: P. van Duin), the Foundation Rembrandt Research Project (Amsterdam University: Prof.dr. E. van de Wetering (director)), Amsterdam University (Faculty of Arts; Prof. dr. F. Theuws), Leiden University (Faculty of Arts: Prof.dr. D.J. de Vries; Faculty of Archaeology: Prof.dr. H. Fokkens) and the Free University (Amsterdam, Faculty of Arts; Prof.dr. N. Roymans and Prof.dr. J. Bazelmans). The commissioners of dendrochronology who show interest in the DCCB initiative are connected to businesses and cities administrations throughout the Netherlands. Part of these attended the workshops (see appendix 2), others contributed ideas during personal interviews.

Earth Sciences

Researchers and project leaders in palaeo-ecology, earth sciences and archaeometry who support the DCCB initiative are located at the RACM (O. Brinkkemper and M.C. Kosian), Amsterdam University (B. van Geel), Free University (Amsterdam, Faculty of Geosciences, Institute for Geo- and Bio-archaeology: Prof.dr. H. Kars (director)), Groningen University (Faculty of Arts: Prof.dr. M. Spek) and Utrecht University (Faculty of Geosciences: W.Z. Hoek). TNO has shown interest in setting up a connection with the DCCB by linking its database DINOshop to the DCCB archive (H.J.T. Weerts).

Forest ecology

Researchers in forest ecology who support the DCCB initiative are located at Wageningen University (U. Sass-Klaassen and P. Copini).

Advisory board of the DCCB

An international advisory board was created in order to oversee that the DCCB will be designed as a state-of-the-art archive in dendrochronology. The advisory board consists of scientists and project leaders with a strong curriculum and international scope and visibility. Per June 2007, the advisory board consists of six members:

- M. Friedrich (Tree-ring laboratory University of Hohenheim (Germany); dendrochronological data archive HISTRA (see 2.2.3.3);
- C. Groves (University of Sheffield; UK);
- C. Lavier (Ministère de la Culture/CNRS, Paris; FR) ;
- B. Schmidt (Laboratory of Dendrochronology, University of Cologne; BRD);
- W. Tegel (University of Freiburg; BRD);
- Prof.dr. E. van de Wetering (Foundation *Rembrandt Research Project*, University of Amsterdam; NL).

If the DCCB receives funding, the first task of the board will be to develop international digital standards for archiving in dendrochronology which are based on the cultural historical and palaeo-environmental research possibilities offered by international data collections. Also important is the fact that the members will provide the DCCB with data from outside the Low Countries that are relevant for cultural historical studies involving the Low Countries.

5.2.2 Initial content of the DCCB

The DCCB is an archive containing dendrochronological data from both pre-contemporary cultural historical materials and biological materials from *in situ* contexts (not yet fossilised tree trunks and living trees). It includes all tree species of which the growth rings have been measured and/or dated, such as oak (largest component), beech, ash, pine, larch and spruce. Initially, the DCCB will contain at

least nine archives: data from RING (and its predecessors at Amsterdam University and ROB³⁴), the RDMZ,³⁵ the universities of Wageningen, Leuven and Gent, the companies BAAC bv, Dendrolab NL and Pressler und Partners, and the data on Dutch and Flemish art managed by the CRNS/Louvre by C. Lavier (table 1).

Table 1 Basic data of the DCCB

Laboratory	# digital measurement series	Format	# paper measurement series	# wood elements	# projects/ structures	Detail of metadata
RACM and RING Foundation	16500	Heidelberg	300 (graphs)	10150	1700	Coordinates are in part not present
Former RDMZ (D.J. de Vries)	None	None	400 (numbers)	400	80	Coordinates are not present
BAAC bv	1900	Heidelberg	350 (numbers)	1600	Unknown	Variable
Dendrolab NL	450	Heidelberg	None	?	?	Coordinates are not present
Wageningen University	?	Heidelberg	None	?	?	Good
Kristof Haneca, University of Gent (post doc)	1250	?	None	?	?	Variable
University of Leuven	5000	CNRS	None	?	?	Good
Pressler & Parnter	2500	Heidelberg	None	unknown	400	Good
CRNS/Louvre	200	CNRS		100	20	Good
Total	27800		1050	> 12250	> 2300	Variable

6 REQUIREMENTS OF THE DCCB

6.1 THE COMPOSITION OF THE DCCB

6.1.1 Structure

Trusted Digital Repository

In consultation with DANS/KNAW we have selected a *Trusted Digital Repository* as the optimal form for the digital archive. In this structure different, previously specified data formats can be used and made compatible using an XML-scheme. This XML-scheme reflects the common elements that appear in the various archives connected to or residing in the DCCB, that is to say, the data fields that the different formats have in common and that the data collectors regard as necessary. A user interface enables both the authors and users of the data to query the archive.

Central versus decentralized data management

The core concept of the DCCB is decentralized data management on the content level of the included archives. In this concept, the authors of the data are responsible for keeping their local archives (which are connected to the DCCB) updated.

Data protection

In order to attract parties who wish to protect (part of) their data from certain types of use, such as commercial companies who are in competition for assignments and therefore safeguard their own data

³⁴ Per November 2006 the ROB merged with RDMZ to RACM, which is part of the Ministry of Education, Culture and Science (OCW).

³⁵ Per November 2006 the RDMZ merged with ROB to RACM (see also footnote above).

and chronologies, the participating dendrochronologists must be able to define and change levels of access to their data and must also be able to specify that archives are completely protected (thus, not visible to other users).

The identification of data

Every laboratory has its own codes for dendrochronological measurements; theoretically these codes may already have been used by other laboratories. In order to avoid recoding and the attendant pitfalls, data entered into the DCCB will receive, alongside their original code, a unique DCCB code.

Flexibility

It must be possible for owners of (part of) the archives to change and add data and meta-data on line, in order to keep the archive updated according to the newest insights and results. This means that the DCCB will have countless versions. Users need to know which version they use and this should be mentioned in the user interface for proper reference. New archives can be added at any time. What can be retrieved from the archive (by particular questions and specific search routines) is technically dependent on the services that have been, and will be, developed during and after the project. It should be possible for users of the DCCB to develop and add new services at any later time. The DCCB must not have an unchangeable structure in terms of descriptive fields for metadata and the formats of raw measurement data, but one which can be repeatedly altered by experts after testing by users ('version management'). We propose to form an international network of (potential) dendrochronological and other users who come together at particular times to evaluate the efficiency of the archive and to propose adaptations.

Visibility

It is important that the content of the DCCB is clear to anybody who enters the website. Starting with any pilot version of the DCCB, the user interface should not only provide a clear explanation of the project, but also a geographical overview of data stored in the DCCB (as far as the metadata contain coordinates). We also recommend a service that enables users to zoom into specific regions, object types or chronological intervals. This latter service, however, could also be added at a later time.

6.1.2 Quality

The aim is to build a high-quality dendrochronological archive. This means that the tree-ring series in the archive have to be correct. Dendrochronology uses numerical analyses in which mistakes are made easily, especially when short series are analyzed or when the calendars used for dating represent growth regions that differ widely from the region where the researched wood came from. This means that part of the series that will be entered into the DCCB in time must be re-analysed, such as isolated samples (one sample per structure), short series and series showing weak matches with (just a few) existing chronologies. In addition, the agreed upon final archiving standards will imply that metadata have to be unearthed and added to the archive. These activities, however, do not belong with the technical DCCB project itself but are the responsibility of the dendrochronologists who will use the DCCB.

A problem that does have to be tackled in the DCCB project is that data that represent converted ITRDB/Tucson-files and that start with BC-dates (oldest growth value) while ending with AD-dates (youngest value), have to be checked for accurate dating. The reason is the 1-year shift in the BC- or AD interval due to the fact that this format reckons with the non-existing year zero (0). The same holds for CATRAS-files that have undergone conversion into ITRDB-format before being converted to for example Heidelberg format.

6.1.3 Technical prior conditions

The data in the DCCB must be stored on a separate web server. It is advisable that the RACM offers this service to participants who are not in a position to have their own web server. Participants not owning a web server should upload their data to the RACM-server in a fixed cycle that should be agreed upon at the beginning of the collaboration, for example at the beginning of each year. Data managed by the RACM must be entered in a mutually agreed-upon format or formats. Data in local formats stored on separate web servers managed by other organisations can be combined with each other in the DCCB through an XML-scheme.

6.1.4 Services

Data conversion

An essential basic service of the DCCB for the data collectors, which must certainly be included in the first version, is the conversion of ring measurements from and to various data formats that are used in dendrochronology. With this service the data collectors can quickly render the data usable for various types of analyses.³⁶

Conversion of coordinates

A second service that must be incorporated into the first version of the DCCB is a conversion module for coordinates (UTM-translator) so that the data collectors can provide the required coordinates without much handwork. A related service, which is particularly important for earth sciences, is the ability to return the spatial coordinates of locations (Google Earth, topographic maps, soil maps, with acknowledgements, of course).

Information/education module

A desirable service for students and interested parties is information and education about dendrochronology. This service provides guidelines for dendrochronological sampling and research, as well as digital pictures of different types and species of wood from which measurements can be made from the screen and controlled for mistakes by comparison with underlying accurate measurements and dated by comparing with several series of public calendars. Also in the module are examples of research (with a step-by-step explanation using concrete data and procedures), and several data files that have been used in cultural history and earth science with which the user can practice. This service should also contain links to existing educational sites on dendrochronology.

Other services

Other services that will attract users are: 1) the ability to draw relations between fields that reside in the XML-scheme at different levels of information (data and metadata); 2) an application allowing the user to search for data within a given time frame; 3) a service also offered by the ITRDB in which the user can make selections of stored research on a simple map on the screen using a mouse; and 4) the ability to search for useable calendars for dating in a specific time period and region.

6.2 ORGANISATION OF THE CONTENT OF THE DCCB

A proposal regarding the optimal structure of data and metadata is made in appendix 3. This model is *not* a requirement of the first DCCB version; required fields are underlined. The lowest and most basic level is the measurement level. All data on a higher level than that of the actual measurement series are considered metadata.

Measurement series: scenario 1

Dendrochronological series of measurements must be stored individually, enabling the search for series that meet specific requirements (species, tree age, historical period and others) and they must be linked to the metadata describing the series. The measurement series in the DCCB must be stored by the data providers in one of at least three dendrochronological text formats (appendix 1):

- Heidelberg format (*.fh; appendix 1e);
- The format of the Base de Données dendrochronologiques (CNRS)
- V-format (*.oj; used in Göttingen University as well as in former EU-projects);

Of these formats, the Heidelberg format with its extensive header is most suited to the DCCB, because this format is used widely in Europe and the majority of dendrochronological software allows for the conversion to this format.

The DCCB does not need to store the binary data format CATRAS, which was used in many laboratories for decades but meanwhile has become somewhat obsolete. However, considerable amounts of data in many research facilities are stored in CATRAS-format (see 4.3). It is therefore

³⁶ The standard analytical tools used in dendrochronology require their own format, which often is the ITRDB-format. Currently, parts of the necessary conversions are done manually because a varying quantity of space is conferred to coding and dating the measurements in the various formats. Adding a conversion service saves time for users and makes the DCCB attractive for potential partners.

necessary to provide a routine with which bulks of CATRAS files can be converted locally to Heidelberg format before incorporating them into the DCCB.

The ITRDB-format is not an acceptable format for the DCCB, because of inaccurate dates rising from the assumed year zero (0) and other reasons (see 4.1). The DCCB should however contain the possibility to extract data in ITRDB-format, because important dendrochronological software (shareware) only works with this data format.³⁷ The conversion from ITRDB-format to Heidelberg format is offered by existing software in dendrochronology and does not need to be included in the DCCB.

Measurement series: scenario B

An alternative to the proposed formats mentioned in scenario A is to store each measurement series in a column, for example by using the PAST format. By using columns (with each row representing a separate year), it will be easier to add new types of annual observations to the file at a later date (such as cell wall characteristics, vessel size *et cetera*). Contrary to rows of numbers (ITRDB, CNRS, and Heidelberg format), a column format does not need to be converted before being usable in statistical and graphical programs. The drawback of this scenario is that participating laboratories already using one of the three other formats mentioned in scenario A would possibly end up editing two archives: the DCCB archive and their working archive in which the data are stored in the current lab-format.

Archives

Compatibility between the archives is secured by using a XML-scheme. The variables in this scheme will be defined as an international standard, which will be updated periodically in a well-defined cycle of version management. The first version of this standard will probably (and for practical reasons) consist of the smallest common denominator of the variables in the included archives. To make multidisciplinary use possible, it is conceivable to use a standard that varies somewhat per type of source material, whereby in particular the difference between wood found *in-situ* and that found *ex-situ* and the difference between contemporary woods and cultural items made from pre-contemporary wood are made clear.³⁸

6.3 LINKS TO OTHER ARCHIVES

As far as data from the Netherlands are concerned the DCCB should be linked to the national archaeological and historical registration systems (ARCHIS and CIS) as well as DINOshop of TNO (see 5.1.3 *Geosciences*) and - if feasible - the database of soil cores developed by H. Berendsen (Utrecht University). For the built heritage it should be possible to link to cadastral information. Where applicable, research should be linked to the digitized archaeological reports available through eDNA.³⁹ The DCCB should have a relationship to the Dutch Knowledge Infrastructure Cultural History (KICH).⁴⁰

7 THE DCCB AS A TOOL FOR INTERREGIONAL AND INTERDISCIPLINARY RESEARCH IN THE LOW COUNTRIES

The strong point of the DCCB is that it provides an updated geographical network of dendrochronological data and metadata for a larger area that exists at present. This enables us to ask new research questions, as well as to work on existing research questions in more detail and based on much more observations than is possible at present.

7.1 RESEARCH DIRECTIONS IN CULTURAL HISTORY

Trade relationships

Using the new DCCB archive it will be possible to contribute to the study of the development and changes of trade relationships using quantitative data on wood provenance. Using a small dataset of

³⁷ The ITRDB Program Library; see xxxxx.

³⁸ The terms 'biologically *in situ*' and 'biologically *ex situ*' were proposed by O. Brinkkemper during the Landscape development workshop (March 5, 2007).

³⁹ eDNA is an e-depot for research results in Dutch archaeology, on the initiative of DANS/KNAW and RACM. See <http://edna.itor.org/nl/>.

⁴⁰ See <http://www.kich.nl/>.

159 dated measurement series from oak used in 51 objects (paintings, sculptures, a doll's house, cabinets, chests, clocks, tables and desks, pulpits and altar pieces from the Netherlands and Flanders) it has for instance been shown that around 1650 a shift took place from Baltic to South German oak (Jansma *et al.* 2004). A factor of influence may have been the British Navigation Acts, a series of Laws which in 1651 and 1660 successfully restricted Baltic trade by the Dutch. Using the DCCB it can be ascertained whether this hypothesis still holds when a larger data set is studied. The DCCB can also be used to detect and study other shifts in trade, as well as shifts from local to exogenous wood provenance due to increasing wood scarcity. An interesting research question in this respect is whether the late 2nd century scarcity of archaeological data in the archive of Foundation RING (Visser 2006), which may be the combined result of sample bias and the actual switch by the Romans to the use of stone instead of wood for building fortresses, also holds for regions further inland along the Rhine such as the Cologne region with its rich archaeology and extensive dendrochronological dataset.

The transport of wood

The DCCB can also be used to deduce the manner and shape in which the wood was transported. It is possible to discern traces of rafting on timber.⁴¹ Combining the metadata in the DCCB about these traces and analyzing the common signal in the ring patterns of the timbers showing these traces will enable us to start identifying wood that was rafted in one and the same raft but was used for different purposes, as well as to determine the provenance of the timber and therefore most likely route of the raft to the Netherlands.

Wood-technological choices

Using the DCCB it will also be possible to find out which wood qualities were considered important for specific applications. For instance straight oaks with narrow rings, derived from shadowy closed-canopy forests, can be split easily into planks, which is one of the assumed reasons planks and panels in the sixteenth and seventeenth century were until 1650 brought in from the Baltic. In the Roman period on the other hand, bog oaks were selected for ship's parts that underwent mechanical stress during the ship's voyage. The DCCB will enable us to verify and expand our knowledge about the rationale underlying this kind of wood selection.

The ritual use of wood

Another phenomenon to be studied is the very characteristic and economically unrewarding use of hollowed out tree trunks as water wells and coffins between ca. AD 500 and 1100.⁴² It has been argued that the trees worked in this manner were free standing landmarks that were cut down for this specific reason only. Fortunately, it is possible to discern between closed-forest and free-standing trees using characteristics of the growth patterns. By studying the combined archives of the DCCB, it will be possible to get a better grip on this phenomenon than would be possible when only the few hollowed out trunks present in one individual archive are studied.

Economic studies

A general and in its simplicity very rewarding topic of study is former conjuncture. In the Low Countries simple numerical studies of the amount of wood used in the cultural environment have never been carried out because of the understanding that single archives such as the database of Foundation RING simply are too small to reflect former economical developments. However, a preliminary survey of all felling dates in the archive of Foundation RING shows that a slight but distinctive dip in general felling activity occurs (in this data set) during the Black Death or Bubonic Plague of AD 1348-1350 (Jansma, unpublished data). It would be worthwhile to analyze this phenomenon using more data, in order to assess in what regions abroad forest exploitation was hampered most severely and in order to identify those sectors of our regional industries that as a result suffered most.

⁴¹ These consist most often of a set of two square holes at the end of beams; these holes have no function in the actual context of the timber and show how beams were connected into rafts (for instance using rope which was hammered into the holes using wooden pegs, thereby creating a connection between adjoining beams).

⁴² When a trunk is hollowed out, most of the wood has to be thrown away. This type of use therefore cannot have had economic reasons.

Other

Already at the current preliminary stage of the DCCB, culture-historical projects are being defined by RACM that presuppose a functioning DCCB. An example is a project regarding 17th to 19th wood scarcity related to the increase in the ship's and house building industries, the rise of industrialization and the steel industry.⁴³ New sampling strategies are being designed in the context of this project, because the majority of current data sets in dendrochronology are the result of requests for dating (which in general involves four to six samples, most often from the largest timbers only) and do not reflect the considerable variety of timbers and planks from widely different geographical regions that was used for ships and the built heritage. This variety reflects technological choices, a topic of which researchers of the cultural heritage are now becoming aware as the result of the DCCB pilot project.

7.2 RESEARCH DIRECTIONS IN CLIMATE RESEARCH

Wood provenancing

As with cultural-historical questions, the study of past climate and climate change cannot be based on small specific datasets, but should be based on detailed grids of dendrochronological information. In the Netherlands, the effort should first concentrate on identifying indigenous oak, as has been done already for the Roman Period (Visser 2006).

Pointer-year analysis

Using climate-response functions and both tree-ring series of living trees and monthly environmental data (temperature, precipitation, ground water levels), it has been shown that the annual growth of contemporary oak in periodically wet surroundings is restricted by an excess of precipitation during the previous winter and following spring (Sass-Klaassen, NWO/ALW project number 750-70-004). If this model is projected upon the growth patterns of indigenous oaks that during the Roman period grew on indigenous 'wet' sites, the results of a straightforward pointer-year analysis (Schweingruber 1993) can be used to produce annual maps of above- and below-average precipitation during winter and spring. Recently this approach was used to argue that the winter and spring of AD 40 were characterized by above-average rainfall whereas the winter and spring of AD 41 were much drier than average (Jansma, national Dutch archaeological conference 'Reuvensdagen', November 2006). This kind of approach is very straightforward and may be somewhat at odds with the complicated processes that determine the annual growth of oaks, but it does show that chronologically detailed hypotheses about previous meteorological circumstances can be developed using the common signal in the growth patterns of oak.

Connecting to research abroad

A somewhat similar but more refined approach has been used in France (S. Durost, publication in preparation). The results are annual maps of France for the 1st century AD showing annual predominant meteorological inferences. Durost lately has extended his study to Belgium and during a personal interview has expressed a strong willingness to extend his project with Dutch data in collaboration with the authors of these data. The DCCB would provide an excellent opportunity for dendrochronologists in the Netherlands to join this and similar large-scale projects on climate reconstruction.

7.3 RESEARCH DIRECTIONS IN FORMER VEGETATION STUDIES

Research of dendrochronological data from the Roman period has shown that the Romans used local sources of wood until well into the 2nd century. Growth signals in these ring patterns which are related to thinning (forest management) have been noted but not published (Jansma, unpublished data), because these observations were based on relatively small data sets. The DCCB will provide a dataset that is large enough for a thorough analysis of the anthropogenic signals in the measurement series on a decadal to millennia-long timescale, using variables such as the age structure of former stands (a uniform age structure points at regeneration after felling) and growth releases coinciding with felling activity (death dates of timber; if these coincide, this points at possible thinning activities). This approach will provide new information about former practises of forest exploitation. In addition, the

⁴³ Personal and e-mail communications by M. Kosian and M. Manders (RACM).

analysis of the provenance of the timber represented in the dataset (local vs. non-local) can be used to infer changing degrees of former deforestation.

7.4 RESEARCH DIRECTIONS IN DENDROCHRONOLOGY

New chronologies

The accuracy of determinations of the provenance of wood depends on the quality of the local and regional calendars used as a reference when determining the provenance. Most of the calendars from Germany, Scandinavia and the Baltic that are used in the Netherlands for this purpose have been constructed from tree-ring series that remain unpublished and inaccessible, which means that the common signal in the calendars and their quality for determining growth regions cannot be assessed statistically. It has been shown that some important regional German chronologies during specific time intervals do not reflect the growth behaviour of trees from the supposed region (Jansma 1995). In order to set up a proper archive of calendars that are suited to determine in detail where trees grew, the existing data have to be reanalyzed using stricter statistical criteria than those that were used in the past. The DCCB provides an archive and setting in which this can be done, in a close collaboration between the dendrochronologists who are the authors of, or responsible for, the data. New chronologies resulting from the DCCB will have a clear and well-understood environmental signal due to strong common environmental forcing. These calendars will be well suited to determine the original growth regions of newly investigated wood. Using knowledge about the factors determining their annual characteristics these calendars also can be used to refine our insight into former climate and other environmental factors. Major publications can be expected based on this approach.

Sapwood estimation

A pressing matter in dendrochronology is the estimation of rings that have been removed on the outside of timbers and planks. The more accurate this estimation is, the more accurate the estimation of the actual felling date will be. Oak is a tree species that is characterized by a zone of sapwood rings of 1-3 cm, directly under the bark. If some sapwood rings are present on a piece of oak, it is therefore still possible to estimate the actual felling date. There exist various approaches towards sapwood estimation. Some of them are based on tree age, others on observations about the width of the average sapwood zone and the average ring width in the studied wood. Until recently, Foundation RING used sapwood estimates based on German timber (Hollstein 1980). It now has become clear that oaks that grew in the Netherlands in general contained more sapwood rings than the German estimation accounts for, which means that in the Netherlands we have been underestimating the actual age of oaks and overestimating the time interval that has passed since the trees were felled (Jansma 2007a). The correction of estimated dendrochronological felling dates is tree-age dependant and will not be larger than a few years at most. This new insight does however show that dendrochronologists cannot depend on published sapwood estimates. The DCCB will enable us to approach this dendrochronological issue using a larger and geographically more diverse data set. One of the first intentions of the dendrochronologists participating in the DCCB is to take sapwood estimation to the next level of geographical and biological detail.

Characteristics of 'undatable' oak

Undated measurement series in existing data sets are a pressing problem. With more and more reference calendars becoming available in Europe, including the Low Countries, it is likely that some series that were initially not dateable have become possible to date. Analysis of the remaining not dateable measurements in the DCCB can help identify types of wood and the habitat from which they came. A usable working hypothesis is that wood used in later periods in scarcely forested regions came from relatively young, locally harvested trees from copses or from trees along land divisions.

Other

Some research questions in dendrochronology are not recognized explicitly as a priority in the fields of cultural history and paleo-environmental studies (including climatology), but are of great importance to these fields. These questions either have to do with dating accuracy or with the level of detail with which the provenance of wood can be determined. Accuracy in both instances depends on the quality of the reference chronologies that are used. Before 3000 BC the level of dendrochronological information in the Low Countries is lower than it should be if we are to study former vegetation and environmental change. The DCCB will enable us to argue this point using a larger, denser and

geographically more extensive data set. In this manner the DCCB will contribute to defining the Low Countries' research agenda for the earlier time intervals (7000-3000 BC).

8 ASPECTS OF THE WORK PLAN

Formulation of international 'archiving standards'

The first step necessary to make the DCCB operative is to define a digital standard for dendrochronological data. In case of funding, an international meeting between the DCCB advisory board and the dendrochronologists of the DCCB will immediately take place for this purpose. During the meeting the greatest common denominator among the many possible descriptive fields (metadata) will be established or (if the underscored selection in appendix 3 is accepted) ratified. From this a minimal standard for the archiving of metadata will be agreed upon. This first standard may well be conforming to the proposal in appendix 3, but it is possible that some descriptive fields will be added to the proposed fields because of their common presence in current archiving. During the first phase of the proposed project (see below, *Pilot phase of the DCCB*) this common denominator will serve as the basis for developing the XML-scheme.

Pilot phase of the DCCB

Based on the minimal standard agreed upon and the operative formats for archiving data, an XML-scheme will be developed. An environment will be built using small example archives representing each of the types of source data (artefacts and non-artefacts (i.e., vegetation remains and living trees)). The data structure and the ability of the XML-scheme to realize interaction between the archives will be tested. The ability to convert formats and to change levels of data protection will be added as a feature. After the internal tests and applications are complete, the environment will be available on the internet. The publicly available beta version can be tested by the DCCB partners and the advisory board (overviews of certain categories of metadata will be generally available; access to the data and their dendrochronological interpretations will require a log-in code).

International standard(s) for digital archives in dendrochronology

During following meetings with the advisory board priority will be given to refining the minimal archiving standard. We can expect the resulting standard for metadata to vary according to the type of source material (cultural, biological and geological data). The usefulness of this optimized standard in the early stage of the DCCB is not certain because it is not yet possible to know if and to what degree the archiving of metadata by participating laboratories already adheres to this future standard. The new standard(s) will be incorporated in the DCCB XML-scheme and must be adopted for future registration and archiving by the DCCB laboratories.

Developing the real DCCB

After testing by the user group and following bug-shooting and after the quality of the beta-version is affirmed, the possibility to upload metadata to the DCCB will be installed and tested.

Staffing and financing the DCCB 2008-2010

A project leader for the DCCB must be appointed to prepare and coordinate the diverse activities, to oversee the finances and to report to the RACM, NWO and the DCCB network. Support for the project leader (secretarial work, organisation of a yearly convention, etc.) must be budgeted. The project leader must work together with a representative of the Sector Knowledge Exchange within the RACM, which will require extra support from the RACM.

The technical aspects of the DCCB (pilot project and final design) will be developed by external contractors.

The setting up of the DCCB will require the participating laboratories to do some practical work. Data collections on paper will have to be digitalised and existing collections of measurement series must be verified and supplemented with metadata. An initial *lump sum* for participating laboratories, based on an estimate of the work required, will be part of the budget requested. Laboratories will have to agree to deliver the product required.

Because the DCCB is an international project, part of the budget will have to be reserved for international travel expenses incurred during the project.

Staffing for the DCCB 2010 and later

Once set up, the DCCB cannot function without a part-time webmaster (to manage the archives and to make periodic adjustments to the XML format) and periodic evaluations (annual or biannual conventions for agreeing upon and/or adapting digital standards, etc.).

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Appendix 1 Data formats of in dendrochronology

Dendrochronology involves the analyses of the records of annual growth that are archived in wood. The 'raw' measurements on these records are considered primary data in dendrochronology. In addition to such measurement series good research descriptions involve many types of metadata about the wood, such as the dendrochronological data of the object, its geographical location (address or coordinates, the manner and research context in which it was investigated (and by whom, and when), the specific research questions leading to the necessity of dendrochronological dating, the typological, morphological and wood-technological descriptions of the object, geographical information, contextual information including soil descriptions (for wood buried in the soil), and pictures of both the ring patterns as well as the objects and context. The dendrochronological tools used during the research, such as standard chronologies used for dating, indexing methods and the statistics describing the found matches, should also be considered as metadata.

1a Dataformat of the *International Tree-RING Data bank*

Individual measurement series

Object description

1st line: location (here: ABCOUDE/BAAMBRUGGE); object description (here: SUBFOSSIL OAKS); date and number of entrance in the ITRDB (here: 20DEC94-1501).

Data

Column 1 (6 digits):

measurement code

Column 2 (6 digits):

date (year) of the ring width noted in the 3rd column

Column 3-12 (6 digits):

ring width

Last line, last value (999):

end marker of series

Format of individual measurement series

```
ABCOUDE/BAAMBRUGGE, SUBFOSSIL OAKS [ 20DEC94-1501 ]
ABC011 -181 85
ABC011 -180 136 161 136 173 192 130 52 57 117 131
ABC011 -170 146 164 197 164 182 200 102 143 221 119
ABC011 -160 87 84 85 68 42 31 44 132 150 138
ABC011 -150 166 194 71 101 53 73 60 65 89 117
ABC011 -140 125 301 234 182 120 135 290 150 182 234
ABC011 -130 160 110 183 59 158 156 158 226 151 142
ABC011 -120 118 72 107 150 122 80 80 92 83 64
ABC011 -110 46 51 65 63 82 99 122 68 73 67
ABC011 -100 103 90 87 105 201 188 196 151 143 73
ABC011 -90 76 61 92 82 113 75 105 183 286 237
ABC011 -80 193 210 174 167 117 95 88 83 192 304
ABC011 -70 253 213 206 234 146 178 226 274 289 159
ABC011 -60 136 130 178 191 171 95 176 192 169 201
ABC011 -50 164 190 237 158 171 84 138 158 96 85
ABC011 -40 74 62 49 45 29 38 35 39 45 33
ABC011 -30 46 37 40 31 72 76 43 34 42 60
ABC011 -20 43 38 37 33 34 37 46 33 46 53
ABC011 -10 47 59 50 38 61 51 55 39 999
```

Calendars

Object description

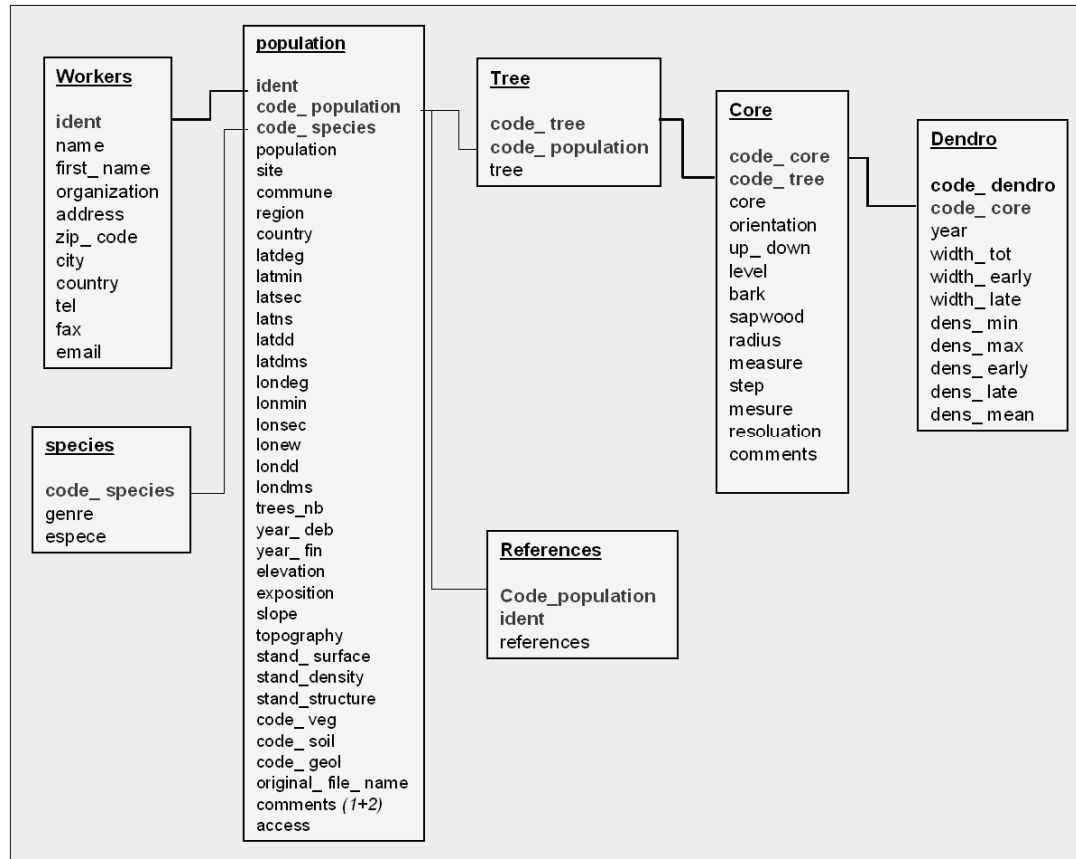
Location code (here: ABC);

1: Location (here: ABCOUDE/BAAMBRUGGE), object description (here: SUBFOSSIL OAKS), code of wood species (here: QUSP);

1b Data format of DendroDB

Database structure

The data base structure is organised around three main tables.⁴⁵ DENDRO table contains raw tree-ring data (ring width, densitometric variables). SITE table gathers information about the location of the sites (geographical co-ordinates, administrative and geographical definition). POPULATION table concerns ecological information about tree sites: topographic characteristics (topography, slope, altitude, aspect), geological and soil characteristics, vegetation characteristics (structure of the forest and phytosociological context). Some other tables contain meta-data about core description: CORE table, which gives information about the wood (sapwood, bark...), TREE table, about trees, SPECIES table and CONTRIBUTOR table, this last allowing a well functioning of the data base policy and future exchanges between users and contributors.



A.

Individual measurement series

Object description

Site: location of the trees

Contact: author of the data

Species: tree species

Parameter: the variable that was measured

Latitude

Longitude

Elevation: height relative to sea level

⁴⁵ Bron: <http://servpal.cerege.fr/webdbdendro/>

Data

Column 1: sample number
 Column 2: measurement number
 Column 3: year belonging to parameter in column 4
 Column 4: measured parameter (here: ring width in 0,0001 mm)

Format of individual measurement series

Data downloaded from DendroDB. Please acknowledge authors

Site: Landgoed Hillenroad

Contact: Maessen

Species: Quercus robur

Parameter: Total width

Latitude: 51

Longitude: 6

Elevation: -999

Tree Core Year Total width

10 1 1829 5950

10 1 1830 3880

10 1 1831 2910

10 1 1832 2850

10 1 1833 3520

10 1 1834 2560

10 1 1835 3190

...

De values of this measurement series and of other series from the same site follow underneath in the same columns.

1c Format of meta data in the public domain part of HISTRA (PANGAEA)



PANGAEA®
 Publishing Network for Geoscientific &
 Environmental Data

You are not logged in ([LOG IN](#))

Please quote reference/citation when using data!

Data Description

Hofmann, Jutta (2007): Tree-ring width of *Abies alba* (Miller) from historical object sample HOF11383-162, *Jahrringlabor Hofmann, Nürtingen, PANGAEA*, unpublished dataset #559596

Citation:

Project(s): [Historical and Postglacial Tree Ring Archive of Hohenheim](#) (HISTRA)

West: 9.1732 * *East:* 9.1732 * *South:* 47.6611 * *North:* 47.6611

Coverage:

Minimum Age: 0.631 kyr BP * *Maximum Age:* 0.689 kyr BP

HOF11383 * *Latitude:* 47.6611 * *Longitude:* 9.1732 * *Elevation:* 394.0 m * *Location:* Konstanz, Baden-Württemberg, Southern Germany * *Campaign:*

Event(s):

Tree_Ring_Collection_S_Germany * *Device:* Historical object

Comment:

Species ABAL; No of rings 59; Begin 1261; End 1319

Parameter(s):

Parameter	Short Name	Unit	Principal Investigator	Method	Comment
AGE	Age	kyr BP			Geocode
LATITUDE	Latitude				Geocode
LONGITUDE	Longitude				Geocode
Age	Age	yr AD 1/100	Hofmann, Jutta	Dendrochronological crossdating	
Ring width	R	mm	Hofmann, Jutta		

Size:

8 data points

Download Data (login required)

[Download dataset as tab-delimited text](#) (use the following character encoding:

ISO-8859-1: ISO Western (PANGAEA default)

[View dataset as HTML](#)

[Contact](#)

1d Data format of the Base de Données dendrochronologiques (CNRS)

Format of individual measurement series (not included in the database, but used by the CNRS)

Object description

Line 1 (date): Date of the research
Line 2: Name of the measurement series (here a plank found in in Queutrey, a village in department 70 (Haute-Saône) in France-Comté
Line 3: ESP Wood species
Line 4: LON Number of measured rings
Line 5: MOE Absence/presence of pith
Line 6: POS Position of the series in an average calendar
Line 7: AUB First ring of sapwood
Line 8: CAM Last ring beneath the bark
Line 9: ORI Date of oldest ring in series
Line 10: TER Date of youngest ring in series
Line 11: VAL Description of data: raw measurements or detrended data (including detrending method)
After last value , A ring was discerned but not measured
After last value ; End marker of series

Dataformat

```
date : 21/03/2007
. Queutrey_(70)_(Tavayllons)
  ESP    QU
  LON    91
  MOE
  POS    176
  AUB    154
  CAM    176
  ORI    1564
  TER    1654
VALeur  NAT
279    296    157    99    87    80    94    114    185    277
205    204    272    278    212    270    282    242    181    172
172    172    179    177    168    232    161    115    140    112
140    110    81    108    133    115    134    147    100    76
82     128    194    158    140    115    90    70    84    160
112    98     92     85     86     89    91    96    120    94
86     113    127    132    106    103    74    80    114    111
76     98     77     109    107    92    146    118    94    120
85     110    102    110    101    66    52    48    51    51
,
;
```

Format of average tree-ring calendars

Calendar description

Line 1 Name of the calendar
Line 2 Number of annual values
Line 3 Date of oldest value
Line 4 Date of youngest value
Line 5 Date of youngest value
Line 6 Date of youngest value
Line 7 Standardization method and name of the calendar
, Rings observed but not measured
; End marker of series
The annual values are separated by 2 digits

Calendar format

```
Perols.FCarl-LCE05
  longueur: 274
  position: -81
  fin: 193
  origine: -81
  terme: 193
VAL Aj/C: Perols.FCarl-LCE05
, , , , , , 66 61 53 86
, , , , , , 140 51 119
142 145 141 190 146 181 145 105 99 167
175 140 76 71 108 116 120 91 86 155
155 61 66 81 40 76 48 64 99 78
75 97 59 88 57 55 73 179 184 204
199 211 95 185 94 120 71 75 83 81
61 191 111 89 55 52 54 24 33 80
133 94 49 104 76 150 124 108 114 162
85 58 47 10 46 82 36 79 141 109
199 122 158 220 178 113 119 160 184 98
139 138 185 189 148 151 119 90 44 37
40 65 109 84 104 169 239 190 188 152
92 130 121 80 162 108 44 1 31 68
123 98 109 84 144 73 105 134 65 126
163 116 79 154 158 81 100 111 115 133
66 75 109 97 109 122 164 125 130 86
62 71 93 122 117 106 119 77 17 11
71 104 119 37 76 84 89 100 124 69
73 101 100 98 106 44 65 82 104 168
194 112 196 100 120 84 139 113 123 133
107 144 112 129 111 93 151 95 69 139
77 99 191 151 51 157 131 131 168 104
132 86 148 53 33 131 56 56 105 168
91 65 133 115 144 87 35 47 127 80
61 109 84 25 90 117 154 114 98 118
105 165 121 200 195 203 108 76 146 97
135 28 73 12 ;
```

1e Data format Heidelberg

HEADER:	
Project=B	project name
DateEnd=-221	Date of last ring
Length=135	Number of rings
Location=Abcoude	Location
Species=QUSP	Tree species
SapWoodRings=33	Number of sapwood rings
WaldKante=---	Presence of last ring under bark
PersId=EH	Analist (initials)
Latitude=127	Latitude
Longitude=467	Longitude
KeyCode=ABF00020	Unique laboratory identifier (filename)
Country=NL	Country
District=1	District
Client=Dhr Pal, Dhr Keizer	Commissioner of the research
MissingRingsBefore=3	Missing rings to pith
MissingRingsAfter=5	Missing rings to bark
DeltaMissingRBefore=1	Uncertainty of rings-to-pith estimation
DeltaMissingRAfter=2	Uncertainty of rings-to-bark estimation
DataType=rw	Measured variable
SeriesType=mean	Type of series
CreationDate=19960723	Date of measurement
LastRevisionDate=19960723	Date of last revision
DATA:Tree	

145	255	378	314	219	118	152	109	139	133
154	51	120	315	253	162	202	182	166	169
120	257	415	635	393	300	141	158	244	219
169	241	225	224	141	186	190	247	160	184
246	217	111	99	106	148	175	228	347	254
112	91	108	133	175	134	105	108	159	210
123	90	80	72	77	67	39	46	37	61
57	51	63	65	111	81	87	111	101	162
135	150	148	109	100	139	146	173	290	260
177	107	124	113	127	150	213	206	184	119
94	114	89	90	112	94	83	109	123	143
143	170	115	90	109	103	88	67	45	58
57	39	53	48	52	47	52	61	58	64
55	54	46	49	39	0	0	0	0	0

2f Data format PAST

Project=
 Age=
 FromSeedToDataBegin=
 InvalidRingsBefore=
 InvalidRingsAfter=
 MissingRingsBefore=
 MissingRingsAfter=
 DeltaMissingRingsBefore=
 DeltaMissingRingsAfter=
 JuvenileWood=
 Bark=
 EstimatedTimePeriod=
 Sequence=
 SpeciesName=
 BHD=
 Circumference=
 TreeHeight=
 SocialStand=
 LeaveLoss=
 SamplingPoint=
 SamplingHeight=
 State=
 Country=
 District=
 Town=
 Street=
 HouseName=
 FieldNo=
 Latitude=
 Longitude=
 SiteCode=
 Elev=
 CardinalPoint=
 Exposition=
 SoilType=
 LocationCharacteristics=
 LocChar=
 DateOfSampling=
 Collector=
 Client=
 AcceptDate=
 PersID=
 CreationDate=
 LastRevisionDate=
 TimberType=
 TimberWidth=
 TimberHeight=
 Bundle=

ShapeOfSample=
 WorkTraces=
 DataType=
 QualityCode=
 SeriesType=
 Unit=
 Comment=
 DAQ=
 TreeNo=
 CoreNo=

]]></HEADER><DATA><![CDATA[98,7441653981038 1 1 0 98,7441653981038

103,006627428255	2	2	0	103,006627428255
101,947081409648	2	2	0	101,947081409648
111,764852881687	3	3	0	111,764852881687
87,8158761386653	4	2	0	87,8158761386653
103,54980180883	4	3	0	103,54980180883
107,524225164384	4	3	0	107,524225164384
104,325007841116	4	1	0	104,325007841116
97,8478022119469	4	2	0	97,8478022119469
86,6011710092027	4	0	0	86,6011710092027
64,9749353741876	4	0	0	64,9749353741876
54,2412776247291	4	0	0	54,2412776247291
109,738801723895	4	4	0	109,738801723895
151,92860822106	4	4	0	151,92860822106
136,603188985556	4	0	0	136,603188985556
136,765658885282	4	3	0	136,765658885282
144,882604587568	4	2	0	144,882604587568
98,3058014507577	4	0	0	98,3058014507577
54,9334990653381	4	0	0	54,9334990653381
73,2112903298748	4	4	0	73,2112903298748
74,6260525560508	4	2	0	74,6260525560508
64,4637468576369	4	1	0	64,4637468576369
84,5175549575643	4	4	0	84,5175549575643
77,5894846630714	4	0	0	77,5894846630714
120,440676656088	4	4	0	120,440676656088
125,28219765966	4	4	0	125,28219765966
113,685165238779	4	0	0	113,685165238779
106,820996183979	4	2	0	106,820996183979
133,229877637322	4	4	0	133,229877637322
90,5064610985121	4	0	0	90,5064610985121
81,0798188664952	4	0	0	81,0798188664952
99,1380438124594	4	4	0	99,1380438124594
105,664498777342	4	3	0	105,664498777342
88,6750911202797	4	0	0	88,6750911202797
86,8143881434027	4	2	0	86,8143881434027
90,7610403186829	4	3	0	90,7610403186829
114,709739431096	4	3	0	114,709739431096
125,669261229168	4	4	0	125,669261229168
121,349257423092	4	2	0	121,349257423092
92,0880271665503	4	0	0	92,0880271665503
98,7484439366109	4	3	0	98,7484439366109
108,806438534819	4	4	0	108,806438534819
123,714412458555	4	4	0	123,714412458555
75,3712467439292	4	0	0	75,3712467439292
83,6280949111179	4	4	0	83,6280949111179
83,4119554899215	4	2	0	83,4119554899215
95,9746750079367	4	4	0	95,9746750079367
98,1125360469418	4	3	0	98,1125360469418
108,295124756128	4	4	0	108,295124756128
93,6126429741088	4	0	0	93,6126429741088
73,0840836769882	4	0	0	73,0840836769882
109,155383752133	4	4	0	109,155383752133
139,046387115609	4	4	0	139,046387115609
112,768165365641	4	0	0	112,768165365641
76,0901851740837	4	0	0	76,0901851740837
114,460656157472	2	2	0	114,460656157472
99,6597967850509	2	0	0	99,6597967850509

109,020625085878	2	2	0	109,020625085878
81,0001013268338	2	0	0	81,0001013268338

1g The V-format

Data format of individual measurements

```
VIF14      .!OJmm    135      -1066      00/00/-1900  00/00/-190002  0 .  0 .
T:0/I:      /S:    0/D:0/E:0/Q:0/P:0/L:
  65      35      75      97      81      146      108      77      160
  202     177     129     106     159     204     199     263     132     121
  154     98     142     90     57     50     40     42     36     34
  43      31     40     68     56     48     47     43     50     36
  28      24     24     26     35     53     54     56     51     48
  44      50     58     68     70     103    102     83     55     55
  132     192    229     276    271     246    221     181    210    154
  108     96     113     98     79     97     51     149    228    186
  170     121    129     93     77     65     94     79     58     62
  92      65     49     42     51     60     48     41     37     47
  50      51     77     122     87    119     154    151    130    143
  157     154     78     74     103    104     71     98     133    141
  157     119     49     71     95     104    113     81     92     91
  90      81     77     120     64
```

Data format of average chronologies

```
NL_AB551.#RJ      458Qusp    335 Oudekerk aan de IJs29.07.96*  3.08.0002  0 0  0 0
Summary
  .3319      .0002      .1555 P .2702 P .4859 P -.059 P .0072( .0863( -.117( -.164
(0 -.094(0 -.351(0 -.13(0 -.144(0 -.134(0 -.297(0 -.158(0 .0030(0 -.078(0 -.193
(0 -.074(@ -.212(P -.072(P .1264(_ .21130 .11160% .16240% .06900% -.1060% -.082
00 .025605 -.2190: .05530: .36620: .14740@ -.4950@ -.0310J -50J .20980J .2669
0J .40590J .16330P .18100P .19750P -.0440P -.0130U -.2380U -.0170Z -.2840Z -.162
0Z -.0430Z .17820_ .10680_ .05720_ -.0960_ .08910e .02770j .01140o -60o -.085
0t -.1640z -.0328 .07178" .12758% .11178% .02978% -.3278' -.2698' -.2818' -.134
8' .15488' .09048' .10588' .33238' .33748' -.0038' .30278' -.0878' .23588' .1632
8' .05558' .13928) -.0518+ -.2298+ -.2158+ -.3068+ -228, -.1528. -.2588. -.036
80 .005183 .096683 .123983 -.00583 -.25383 -.30585 .105885 .344885 .308489 .0713
8: .10728: .44418> .26498@ .06378@ -.0178@ .07818@ -.0378@ -.0268@ -.0148@ -.113
8G -.1218G -.0528G -.0798G -.0098G .05048H -.1618H .06728H -.6438J -.3978J -.319
8J -.0318L .14558N .16798P -.0718Q .09498Q -.0288U -.0318U .23268U .24408U .2619
8W -.1898X -158X -.0738\ -.0138\ .19948\ .20198\ 548^ .49028_ -.1488_ -.177
8_ -.4448_ -.2648a .11088a -.1588a -.2458a -.0538a -.0558_ -.1718_ .17918\ .3468
8\ .19578Z -.2288X -.2198X -.0818X .01888X -.0648X -.0248\ .05358\ .21248^ .1741
8_ .42938\ .08848\ -.1588X .28388X .13678X .40248U .06828S -.2728S -.0498S -.156
8S .05768N -.2488N -.5118N -.2118J -.1618L -.0958N .27708N .07968N .20418L -.107
8L -.3568J -.2648G .06908H -.1868E -.1328A .14228@ .12868< .01028: .02028: -.004
89 .140989 .220287 5689 .486889 .189889 -.08189 .140789 .022085 -.14883 -.448
82 -.27380 -.1258, .07158, -.2028, -.1368+ -.1938) -238% .2218% -.2128 -.156
0t -.0260o -.0070o .29660o .13230e .22070P .00440P -.1050P .01700P -.0880P .1736
0P -.1060P .11700@ .04600@ .19520@ .16760: .08960: .17690: .12180: -.01305 -.057
00 -.21800 -.23300 -.2270+ -.1430+ -.0580+ -.2470% -.1050% -.0180% .16540% .2242
0% .15920% .16010% .08680% -.1870% .17500% .1262(P .2098( S.1948( .4807( .1394
( .0573( -.036( .0327( -.156( -.012( .0170( -.061( -.062(0 -.093(0 -.081
(0 -.211(0 -.209(0 -.072(0 -.238(0 -.416(0 -.249( -.293( -.121( -.332(0 -.106
(0 .0722(0 .4226(0 .3094(0 .1752(0 -.276(0 -.372(0 -.277(0 -.005(0 .0856(0 .0614
(0 -5(0 -.096(0 .0515(0 .1529(0 .3375(0 .3354(0 .1573(0 .1676(@ .1950(@ .1711
(@ .2270(@ .1810(@ .0824(@ .1420(@ .0723(@ -.144(@ -.037(@ .0256(@ -.177(@ -.269
(@ -.253(@ -.062(@ -.112(@ -.173(@ .0206(@ .1164(@ .1306(@ -.007(@ -.032(@ -.062
(0 .1144(0 .2114(0 -.221(0 -.289(0 -.279(0 -30(0 -.211(0 -.069(0 -.108(0 -.155
(0 -.092(0 -.029( -.2655( 55( .0839( .0327( .0346( .1654( -.076( .0416
( -.015( .2503( .2235( .0522( .3232( .2444( .1695( -.223( -.067( -.256
( -.055( -.226( .0514( .0806( -.237( -.152( .1965( .0516( -.048( -.11
( -.239( .0295( .2576( .0729( -4( .1235( -.263( -.035( -.276( -.543
( -.312( -.273( -.031( .1386( .3662( 22( .0053( .0289( .1668( .1490
( .3303( .3397( .1125( -.362( .0499( .1365( .1705( .0232( .1724( -2
( .2597( -.038( -.22( -.152( -.287( -.002( -.129( -.26( -.387( -.306
( -.097( -.004( -.164( .0687( -.008( -.047( .0688 P .1341 P .2467 P .0073
P .1870 P -.097 P 50 P .2688 P .1494 P -.145 P .2831 P .2386 P -20 P .0802
P .2443 P .1964 P .0452 P .0045 P -.192 P -.123 P -.313 P .1354 P -.268 P -.082
P -14 P -.054 P -.109 P -.175 P -.255 P -.431 P -.089 P -.024 P .1051 P -.059
P .0004 P -12 P .0875 P .2771 P .0679 P .0281 P .0444 P .0151 P .1987 P .2124
```

P .0651	P .2190	P .1637	P -.053	.2432	-.078	.2497	.1529	-.413	-.202
-.514	-.156	.0716	-.402	-.042	-.314	-.199	-.298		

Appendix 2 – Workshops DCCB

2a Workshop programs

Workshop DCCB cultural history

- Introduction: the pilot project Digital Collaboration on Cultural-historical Dendrochronology in the Low Countries (*Digitaal Collaboratorium Cultuurhistorische Dendrochronologie* (DCCB))
- Presentation of the results of the surveys on cultural history and palaeo-environmental studies.
- Brain dump of the users' wishes in cultural history (technical prior conditions DCCB).
- Brain dump of gaps in the knowledge in cultural history (refinement of the research agenda of the DCCB and its partners).
- Summary, discussion and conclusions.

Workshop DCCB Palaeo-environmental studies

- Introduction: the pilot project Digital Collaboration on Cultural-historical Dendrochronology in the Low Countries (*Digitaal Collaboratorium Cultuurhistorische Dendrochronologie* (DCCB))
- Presentation of the results of the surveys on cultural history and palaeo-environmental studies.
- Brain dump of the users' wishes in palaeo-environmental research (technical prior conditions DCCB).
- Brain dump of gaps in the knowledge in palaeo-environmental research (refinement of the research agenda of the DCCB and its partners).
- Summary, discussion and conclusions.

Workshop DCCB dendrochronology

- Introduction: the pilot project Digital Collaboration on Cultural-historical Dendrochronology in the Low Countries (*Digitaal Collaboratorium Cultuurhistorische Dendrochronologie* (DCCB))
- Presentation of the results of the surveys on cultural history, palaeo-environmental studies and dendrochronology.
- Presentation of the responses from the international dendrochronological field.
- Inventory of the dendrochronologists' wishes regarding content and technical and juridical aspects of the DCCB (Low Countries).
- Inventory and evaluation of current data formats in dendrochronology.
- Summary, discussion and conclusions.

2b Participants

DCCB workshop cultural history		
Monday March 5th, 10:00-13:00, location RACM-Amersfoort		
Name	Organisation	Department
Dhr. Drs. N. Arts	Archeologisch Centrum Eindhoven	
Dhr. Drs. J. Van Doesburg	RACM Amersfoort	Landschappelijk en Stedenbouwkundig Erfgoed
Dhr. Dr. B. J. Groenewoudt	RACM Amersfoort	Sector Landschappelijk en Stedenbouwkundig Erfgoed
Mw. Drs. A. E. M. Hanraets	Foundation RING, Lelystad	
Mw. Dr. E. Jansma	RACM Amersfoort / Foundation RING, Lelystad	Landschappelijk en Stedenbouwkundig Erfgoed
Dhr. Drs. M.C. Kosian	RACM Amersfoort	Landschappelijk en Stedenbouwkundig Erfgoed
Mw. Drs. A. Overmeer	Nieuwland Erfgoed Centrum	Afdeling Onderzoek (oio)
Dhr. Drs. A. Reinstra	RACM Zeist	Gebouwd Erfgoed
Mw. Drs. P. Van Rijn	BIAX Consult, Zaandam	
Mw. Drs. T.J.J. Vernimmen	Foundation RING, Lelystad	
Dhr. Drs. R.M. Visser	RACM Amersfoort /Free University (PhD student)	Sector Kennis erfgoed/VU Letteren

Dhr. Prof.dr.ing. D.-J. De Vries	RACM Zeist / Leiden University	Gebouwd Erfgoed / Faculteit der Letteren
Dhr. Dr. A. Wallert	Rijksmuseum	Collecties: schilderijen

DCCB workshop Palaeo-environmental studies Monday March 5th, 14:00-17:00, location RACM-Amersfoort		
Name	Organisation	Department
Dhr. Dr. H. J. A. Berendsen	Utrecht University	Faculteit Geowetenschappen, Fysische Geografie
Dhr. Dr. O. Brinkkemper	RACM Amersfoort	Sector Landschappelijk en Stedenbouwkundig Erfgoed
Dhr. Ir. P. Copini	Wageningen University	Leerstoelgroep Bosecologie en Bosbeheer
Dhr. Dr. B. Van Geel	Amsterdam University	Faculteit der Natuurwetenschappen, Wiskunde en Informatica
Mw. Drs. A. E. M. Hanraets	Foundation RING	
Dhr. Dr. W. Z. Hoek	Utrecht University	Faculteit Geowetenschappen, Fysische Geografie
Mw. Dr. E. Jansma	RACM Amersfoort / Foundation RING, Lelystad	Landschappelijk en Stedenbouwkundig Erfgoed
Dhr. Drs. M.C. Kosian	RACM Amersfoort	Landschappelijk en Stedenbouwkundig Erfgoed
Mw. Dr. U. Sass-Klaassen	Wageningen University	Leerstoelgroep Bosecologie en Bosbeheer
Mw. Drs. T.J.J. Vernimmen	Foundation RING, Lelystad	
Dhr. Drs. R.M. Visser	RACM Amersfoort /Free University (PhD student)	Sector Kennis erfgoed/VU Letteren
Dhr. Dr. H.J.T. Weerts	TNO Bouw en Ondergrond	Business Unit Bodem en Grondwater
Dhr. E. Vriezen	RACM Amersfoort (stagiair)	Landschappelijk en Stedenbouwkundig Erfgoed

DCCB workshop dendrochronology Thursday March 8th, 10:00-13:00, location RACM-Amersfoort		
Name	Organisation	Department
Dhr. Ir. S. Van Daalen	BAAC Deventer	Dendrochronology
Mw. Ir. M. Domínguez Delmás	DendroLab NL	
Mw. Drs. A. E. M. Hanraets	Foundation RING, Lelystad	
Mw. Dr. E. Jansma	RACM Amersfoort / Stichting RING, Lelystad	Landschappelijk en Stedenbouwkundig Erfgoed
Dhr. Drs. M.C. Kosian	RACM Amersfoort	Landschappelijk en Stedenbouwkundig Erfgoed
Mw. Drs. T.J.J. Vernimmen	Stichting RING, Lelystad	
Dhr. Dr. M. Wansleeben	DANS (KNAW/NWO)	Extern, projectleider archeologie
Dhr. Drs. R.M. Visser	RACM Amersfoort /Free University (PhD student)	Sector Kennis erfgoed/Free University Letteren

Appendix 3 Theoretical model of digital archiving in dendrochronology

The workshop on dendrochronology on March 8th has resulted in a tentative model of digital archiving in dendrochronology. Minimum descriptive fields for the DCCB are underlined.

Levels

- Research context
 - Object/dendrochronological project
 - Object description
 - Research results of dendrochronology
 - Wooden element
 - Description of element
 - Interpretation of element
 - Wood sample
 - Measurement series
 - Researcher
 - Measurement
 - Interpretation of measurement series
 - Tools used for the interpretation
 - Later applications of the measurement series
 - Dendrochronological tools (overview)

Research context

- Country
- Year(s) of research
- Type of research: archaeological, environmental, historical, restoration/preservation, living trees, other
- Organisation of research (commissioner, performing organization, project leader)
- Contact person (name, organization, address)
- National registration of research: type of registration and number (in the Netherlands for instance the national archaeological research registration number ('onderzoeksmeldingsnummer' of the system ARCHIS) and for built heritage CIS-numbers)
- Outline coordinates of the research area (x, y)
- If possible: links to cadastral maps
- Purposes of the research
- Archaeological heritage: type of excavation (trial ditch, full excavation), guidelines used for the program of demands (requirements) and design of the excavation (national guidelines; KNA)
- Relevant literature (reports), websites and such

Object/dendrochronological project

A piece of wood can be part of an object consisting of more wooden elements. Examples are paintings consisting of various panels, but also chests and tables, pulpits, roof constructions, foundations, barrels, water wells, bridges, revetments, roads and ships. It is a standard practise to describe these objects with a term related to their function. The DCCB will follow this practice. Per object the DCCB should contain information about the object itself and contextual information about the research of the object.

Object description

- DCCB project code
- With material from the sub soil: date of find
- Date of dendrochronological sampling
- Date of the request for dendrochronology
- Specific purposes of the dendrochronological research
- Classification of the object: artefact or non-artefact

- Artefact
 - If known: country where the artefact was manufactured
 - Object type (functional description: building (church, house etc.) water well, painting, musical instrument (and type), ship (and type)⁴⁶
 - Individual name (such as the name of a ship, building or painting)
 - If the artist is known: name and workshop
 - If the date is already known in more or less detail: date and method of dating (geological context, associated finds, typology, stylistic aspects, carpenter marks, radiocarbon, OSL, other methods)
 - Objects *in situ*: coordinates (x, y and if possible z (height/depth))
 - Location (e.g., province, city, address, toponym)
 - Graphical information: digital pictures
 - Number of available wood samples
 - Relevant literature (reports), websites and such
- Non-arteifact:
 - Remains in the sub soil (forests and woodlands)
 - Date of find
 - Lithostratigraphical position
 - Soil type and layer (existing terminology (the Netherlands: ABR))
 - If a date is known in more or less detail: date and method of dating (geological context, contextual information (e.g., palynology), radiocarbon, OSL, other methods)
 - If known: type of forest or woodland
 - Soil profile and core descriptions available or not
 - If available: database and registration number
 - If available: report in which this was published
 - Relevant literature (reports), websites and such
 - Link to DINOshop (TNO, <http://dinolks01.nitg.tno.nl/dinolks/DINOLoket.jsp>)⁴⁷
 - Living trees (see appendix 2b for a good registration model)
 - Type of forest or woodland
 - Forest-management strategy (planting dates, dates of thinning etc)
 - Density of tree cover
 - Other site conditions (water tables etc.)

Research results of dendrochronology

- Project leader (dendrochronologist)
 - Family name
 - First name
 - Organisation
 - Address
 - Zip code
 - City
 - Country
 - Phone.
 - Fax.
 - E-mail
- Artefacts
 - Morphology/typology: one or more construction phases
 - In case of more phases: arguments
 - Number of studied elements
 - In case of > 1 element: average correlation between measurement series
 - Evaluation of the quality of the material for
 - Follow-up research on dendrochronology
 - Follow-up research in other fields
 - Type of dendrochronological report: standard, extensive
 - Publications

⁴⁶ In the Netherlands we can use the Archaeological Basis Register to determine for which types of objects a code already exists.

⁴⁷ Dinoshop is the central portal to Data and Information of the Subsurface of The Netherlands.

- Non-artefacts (material that is biologically *in situ*)
 - Chronology of the forest or woodland (earliest germination date, youngest death date)
 - Number of studied trees
 - In case of > 1 tree: average correlation between measurement series
 - Evaluation of the quality of the material for
 - Follow-up research on dendrochronology
 - Follow-up research in other fields
 - Type of dendrochronological report: standard, extensive
 - Publications

Wooden elements within object

Dendrochronological measurements result from observations of the growth patterns in individual wooden elements. Such an element can be a plank or panel, a post, a beam, a tree trunk preserved in the soil where it grew, or a living tree. When dendrochronological research starts, the assumption is that each element represents an different tree. The analysis can show that several planks were derived from a single tree; such results can be added in the interpretation of the dendrochronological results. Per element, the DCCB contains the following information

Element

- DCCB-code of the element (together with the code of the measurement and the object this should result in a unique identifier)
- Tree species (registration method ITRDB; see <http://web.utk.edu/~grissino/species.htm> for an extensive list of codes)
- If existing: external registration- or find number of the element
- Link to RADAR (Relational Archaeobotanical Database for Advanced Research), which contains research results on botanical macro remains from Dutch archaeology (see http://matrix.den.nl/row.aspx?matrixid=terminologiebronnen&rowid=18&view=Digitaal_Erfgoed)
- Assessment of the dendrochronological quality of this element
- Number of available wood samples from this element
- Type of element
 - With artefacts:
 - Shape (plank, panel, stave, lid, beam, L-shaped, pole)
 - Functional term (terminology ship's archaeology, roof constructions, art research and such)
 - Dimensions: length, width, depth
 - Position in tree trunk (registration method BIAX Consult)
 - Presence of carvings: inscription, carpenters' mark, traces of rafting
 - Contextual and morphological observations about primary/secondary secondary use
 - Other observations
 - With non-artefacts:
 - Living tree (see appendix 2b for a good registration model)
 - Coordinates (x, y of the heart of the tree boom)
 - Tree height
 - Crown diameter
 - ... other observations...
 - Remains in the soil
 - Position trunk: horizontal or vertical
 - If horizontal: general direction (East-West etc.)
 - Coordinates (x, y, z; for example a point coordinate with root systems in a vertical position and line coordinates with trunks in a horizontal position)
 - Presence root system
 - If root system is present: dimensions (diameter, thickness, diameter of largest and smallest roots)
 - If root system is present: height of preserved trunk relative to the roots
 - Dimensions van de preserved trunk (diameter top and bottom)
 - Observations regarding degradation

- Other observations

Interpretation of the observations of the element

- If dated: year in which the tree died
- If dated: uncertainty of the date: terminus post quem date, range of uncertainty
- Date of the outer ring present in the element (derived from the separate measurements; see below)
- Meaning of the date (what event has been dated?)
- Maximum number of observed rings in the wood (derived from the separate measurements; see below)
- Link to other wooden elements derived from the same tree
- Artefacts: estimated provenance of the wood and the arguments for this provenance
- Artefacts: estimated type of forest or woodland and the arguments on which this estimation is based

Dendrochronological samples

It is possible to take several wood samples per studied element (this is unusual in cultural history, but common practise in the study of living trees). These samples are the material with which dendrochronologists work and should be documented properly. Per sample the following should be recorded:

- DCCB-code of the sample
- Date of sampling
- Manner of sampling
- Party responsible for the dendrochronological sampling
- Artefacts
 - Position of sample in the element (if possible with documentation (sketch, photo etc.))
- Non-artefacts
 - Diameter of the trunk at sampling height
 - Height of the sample relative to the lowest preserved part (root system or other)
 - Trees in vertical position: orientation of the sample
- Accessibility of the sample for further research
 - Location of storage
 - Manner of storage
 - Storage number
 - Preservation/conservation
- Documentation of further research for which the sample was used (cell properties, isotopes and such).

Measurement series

Laboratory analyst

Dendrochronologists may or may not work in a team setting. If they work in a team, more than one person may be measuring wood from the same object. This is why it is important to document the researcher at the level of single measurements.

- Family name
- First name
- Organisation
- Address
- Zip code
- City
- Country

Measurement series

Single measurement series are the basic material in dendrochronology. Per measurement the following should be recorded:

- DCCB code of the measurement (together with the CDDB-codes of the sample, element and project this should result in a unique identifier)
- Laboratory code of the measurement (this does not need to be a unique identifier)
- Date at which the measurement was made (optional: year or day-month-year)
- Source of the measurement: wood, picture (digital or hard copy; resolution/scale; date of picture; author of picture), scan of the wood (digital or hard copy; resolution/scale; date of scan; author of scan), cast (method and material used to make the cast; date; author), CT-scan (digital or hard copy; resolution/scale; date; author)
- If digital source of measurement is available: inclusion in DCCB
- Method of measurement: with a lens, microscope (resolution), measured from screen (resolution, description of software), image analysis (resolution, software), radio densitometry (details)
- Description of measured growth values (total ring width, early wood, late wood, wood density (early wood, late wood, maximum density, minimum density, average density), vessel size, others)
- Number of measured growth values
- Observations about anomalous rings
- Pith absent/present
- With oak:
 - Sapwood absent/present
 - If present: number of sapwood rings
- Last ring under bark absent/present
 - If absent: estimated number of missing rings to the bark
 - If present: bark absent/present
- If the outer ring is present: is it complete or not, season of felling
- Descriptive statistics (standard dendrochronological variables: average ring width, autocorrelation, standard deviation).⁴⁸

Interpretation of the measurement series

- Assessment of the quality of the measurement series (may it contain errors or not)
- Series dated (yes/no)
 - If dated: last date of the series (year in which the last ring was formed)
- Involvement in the results of other researchers: name, address etc.
- General observations about matters such as juvenal growth, growth depressions, periodicities, cell morphology

Tools used for the interpretation of the measurement series

- Method of standardization/indexing
- Software (including references)
- Statistical foundation of the date
 - Used calendars, per calendar:
 - DCCB code or laboratory code of the calendar
 - Date based on tree-curve or object chronology
 - Number of compared values (length of overlap between series and calendar)
 - Student's t-value
 - %PV ('Gleichlaufigkeit', or percentage of parallel variation) en its level of significance
 - Correlation coefficient and level of significance
 - Other (this section should be expanded because in de dendrochronological field a variety of dating statistics is used)
- Absence/presence of pith and estimations regarding the missing number of rings towards the pith)
- Absence/presence of the outer ring and/or bark
- With oak:
 - Estimated number of sapwood rings that are missing
 - Estimation method of missing sapwood rings

Follow-up applications of the measurement series

- Has the series been used in an average chronology and if so

⁴⁸ This option can well be added later in a service of the DCCB and does not need to be an integral part of the archives.

- DCCB code of the chronology
- Link to the chronology

Dendrochronological tools

Statistics

Where possible information about the statistics used to derive dendrochronological results should be accessible by links to existing environments, digital publications etc. The statistical backgrounds of dendrochronology may be added later in the form of a DCCB service (educational module).

Calendars

Calendars used as a reference for dating the measurement series in the DCCB should be recorded in the DCCB. As the DCCB continues, more calendars will be added. Per calendar the following information should be available:

- DCCB-code (unique identifier)
- Laboratory code (does not need to be unique)
- Author(s), year, publication(s)
- Purpose for which the calendar was constructed
- Chronological interval (first and last year)
- Replication (number of observations per year)
- Outline coordinates of the research area (x, y)
- Point coordinates of the sites from which the series are derived
- Assessment of the quality for dating purposes (and arguments)
- Assessment of the quality for determining the provenance of wood (and arguments)
- Older and more recent versions of this calendar (links to DCCB codes of these calendars)