

# Weathering of Untreated Timber Architecture in the North Netherlands

Reserch Plan

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## Introduction

**Research Question:** How does the climate and local environment of the North Netherlands impact the weathering of untreated timber facades?

The use of wood has always played an essential role in our interaction with the environment. It is an integral part of the natural world, which we have been employing for various purposes such as shelter, fuel and tools. Wood is one of the oldest building materials, resulting in a “form of construction from which all later forms took their lead” (Herzog et al., 2004, p. 24). Being a very flexible and widely used building material, untreated wood, however, is very sensitive to solar radiation and precipitation. Wooden facades exposed to weather often change their colour and pattern. The overall term for weather-caused changes on the surface of the material is weathering (Hirche, 2014).

Untreated timber facades are exterior cladding in wood which does not undergo any kind of treatment prior to or after its installation. Wood treatment or impregnation with chemical preservatives improves its resistance to wood-decay fungi and insects. It is important to understand, however, that most impregnation agents contain toxic substances which are hazardous to human health and the environment (Zimmer et al., 2020, p.13). Even though nowadays we witness the development of biocide-free (non-toxic) wood protection systems (Zimmer et al., 2020, p.13), this study focuses on the timber cladding used in its natural form.

While weathering, in a broader term, means the breakdown and dissolution of materials, it should not be confused with a destructive process of material decay (Hirche, 2014). Hirche brings to attention the fact that most of the research in timber weathering is done by forestry or building research institutes. A commonly shared perspective among researchers in the field is that weathering is mainly regard-

ed as undesired as it results in material vulnerability and is aesthetically problematic.

The objective of the research, however, aligns with recent studies conducted at Aalto University, the Norwegian University of Science and Technology and the Norwegian Institute of Bioeconomy Research (NIBIO) (Herche, 2014; Fajer, 2022; Zimmer et al., 2020). Together, these works aim to change the perception of wood weathering as a positive rather than negative aspect by providing information on possible predictions of wood colouration and the influence of the building's overall design on the weathering outcome. Similar to these researches, this study addresses the gap in architectural practice in understanding and using wood weathering to our benefit in the design process.

In contrast to previously conducted research on timber weathering mentioned above, this study explores the topic in the context of the Netherlands, where the timber tradition is less strong than in Nordic countries. Therefore, this research will focus on translating the existing findings on wood weathering and possible benefits for building design character into Dutch conditions such as temperate climate, external timber supply and lack of local precedents implementing untreated timber for exterior cladding.

## Context: Timber Architecture in The Netherlands

Similar to the situation in many European countries, timber once used to be one of the most common construction materials in the Netherlands. The tradition of building in timber gradually declined around the 15th-16th centuries and has been subsequently lost (van Tussenbroek, 2017). New building regulations following the 1421 and 1452 city fires in Amsterdam, the overspreading of brick construction and the lack of local timber resources were the main factors contributing to the disappearance of timber construction (Verschoor, 2023).

With the contemporary agenda for sustainable building, which advocates for the reduction of greenhouse gas emissions and an increase in the use of renewable building materials, timber is an excellent alternative to other materials contributing to the pollution of the environment. In 2021, the Metropolitan Region of Amsterdam (MRA) signed the Green Deal Timber Construction covenant. That means that all new construction has to include at least 20% timber/biobased materials (AIAMS, 2021). Increasing timber use in buildings naturally leads to increased timber application as a facade material. It is, therefore, beneficial for future facade designs to understand the opportunities and limitations untreated timber provides.

Several contemporary Dutch architectural firms, including Marc Koehler Architects and Julius Taminiau Architects, have presented untreated timber facade designs in recent years. Their projects, located in diverse rural and urban contexts, indicate an emergent interest in the natural weathering of timber. Nevertheless, initial research suggests that these endeavours are presently regarded as experimental rather than conventional architectural approaches.

Although generally, we witness an advancement in timber construction technologies, with spans getting longer and buildings higher, timber often stays primarily a structural material, which is concealed from the outside. There is a general lack of studies regarding timber usage in building envelopes, which results in undesired weathering outcomes or avoidance of timber external application. The research of timber weathering in the context of the Netherlands' climate and local environment can contribute to its broader and smarter use as a cladding material.

## Theoretical Framework

This study bridges the fields of wood architecture and design with wood technology, which includes disciplines like wood anatomy, biology, chemistry, physics, and mechanical technology. Consequently, both architectural and scientific viewpoints are essential for providing the theoretical framework. This research is built upon three important studies on timber weathering in architecture conducted in the Nordic region over the last decade.

The earliest work in this research sequence is the PhD thesis by M. Hirche (2014), which explores the possibilities of predicting precise wood colouration changes resulting from wood weathering depending on timber cladding patterns. The research provides detailed results on the weathering of pine wood facade samples in Trondheim weather conditions. To the best of the author's knowledge, Hirche's work is the first peer-reviewed scientific work contributing to the subject of wood cladding and facade weathering. Prior knowledge in this area is based solely on experience from the weathering of timber facades and lacks a research foundation (Hirche, 2014, p. 19).

Fajer's Master's thesis (2022) examines the potential effects of weathering on the facade of the building in relation to its overall design, including building orientation, ornaments, windows, gutters and eaves. By analysing selected architectural examples, the study explores the possibilities of integrating timber weathering in the architectural design process using 3D simulations that account for solar radiation and wind patterns. Notably, Fajer's research, while comprehensive, does not account for the influence of precipitation on timber weathering. This limitation may necessitate caution when applying the findings to climatic conditions in the Netherlands.

The report authored by Zimmer et al. (2020) from the Norwegian Institute of Bioeconomy Research (NIBIO) represents a collaborative effort involving researchers from the fields of wood technology, forestry, and architecture. This research publication aims to function as an informative and instructive resource for a diverse audience, including architects, craftsmen, manufacturers, homeowners, and anyone with a vested interest in the application of unpainted wooden claddings.

Unlike the study conducted by Hirche and Fajer, the NIBIO paper primarily focuses on unpainted wooden facades, encompassing case studies that involve facades constructed from both modified and treated wood. It is important to note that while Zimmer et al. (2020, p. 5) contend that treated or modified wooden facades undergo a similar ageing process, this study, consistent with the viewpoint of Hirche and Fajer, intentionally excludes the consideration of treated wood to prevent potential confusion.

## Methodology

### WOOD + DESIGN + WEATHER + TIME = WEATHERING

(Hirche, 2014, p. 37)

In the equation above, Hirche (2014) identifies four main factors informing the outcome of weathering in timber architecture: wood type, design of cladding, specific in-situ weather conditions and time of exposure. According to Hirche, experimental research is one of the most effective approaches to understanding the impact of each variable on the weathering process. Experimentation involves methods which resemble conditions in the built context while allowing for a thorough assessment of a specific weathering factor.

Hirche's study (2014) proves that experimental research can reveal more accurate and informative results for specific weather conditions than the general "rules of thumb" presented in building guidelines. For example, the experiments in Voll showed the fastest and most uniform grey colour development on the West-facing samples due to their exposure to wind-directed rain, while the literature suggested this effect to happen on the North-facing samples (Hirche, 2014, p.199).

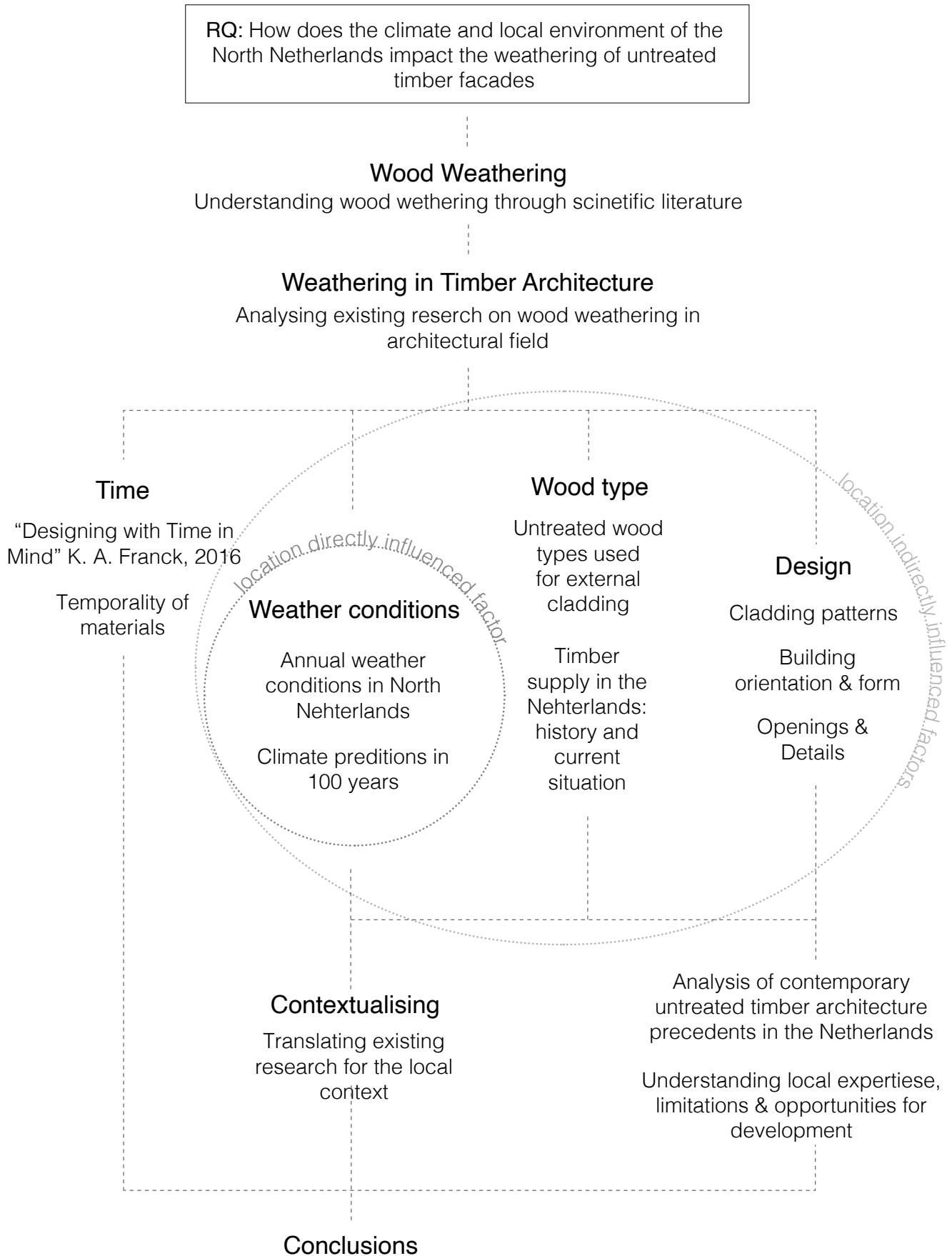
The primary limitation of experimental research in timber weathering is the time aspect. Likely, experiments with samples exposed to weathering just for a few weeks would give very limited information, which would not be enough to make certain conclusions. An alternative research method would be the analysis of several case studies in the context of the North Netherlands. The preliminary research, however, indicates the general shortage of untreated timber use for external cladding in the study area, which does not allow for further development of a later approach as the primary research method.

Taking into account the limitations mentioned above, the research will be mainly carried out through the available literature on the tim-

ber weathering process. The objective is to translate the existing research in timber weathering in the architectural field in Nordic countries (Hirche, 2014; Fajer, 2022) into the context of the North Netherlands. This will then allow us to understand the opportunities the weathering process can provide for the aesthetics of timber buildings in this area.

The primary part of the research will involve contextualising existing experimental and case study research to the local climate. The weather conditions in the North Netherlands, specifically Groningen, need to be studied. Those can be documented in weather maps to provide a complete overview of winds, precipitation and sun hours over the year. As climate is a critical factor in timber weathering, this is a crucial tool in revealing the main points of interest regarding the weathering process in specific in-situ conditions.

Compared to the independently positioned timber cladding elements analysed by Hirche, wooden facade components usually face a more intricate physical context. Factors such as thermal bridges, electrical and other installations, facade openings, projecting architectural elements, nearby vegetation, human activity, and construction methods collectively influence the weathering process. These variables can significantly affect how facade elements are exposed to weather conditions, leading to alterations in colour and pattern due to weathering. Therefore, this research also aims to identify and discuss the key environmental factors elucidated in Fajer's (2022) and Zimmer et al. (2020) studies that need to be considered when comprehending timber weathering in the context of North Netherlands.



# Climate Analysis

A combination of climate and local environmental factors influences the weathering of untreated timber cladding. Due to the approach of this study of translating the existing research on timber cladding weathering to the context of the North Netherlands, the collection and representation of weather data is an essential part of the research. The primary weather factors responsible for wood weathering are wind-driven rain (WDR) and solar radiation, specifically ultraviolet (UV) radiation. (Hirche, 2014) In the following section, various methods of measuring and representing these weather aspects will be discussed.

Radiation is one of the foremost degrading agents in the weathering processes (Rüther, 2011). The solar radiation intensity is measured in Watts per square meter ( $\text{W/m}^2$ ). It can be represented in graphs or maps as well as using digital 3D simulation tools (sometimes referred to as surface weather maps). In the context of weather maps, a relevant metric depicting exposure to solar radiation is sun hour data, denoted in hours per year (h/y). When both solar radiation and sun hour data are presented using polar diagrams, they convey analogous visual information, rendering them potentially interchangeable as tools for documenting sunlight exposure. However, further research is necessary to determine which of these metrics is better suited for the specific objectives of this research study.

Wind-driven rain (WDR), another significant factor in timber weathering, is measured in millimetres per year or recorded as wind-driven rain events with wind speed measurements in meters per second (m/s). Hirche (2014) and Rüther (2011) employed the use of polar diagrams, which incorporate data on exposure to solar radiation and WDR. These diagrams, known as directional weather maps, offer advantages over the more commonly used bar charts. They enable a smoother tran-

sition of information for both on-site observations and the development of situational plans.

To establish a foundation for comprehending the local climate's influence on the weathering process, we will create weather maps that provide data on solar radiation/sun hours and WDR. These maps will be specifically tailored to the North Netherlands. Employing consistent weather maps will enhance our ability to translate existing research findings into the unique climate conditions of this region. This step is essential to gain a deeper understanding of how the North Netherlands' climate affects the weathering of untreated timber facades.

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