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# CHePiCC Summer School

# "Cultural Heritage Protection in Climate Change"

**Trondheim, Norway**

**30th May 2022 – 4th June 2022**

**Chiara Bertolin** **America Califano** **Markus Schwai**

# CHePiCC Summer School

## May 30 – June 4

## 2022

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# PART I

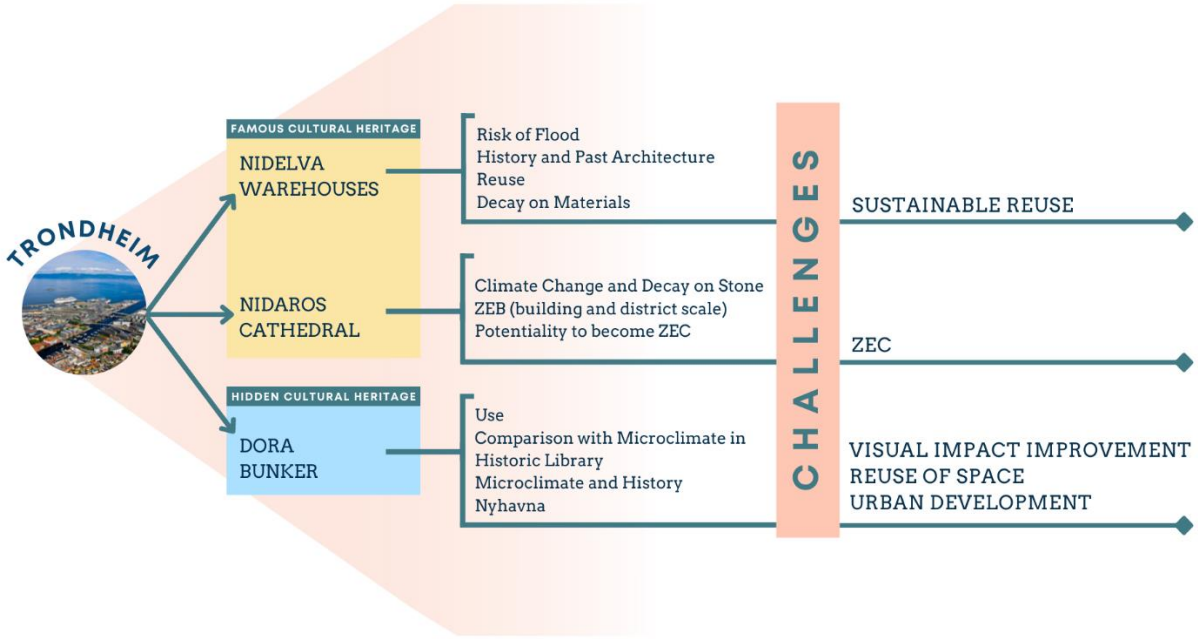
*C. Bertolin, A. Califano, M. Schwai*

# CHePiCC SCHOOL CONCEPT

## [MAIN IDEA]

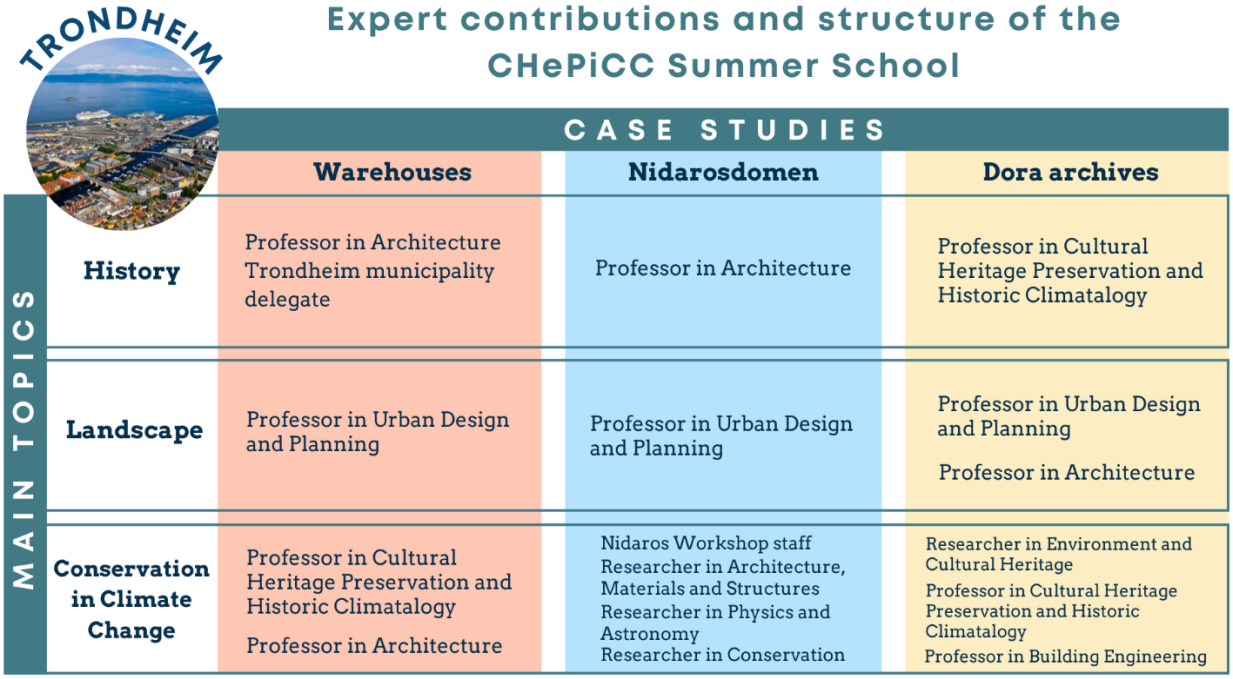
The concept of the Cultural Heritage Protection in Climate Change (CHePiCC) School focuses on built cultural heritage as integral part of cultural landscapes and vice versa, both seriously affected by climate change and related natural catastrophes. Climate change itself is the connecting element and affects both cultural landscapes and cultural heritage. Higher Education (HE) students are given the chance to learn about applicable maintenance, preparedness and preservation measures by developing tailored measures for a given site and by implementing and actually testing their ideas. The concept focuses on the effects of climate change in a certain climate zone, and develops possibilities to teach sustainable, eco-friendly and cost-efficient preparedness measures for built cultural heritage and maintenance measures for cultural landscapes. The whole concept is hybrid, student-centred, following a strict hands-on approach and is research based. The entire concept of the School can easily be transferred to other frameworks. As a matter of fact, the idea of the School is summarized as follows:

- choosing a city (Trondheim, in this case);
- selecting the points of interest (both touristic and hidden cultural heritage) according to the School's topics;



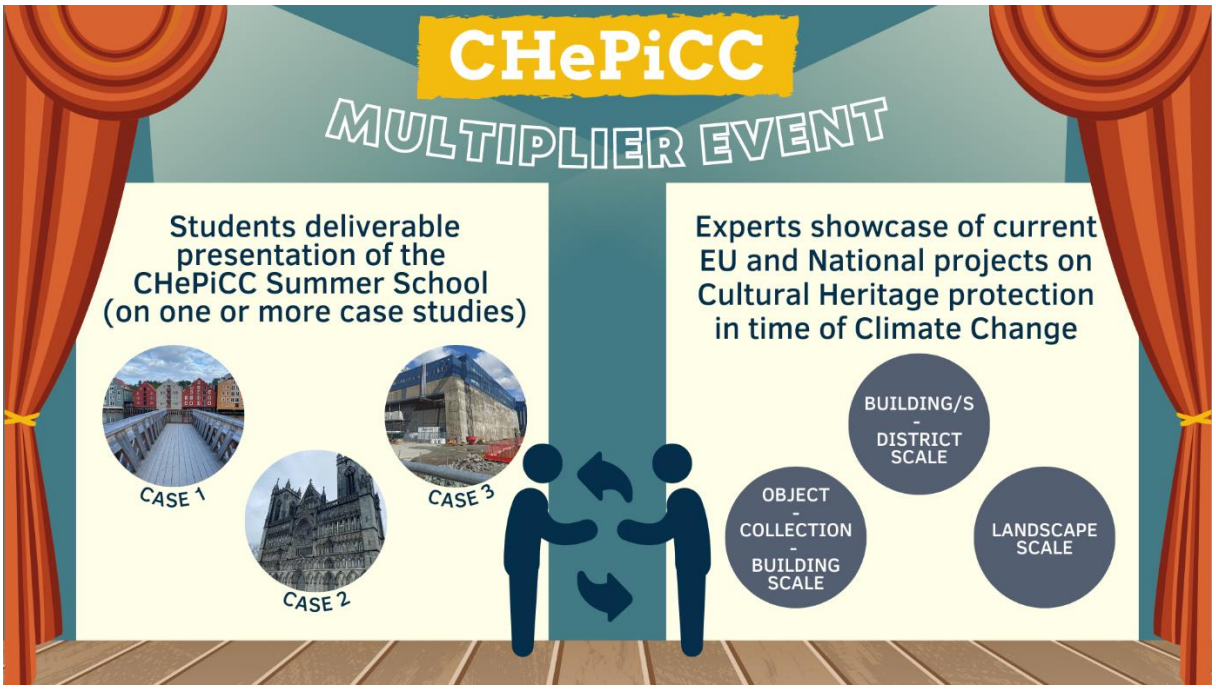

**(Credits: Giulia Boccacci, "La Sapienza" University, Rome – Italy)**

- engaging the local and international experts in the field (academics, stakeholders etc.) for the organization of high-level lessons and on-the-field activities;



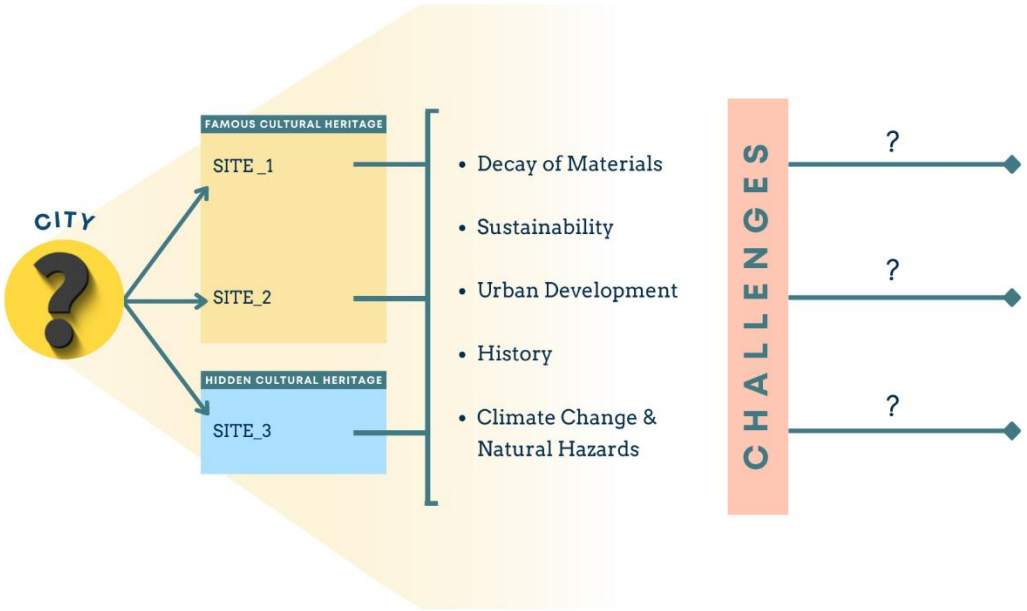

**(Credits: Giulia Boccacci, "La Sapienza" University, Rome – Italy)**

- dissemination of the students deliverables and of the main international research projects and activities focused on the School topics through a dedicated Multiplier Event.




**(Credits: Giulia Boccacci, "La Sapienza" University, Rome – Italy)**

For the above reasons, the School main concept has a high potential and can be ideally adapted to other conditions, cities and situations that may be interesting to study in the framework of the Cultural Heritage Protection. The concept for the summer university is applicable to any cultural landscape and its built heritage in Europe. It functions as important medium to gather practical experiences and get to know the respective built heritage and cultural landscapes on-site.




**(Credits: Giulia Boccacci, "La Sapienza" University, Rome – Italy)**

## [ACTIVITIES FOR TEACHING STAFF]

The CHePiCC School is a transdisciplinary summer university school on cultural landscapes in climate change. It was mainly focused on cultural and natural landscape in Norway and on the most used material constituting its heritage-built environment i.e., wood. Notwithstanding, per each day of lesson a comparison with other landscapes in different climate zones (e.g., central Europe or the Mediterranean area) and/or other historic materials prone to climate-induced decay is provided.
In addition to the topic of the climate change impact on cultural landscapes, several lessons are focused on the Norwegian research directions towards application of green energy (especially solar energy that is a challenge in Scandinavian countries) and the achievement of zero emission to the built environment (here included the sub-group constituted by historical buildings). The teaching staff is made up by experts from several fields that provide their guidance and support during lessons, activities and visits. All the activities are coordinated

through internal meetings carried out during the School. The activities described above and carried out by the teaching staff contribute to reach the project's objective by fulfilling the following duties:

- preparation of easily understandable lessons on the treated topics by means of presentations with both theoretical and practical aspects;
- delivery of lessons to a wide group of international students, providing them insights and food for thought about the topics of concern;
- provision of support during the students self-learning activities, giving the learners the possibility to raise questions, share ideas and improve the scientific communication between people with different backgrounds (architects, engineers, conservators, geologists…);
- provision of support during the on-the-field visits, giving the learners the possibility to always count on experts for possible questions and discussions.

This way it is possible to bring heritage back into higher education (HE) teaching and learning, to enable future generations to protect cultural heritage and to facilitate a behavioral change concerning cultural heritage protection and climate change, especially in the prospective professional lives of HE learners and teachers, and to enable HE teachers to build and deliver engaging and high-quality learning formats.

## [ACTIVITIES FOR LEARNERS]

The summer university is primarily addressed to students of architecture, protection of built cultural heritage, archaeology, urban/landscape planning, mechanical engineering, restauration, and architectural heritage. The program for HR learners comprises an intensive mix of frontal lessons, on-the-field visits and self-learning activities based on stimulating the discussion on the topics of concern. The program is thought in order to give the HE learners the right time to acquire and assimilate the theoretical and practical aspects of the frontal lessons, to actually see the real case studies and the local points of interest and, then, to elaborate the acquired information by sharing ideas with the other learners and staff and by writing group reports on the School topics.

The activities described above and carried out by the learners contribute to reach the project's objective by fulfilling the following duties:

- Attending frontal lessons;
- Real-time training on the software presented and explained during the lessons;
- Collecting photographic material and information during the on-

the-field visits;
- Working in groups and collecting the acquired knowledge in written reports and power-point presentations.

The above activities help to bring basic, academic need concerning cultural heritage (tangible, whether movable or immovable, but also intangible) and its protection back into society and to foster the understanding of its importance, its shared values and identities. The more tangible needs of building inclusive, modular and transdisciplinary learning programs for higher education learners enabled them to include in their professional lives all necessary disciplines for enhancing climate protection means, preparing cultural landscapes and their built heritage for the immediate effects of climate change and natural catastrophes, and doing the same for movable cultural heritage.

# PART II

*C. Bertolin, A. Califano, M. Schwai*

# PRACTICAL INFORMATION

## [COVID-19]

Since 12.02.2022 there are no requirements for testing, quarantine or registration upon arrival in Norway. Anyway, you are invited to behave responsibly, to wash your hands regularly, to keep the safety distance and to avoid crowded places when possible.

In order to enter Norway, beside your passport (and eventually VISA if you are from Extra EU countries) you need to have the green pass and use a face mask if needed.

Official updates available at

https://reopen.europa.eu/

https://www.regjeringen.no/en/topics/koronavirus-covid-19/id2692388/

## [TRAVEL]

Upon arrival at Trondheim Airport (*Trondheim Lufthavn*, in Norwegian), it is possible to reach the city center via bus or via train.

Via bus (at any time): https://www.atb.no/en/trondheim-airport/

(timetable at https://www.atb.no/getfile.php/1394071-1646391897/Rutetabeller/21-22_by/AtB_Linje70.pdf)

Via urban ATB bus (in diurnal time): line 70 is recommended as it stops in Buran 1, which is only 750 m away from the students' accommodation, the Trondheim Vandrerhjem Hostel.
(See the walking itinerary from Buran 1 to Trondheim Vandrerhjem at https://goo.gl/maps/EBwpEnYDZJsyDeNW7)

Information about tickets and tickets purchasing available at:
https://www.atb.no/en/ticket/#collapse-article_8

Make sure you have a valid ticket for the entire trip by purchasing for the right zone. For example, if you are traveling from the Airport to

Trondheim, you must purchase a ticket for two zones. The average price for an adult two-zones single ticket is 84 NOK (8.50 € circa). Additional info at https://www.atb.no/en/zones-and-zone-maps/#collapse-article_6

The trip from Trondheim Airport to Buran 1 via ATB bus lasts about 50 minutes.

Via train: https://www.vaernesekspressen.no.

The Vaernes Express from Trondheim Airport (Lufthavn) Vaernes to FB 73 Buran is recommended. The trip lasts about 27 minutes and the average ticket price is 189 NOK (19.20 € circa).

Information about timetables, fares and ticket purchasing available at https://www.vaernesekspressen.no/no/rutetider/

Please beware that the Vaernes Express website is in Norwegian.

**IMPORTANT NOTE FOR PEOPLE HAVING CONNECTION FLIGHTS THROUGH OSLO:** please be aware that, upon arriving at Oslo Airport, it is mandatory to pick up eventual checked-in baggage and go through the check-in and the custom controls again. In case you do not own checked-in baggage, you need to go through the custom controls again as well. This usually takes a long time, so please keep an eye on your time-schedule.

## [ACCOMODATION]

Students and part of the Staff will stay at the Trondheim Vandrerhjem Hostel (https://www.trondheimvandrerhjem.no/home) located in Weidemanns vei 41 B, 7043 Trondheim.

Trondheim Vandrerhjem shared dorms/rooms/apartments are equipped with bed linen and towels. There are no bars or cafeterias within the building, but free tea and coffee are always available in the common area. Guests can make their own food in the fully equipped guest kitchen, order take-away food from food delivery services or go to restaurants. The closest restaurant is 3 minutes away from the hostel. However, by walking 10 minutes down to Solsiden, a wide selection of restaurants and cafes can be found. The hostel has free Wi-Fi, a laundry room and is facilitated for special needs. Smoking is strictly forbidden indoors, and the alcohol consumption is prohibited in the common areas.

From the hostel, the closest grocery stores are 5 minutes walking (i.e., Bunnpris supermarket), and 7 minutes to Rema 1000 supermarket at Rosenborg
Concerning the distance to other nice spots in the city:

- To the NTNU campus in Gløshaugen you can expect 30 minutes walking
- To the lovely cobblestone streets of Bakklandet, you can expect a 16 minutes walk.
- Torvet in the city center is situated 20-25 minutes walk from Trondheim Vandrerhjem.
  Please be aware that the return to the hostel might take longer, as Trondheim Vandrerhjem is placed on top of a hill.

If you do not prefer walking, there are tons of colourful electric scooters placed all over the city, which might be rented for a small fee.

## [FOOD]

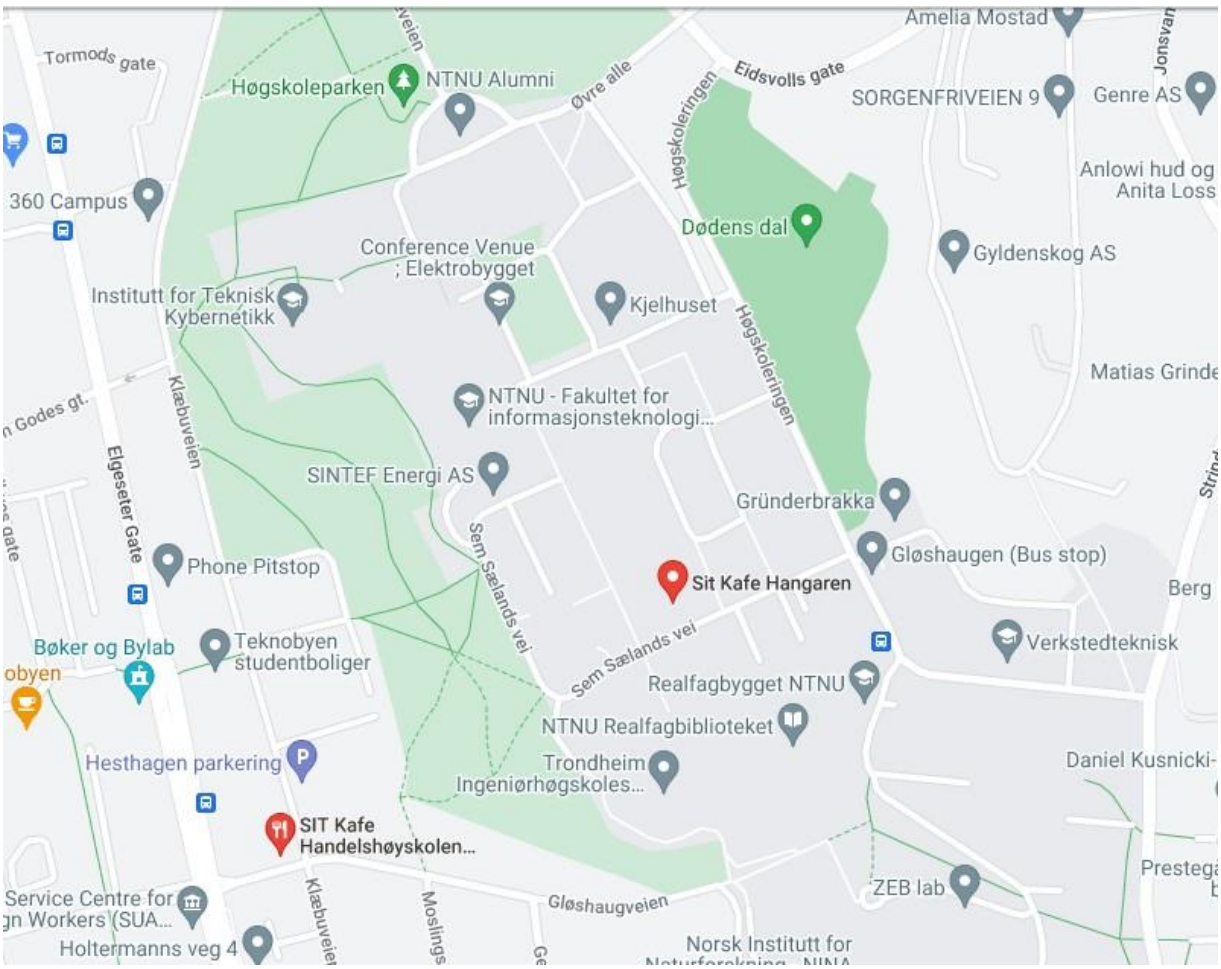
During lunchtime from Monday 30th of May to Friday 3rd of June, Students and Staff are on their own for the meals. On Saturday 4th of June, the lunch is offered from NTNU to students and staff.

After the morning lessons, students and staff will go together to have lunch to the cantina located in Sentralbygg 1 in Gløshaugen (Sit Kafe Hangaren).
During the days with lessons and during the multiplier event of Saturday 4th of June coffee breaks will be organized by NTNU.

For the dinners Students and Staff are on their own.
An outdoor social evening event will be organized for students and staff if the weather will allow it during the week (based on nice weather forecast, during one evening from Monday to Thursday).

A social dinner will be organized for the teaching staff and guest lecturers on Friday 3rd June at 19:00 at the Olivia restaurant, Beddingen 16, 7014 Trondheim.
https://oliviarestauranter.no/restaurant/solsiden/

Please consider that the Campus is equipped with bars/cafeterias, the cantina in Sentralbygg 1, and a small supermarket (RAPIDO) in the same building.




## [CURRENCY]

In Norway the official currency is the Norwegian krone (NOK). Please note that 1 € is about 10 NOK and that you can pay by card everywhere. Norway is expensive, remember to plan your budget accordingly. There is 25% VAT included in all prices and tipping is not customary.

## [CLOTHING]

Pack warm clothing - there is a reason Norwegians are known for their wool sweaters! Trondheim's average maximum temperature in June is 15°C/17°C, while the minimum temperature is 7°C/9°C. The following clothing items are recommended:

- cap (and gloves)
- waterproof jacket or umbrella
- proper footwear (sturdy hiking boots or rain boots)

- warm clothes if the temperature goes down

In addition, be aware that in Trondheim in May/June the sun rises at 3 AM and sets at 11 PM. The use of eye-masks for sleeping is highly recommended.

## [MISCELLANEOUS]

It is recommended for students and staff to bring:

- sketchbook/pens/laptop/pendrive
- camera
- travel documentation (passport, health insurance, travel insurance, *etc.*)
- personal medicine

## [USEFUL PHRASES]

There are many local dialects of Norwegian, but everybody can speak English. Here are some words to help you get by in the local language:
Thank you – Takk
Sorry – Beklager
Hello – Hei, god dag
Goodbye – Ha det
Yes – Ja
No – Nei
Excuse me – Unnskyld
Where is…? – Hvor er…?
Cheers! – Skål!

# BACKGROUND INFORMATION

## [ABOUT TRONDHEIM]

Trondheim is a city and municipality in Trøndelag county, Norway. It is the third most populous municipality in Norway, although the fourth largest urban area. Trondheim lies on the south shore of Trondheim Fjord at the mouth of the River Nidelva. Among the major technology-oriented institutions headquartered in Trondheim are the Norwegian University of Science and Technology (NTNU), the Foundation for Scientific and Industrial Research (SINTEF), and St. Olavs University Hospital. According to the sagas, the city was founded by king Olav Tryggvason in 997, but archaeological evidence suggests that there was already a settlement, or a seasonal a trading post on the left bank of the estuary. Olav Haraldsson ('the holy king') built a royal residence close to the settlement in the early 11th C, and served as the capital of Norway during the Viking Age until 1217, when the kings took residence in Bergen. Trondheim remained the clerical centre of Norway, where Olav Kyrre, the son of Olav Haraldsson's half-brother Harald Hardrada, established a see with resident bishhop and funded the building of a large stone-built church for this purpose. This was commenced around 1070 on the site of the present cathedral. From 1152/-53 the city was the seat of the Catholic Archdiocese of Nidaros until the Reformation in 1536-37; since then, it has remained the seat of the Lutheran Diocese of Nidaros. The current municipality dates from 1964, when Trondheim merged with Byneset, Leinstrand, Strinda and Tiller, and the municipality was further expanded 1 January 2020 when Trondheim merged with Klæbu. The main attractions of Trondheim are:

- Nidaros Cathedral and the Archbishop's Palace, located side by side in south of the city centre. The cathedral, built partly on the foundations of Olav Kyrre's church, is the most important Gothic monument in Norway and is said to have been the most important Christian pilgrimage site of Northern Europe during the Middle Ages. Today, it is the northernmost medieval cathedral in the world, and the second largest in Scandinavia;
- DORA 1, a German submarine base that housed the 13th U-boat Flotilla during the Second World War occupation of Norway. Today the bunker houses various archives, among them the city archives, the university and state archives. More recently, DORA has been used as a concert venue;
- Kristiansten Fortress, built in the 1682-84, extended 1740, located on a hill above the eastern bank of the river. It repelled the invading Swedes

- in 1718. Abandoned as a military fortress 1816 after the union of Sweden and Norway 1814.
- the statue of Olav Tryggvason, the founder of Trondheim, located in the city's central square, mounted on top of a column. The statue was made by the sculptor Wilhelm Rasmussen, who held a high artistic standing before World War II, and also made several sculptures on the Cathedral, a.o. the Calvary group above the central West door. His reputation became somewhat tainted after the war, as he was a member of the Norwegian Nazi party.
- the isle of Munkholmen, a popular tourist attraction and recreation site. The islet has served as a place of execution, a monastery, a fortress, prison, and a Second World War anti-aircraft gun station;
- Stiftsgården, built as aprivate residence for a wealthy widow 1774-78, sold to the Danish-Norwegian State 1800 and used as residence and office for the county governor and administration until 1906. It has been the royal residence in Trondheim since 1800, and is said to be the largest wooden building in Northern Europe.

*Source: https://en.wikipedia.org/wiki/Trondheim*

## [SCHOOL OBJECTIVES]

The summer university school funded by the Erasmus+ project "Cultural Heritage Protection in Climate Change online (ChePiCC online)", will take place on the premise of the Norwegian University of Science and Technology (NTNU) in Trondheim, Norway.

This will be a transdisciplinary summer university school on cultural landscapes in climate change. It will be mainly focused on cultural and natural landscape in Norway and on the most used material constituting its heritage-built environment i.e., wood. Notwithstanding, per each day of lesson a comparison with other landscapes in different climate zones (e.g., central Europe or the Mediterranean area) and/or other historic materials prone to climate-induced decay will be also provided.

In addition to the topic of the climate change impact on cultural landscapes, several lessons will be focused on the Norwegian research directions towards application of green energy (especially solar energy that is a challenge in Scandinavian countries) and the achievement of zero emission to the built environment (here included the sub-group constituted by historical buildings).

Finally, in term of preventive conservation of movable cultural heritage and preparedness in emergency, the University School will offer a set of lessons on climate-induced degradation processes and optimal microclimate for the preservation of paper and book collection kept in libraries and archives. This topic will be presented in the framework of a unique case study that exists in Trondheim i.e., the Dora archive into a IIWW bunker. This archive in addition of being unique for its way of re-using/re-thinking a IIWW heritage, it offers optimal natural conditions for preservation.

All these topics will offer food for thought to the students to see and experience the changes and, thus, absorb the necessity of climate change actions related to the preservation of cultural landscapes and their integral cultural heritage. Beside frontal lessons in the morning, a mixture of excursions and support during self-learning days through discussions will be offered to the participants. The afternoon excursions include the modern urban development of Trondheim laying its focus on the district of Nyhavna, the old harbor district with its historic wooden warehouses and the U-boat bunker "Dora" from World War II, which, as described above, is used to this day as an archive, among other things.

## [STAFF EXPERTISE]

The teaching staff participates as experts on:

- cultural landscapes (from Scandinavian to Mediterranean countries e.g., NTNU, DUK, ISAC-CNR, ULPGC),

- preservation and preparedness measures, recovery of cultural heritage, cooperation with emergency responders in crisis situations (e.g., DUK)

- built heritage, material preservation and maintenance as well as preparedness measures for built and movable heritage and material handling (e.g., NTNU for wooden structures and ITAM for post disaster recovery)

- climate change impact, climate-induced risk assessment and material preservation in time of climate change (e.g., CNR-ISAC and NTNU)

- recovery and preservation of different types of movable heritage and material (e.g., UAA).

The summer university is primarily addressed to students of architecture, protection of built cultural heritage, archaeology, urban/landscape planning, mechanical engineering, restauration, and architectural heritage.

## [SCHOOL EXPECTED DELIVERABLE]

It is expected that the 4 groups of students will deliver each a deliverable in form of:

- a working document as .docx and as .pdf file
- a presentation as .ppt file
- The presentation will be presented by the components of each group during the multiplier event, on Saturday 4th of June in the morning in the Auditorium R9 in the Realfabygget at the NTNU Gløshaugen Campus (see the detailed program below). The multiplier event has been organized by NTNU within the framework of CHePiCC and aims to cluster the research and networking projects in which NTNU is involved to optimize the dissemination of research results and activities.

The participants to the summer university school, following a successful completion of the above-mentioned deliverable, will obtain a certificate with the possibility to obtain ECTS at their own university.

## [SCHOOL ORGANIZERS]

The school has been organized by Prof. Chiara Bertolin and Prof. Markus Schwai of NTNU within the framework of the Erasmus CHEPICC project, with the support of the Coordinator Universitat fur weiterbildung Krems (UWK), Austria, and the partners of the Erasmus project: Universitat fur Angewandte Kunst Wien (UAA), Austria; Ustav Teoreticke a Aplikovane Mechaniky Avcr (ITAM), Czech Republic; Consiglio Nazionale delle Ricerche – Istituto di Scienze dell`Atmosfera e del Clima (CNR-ISAC), Italy; Universidad de Las Palmas de Gran Canaria. Details of the staff directly involved in the lessons are reported on page 20.

## [SCHOOL ACKNOWLEDGEMENT]

The organization of the University Summer School has been possible thanks to the economic support of the:

- Cultural Heritage Protection in time of Climate Change Online (CHePICC) Erasmus+ Project No. 2020-1-AT01-KA226-HE092550 funded by the EU commission

- Sustainable Management of Heritage Building in a long-term perspective (Symbol) Research Project n. 274749 funded by the Norwegian Research Council

- TC20 – Structural Integrity and Condition Monitoring of Historical Structures.TC 20 is an ESIS (European Structural Integrity Society) Technical Committee completely dedicated to the structural integrity and preservation of historical buildings.The evolution and impact of climate changes on past and recent structures together with the health monitoring of existing structures is also aim of this TC.

The organization of the Multiplier event on Saturday 4th of June 2022 has been possible thanks to the economic and scientific support of the:

- Cultural Heritage Protection in time of Climate Change Online (CHePICC) Erasmus+ Project No. 2020-1-AT01-KA226-HE092550 funded by the EU commission

- Sustainable Management of Heritage Building in a long-term perspective (Symbol) Research Project n. 274749 funded by the Norwegian Research Council

- Spara Och Bevara Project n. 50049–1 funded by the Swedish Energy Agency

- Enhancing optimal exploitation of solar energy in Nordic cities through the digitalization of the built environment (Helios) Project n. 324243 funded by the Norwegian Research Council

- Energy eFFiciency buIlding and CirculAr eConomY for thermal insulating solutions (Efficacy) EEA Bilateral Initiative funded by EEA and Norway Country

- Protecting our industrial heritage: preservation and new uses for traditional warehouses (PROTIND) EEA Bilateral Initiative funded by EEA and Norway Country;

- - TC20 – Structural Integrity and Condition Monitoring of Historical Structures, belonging to ESIS.

The scientific dissemination of the presentations at the Multiplier Event on Saturday 4th June 2022 is possible thanks to the help and support of the:

- Symbol Research Project n. 274749, funded by the Norwegian Research

Council

- Italian Group of Fracture (IGF);

- - TC20 – Structural Integrity and Condition Monitoring of Historical Structures, belonging to ESIS.

Acknowledgements go to guest lecturers that have become available during both the University summer school and the Multiplier event to present their work and research projects. Special thanks to the Norwegian Research Council and the Symbol project that have allowed the economic support to have NTNU students and staff during the University school and the Multiplier Event.

# PLACES

## [NORWEGIAN UNIVERSITY of SCIENCE and TECHNOLOGY – NTNU]

Gløshaugen Campus

Almost all activities of the School will start in the morning at the Gløshaugen Campus of NTNU. A walking itinerary from the Trondheim Vandrerhjem Hostel to the Campus is available at https://goo.gl/maps/D6W2hdUtJtNBFQLA6 .

Logistical information about the Campus available at https://www.ntnu.edu/gloshaugen

Gloshaugen Campus Picture by Gunnar K. Hansen/NTNU

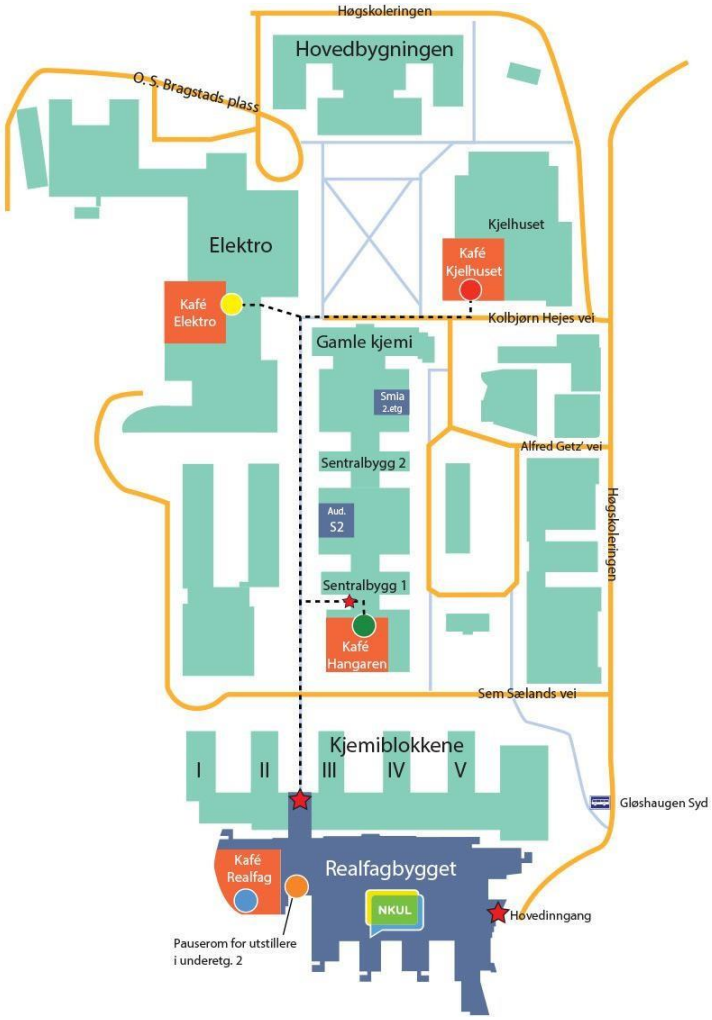
The lessons/activities held in Gløshaugen Campus will follow the subsequent room schedule

| Date | Building | Room | Time |
|---|---|---|---|
| 30.05.2022 | Sentralbygg 1 | S1 | All day |
| 31.05.2022 | Kjelhuset | KJL2 | All day |
| 01.06.2022 | Kjelhuset | KJL21 | All day |
| 02.06.2022 | Sentralbygg 1 | S1 | All day |
| 03.06.2022 | Kjelhuset | KJL21 | All day |
| 04.06.2022 | Realfabygget | R9 | All day |

The internal CHePiCC staff meeting will be held according to what follows

| Date | Building | Room | Time |
|---|---|---|---|
| 01.06.2022 | Sentralbygg 1 | 265 | 13:00 – 15:00 |

For the buildings locations please refer to the Gløshaugen Campus map below and to the map locator site of NTNU: https://www.ntnu.edu/map
Through this website, it is possible to search rooms within the NTNU Gløshaugen campus in the dropdown-menu on the left.



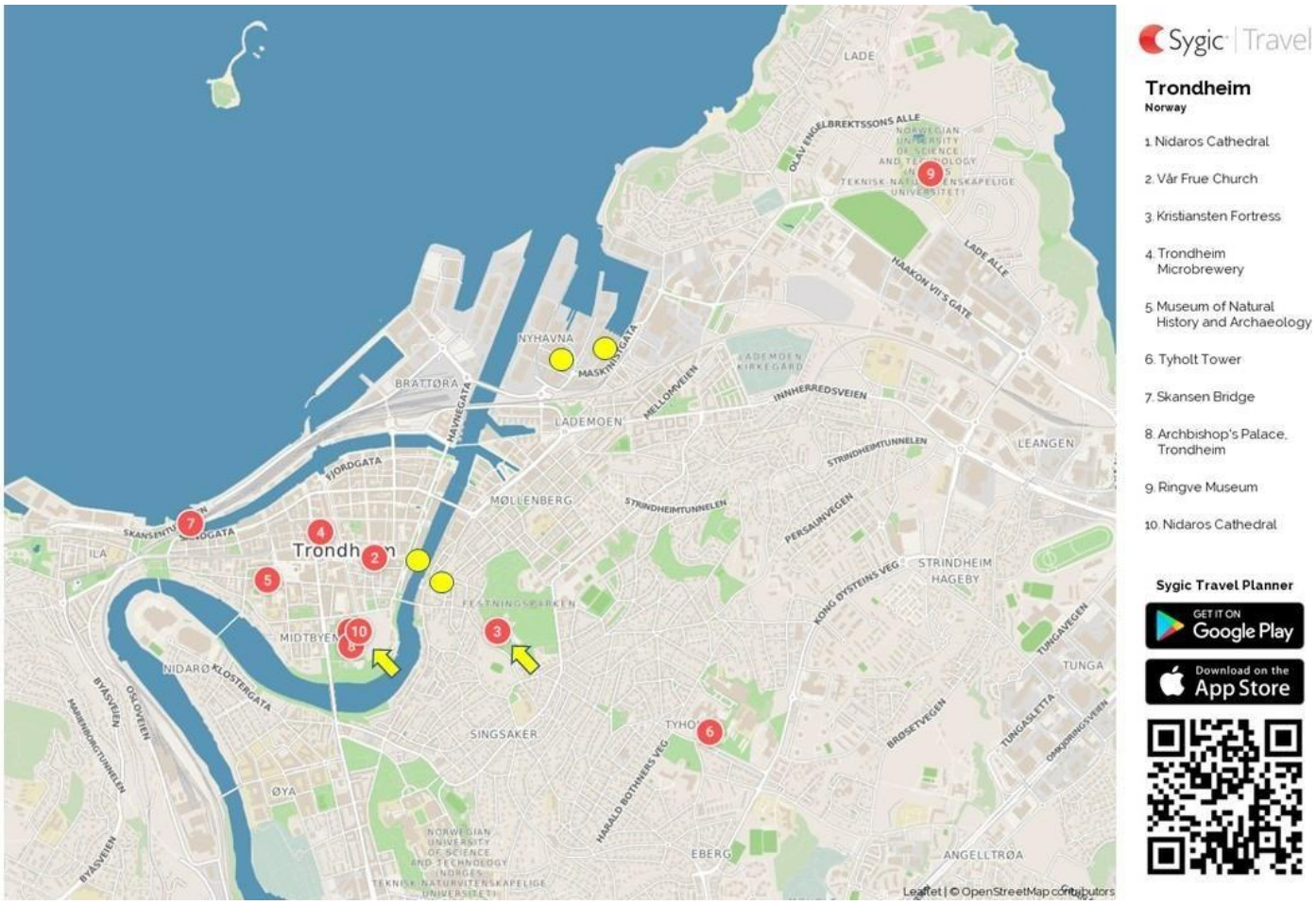

## [TRONDHEIM CITY CENTER]

During the School several on-the-field visits will be arranged. They will be focused on exploring the following sites located in Trondheim:

- Bakklandet
- the Warehouses
- the Nidaros Cathedral
- the Cathedral Stone Workshop
- the Fortress
- Nyhavna

## Places

- Dora
- Dora Archive



# PEOPLE

## [STUDENTS]

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| Grabner | Christof | UWK | sgagrc@yahoo.com |
| Higgins | Peter | UWK | Peter.Higgins@stud.sbg.ac.at |
| Jokin | Ivo | UWK | ivo_jokin@abv.bg |
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| Moreno Falcon | Monica | NTNU | mmorfal@upo.es |
| Ogut | Ozge | NTNU | ozge.ogut@polimi.it |
| Panahifar | Mehrnaz | UWK | mehrnazpanahifar@gmail.com |
| Parracha | Joao | IST/LNEC | jparracha@lnec.pt |
| Trujillo Cabrera | Laura | ULPGC | laura.trujillo109@alu.ulpgc.es |
| Vergelli | Lisa | NTNU | lisa.vergelli@uniroma1.it |

## [STUDENTS' GROUPS]

The students have been divided in the following groups for carrying out self-learning activities.

| Group 1 | Group 2 | Group 3 | Group 4 |
|---|---|---|---|
| Afonso Santana J. E.<br>Calapiña Arriaga C.<br>Klinkert M.<br>Higgins P.<br>Vergelli L. | Bartolucci B.<br>Grabner C.<br>Kocabas E.<br>Parracha J.<br>Trujillo Cabrera L. | Dietrich F.<br>Jokin I.<br>Moreno Falcon M.<br>Ogut O. | Aguiar Botello C.<br>Barakat I.<br>Boccacci G.<br>Panahifar M. |

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**IMPORTANT NOTE:** The Staff needs to be available for counseling and supporting the students self-learning activities on June 1st 2022 and on June 3rd 2022 from 10:00 to 12:00 and from 13:00 to 15:00. In addition, the Staff will always follow the students during their walking visits.

## [CONTRIBUTORS]

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# PROGRAM OVERVIEW


(Credits: Giulia Boccacci, "La Sapienza" University, Rome – Italy)

## [DAY 1 – 30.05.2022]

Where:
- Gløshaugen Campus (morning)
- Bakklandet (afternoon)
- The Warehouses (afternoon)

What:
- Welcome, Presentation of School Program (morning)
- Lessons (morning)
- In situ visits (afternoon)

## [DAY 2 – 31.05.2022]

Where:
- Gløshaugen Campus (morning)
- Nidaros Cathedral (afternoon)
- the Cathedral stone workshop (afternoon)
- the Fortress (afternoon)

What:
- Lessons (morning)
- In situ visits (afternoon)

## [DAY 3 – 01.06.2022]

Where: Gløshaugen Campus (all day)
What: Students self-studying activities (all day)
What: Staff Internal CHePiCC Meeting (afternoon)

## [DAY 4 – 02.06.2022]

Where:
- Gløshaugen Campus (morning)
- Nyhavna (afternoon)
- Dora and Dora archive (afternoon)

What:

- Lessons (morning)
- In situ visits (afternoon)

## [DAY 5 – 03.06.2022]

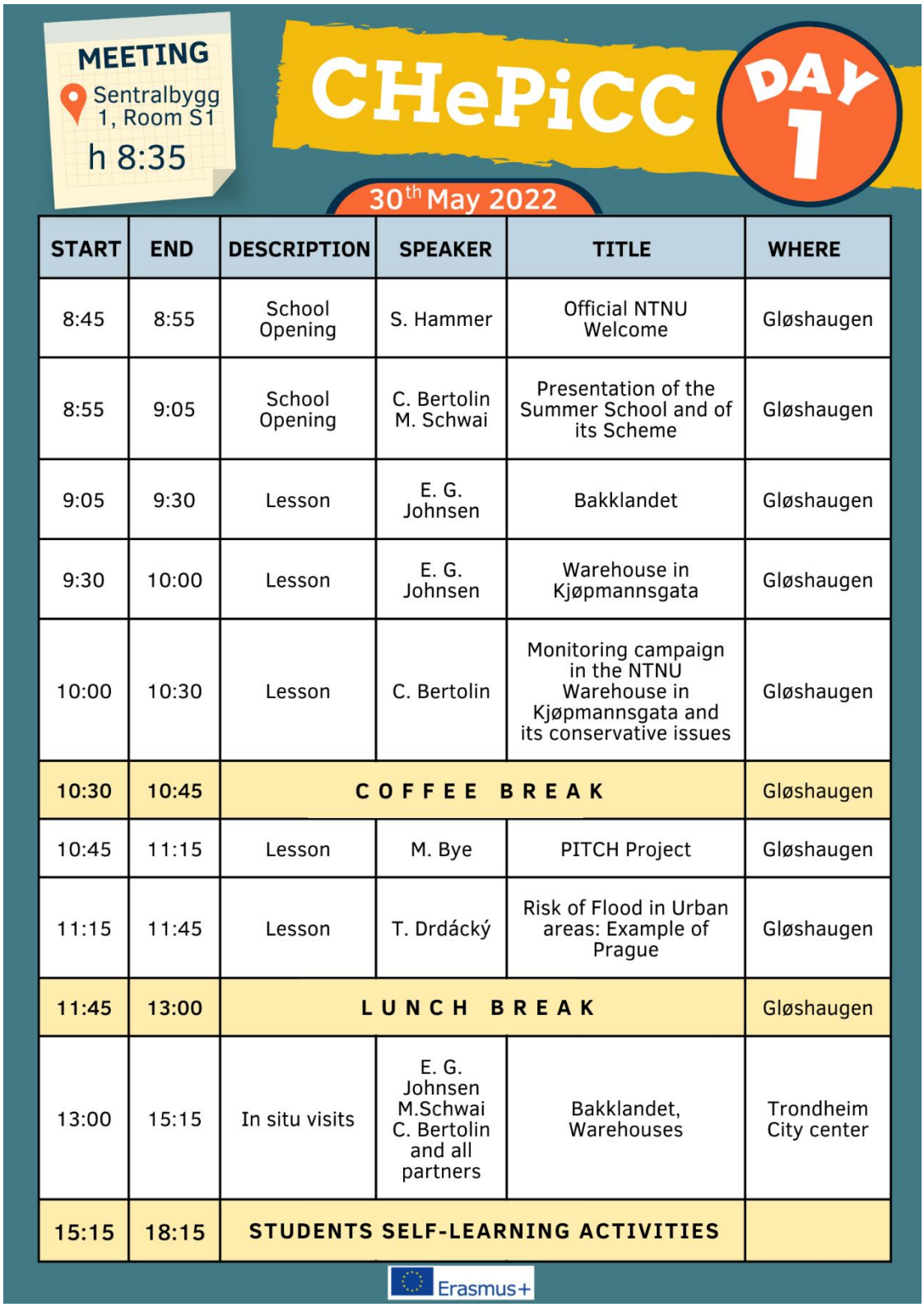
Where: Gløshaugen Campus (all day)
What: Students self-studying activities (all day)
What: Staff Internal CHePiCC Meeting (afternoon)

## [DAY 6 – 04.06.2022]

Where: Gløshaugen Campus (all day)
What: Multiplier event (all day)

# DETAILED
# DAY-BY-DAY
# PROGRAM

## DAY 1 - 30.05.2022




| START | END | DESCRIPTION | SPEAKER | TITLE | WHERE |
|---|---|---|---|---|---|
| 8:45 | 8:55 | School Opening | S. Hammer | Official NTNU Welcome | Gløshaugen |
| 8:55 | 9:05 | School Opening | C. Bertolin M. Schwai | Presentation of the Summer School and of its Scheme | Gløshaugen |
| 9:05 | 9:30 | Lesson | E. G. Johnsen | Bakklandet | Gløshaugen |
| 9:30 | 10:00 | Lesson | E. G. Johnsen | Warehouse in Kjøpmannsgata | Gløshaugen |
| 10:00 | 10:30 | Lesson | C. Bertolin | Monitoring campaign in the NTNU Warehouse in Kjøpmannsgata and its conservative issues | Gløshaugen |
| 10:30 | 10:45 | COFFEE BREAK | | | Gløshaugen |
| 10:45 | 11:15 | Lesson | M. Bye | PITCH Project | Gløshaugen |
| 11:15 | 11:45 | Lesson | T. Drdácký | Risk of Flood in Urban areas: Example of Prague | Gløshaugen |
| 11:45 | 13:00 | LUNCH BREAK | | | Gløshaugen |
| 13:00 | 15:15 | In situ visits | E. G. Johnsen M.Schwai C. Bertolin and all partners | Bakklandet, Warehouses | Trondheim City center |
| 15:15 | 18:15 | STUDENTS SELF-LEARNING ACTIVITIES | | | |

Erasmus+

**(Credits: Giulia Boccacci, "La Sapienza" University, Rome – Italy)**

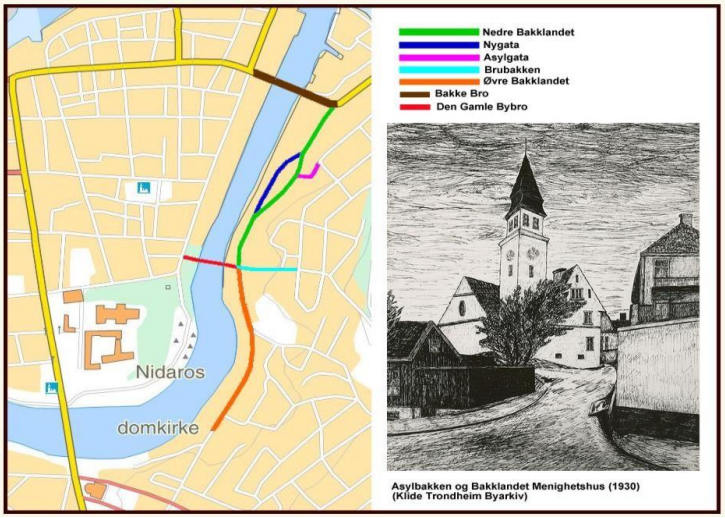
The Speakers are invited to upload their presentations before the beginning of their session. Please note that the presentations will be recorded. Zoom link: https://NTNU.zoom.us/j/99265434015?pwd=ZEZpNmlYMitBa2lJdW41bFhoQnloQT09

## [IN SITU VISITS]

Meeting Point: Outside the main entrance of Sentralbygg 1, close to the Kantina
Meeting time: 13:00

Bakklandet

It is Trondheim's best-known neighborhood. With original, colorful wood buildings and cobblestone streets, it has a "*koselig*" atmosphere and is a great place to spend an evening. You can sit outside one of the many street cafes or grab a beer at *Antikvariatet* while listening to live music at night.



## The Warehouses

The historic harbour of Trondheim was the estuary of the river Nidelva. Along the western bank (city side) the merchants had their properties with dwellings and shops, and storage houses towards the river. The city consisting almost entirely of timber buildings was often ravaged by fires, and was in 1681 almost entirely destroyed. The measured for fire-safety taken after the former fire of 1851 proved inadequate, and an entirely new town plan with broad, straight streets was envisaged by the king. The storage buildings were separated from the rest of the built-up area by an avenue with an upper level serving the merchants' mansions, and a lower street serving the warehouses. This resulted in one of the most distinctive city-scape, not only in the city, but as a cultural and aesthetic heritage of national importance. The buildings stand along both sides of the Nidelven river; those on the east bank belonging to the un-regulated suburb Bakklandet after the more mediaeval pattern with dwelling, shop and warehouse combined on the same lots. Originally they were used as storage for such goods as grain, sugar, salt and fish.

The construction was the traditional technique of interlocking logs, with naked log-timber interior surfaces. When the shallow waters to the north of the city were dredged and protected by a sea wall in the early 19th century the insufficient harbour facilities were supplied with a necessary extension, and similar warehouses were built on the northern shore of the city, and later connected with the railway station on the artificial islands, forming another distinctive feature of the city-scape, the canal harbour. The original wharfs were not used as dwellings, but today, many have been converted into residential houses; this is however not permitted in the city side row along the river. Others are art galleries, coffee shops, restaurants, and boutiques. The cobbled walking paths make exploring the historic wharfs an easy and beautiful stroll. There are also several benches along the paths for those who want to relax. The Old Town Bridge over the Nidelven River is a great spot to get a picturesque view of the historic wharfs from a distance.


*Source: https://www.gpsmycity.com/attractions/historic-wharves-29654.html*

## [RESEARCH QUESTIONS]

1. It is clear that the warehouses have an impact on the landscape of the city of Trondheim. Which warehouses' aspects have the most important identity among: color, form, location and use? In addition, what needs to be preserved the most?

2. How did the past decisions of the municipalities and of the people influence the actual landscape?

3. How does a NH, as a flood, put the CHB at risk? And how do extreme events modify the actual landscape?

4. What is the expected impact of climate change in term of intensity and frequency increase of flood events? What can be the impact in the Bakklandet district?

5. What are the preventive conservation challenges of Bakklandet district? What are the possible future steps? In your opinion, how could the preservation, the significance and the use of this district be improved, in a time of climate change?

# DAY 2 – 31.05.2022


| START | END | DESCRIPTION | SPEAKER | TITLE | WHERE |
|---|---|---|---|---|---|
| 9:00 | 9:25 | Lesson | M. Schwai | Urban layout of the center of Trondheim and the fortress | Gløshaugen |
| 9:25 | 9:50 | Lesson | D. Nilsen | The Cathedral of Nidaros, Building a Historic Monument | Gløshaugen |
| 9:50 | 10:15 | Lesson | M. L. Anker | Energy Smart Nidaros Cathedral | Gløshaugen |
| 10:15 | 10:30 | COFFEE BREAK | | | Gløshaugen |
| 10:30 | 10:55 | Lesson | A. Loli | The ZEB concept and the ZER tool at building scale and at district level | Gløshaugen |
| 10:55 | 11:20 | Lesson | S. Cavazzani C. Bertolin | Climate change impact on stone building: the Trondheim case study | Gløshaugen |
| 11:20 | 11:45 | Lesson | M. Haselberger | Problems today - challenges tomorrow! Decay of stone cultural heritage in Austria and expected changes related to climate change | Gløshaugen |
| 11:45 | 12:45 | LUNCH BREAK | | | Gløshaugen |
| 12:45 | 15:15 | In situ visits | M. L. Anker | Cathedral, The stone workshop, The fortress | Trondheim City center |
| 15:15 | 18:15 | STUDENTS SELF-LEARNING ACTIVITIES | | | |



(Credits: Giulia Boccacci, "La Sapienza" University, Rome – Italy)

Day 2 – 31.05.2022

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## [IN SITU VISITS]

Meeting Point: Outside the main entrance of Sentralbygg 1, close to the Kantina
Meeting time: 12:45

The Nidaros Cathedral

The Nidaros Cathedral, Scandinavia's largest medieval structure, is worth seeing even if just from the outside. Its history of construction is visible on the interior, with parts built in different styles. This is where St. Olav Ways, (a 643 km pilgrimage from Oslo built during the Middle Ages), ends, and where the royals of Norway are coronated.


The Stone workshop

The Norwegian parliament has designated the restoration workshop (Bygghytta) belonging to Nidaros Cathedral Restoration Works (NDR) as

a national competence center for the preservation and restoration of historic stone buildings. This means that in addition to restoring and maintaining Nidaros Cathedral and the Archbishop's Palace, NDR is tasked with preserving and further developing the traditional crafts represented at the Bygghytta craftsmen's lodge.

*Source: https://www.nidarosdomen.no/en/ndr/om-ndr/nasjonalt-kompetansesenter-for-verneverdige-bygninger-i-stein*

## The Fortress

The fortress from 1695 can be visited for free. The surrounding park offers amazing views over the city and is popular for sunset picnics and sports. For a bird's-eye view of the entire city, go to the observation deck at Tyholttårnet. The tower hosts a restaurant with a pizza buffet (117 NOK, daily until 6 PM).

## [RESEARCH QUESTIONS]

1. How has the Cathedral influenced the history and the development of the city of Trondheim? Is the Cathedral still influencing the city attraction? Is there any tangible and intangible value?

2. How has the landscape been preserved over the centuries? Why? Has the Cathedral influenced the landscape development?

3. How may the new project of an energy smart Nidaros Cathedral transform the significance of the Cathedral itself and of the surrounding environment?

4. Which strategy may be adopted to find a trade-off solution between the preservation of heritage/landscape significance and the adoption of mitigation actions to CC? Are you able to think about further possible mitigation actions applied to this case study?

## DAY 3 - 01.06.2022


(Credits: Giulia Boccacci, "La Sapienza" University, Rome – Italy)

# DAY 4 - 02.06.2022


| START | END | DESCRIPTION | SPEAKER | TITLE | WHERE |
|---|---|---|---|---|---|
| 8:35 | 9:00 | Lesson | M. Haselberger | Problems today - challenges tomorrow! Decay of stone cultural heritage in Austria and expected changes related to climate change | Gløshaugen |
| 9:00 | 9:25 | Lesson | E. Verticchio | Archives and Libraries in Historic Buildings: natural climates and microclimate conditions for preservation | Gløshaugen |
| 9:25 | 9:50 | Lesson | C. Bertolin | The Dora archives: opportunities and conservation challenges | Gløshaugen |
| 9:50 | 10:15 | Lesson | A. Kaiser | Emergency preparations for libraries and archives | Gløshaugen |
| 10:15 | 10:45 | COFFEE BREAK | | | Gløshaugen |
| 10:45 | 11:10 | Lesson | M. Schwai | Nyhavna the district and the plans of development | Gløshaugen |
| 11:10 | 11:35 | Lesson | R. Narbona | Transfers: Landscape-Project | Gløshaugen |
| 11:35 | 12:00 | Lesson | G. Lobaccaro | Solar Energy in new district, the challenges of the Scandinavian Countries | Gløshaugen |
| 12:00 | 12:55 | LUNCH BREAK | | | Gløshaugen |
| 12:55 | 15:15 | In situ visits | C. Bertolin<br>M. Schwai<br>G. Lobaccaro | Nyhavna<br>Dora<br>Dora archives | Trondheim City Center |
| 15:15 | 18:15 | STUDENTS SELF-LEARNING ACTIVITIES | | | |



(Credits: Giulia Boccacci, "La Sapienza" University, Rome – Italy)

The Speakers are invited to upload their presentations before the beginning of their session. Please note that the presentations will be recorded. Zoom link: https://NTNU.zoom.us/j/99265434015?pwd=ZEZpNmlYMitBa2lJdW41bFhoQnloQT09

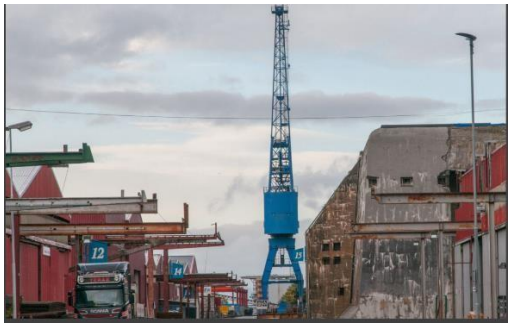
## [IN SITU VISITS]

Meeting Point: Outside the main entrance of Sentralbygg 1, close to the Kantina
Meeting time: 12:55
Meeting Point and time near Nyhavna/Dora: Maskinistgata 1, 7042 Trondheim at 13:30.

Nyhavna

> Nyhavna is a port area in Trondheim, between Nidelva in the west, Lademoen in the east, Ladehammeren in the north and Nedre Elvehavn in the south. The harbor area at Brattøra is located on the other side of the River Nidelva, which passes between Nyhavna and Brattøra. In 1912, a new port plan was drawn up for Trondheim. This new area, between Nidelva and Ladehammeren, was named Nyhavna. Here is where the two German submarine bunkers, Dora 1 and Dora 2, from World War II were built.
>
> *Source: https://no.wikipedia.org/wiki/Nyhavna*


Development of quay facilities at Orkanger in the 1920s. Photo: Orkangerinfo.no



## Dora

The two German submarine bunkers, Dora 1 and Dora 2, from World War II were built at Nyhavna. Dora 1 was completed in the summer of 1943, while Dora 2 was never completed. Dora 1 was later converted into a warehouse and office building, and after the war Dora 2 was left to The Port of Trondheim. In 1943, Dora was bombed by the American Army. It was not damaged completely, while the buildings in the rest of the area around Nyhavna were badly damaged during the attack.

Construction of the bunker

Dora I, a former submarine bunker

*Source: https://no.wikipedia.org/wiki/Nyhavna*

## Dora archive

The Dora archive consists of four archive institutions, one library and one museum. The mission is to preserve state, municipal and private archives from the Middle and North Norway and make these available to the general public. People are welcome to the communal reading room where they can study protocols, letters, photographs, maps and drawings, and carry on scientific research,and investigations.

*Source: https://www.arkivsenteret.no/om-oss/*

Archive Shelves

Archive records...an old book from the Middle Ages

## [RESEARCH QUESTIONS]

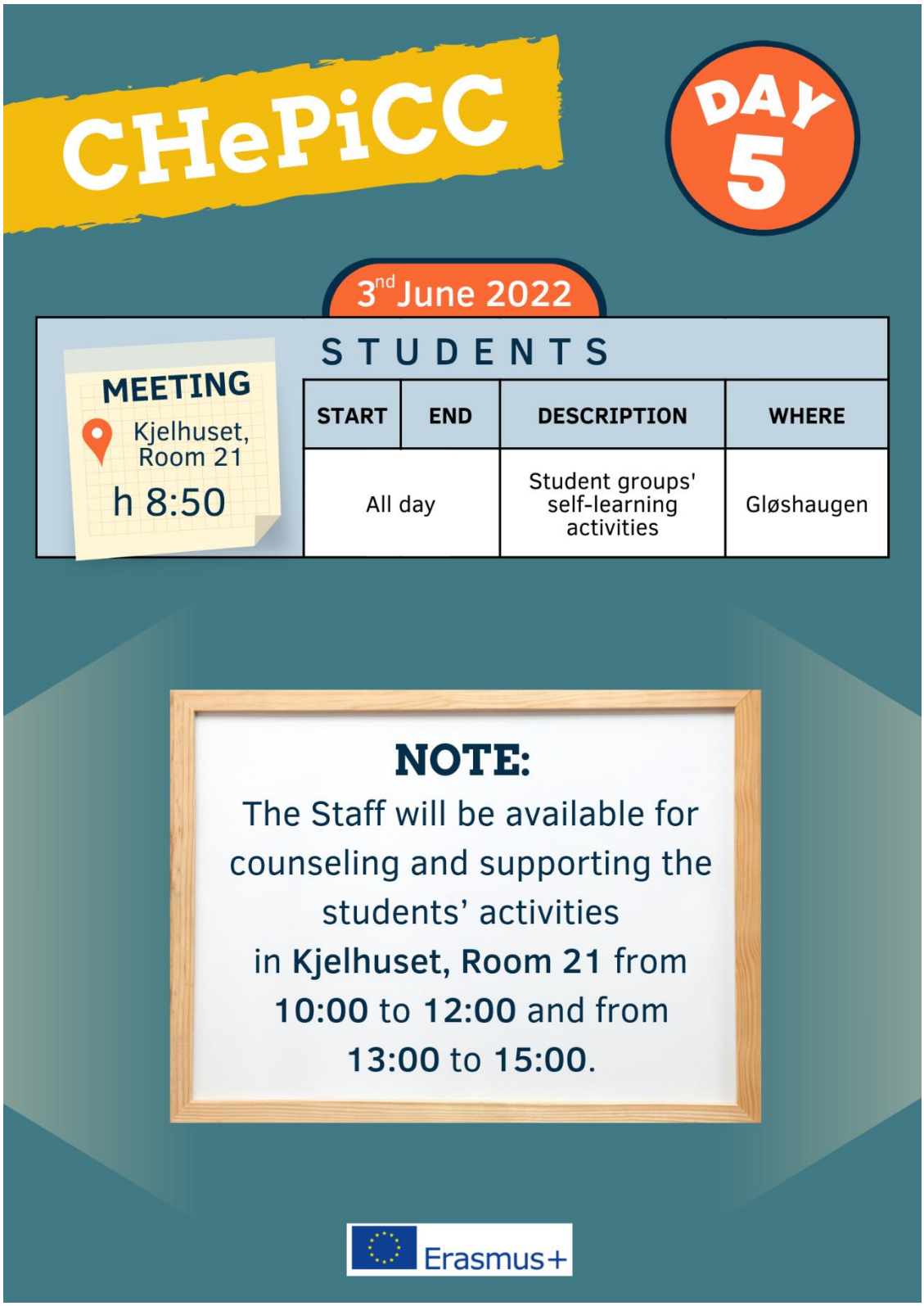
1. How do IIWW CHBs impact a landscape? What is your idea about keeping/demolish/reuse them? How is it possible to preserve the tangible and intangible value of these structures in a landscape that is always evolving/changing?

2. What can the request of maintenance and refurbishment of these structure be in the next future, due to the climate change forecasts? If you decide to keep the structures, what are the possible other suggested uses behind archives?

3. What is next? What are your ideas about attracting people to this district? What is your idea about better protecting/reusing the structures in time of climate change?

4. Comment the fact that they started building with stones to decrease the risk of fire.

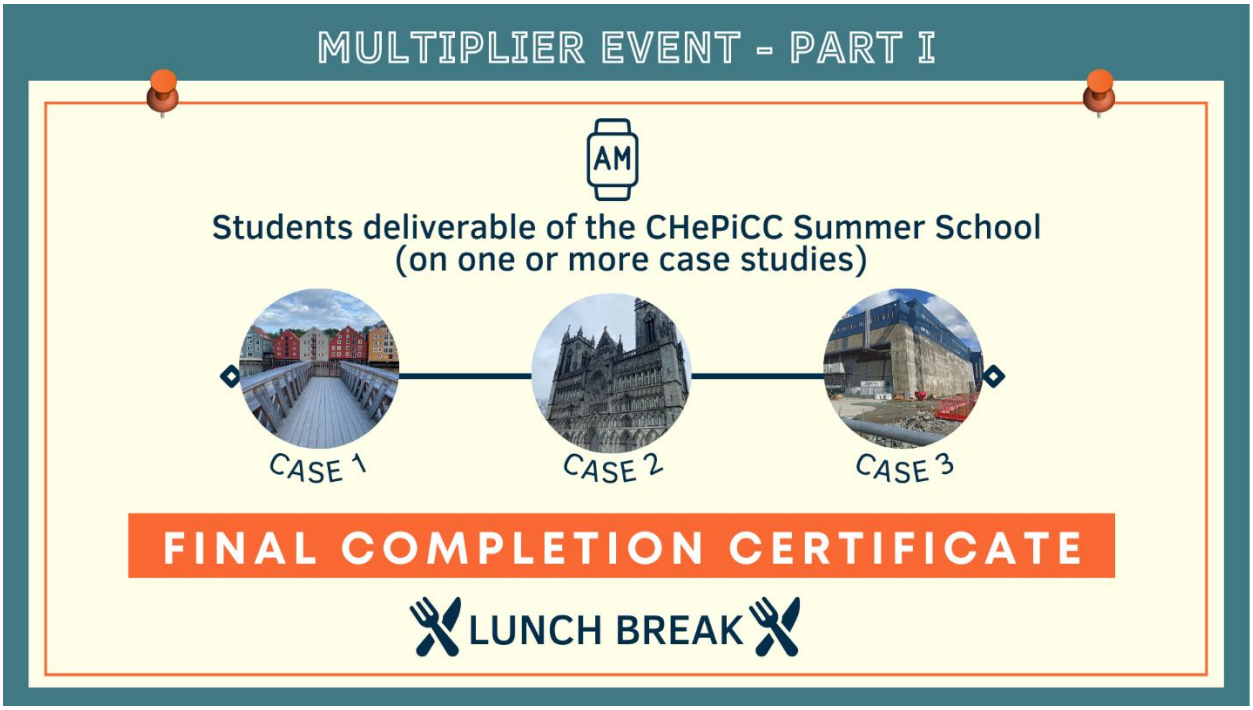
## DAY 5 - 03.06.2022

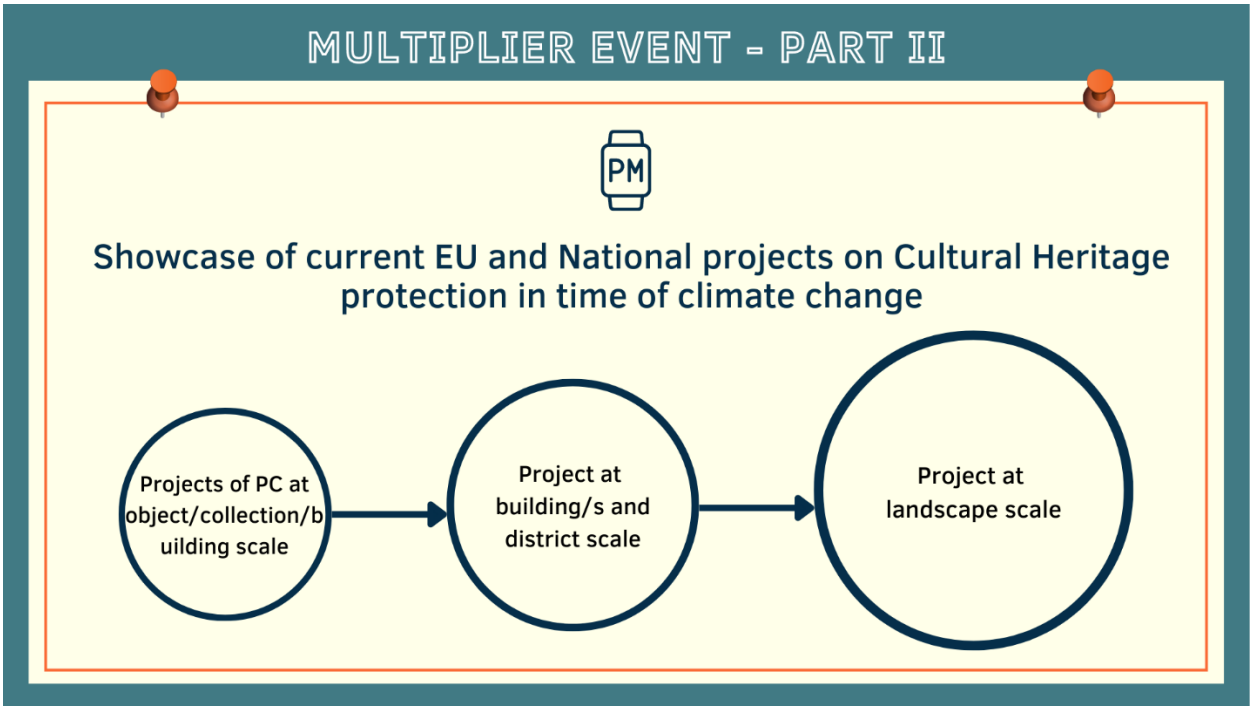



(Credits: Giulia Boccacci, "LaSapienza" University, Rome – Italy)

# DAY 6 – 04.06.2022

The Multiplier Event has been organized by NTNU within the framework of CHePiCC and aims to cluster the research and networking projects in which NTNU is involved to optimize the dissemination of research results and activities. It is structured as follows:




**(Credits: Giulia Boccacci, "LaSapienza" University, Rome – Italy)**

**MEETING**
Realfabygget, Room R9
h 8:50

# CHePiCC DAY 6

4th June 2022

| START | END | DESCRIPTION | SPEAKER | TITLE | WHERE |
|---|---|---|---|---|---|
| 9:00 | 9:15 | Welcome | A. Kaiser | The CHePiCC - Online Erasmus Project | Gløshaugen |
| 9:15 | 9:30 | Into the work of the groups | S. Hammer C. Bertolin M. Schwai | The University Summer School | Gløshaugen |
| 9:30 | 10:00 | Students' Presentation | Group 1 | Deliverable of the Summer School | Gløshaugen |
| 10:00 | 10:15 | COFFEE BREAK | | | Gløshaugen |
| 10:15 | 10:45 | Students' Presentation | Group 2 | Deliverable of the Summer School | Gløshaugen |
| 10:45 | 11:15 | Students' Presentation | Group 3 | Deliverable of the Summer School | Gløshaugen |
| 11:15 | 11:45 | Students' Presentation | Group 4 | Deliverable of the Summer School | Gløshaugen |
| 11:45 | 12:45 | LUNCH BREAK | | | Gløshaugen |
| 12:45 | 13:05 | Projects of PC at object/collection /building scale | C. Bertolin | The Symbol Project | Gløshaugen |
| 13:05 | 13:25 | Projects of PC at object/collection /building scale | A. Califano | Spara och Bevara & Symbol Project | Gløshaugen |
| 13:25 | 13:45 | Projects of PC at object/collection /building scale | P. Foti F. Berto | GREIG | Gløshaugen |
| 13:45 | 14:05 | Projects of PC at object/collection /building scale | F. Frasca | Collection Care | Gløshaugen |

**(Credits: Giulia Boccacci, "LaSapienza" University, Rome – Italy)**

| START | END | DESCRIPTION | SPEAKER | TITLE | WHERE |
|---|---|---|---|---|---|
| 14:05 | 14:25 | Projects of PC at object/collection /building scale | B. Rankl | Conservation scientific research at the University of Applied Arts Vienna | Gløshaugen |
| 14:25 | 14:40 | COFFEE BREAK | | | Gløshaugen |
| 14:40 | 15:00 | Project at building/s and district scale | I. Flores-Colen M. P. Mendes | Efficacy Project | Gløshaugen |
| 15:00 | 15:20 | Project at building/s and district scale | R. Cacciotti | Small-scale wind tunnel for the investigation of the performance of building materials | Gløshaugen |
| 15:20 | 15:40 | Project at building/s and district scale | E. Poletti | PROTIND | Gløshaugen |
| 15:40 | 16:00 | Project at building/s and district scale | G. Lobaccaro | Helios | Gløshaugen |
| 16:00 | 16:15 | COFFEE BREAK | | | Gløshaugen |
| 16:15 | 16:35 | Project at landscape scale | A. Bonazza | The Interreg Central Europe Project STRENCH - STRENgthening resilience of Cultural Heritage at risk in a changing environment through proactive transnational cooperation | Gløshaugen |
| 16:35 | 16:55 | Project at landscape scale | A. Sardella | The Risk Mapping Tool Cultural Heritage Protection | Gløshaugen |
| 17:15 | 17:35 | Project at landscape scale | R. Narbona | Research group: Architecture, Heritage and Landscape from ULPGC. Integral project: Terraced Landscapes. | Gløshaugen |

Erasmus+

(Credits: Giulia Boccacci, "LaSapienza" University, Rome – Italy)

# PART III

Students’ deliverables

# GROUP 1

## The challenges of preventive conservation and discussion of future use regarding the historic warehouses along the Kjøpmannsgata in Trondheim (Norway): consideration of special risks due to ongoing climate change

*J. E. Afonso Santana, C. Calapiña Arriaga, M. Klinkert, P. Higgins, L. Vergelli*

[HISTORY]

### The early Trondheim

In Trondheim, the first recorded human activities can be tracked back ca. around 700 AD.

In the Year 997, when Olav Trggvason ordered the building of a residence and the church of Klemenskiren, which became later the foundation for Trondheim, there were already docks with warehouses towards the water. Since Norways Geography contains mostly of mountans and fjords Trondheim is, together with Oslo, the only place with a continuous form of lowlands.[1]

After the battle of Stiklestad in 1030, Christianity was implemented. Paganism was outlawed and new forms of cities which included churches were able to emerge. The first churches and monasteries in Trondheim were also built during that time.[2]

Figure 1 - Hypothetical Map of early Trondheim[3]

### The rise of trading

At the end of the 12th century, more and more different types of buildings were erected; some were used as warehouses others also as homes. Between 1200 and 1400 the population of the city grew steadily. The warehouses played a vital role in the development of the city. Between 1274 and 1276 the King of Norway

Magnus Hakonson Lagabotes issued laws like the "landslov", one of most important laws of medieval Europe. Among other rules and laws there was also a city law specifically for places like Trondheim. This law specifically ordered all merchants that they had to lay down on the piers where they rented a warehouse. It was forbidden to sell goods directly from the boat.[4] This was one of the reasons why the piers with warehouses became the lifeblood of the city.

The piers belonged to the shipowners and wholesalers. Their properties were divided into plots across the river.

The warehouses were not only used for the purpose of fishing and storage, but also some of them had entire farm facilities with residential and private houses, barns, and storage cages. Behind the warehouses there were residential houses constructed in a very cramped way. The Streets were usually build in a tight way, most buildings were made of wood. Only churches and a few other buildings consisted of stone.[5]

During the construction activity in the city, a lot of material was simply dumped into the river and created little islands. Because of that the piers were therefore built further out into the river and thick pawls were lowered to the bottom of the river, so merchants were still able to load and unload their ships. The use of flat jetties made it possible to walk across the river without a boat.[6]

## The reconstruction of Trondheim

In 1625 there was also a landslide on the east side of the river. On the new terrain the foundation was laid for what is now Bakklandet.

Figure 2 - Map from 1658 depicting Bakklandet[7]

At that time the piers started to develop their characteristic appearance.

[1] Thomas Hall- Planning and Urban Growth in the Nordic Countries 1. edition.
[2] Imsen Steinar- The Norwegian Domination and the Norse World, C.1100-c.1400 - Tapir Academic Press.
[3] Troøyen, M. / Johnsen, E.G.: Kjøpmannsgata 27, unpublished Master Thesis, Department of Architecture, NTNU Norwegian University of Science and Technology, Trondheim 2022.
[4] Pål A. Bertnes- Legal information in Norway - electronic and printed sources 5th edition.
[5] Thomas Hall- Planning and Urban Growth in Nordic Countries 1. Edition.
[6] Troøyen, M. / Johnsen, E.G.: Kjøpmannsgata 27, unpublished Master Thesis, Department of Architecture, NTNU Norwegian University of Science and Technology, Trondheim 2022.
[7] Troøyen, M. / Johnsen, E.G.: Kjøpmannsgata 27, unpublished Master Thesis, Department of

From the 15th century on the city's growth stagnated. The powerful Hanseatic League (Hansa Teutonica) decided to choose Bergen instead of Trondheim as their main hotspot for trading.[8] There was also the constant problem of fire outbreaks and the war with Sweden. While this was a problem for many cities in Europe, Trondheim burned down overall 15 times. Usually, the inhabitants just rebuild the damaged and destroyed part of the city again until Major General Johan Caspar von Cicignon ordered the rebuilding of the town. He was deprecatory towards the old medieval style of the city.

Figure 3 - Plan for reconstruction of Trondheim (1681)[9]

The new Trondheim should be modelled after a more baroque style like Versailles, so it could fit all the military and safety needs. Alongside the river there were streets with trees on both sides so there was an easy access to the warehouses.

Cicignon was also commited to further fortifier Trondheim. However, his plan was only followed partially.[10]

## The industrial revolution

Trondheim was able to flourish and Bakklandet was still an important part of the city, until the industrial revolution reached Norway around 1850.

One important factor of the industrial revolution was the population growth. Along with other Norwegian Cities Trondheim underwent changes in infrastructure and urban development. Another way to boost the economic growth was the abolition of former trade restrictions. Together with the industrial revolution bigger ships with a much higher carrying capacity were established. With the consequences that the warehouses were seen as an obstacle to the town's development.

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Architecture, NTNU Norwegian University of Science and Technology, Trondheim 2022.

[8] Elisabeth Gee Nash - The Hansa 1995 - Barns and Nobles.

In addition, the new Bakka bridge was also built, which made it difficult for larger ships to sail up to the piers. Trondheim maritime infrastructure needed to be modernized.

After Carl Adolf Dahl´s plan for the modernization of Trondheim was accepted in 1876 and the building of a new harbour, which was in the direction of the fjord meant that the centre urban development shifted away from places like Bakklandet.

After almost 1000 years of being the centre of Trondheim the piers lost its original function, and that also included Bakklandet.[11]

## The abandonment and the decay

During the 20th century the warehouses of Bakklandet were still in some form of intermittent use for fishers but they were no longer the central place of the city.

Since they were not used that often anymore the forecourt increased.

They were seen as a problem and in the context of modernism some proposals were made to tear them down. They withstand the second world war without any serious damages and some of them showed signs of decay.

However, with the Midtbyen Plan from 1975 wooden houses were seen as a historic image of the city and it was therefore decided that buildings, like the warehouses of Bakklandet, should be preserved.[12]

[9] Troøyen, M. / Johnsen, E.G.: Kjøpmannsgata 27, unpublished Master Thesis, Department of Architecture, NTNU

[10] Thomas Hall- Planning and Urban Growth in Nordic Countries 1. Edition.

[11] Thomas Hall- Planning and Urban Growth in Nordic Countries 1. Edition.

[12] Troøyen, M. / Johnsen, E.G.: Kjøpmannsgata 27, unpublished Master Thesis, Department of Architecture, NTNU

## [STATE OF THE ART (CONSERVATION STATE - RELATION BETWEEN BUILDING AND ENVIRONMENT - ACTUAL USE)]

In today's Trondheim the influence of the warehouses facing the Nidelva River is profoundly central at the urban level. They are in an enclave influenced by the forced connection between two densely populated districts, the city centre and the Bakklandet district, naturally separated by the river.

In the space between the two main bridges that guarantee this connection and, at the same time, on the west bank of the river, is where the warehouses of greatest historical importance are located, and they are the ones which are the subject of this study.

This front of buildings of Kjøpmannsgata, beyond being a historical landmark in the drawing of the city, is a central point in itself, and it is the image that the city wants to project towards its visitors.

It is important to highlight the relevance of the sector as a whole, beyond the interest of any individual warehouse. That what is presented in this section of the Nidelva river acts like an exposure of a particular constructive and architectural system of continuous application. In addition, it speaks directly of the idiosyncrasy of the city and its deepest conditions and traditions.

Although the sector continues to be an absolutely central point in the city and surely its most visible face; there is a deep conservation problem linked to the disappearance of its original use, that of goods and food storage, and the consequent lack of maintenance and repair tasks directly linked to this commercial activity.

Since the sudden disappearance of the original use of the warehouses caused by the construction of the new wharf, better prepared for larger ships, there has been a prolonged dichotomy between the abandonment of some of the warehouses and the architectural adaptation of the rest to a changing variety of uses. Today this dichotomy still holds, and even does so in a more complex way.

With the development of urban and architectural regulations, the level of intervention and reconstruction with respect to the original state of the buildings has become deeply invasive for most of the proposed and existing uses.

On the other hand, there are initiatives under development for the intensive conservation of the original state of some of the buildings which, however, have great difficulties searching for possible owners who might be interested in a building with a high level of historical responsibility, maintenance and ongoing continuous costs and whose future use and potential long-term profitability from a particular investment point of view are virtually unknown.

With this situation, the establishment of an intermediate situation is of critical importance, where the buildings can be used and have a certain level of economic

profitability, but without this implying the loss of the character and original construction system. For this, it would be important to explore new uses, whose adaptation needs were not so far from those of the original use of the building.

The objective of this brief investigation, given this alarming situation (which is also aggravated by the conservation problems linked to climate change), focuses on the study of a series of proposed criteria to study the possible consequences and the level adaptation of possible future uses for these buildings.

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## [OVERVIEW OF CLIMATIC PARAMETERS AND COMFORT ISSUES]

### __Trondheim "historical" climate and climate change

In Trondheim (coordinates: 63,430-degree latitude & 10,395-degree longitude)the summers are cool, wet, and mostly cloudy and the winters are long, freezing, snowy, and overcast. Trondheim is located near a large body of water (e.g., ocean, sea, or fiord).

*Temperature*

Over the course of the year, the temperature typically varies from -5°C to 18°C and is rarely below -13°C or above 25°C (Table 1).

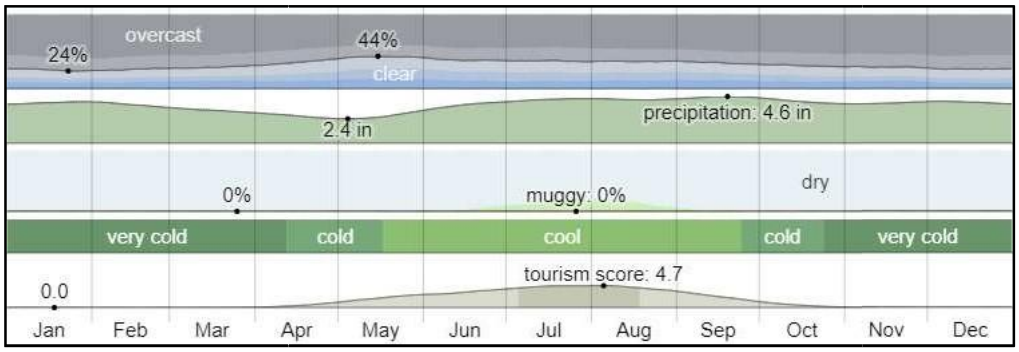
| season | average temperature |
|---|---|
| warm (from June to September) | 15°C<br>July (hottest month): high average = 18°C VS low average = 11°C |
| cold (from November to March) | 4°C<br>January (coldest month): high average = 1°C S low average = -4°C |

Table 1 – average temperature in warm and cold seasons

Average water temperature experiences some seasonal variations over the course of the year (Table 2).

| season | average temperature |
|---|---|
| warmer water (from July to September) | above 12°C(high average of 14°C in August) |
| cooler water (from Dece ber to May) | below 7°C (low average of 5°C in March) |

Table 2 – average water temperature in warm and cold seasons




*Trondheim weather by month. Click on each chart for more information.*

*© WeatherSpark.com*[33]

*Precipitation*

The wetter season lasts from June to March (the wettest month is September). The drier season lasts from March to June (the months with the fewest wet days in Trondheim are April and May). Among wet days, precipitation may be rain, snow (specifically from October to April), or a mixture of two.

*Sun*

The length of the day in Trondheim varies extremely over the course of the year (the shortest day in December has got around 4 hours and 30 minutes of daylight; the longest day in June 21 has got around 20 hours and 30 minutes of daylight).

The total daily incident solar radiation (UV and VIS waves) reaching the surface of the ground is a number which considers:

- seasonal variations in the length of the day
- elevation of the Sun above the horizon
- radiation absorption by clouds and other atmospheric constituents.

[13] https://weatherspark.com/y/68746/Average-Weather-in-Trondheim-Norway-Year-Round.

The average daily incident solar radiation experiences extreme seasonal variation over the year.

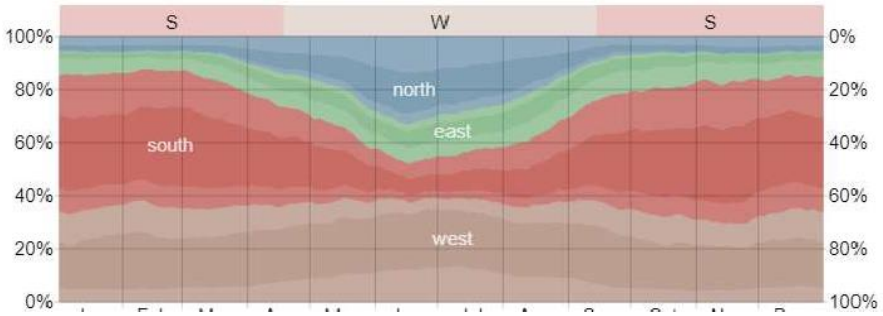
| period | average daily incident solar energy per square meter |
|---|---|
| brighter period (from May to August) | above 4,2 kWh<br>(June, the brightest month, average = 5,2 kWh) |
| darker period (from October to February) | below 1,1 kWh<br>(December, the darkest month, average = 0,1 kWh) |

Table 3 – average daily incident solar radiation in warm and cold seasons

*Wind*

| period | average hourly wind speeds | direction of wind |
|---|---|---|
| windier period (from October to April) | more than 10 km/h<br>(January, the windiest month, is 14 km/h) | more often from the south |
| calmer period (from April to October) | less than 10 km/h<br>(July, the calmest month, is 7 km/h) | more often from the west |

Table 4 – average hourly wind speeds in warm and cold seasons




*The percentage of hours in which the mean wind direction is from each of the four cardinal wind directions. The lightly tinted areas at the boundaries are the percentage of hours spent the implied intermediate directions (northeast, southeast, southwest, and northwest).*

*WeatherSpark.com*[14]

[14] https://weatherspark.com/y/68746/Average-Weather-in-Trondheim-Norway-Year-Round.

*Climate change*

In Trondheim the average temperature has not had a sharp increase in the 30 years from 1961 to 1990: only temperature-value dispersion has increased. This datum, confirmed also for the 30 years from 1991 to 2020, means an increase in extreme phenomena (hotter summers VS shorter and colder winters), with the consequent variation in the length of the different seasons. The increase in temperature fluctuations in the first and last months of the year causes freeze and thaw cycles, which usually occur precisely in winter. The cycles are harmful to the materials, e.g., the hygroscopic wood (damage functions).

**Object comfort versus human comfort - challenges and approaches**

Built heritage and heritage collections require conservation approaches, which can cause conflict with the demands of human comfort.

Passive environmental control strategies historically focused on the wellbeing of the people who inhabited the buildings. This was at a time, where no electricity and advanced heating methods were available. As a side effect, many of these building constructions were also very conducive to the preservation of the building fabric. Unfortunately, not all of these approaches can be applied to the conservation of cultural heritage. In addition, the official regulations for the use and air conditioning of buildings in terms of health regulations and well-being have become more stringent, which limits the possibilities for using the buildings.

According to ISO 7730:2005[15]the level of comfort for a sedentary activity should be inside the margin between 19°C and 29°C on the floor surface, with the most ideal temperature being around 26°C. One of the main issues in developing suitable conservation concepts is balancing the essential conservation requirements of the objects with the needs of the people who live or work in these buildings. In terms of the challenging Norwegian climate, this makes things even more complicated.

KING and PEARSON discussed this problem in relation to buildings in Australia, but important key messages are applicable to this topic [Pearson *et al.*, 2000[16]].

➔ Objects and buildings are static and cannot move away from an adverse environment. In contrast,humans can adapt to unfavourable climate conditions by changing their location, seeking shelter, or dressing appropriately.

➔ Sensory compensations and comfort preferences by humans can be contrary to the conservation requirements of the historic materials, for example:

O Lowering of relative humidity increases human comfort but hastens the desiccation of wood and leads to mechanical stress in the form of shrinkage and cracking.

O People prefer higher temperatures and may seek out radiant heat sources, which promote intense differential temperature stresses, resulting in strong mechanical strains and increased rates of oxidation.

The recognition that humans are more adaptable to uncomfortable climatic conditions than static objects due to their mobility and flexibility should be taken into account in relation to significant and vulnerable cultural heritage. Therefore, strategies for passive and low energy environmental control can be preferred for providing stable environmental conditions, which might not always match optimal conditions for human comfort. The main tasks are to identify aspects of the building construction which are beneficial for the environmental stabilization and to reduce and modify harmful factors [Pearson *et al.*, 2000[17]].

**Summary of conservation requirements, objectives, and possible strategies**

*General material parameters*

The Bakklandet warehouses are mainly wooden timber constructions, built on natural stone foundations, located close at and partly above the river. The foundations (basement) consist of a ring wall made of natural stone masonry, the river fronts are supported by inner and outer rows of massive wooden pillars. The timber constructions are characterized by a high frequency of vertical pillars for stabilization and closely staggered wooden boards around the walls and floors. The ceiling height is low, daylight can only enter most buildings through windows at the riverside and roadside (except warehouses situated next to open places). The buildings contain windows and wooden doors of different sizes and periods. Towards the river side there are large openings and wharves, which were used for loading goods. The roofs are a combined rafter and ridge roof, covered with slate or corrugated iron. Most of the warehouses are painted in different colours; most likely linseed oil was used as a binding agent [Troøyen, M.*et al.*, 2022[18]] .

[15] EN ISO 7730:2005: *Ergonomics of the thermal environment - Analytical determination and interpretation of thermal comfort using calculation of the PMV and PPD indices and local thermal comfort criteria* , German version EN ISO, https://www.din.de/de/mitwirken/normenausschuesse/naerg/veroeffentlichungen/wdc-beuth:din21:89417255, accessed on 26.05.2022.
[16] Pearson, C. / King, S.: Passive Environmental Control for Small Cultural Institutions in Australia, in: Australian Academic & Research Libraries, 31/2/2000, pp. 69-78, DOI: http://dx.doi.org/10.1080/00048623.2000.10755117, accessed on 26.05.2022, pp.73-74.
[17] PEARSON / KING 2000, p. 74.
[18] Troøyen, M. / Johnsen, E.G.: *Kjøpmannsgata 27*, unpublished Master Thesis, Department of Architecture, NTNU Norwegian University of Science and Technology, Trondheim 2022.

*Risks and vulnerabilities*

In order of priority, the risks/vulnerabilities affecting warehouses are:

**1) fire**: history teaches us that fire has always been the main enemy of wooden warehouses: in presence of wind, the fire can spread from one warehouse to another,affecting the entire structure, from foundations to roof, and damage of wood is irreversible.

**2) flood**: considering the position of the houses, by the river, with their foundations directly under the water resting on a "quick clay", the risk of flood occurs whenever the water level of the river rises (due to long periods of rain or due to the melting snow) and, for this reason, the static capacity of the structure is lost. Due to climate change, the risk of floods is now increasing, as it is increasingly frequent the occurrence of extreme weather events.

**3) biological infestation**: one of the main consequences of elevated moisture/liquid water content (in general high humidity values) is the biological contamination by microorganisms, insects, and other invasive species. Damp wood is vulnerable to attack by mould, bacteria, and pests, whose life cycle is as fast as the conditions are suitable for their growth. The result of climate change is a warmer and more humid climate with the consequent acceleration in biological growth and a higher risk for infestation of structural wood (organic material).

**4) exposure to weather**: the external surface of the warehouses -roof and facades- in addition to the foundations is obviously subject to the continuous action of external atmospheric agents. The rain, whose direction and force are due to the action of the wind, can be more or less intense. The most exposed portions of wood will be more humid with all the consequent problems related to the water/moisture content inside the structure of the organic material. Climate change (stronger wind and heavy rainfalls/snowstorms) can make the situation worse. In addition, sunlight exposure depends mainly on the season of the year (different inclination of the light rays with respect to the earth's surface) and on the presence or absence of clouds in the air which represent a screen that attenuates the energy carried by the light rays, therefore their intensity. The irradiation of a surface consists in a transfer of heat and therefore in a heating of the irradiated material, in the case of wood the consequences are physical-mechanical stressors (deformations, fractures, cracks, loss of stability). Climate change action consists of an increase in sunlight intensity, thus in the wood decay.

**5a) freeze-thaw cycles**: Trondheim climate shows severe variations in temperature throughout the year. The problem of freeze-thaw cycles occurs whenever the temperature falls below 0°C (or much below in the presence of salts dissolved in the water) and goes back above 0°C (or above the temperature of transition between liquid water and ice). The consequences of the cycles are minimal if the cycles occur with low frequency over time but become alarming if the freeze-

thaw cycles are recurrent (as in the case of the strong fluctuations in temperatures recorded in recent years due to climate changes). The mechanical stress to which the wooden material constituting the structure of the warehouses is subjected is caused by the greater volume occupied by the ice compared to the one occupied by liquid water. The liquid water that infiltrates into the pores and the voids of the wood, becoming ice below 0°C and increasing in volume, causes an increase in the size of the pores and the voids with consequent fractures and cracks. Due to climate change, we observe frequent freeze-thaw cycles also during winter, these are caused by the rise of average temperature.

**5b) salt (sub)efflorescence**: although there it is river water, its proximity to the sea makes it "mixed" and the capillary rising of salts through liquid water is a natural phenomenon for wet wood. The problem of the cycles increases when the water passes from the liquid form to the vapor form (evaporation) and the salts (mostly chlorides and nitrates) become insoluble in a smaller quantity of water (supersaturation of the solution) and crystallize in the pores and voids of the wood. Repeated cycles over time cause an increasingly marked crystallization. If the evaporation is fast (high temperature and presence of wind) the crystals are small in size and form below the surface → sub-efflorescence, if the evaporation is slow (low temperature, absence of sunlight and wind) the crystals are large in size → efflorescence. The greater intensity of climate fluctuations in temperature and humidity due to recent climate changes results in a greater speed of occurrence of the degradation phenomenon caused by the cycles of saline crystallization and dissolution.

**Requirements regarding preventive conservations methods, goals and possible solutions**

*"Sustainability is the idea of using cunning, looking at what people did in the past, adding that to modern physics, and generally designing things that you're proud of because you didn't drag in a whole lot of electricity and energy." - Tim Padfield[19]"*

Considering the climatic risks, material vulnerabilities, heritage value and specific problems related to future uses, there are high requirements in terms of environmental control and preventive preservation. The main aim is to safeguard the warehouses as a cultural heritage while respecting its significance, integrity and authenticity. This includes its accessibility to present and future generations. In addition, in times of climate change and limited energy resources, the reduction of the carbon footprint should be a part of a holistic and sustainable approach. During the last decades, the idea of *Passive Environmental Control* [Pearson *et al.*, 2000[20] ]

[19] https://www.getty.edu/conservation/publications_resources/newsletters/22_1/dialogue.html, accessed 29.05.2022.

[20] Pearson, C. / King, S.: Passive Environmental Control for Small Cultural Institutions in Australia, in: Australian Academic & Research Libraries, 31/2/2000, 69-78, DOI: 10.1080/00048623.2000.10755117,

gained more attention, meaning to adjust climate parameters without mechanical facilities and artificial climate control systems but through well thought building design and fabrics with abilities to buffer. The advantages lie in the cost effectiveness, a less complicated installation and maintenance and environmental sustainability, as much less energy is required[21].These passive, non-mechanical methods often include historic and traditional building techniques.

The main aim of passive environmental control strategies lies in the reduction of mechanical strategies and the resulting reliance on constant energy supply and high maintenance. These strategies may be combined, if non mechanical strategies might not be enough [Maekawa*et al.*, 2015[22] ]. As a result, energy-consumption, installation, and operating costs can be significantly reduced. As there are no complex machineries to be maintained, the environmental conditions are generally more stable and reliable.

Preventive conservation and passive climate control through appropriate building design are the basis for all further measures. Table 5 summarizes the most important aspects.

| Requirement | Specifies | Possible Actions |
|---|---|---|
| **Fire prevention** | - highest priority!<br>- sources of fire need to be avoided at all costs<br>- development of a well thought fire prevention and emergency plan | - no electrical installations and if required: constant maintenance, use of electrical equipment under constant supervision<br>- use of fire-resistant building and interior materials<br>- no kitchens → no restaurants<br>- installation of warning systems<br>- education and information of owners, employees, and fire department |
| **Flood protection** | The risk of flooding is almost unavoidable due to the direct proximity to the river but may be reducible through appropriate flood prevention measures and structural modifications to the surrounding river landscape. | - if possible: barriers and partitions along the river sections<br>- water drains leading away from the warehouses<br>flexible use of the ground floors, no storage of valuable objects in this area and acceptance of regular flooding |

[21] PEARSON / KING 2000, p. 70.
[22] Maekawa / BELTRAN / HENRY 2015, p. 92.

| | | |
|---|---|---|
| **Climate stability** | - creation of a stable indoor environment<br>- low fluctuation rate of temperature and humidity<br>slow adaption of the inner climate to the outside climate and slow acclimatization of the building fabrics | - use of porous and hygroscopic building materials for hygrothermal buffering<br>- controlled natural ventilation (balance between air tightness and defined ventilation openings) with caution to unwanted intake of cold or hot winds, pollutants, insects and driving rain [Maekawa *et al.*, 2015[23] ].<br>no sealing of surfaces through paint layers and protective coatings |
| **Protection against water and moisture intake** | - protect buildings from water intake through rain, in-situ groundwater, and rainwater runoff | - replace the dense tar paving of the adjacent street with permeable paving with natural stones and permeable joints<br>- perimeter foundation drains can limit groundwater intake from the roadside<br>- closure of large openings that are susceptible to water ingress<br>- installation and maintenance of water drainage systems (wall gutters, downspouts, wall projections and drip edges)<br>maintenance of external walls, basement and roofs and closing of leaks |
| **Prevention against biological infestation and pests** | - complete exclusion of pests and biological infestation not possible, but:<br>- reduce access possibilities<br>- deny food sources<br>- avoid conditions they prefer (warmth, water, and high humidity)<br>- related to the protection against water and moisture intake and climate stability<br>avoid building and interior fabrics that could be a food source | - keep temperatures below 20 °c<br>- values less than 75% RH are recommended to avoid microbiological activities [Maekawa *et al.*, 2002[24]].<br>- allow natural ventilation and air circulation<br>- avoid building and interior fabrics that could be a food source (textiles, carpets, organic paint materials)<br>- no storage of food / no restaurants<br>- keep the surfaces clean and remove dirt and dust regularly<br>- Integrated Pest Management:<br>→ monitoring and control<br>→ appropriate education and support<br>→ Remedial action if damaging species are discovered<br>low hazard or non-toxic methods of control[25]. |

[23] Maekawa / BELTRAN / HENRY 2015, p. 99-100.

| | | |
|---|---|---|
| **Protect against extreme climate parameters and sudden fluctuations** | - protection against heat and severe cold<br>- avoid freeze-thaw events<br>- avoid dew point temperatures and resulting condensation<br>dimensional changes and the resulting mechanical stresses in objects, mainly caused by short term fluctuations should be avoided | - controlled conservation heating against condensation and freezing indoor temperatures<br>- controlled air exchange<br>- insulation with water vapor permeable, fire resistant ecological insulation materials (especially roof insulation, e.g., with natural fibres)<br>condensation should be avoided by not letting warm and damp air into cooler rooms [Staniforth, S., 2007[26]].[9] |
| **Ecological and financial sustainability** | - use of electric devices on a low level<br>- low maintenance<br>reduction of the carbon footprint | - preference of passive, non-mechanical strategies of environmental control<br>improvement of energy performance |
| **Consideration of human comfort** | For conservation approaches, it might be necessary to reduce the level of human comfort to improve the environmental conditions for the historic materials. | |

Table 5 – most important aspects of preventive conservation

## [FUTURE USE PROPOSALS AND CONCLUSION]

### Use proposals

The past use is not applicable anymore, the following suggested uses are also not applicable to all warehouses but can be viewed as examples of multiple uses for a liveable district with consideration of the heritage value.

Proposals for new use considers the central location of the warehouses (in the city centre) and their recognized aesthetic value (also for tourists), but also the nature of the buildings which require periodic maintenance-interventions over time and their low ceiling heights associated with the lack of daylight indoors as limits to the possibilities of transforming warehouses to new use.

**A) flea market** where it's possible to buy handmade products and local craft-made objects and gadgets.

| | |
|---|---|
| PRO | - exploitation of the site for daily / weekly / monthly events<br>- bigger flux of tourists in the city |

[24]Maekawa / Toledo 2002, p. 5.

[25]English Heritage Guideline for Integrated Pest management, in: https://www.english-heritage.org.uk/siteassets/home/learn/conservation/collections-advice--guidance/eh-guideline-for-insect-pest-management-ipm-in-eh-historic-properties---website-version.pdf, accessed on 03.06.2022.

[26]STANIFORTH 2007, p.7.

| | |
|---|---|
| CON | - not suitable climate indoors during cold season (but climate is milder than outdoors)<br>- impossibility to also sell food and edible gifts |

**b) temporary exposition** (spoken workshop) where Trondheim university-students and national or international artists can show and discuss their final projects in this unique "exposition space".

| | |
|---|---|
| PRO | - during warm season the location is similar to the one of the Venice Biennale<br>- enlarged knowledge of Norwegian and foreign people about this built cultural heritage |
| CON | - not suitable climate indoors during cold season (but climate is milder than outdoors)<br>- impossibility to expose every kind of artifacts (not heavy, not degradable, etc.) |

**c) offices and housing** (residential private use) not a great solution, the identity of the place is lost.

| | |
|---|---|
| PRO | - the human use (life inside the buildings) lasts all over the year<br>- improvement of the aesthetic issue indoors and outdoors, maintenance for long time |
| CON | - modification to the original structure with loss of the original value<br>- need of an optime thermal comfort inside the building (especially during cold season)<br>- high risk of fire derived from domestic kitchen use |

**d) shops, restaurants** (commercial / private use)not a great solution, the identity of the place is lost.

| | |
|---|---|
| PRO | - the human use (life inside the buildings) lasts all over the year, although the paid access<br>- improvement of the aesthetic issue indoors and outdoors, maintenance for long time |
| CON | - alteration of the original structure with loss of the original value<br>- need of an optime thermal comfort inside the building (especially during cold season)<br>- high risk of fire derived from professional kitchen use<br>- high risk of biological colonization caused by the presence of raw food and ready meals |

**e) visitors' heritage site**, the best solution for the preservation of the warehouses in their original state. They are presented as a museum site for architectural history, as a learning space that offers the possibility to get an idea of the authentic appearance of the city of Trondheim during its history. A walk through the building enriches the visitor thanks to the discovery of information about materials, craftsmanship and building techniques; traces of past; what was the use of the building elements; the results of deterioration due to the climate change (salt efflorescence) ... The visitor, in this way, becomes aware of the urgency of conservation interventions and sustainable lifestyle in any case.

| | |
|---|---|
| PRO | - with public access, the human use (life inside the buildings) lasts all over the year<br>- information given via audio guides and robust panels placed somewhere indoors<br>- maximum authenticity and integrity, no changes of original substance and appearance<br>- no heating and electricity necessary - authentic experience includes sense of "darkness" |
| CON | - not possible for all buildings, only one selected object could be treated like this<br>- requirement of staff and maintenance (suggested public ownership for the public access) |

The following Table summarizes all the previous aspects in relation to the choice criteria.

| | flea market (local products) | temporary exposition (spoken workshop) | offices, housing | shops, pubs restaurants | visitors' heritage site |
|---|---|---|---|---|---|
| heritage interest management(preservation of authenticity, significance, historical value) | | | | | |
| economic advantage (owner) | | | | | |
| comfort of the visitors | | | | | |
| accessibility for the public | | | | | |
| similarity to the original use | | | | | |
| improbability of fire | | | | | |
| occupation through the year(linked to the maintenance) | | | | | |
| applicability of the proposal (high = large scale DISTRICT low = small scale BUILDING) | | | | | |

Table 6: future use proposals in relation to the criteria of choice: high = green; medium = yellow; low = red.

## [CONCLUSIONS]

Even if there are of course no warehouses from the founding time of Trondheim, a place like Bakklandet still can give people the opportunity to see how the city developed, what crises it went through and the foundational changes that affect it. In the past with the industrial revolution and in the present and unfortunately, the future with climate change.
The warehouses are obviously no longer used for their original purpose, because of the introduction of modern transportation and food refrigeration. But there could be a combination of offering groceries and other products.
It would serve the idea that even if you cannot use a Cultural Heritage Building in its old way, there is still a possibility of usage.

Beside the issue regarding conservation of the colour form location and bringing some utilization back, the conformity is also maybe important for the city.

At least one of them could also be used as a form of small exposition.

Since the warehouses were of big economic importance and they were also rebuilt, repaired, and renovated over and over again, they are of course in some way a window into the past.

A small exhibit, which would only use up one of those houses, could show people what the original purpose was. This small exhibit would be much smaller than an actual museum and maybe there would not even be the need for an entrance fee.
Old manufacturing tools and clothing, perhaps a model of an old fish boat, could be shown in combination with signs and audio guides.

Unlike many other small historical exhibits, it would also be an opportunity to display the direct and indirect impacts of climate change on these warehouses.

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# GROUP 2

## Trondheim Cityscape: Preservation of the City Identity

*Bartolucci B., Grabner C., Kocabas E., Parracha J., Trujillo Cabrera L.*

### [INTRODUCTION]

Norway has the world's second largest shoreline, and the sea has been the most important communication system all through Norwegian history. In fact, there is a strong interaction with the landscape, climate conditions, nature resources, and traditional communication systems in the development of the Norway built environment. The ship building technology was extensively developed by the Norwegians and fishery has been a major industry in Norway, i.e., stockfish and klippfish (dried and salted cod) industry has been paramount for the economy. Therefore, most of the Norwegian historic buildings are associated with the sea, which had an important role in the construction of the Norwegian built heritage.

Wood has been the most important construction material in Norway since Viking times. In the medieval time, wood building technology was developed to a very sophisticated level, enabling the best buildings to survive up to our time. The construction systems and technologies have later been developed in different regions considering the availability of materials and other local conditions (e.g., coastal buildings have had to adapt to harsh coastal climate such as strong winds, rain and high humidity). Timber buildings proved to be very suitable facing harsh climatic conditions and adapting to the functional needs of Norwegian society.

In this report we examine the importance of the preservation of the city identity, especially considering the most iconic Trondheim buildings (i.e., warehouses and Nidaros cathedral) and their relative importance on the preservation of the city landscape. We also present herein some solutions towards the maintenance and preservation of the buildings and the city identity.

### [THE WAREHOUSES]

In Mid-Norway there is Trondheim, the largest city of the country and the most important trading port for the region. The river harbour has always offered a safe port where the first urban settlement was located. The city consists almost entirely of timber buildings, often ravaged by fires, like that of 1681.

Interventions can be done in the warehouses as long as their identity can be preserved. With identity we mean their colour, symmetry, cladding, form and different roof shapes, the pile foundation, the traditional log constructions, the flatbrygge along the water, the location and the use. From a visual and social point of view, the warehouses represent an identifiable "city-scape", with cultural and aesthetic heritage value of national importance.

By tradition, Norwegian houses used to be coloured either red, white, or yellow. The colours chosen by the owners of the house would signify their financial status. So, depending on the profession, social status, and location, houses would be

painted the primary colours that symbolized their rank. This was not done to be malicious, but due to their resources. Since red was the cheapest, and easiest to produce, it was mostly reserved for fishers and farmers. Red house paint was used by mixing ochre with cod liver oil, and vegetable or animal oil, to get the bright shade that is popular in Norway nowadays. Therefore, the traditional Norway colour for lower-class houses was red, which stuck with and became a custom over the years, regardless of status. Since, yellow was slightly more expensive to produce, as it was made with ochre and cod liver oil, this was reserved for a higher status of people. Yellow typically symbolized the middle class concerning the Norwegian houses. Finally, white was reserved for the luxurious class, as minerals such as zinc were needed to get the tone. In the older days, white was the most expensive colour. Nowadays, the importance of the warehouses lies in the whole landscape and not in a single building. Therefore, the preservation of the warehouse's colour is a key aspect to preserve the identity of these historic buildings.

In Norway, it is common to have wooden architecture from the past but also in more recent buildings. In an ancient drawing, "Maschiusstikket" from 1674, it is depicted the structure alongside the river and much of the warehouses landscape is as it is today, even though almost everything burnt down in 1681. However, there are some distinct changes in size (e.g., some warehouses are built together, some of them are smaller, larger, or taller). Later, fires have led to many wharf buildings being replaced by newer, more modern types that use similar principles. In the more recent examples, like Kjøpmannsgata 27 (built between 1858 and 1876), the building structure is still clearly visible. Even though its height and size are increased with respect to the earlier warehouses, the way it is built is, of course, based on the traditional techniques: the ground floor consisted of two rows of notched log timber rooms, with a corridor in the middle. This was connected to the river via a gallery, where all the goods were brought on shore. An important aspect is that these buildings would sometimes have a space in front one of the long sides making a useful gap in the row of buildings, to minimise the risk of fire spreading.

The shape of the roof also says a lot about the history of the warehouses, as it was changed over time. Considering the shape of the roof it is possible to know when the warehouse was approximately built. The roof with the ridge in the east-west direction was predominant. From 1845 until about 1925 all the roofs that were built were half-hipped on both sides because of fire regulation. The same regulations also set the maximum height of the bryggen to less than 14 metres and most of the bryggen from 1850-1860 present those dimensions.

The warehouses were used as a food storage, to be able to market it. Therefore, the river is an important point where fishers can access the docks with their boat to put the fish inside the warehouses. Originally, the stairs, next to the doors that faced the river as the street, allowed one to quickly enter the warehouses to transport the merchandise, through a forklift. The building is a dark and cold place, where large air currents occur, allowing food to be better stored.

The original warehouses were not used as dwellings, but today many have been

converted into residential houses, however it is not allowed in the row next to the city along the river. Some are art galleries, cafes, restaurants and boutiques.
Trondheim's warehouses were generally made as a combination of wood frames and log structures allowing the creation of many different space distributions. Most of the buildings contain small and low rooms in the lower levels and very large and high spaces in the upper levels. New buildings are frequently built using concrete instead of wood because these buildings have improved fire performance. Sometimes, the concrete is covered with wood to simulate the old structures. However, the use of the original building material is neglected and can somehow affect the cultural and aesthetic values of the houses. For example, the facades are often retrofitted using aluminium windows, while the original were built using wood. The preservation and retrofitting of these traditional buildings should be always conducted using compatible and reversible materials and interventions. Furthermore, climate change (CC) can also affect the landscape and the structural integrity of the warehouses. In 1816 there was a sand slide upriver, which caused the Nidelva River to be shallow, causing the rise of the water to occur in a more important way. With CC the sea can rise up to 3.4 mm per year and this can strongly affect the warehouses.

### [TRONDHEIM LANDSCAPE AND NIDAROS CATHEDRAL]

Trondheim is well known for its wooden built environment with traces back to the Middle Age. In more recent times much of the traditional wooden houses are being replaced by architecture structures made of brick, concrete and steel, creating a more heterogeneous typology with variations in scale, volume and heights. Moreover, the cultural and historical aspect of the landscape also includes the urban fabric with its green areas, gardens and parks and also how the tangible and intangible dimensions are perceived.
The natural landscape is integrated into the city centre of Trondheim in such a way that the urban and the natural landscape interact with each other for the development of the city. Moreover, the historic city is integrated by natural elements such as the Nidelva River, the Trondheim Fjord, the coastal area, the valley and the hills surrounding the city.
Trondheim developed in medieval times, from the bank to the mouth of the river Nidelva. However, in 1681, almost the entire city was destroyed by a strong fire, which allowed the creation of a new city plan, thus proposing larger streets and building two-storey homes. However, until the 19th century, it was still a village of low-rise wooden dwellings.
In 1841 and 1842 two fires left large parts of the city in ashes and the use of wood as main construction material was banned in 1845. However, before this legislation was implemented, the citizens managed to reconstruct the city using wood. With the implementation of the new legislation, a new architectural style based on brick was introduced. Later on, the use of concrete and steel gradually changed the performance of some parts of the city center into a more diverse and complex urban landscape (i.e. new materials were introduced, and the new typology opened up for buildings in several stories, creating a brand-new

architectural style).
World War II changed the organization of the landscape, giving it a more modern imprint. The biggest variation concerned the use of new materials, such as brick, concrete and steel, and for this reason the image of the city has changed a lot, passing from a landscape rich in wood to a heterogeneous landscape.
Also, there are new changes taking place nowadays. Think, for example, of the fact that people want to work in the city center (Kjøpmannsgata 37 is an example), and this generates pressure to construct new buildings on limited space. This situation can certainly represent a risk to the historical urban fabric of Trondheim, which must be preserved.
The monumental streets and squares replaced the narrow and curvy streets after the fire of 1681. Furthermore, the urban landscape of Trondheim is also characterized by the river Nidelva and the canals surrounding the historic core on the peninsula, establishing attractive urban spaces with its water surface, representing more a visual element than a functional one. Another important spatial element connected to the historic urban landscape of the city center, is the green parks. Marinen park, located on the south of Nidaros cathedral, is the most important green space in the city, especially in summer periods where it also hosts festivals. The river Nidelva and the canals form important prerequisites for the development of the urban landscape that also encompasses the built environment.
Nidaros Cathedral is the world's northernmost important Gothic cathedral and Norway's national sanctuary. It is situated in the middle of Trondheim city centre and was originally made of wood and built from 1031 onwards. During the Middle Ages, and after independence was restored in 1814, the Nidaros Cathedral was the coronation church of the Norwegian kings. In 1991, the present King Harald V and Queen Sonja were consecrated in this cathedral, demonstrating the importance of the monument for the Norwegians.

[A REFLECTION ON THE IDENTITY OF THE WAREHOUSES AND THE CATHEDRAL]
The identity of Trondheim is very much influenced by the Warehouses and the Nidaros Cathedral, and some of the aspects that are related to the colour, form, location and use of both buildings are of paramount importance for the preservation of the cityscape. It should be stressed again that intervention can be done in the Warehouses as long as their identity can be preserved because they represent an identifiable cityscape with cultural and aesthetic values of national importance. Those buildings vary in height, width and proportions, roof shape and angle, as well as in colour and detail. These aspects give the Warehouses their charming and characteristic rhythm and at the same time appear as clear individual parts in a whole. Therefore, the importance of the Warehouses lies in the whole landscape and not in the single building. Over a period of time, warehouses have not been used, so no significant structural changes have been made. An important aspect is that these buildings would sometimes have a space in front one of the long sides making a useful gap in the row of buildings, to minimise the risk of fire spreading. What increases its patrimonial value, but the lack of maintenance produces an unattractive visual aspect. The original

warehouses were not used as dwellings, but today many have been converted into residential houses. Therefore, the preservation of the warehouse's identity is a key aspect to preserve the landscape of Trondheim. Interestingly, the warehouses were repeatedly destroyed by fires and rebuilt always on the same sites and following the same construction rules established in the twentieth century.
Nidaros Cathedral is the world's northernmost important Gothic monument, and it is an important part of the city's identity: i.e., in the study of Kyttang and Bye (2019) the Cathedral was identified as the most significant historic building in Trondheim landscape. In this case, aspects like the colour, form, location and use are also of fundamental importance in the preservation of the city landscape. The interaction between nature and the urban fabric is evident. Monumental historical landmark buildings like the Cathedral dominate the urban landscape and thus shape the cityscape. Therefore, all new buildings should not break important landscape silhouettes. The case of Nidaros is representative of the fact that it is necessary to preserve the colour and above all the structure and shape because they are peculiar characteristics of the historical period in which it was built and part of the cityscape. Additionally, the air pollution situation in climate change has contributed to an accelerated deterioration of the monument. Therefore, it is necessary to think of some strategies to avoid irreversible damage and, at the same time, to keep the original materials and the identity of the Cathedral. These strategies, listed in the following subsections, concern architectural barriers, the use and maintenance of the historic building considered, and the proper maintenance of the green spaces.

- **Barriers**

The barriers in the city prevent free movement and make it difficult to use some spaces (Figure 1). It is important that the city has easy connections with the most emblematic sites and that there are spaces of utility and to further relationship between people. For this reason, certain obstacles such as different elevations, various vehicle and train crossings, etc. are complicating free movement. For example, the barriers between the warehouses were set up in order to prevent the spread of fire. And yet, in the cathedral, there is only one minor barrier, which is an outer fence with a gate, that allows people to get close to it (Figure 2).

Figure 1. Some of the barriers identified in the city of Trondheim.

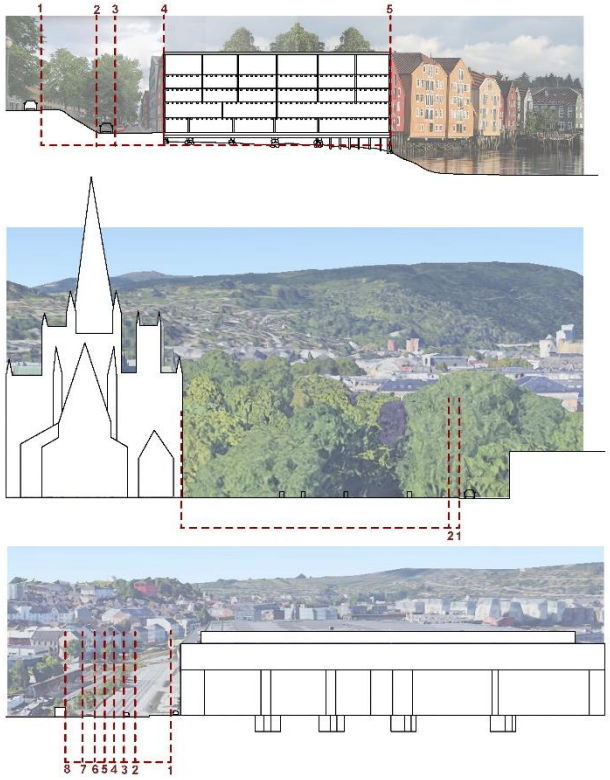

Figure 2. Comparison of the different barriers identified in the city.

- **Warehouses use**

Currently, most warehouses are not in use, so they are not maintained. It is important to reactivate the use of warehouses so that cultural events can take place and business offices can settle herewith encouraging the economy to support the revitalization of the neighbourhood. Therefore, important events such as concerts, social events, and cultural events will help to revive the area.

- **Maintenance**

It is important that maintenance is carried out on a regular basis to maintain the heritage and landscape of Trondheim. An example would be the cathedral of Nidaros, which can be kept in good condition by ongoing repair and restoration. However, the lack of maintenance in warehouses is due to the fact that they are not used and/or due to the lack of funds to keep them intact.

- **Green spaces**

Integrating green spaces means giving the city spaces to develop activities such as sports and provide a "green lung" (Figure 3). Nature provides spaces where you can interact with other people and integrating it can be an option to remove some barriers, such as heavy traffic. An example would be The Fortress and its environs, with large natural spaces where people can relax and relate to each other.


Figure 3. Green spaces that can be integrated in the landscape.

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# GROUP 3

## NO(r)WAY in TRONDHEIM?
## Close-up to CH to find a way to preserve against flood risk

*Dietrich F., Jokin I., Moreno Falcon M., Ogut O.*

[ABSTRACT]

Climate change is one of the global problems that threatens the current conditions, even the future existence of Cultural Heritage (CH) values. Flood, as one the main natural hazards, have been affecting by water cycle changes in the planet towards the climate change. This study tried to investigate the flood hazard and the vulnerability of three significant cultural heritage areas (i.e., Warehouses, Nidaros Cathedral, and DORA facilities) in Trondheim (Norway) according to the framework of integral conservation and the methodological model Art-Risk. The results indicate that the significance and the use of Cultural Heritage are affected by many driving forces that have the potential to reduce -even dissolve- the consequences occur after an emergency. Some suggestions have been made both for decision making and the practical solutions in order to preserve these CH areas against the high flood risk.

[INTRODUCTION]

Floods are natural hazards that affect the city of Trondheim regularly. According to the last report of the Intergovernmental Panel on Climate Change (IPCC, 2022; IPCC, 2022b) the risk of extreme precipitation and modification in trend of the precipitation is increasing. For this reason, in the future the risk of flooding would increase if the levels of prevention, early warning and response are not improved.

When a flood happens, the impact not only depends on the frequency and the severity of the danger, but also depends on the vulnerability of buildings and social resilience (Bonazza et al. 2021). So, to estimate the impact of an emergency it is needed to know danger, vulnerability, and resilience.

To evaluate the vulnerability in a cultural urban area, it is necessary to use methods that consider the resistance of the materials and structures, as well as the resistance of the immaterial value of the heritage building. The material and immaterial values of the cultural areas indicate how these areas will be remembered and rethought around the identity of the city (Paoli et al., 2012). As long as it is possible, it is necessary to preserve all these values.

This document has five following chapters. In the next chapter, the case studies are briefly introduced by their functions and locations in the city. The used materials and methods of implementation of Art-Index in the case of Trondheim

are described. In the section of Results and Discussion, the flood analysis and the vulnerability indexes of three CH areas are presented. Some multi-scale and multi-disciplinary strategies are suggested for each case specifically, as well as general ones to be valid for Trondheim.

## [CASE STUDIES]

This study aims to investigate a part of the upcoming events that will be caused by climate change for three case studies in Trondheim, Norway. The first area is located on the western shore of the river Nidelva. It is the worldwide famous ensemble of the Warehouses (Kittang et al. 2019). The second case is the biggest cathedral in Northern Europe that is called Nidarosdomen (Mikaelsson, 2019). The third one is the DORA facilities -with a specific focus on DORA I (Grini, 2022) that is currently functioning as archive and library- in the north-eastern part of the city (fig. 1).


Figure 1: Location of three case studies. Data obtained from Google Earth.

## [MATERIALS AND METHODS]

To study the hazard, flood zones has been identified according to the 10 years period return and the 100 years period return. A map with the projection of the expected changes for the near future (2100) was also included. The data used for flood zone mapping is from Norwegian Water Resources and Energy Directorate (NVE, 2022).

Based on the produced maps, the factors which puts the Cultural Heritage (CH) sites in danger, are evaluated. Knowing the challenges, the study is to come up with ideas which would support the risk reduction, and which should facilitate the protection of the CH in Trondheim.

To study the vulnerability, the model Art-Risk (Diaz et al. 2022; Moreno et al. 2022) has been adapted to Trondheim scenery. There are different models to evaluate the risk level in a heritage area (Julià & Ferreira, T., 2021). One of these models is Art-Risk, which proposes the use of vulnerability matrix and hazards to map the level of risk in a heritage landscape (Moreno et al. 2022; Diaz et al., 2022). One of the main advantages of Art-Risk is that it allows to include factors related to immaterial values to calculate the vulnerability and risk. By this reason, this model has been selected to discuss different possible scenarios after any possible emergency in cultural urban areas in Trondheim (Norway).

Art Risk uses a list of vulnerability factors and describes five different levels of vulnerability (very low, low, medium, high and very high; 1, 2, 3, 4 and 5 respectively to obtain the numerical values for index) according to different possible situations. From the relationship between the worst possible scenario and the data collected in each building, a vulnerability index is obtained and represented as a percentage. The index is calculated by using the following formula:

$$VI = \frac{SumVulnerabilty\ factors(\ SITE)}{Sum\ Vulnerability\ Factors\ (WORSTCASE)} * 100$$

Table 1 shows the new relations established between the level of vulnerability that is evaluated according to relevant factors i.e., the current occupation, heritage value, structural modifications, maintenance for the installation system, and degree of conservation. Due to the time limitations of this study, the vulnerability levels have been simplified into 3 levels (low, medium, high).

The vulnerability values have been adapted within the theoretical international framework of integral conservation (Obad, 2019). According to this theoretical framework, the interventions in heritage areas should facilitate positive impacts in the present, as well as in the future, in the territory. Besides, it should remark the necessity to include heritage management within the urban planning . This theoretical framework offers other ways to preserve the heritage than traditional approaches. This way to understand the heritage, has been defined by some scholars as something typical for Norwegian cities (Nyseth, T., & Sognnæs, J., 2013).

The abovementioned model implemented to the cases of Warehouses, Nidaros Cathedral, and Dora I Archive allows to identify the factors that decrease the

vulnerability of these heritage places.

Besides, five possible scenarios in terms of usage of warehouses are hypothesized i.e., Museum, Offices, Community Center, Hotel, as well as without any function -vacant-. Each scenario is evaluated by the index and analyzed by considering all the defined factors.

Table 1: Vulnerability factors and level of vulnerability according to possible scenarios.

| **Vulnerability factors** | **Level of vulnerability** | | **Linguistic descriptors** |
|---|---|---|---|
| **Current occupation and use** | Low | 1 | Noticed and respected by people inside and outside |
| | Medium | 2 | Noticed and respected by people only outside |
| | High | 3 | Not noticed and/or respected by people |
| **Heritage value** | Low | 1 | Concerned and well-known at international level |
| | Medium | 2 | Concerned and well-known at national level |
| | High | 3 | Not concerned and/or well-known at all |
| **Structural modifications** | Low | 1 | Nearly no modification |
| | Medium | 2 | Modifications that made with professional guidance |
| | High | 3 | Modifications conflicting with the identity |
| **Maintenance for Installation systems** | Low | 1 | Regular condition monitoring |
| | Medium | 2 | No condition monitoring |
| | High | 3 | No condition monitoring and installation not used for long time |
| **Degree of Conservation** | Low | 1 | Optimal conservation |
| | Medium | 2 | Requires conservation |
| | High | 3 | Ruin |

## [RESULTS AND DISCUSSION]

### Flood Areas

Figure 2 shows the flood zones in Trondheim. These are located on both sides of the riverbank and in the coastal area. Figures 3, 4 and 5 show the affected zones within the 3 study cultural urban areas and show an increase in the flooded zones in the near future (2100). While the cathedral is not affected by the floods, the

Warehouse, and the archive Dora I suffer periodic floods at least every 10 years. The high frequency of the events indicates that the floods in Trondheim are not caused by climatic extreme events. Floods usually occur in late winter, when heavy rainfall falls, and the ground and gutters are still frozen (Meiforth, 2017). For this reason, it is important to take preventive measures that prevent the deterioration of the affected heritage areas in the long term. Figure 6 also shows the square meters of the Dora 1 archive that have been affected by periodic flooding.


Figure 2: Flood zones in Trondheim (forecast in 2100). Flood data obtained from NVE, 2020

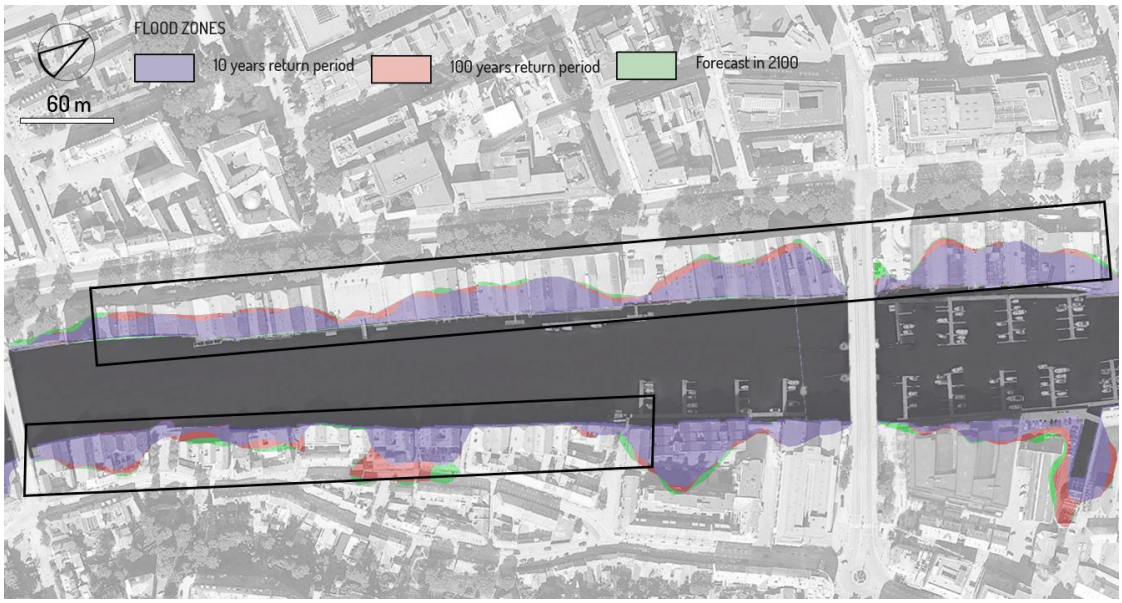


Figure 3: Flood zones near to warehouses. Warehouses are remarked with a black line. Flood data obtained from NVE, 2020

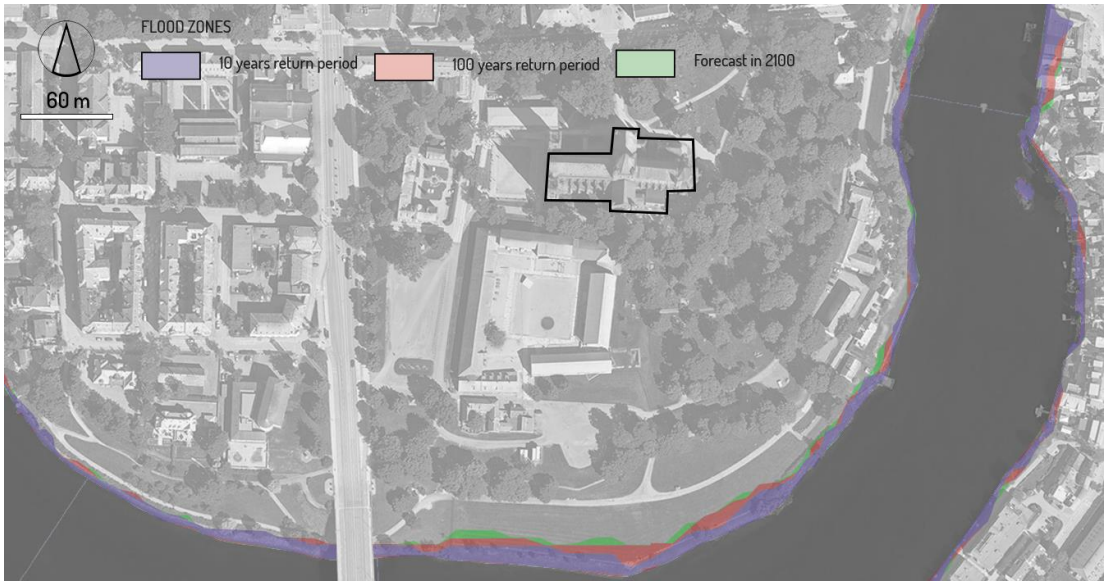


Figure 4: Flood zones near to Nidaros cathedral. Nidaros Cathedral is remarked with a black line. Flood data obtained from NVE, 2020

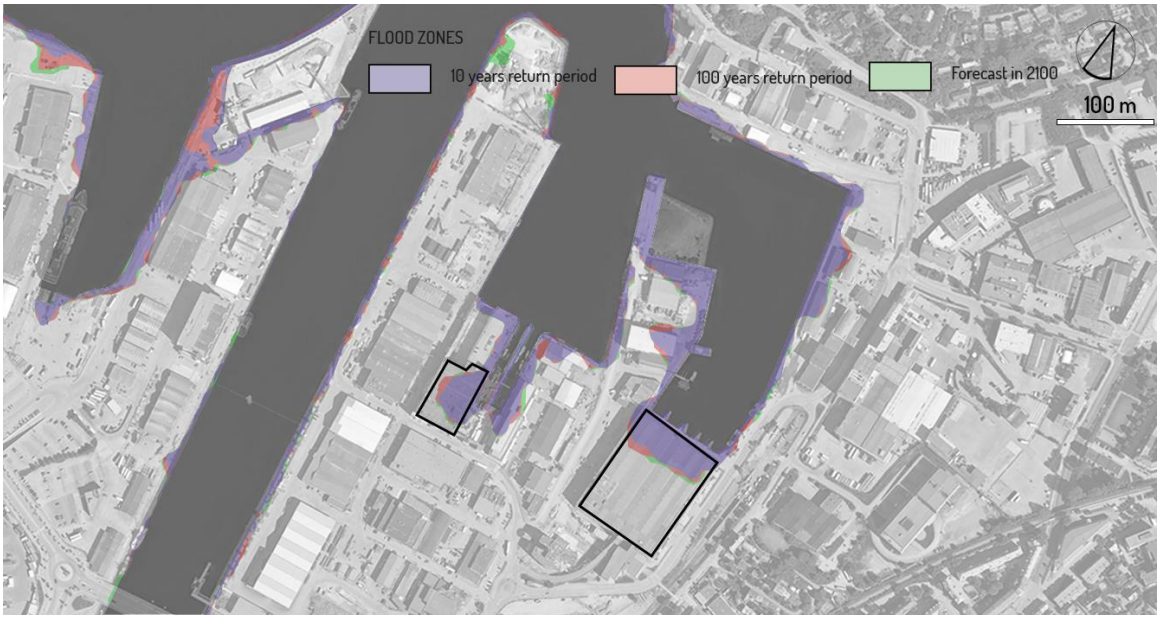


Figure 5. Flood zones near to Dora archives. Flood data obtained from NVE (2020).

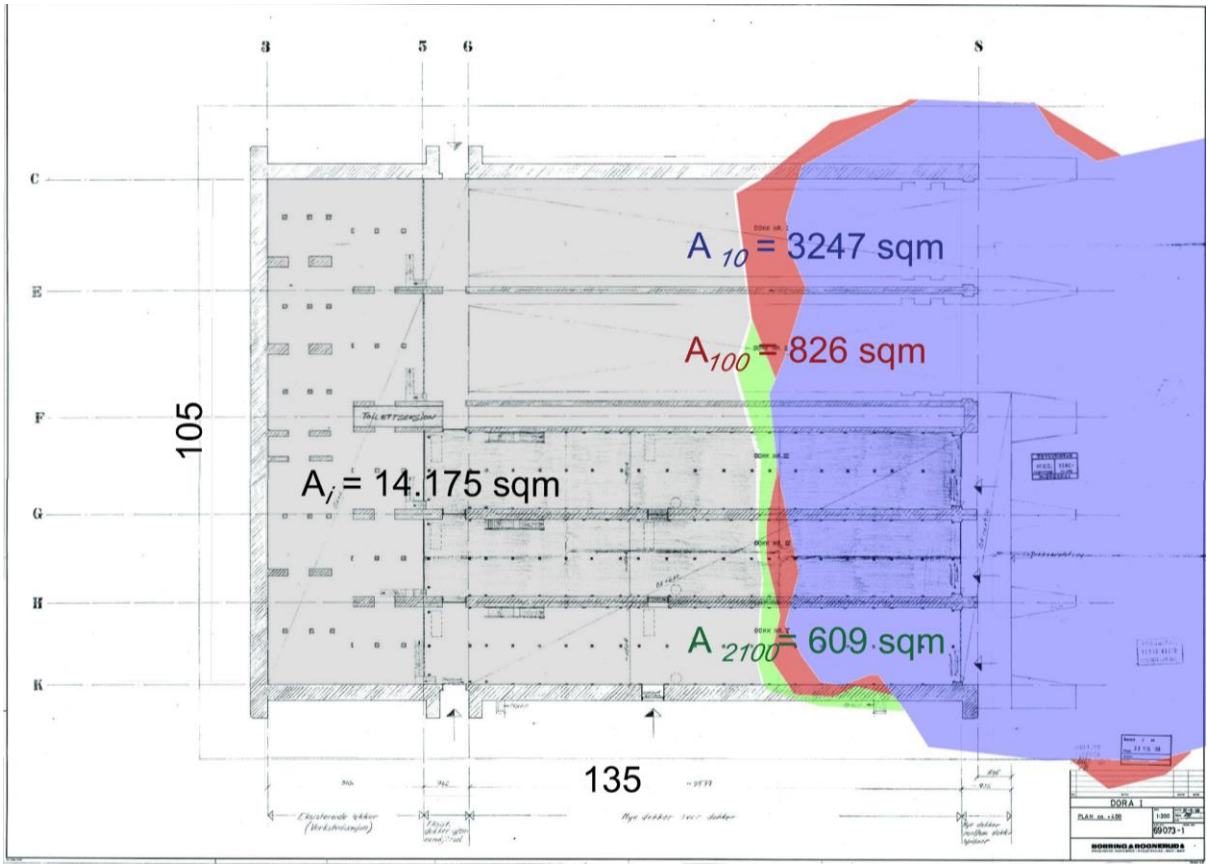


Figure 6. Flood Zone impact on DORA I. Flood data obtained from NVE (2020). Base map (1969) obtained from Municipal Archives of Trondheim (available online: https://www.flickr.com/photos/trondheim_byarkiv/4698749231)

The interior area of DORA I is calculated by excluding the exterior walls. By

overlapping the plan with flood areas, it showed that 23%, 29%, and 33% of the total floor area are at the risk of flood by following the diachronic analysis of flood areas, as it is represented in figure 6.

## Vulnerability

Table 2 shows the vulnerability index and the difference due to defined factors investigated in the three studied cases. The group of warehouses is the most vulnerable (VI= 66%) because nowadays not all of them have an occupation and use. The cathedral is the least vulnerable due to the fact that it is in currently under use every day and hour. Additionally, it is well conserved at national level without improper structural modifications, needs for the installation system. Regarding the degree of conservation, it has low vulnerability. The Cathedral is not in a flood-risk zone, so besides the least vulnerability there is no exposure to the flood hazard.

Table 2: Vulnerability matrix and Vulnerability Index (VI) of Warehouses, Cathedral and Dora I.

| Vulnerability Factors | Warehouses | Cathedral | Dora |
|---|---|---|---|
| **Current occupation and use** | 3 | 1 | 1 |
| **Heritage Value** | 1 | 1 | 2 |
| **Structural modifications** | 2 | 2 | 2 |
| **Maintenance for Installation system** | 2 | 1 | 1 |
| **Degree of conservation** | 2 | 1 | 1 |
| **Vulnerability Index** | 66,67% | 40,00% | 46,67% |

Table 3 show the vulnerability indexes of the possible five scenarios of warehouses. The most vulnerable is vacant situation without any function (VI= 86,67%) and hotel comes after with the value of 60,00%. The vulnerability by structural modifications increases particularly in the hotel and museum scenarios because there are more needs to intervene within the original building in order to meet nowadays' legal requirements for these novel functions e.g., fire protection, emergency exits, and daylight. All the vulnerability factors, except structural modification, is highest in the scenario where the warehouses are not used. On the other hand, VI decreases in the scenarios where warehouses are re-functioned as offices, hotels. According to this matrix, the least vulnerable scenarios are the functions of museums, community center, and offices.

Table 3: Vulnerability Matrix and VI for the hypothetical scenarios

| Vulnerability Factors | Museum | Offices | Community Center | Vacant | Hotel |
|---|---|---|---|---|---|
| **Current occupation and use** | 1 | 1 | 1 | 3 | 1 |
| **Heritage value** | 1 | 3 | 2 | 3 | 3 |
| **Structural modifications** | 3 | 2 | 2 | 1 | 3 |
| **Maintenance for Installation system** | 1 | 1 | 2 | 3 | 1 |
| **Degree of conservation** | 1 | 1 | 1 | 3 | 1 |
| **Vulnerability Index** | 46,67% | 53,33% | 53,33% | 86,67% | 60,00% |

## [SUGGESTED STRATEGIES]

Following the analysis some strategies are proposed for different stakeholder both specific for each case and holistic for all CH sites in Trondheim.

### Case-Specific Actions

As a re-action to the flood forecast (see figure 5 and 6), a waterproof wall that divides the internal structure is proposed as it is shown in figure 7 and 8 due to the fact that 23%, 29%, and 33% of the total floor area are endangered to be in flood zone in 10 years in return, 100 years in return, and 2100 in future forecast respectively.

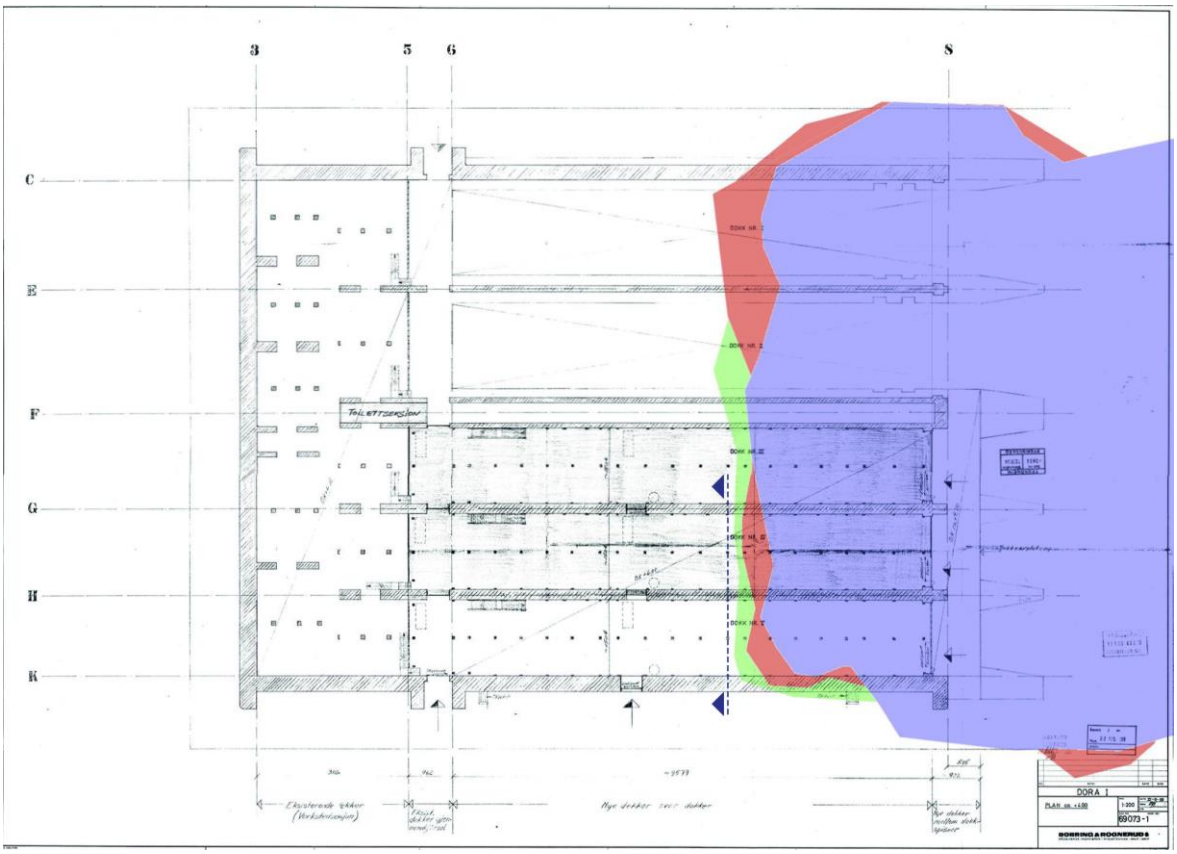


Figure 7. Overview plan for proposal wall. Flood data obtained from NVE, 2020. Base map (1969) obtained from Municipal Archives of Trondheim (available online: https://www.flickr.com/photos/trondheim_byarkiv/4698749231)

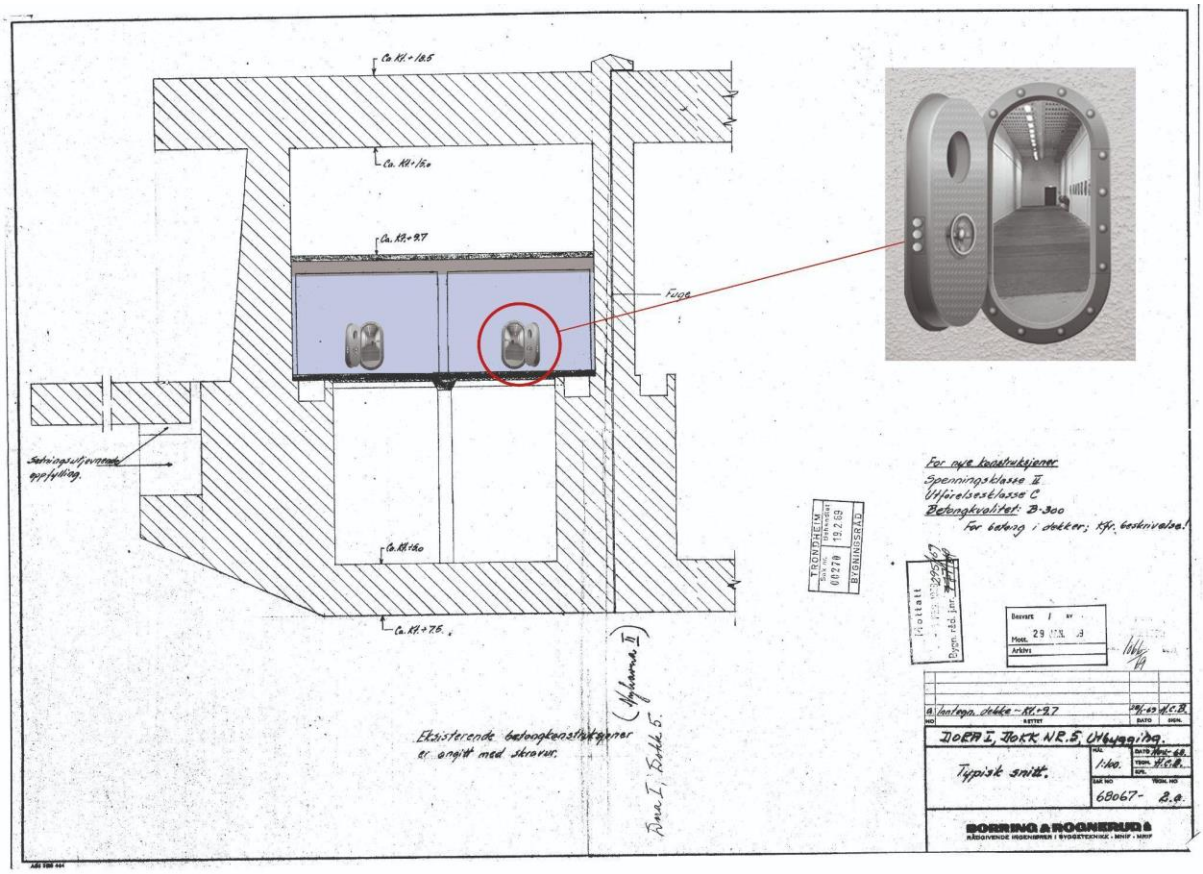


Figure 8. Section for proposal wall. Base section (1968) obtained from Municipal Archives of Trondheim (available online: https://www.flickr.com/photos/trondheim_byarkiv/4698737817/)

**Case-wide Strategies**

**In-situ diagnosis and data gathering:** Depending on the site, specific actions have to be taken. A general recommendation for all three sites is to do Laser Scans in order to have a 3D-Model of the current condition. It would be important to include characterization and aging studies of materials to study the functionality of buildings. Further it is recommended to make sure there are up-to-date architectural projects at hand, in order to have a consistent documentation.

**Questionnaire:** To explore the opinion of the community of Trondheim a questionnaire where both local residents and visitors will be the target audience. The main aim of this surveys is to study the attitudes of the local community regarding the preservation and preservation of cultural heritage and its use in a modern context. To process the results a forced Likert scale with 5 possible answers could be used.

**Stakeholder Engagement:** This topic requires a multidisciplinary and interdisciplinary collaboration with many fields such as conservatives, historicians, architects, mechanical and structural engineers, as well as users of these CH areas

(i.e., tourists and residents) and public actors from multiscale governmental organizations. A preliminary stakeholder scheme is presented below, however, as holistic stakeholder mapping is a mandatory but considering all the interests, concerned, and need of all the related stakeholders. All the possible interactions among the individuals and the organizations need to be studied and considered in all the phases of CH conservation.

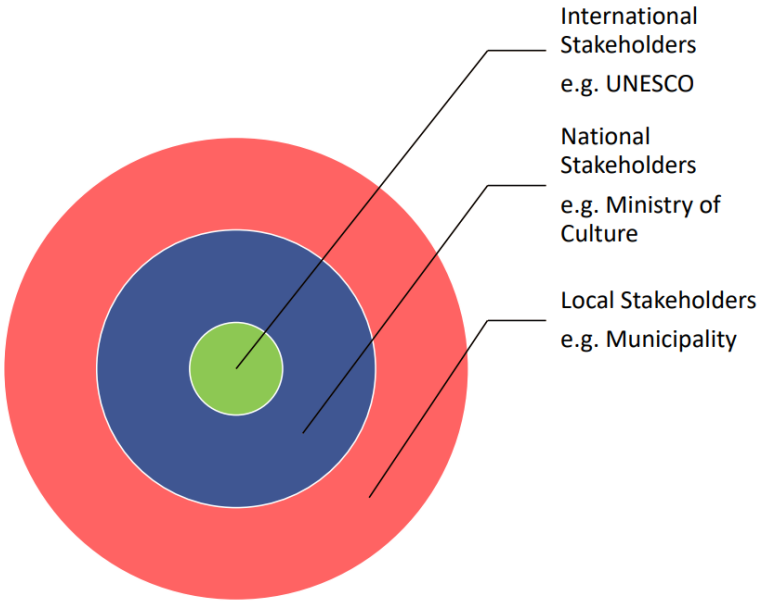


Figure 9. Stakeholder multiscale clustering

## [CONCLUSION]

Built heritage management changes according to cultural, political, and economic contexts.
It has to be researched whether there is a specific way to understand the management of heritage in Norway. It appears that preservation plans, and urban regeneration are strongly linked in Trondheim. A huge interest in preserving the heritage areas is evident since local government promotes their use. When the building has more functions and therefore represents more values, it is more likely that people come up with a solution in case of emergency. Besides, the integral conservation allows more flexible solutions than traditional conservation methods. It is considered to be an advantage that does not make the residents feel a loss and/or change of the form, the colour, or any other feature related to the CH. Even though these changes may cause an irreversible impact on the structure, they can make the CH more resilient according to integral conservation approach.

The chosen method is used to provide an overview of how grave the impact in the three case studies. The results obtained indicate that Warehouses and Dora are affected by periodic floods every 10 years. It is worth to be mentioned that these maps are not 100% accurate as they are most likely based on a climate model.

Knowing that the weather system and world is far more complex it cannot be explained 100% precisely.

Regarding vulnerability, Warehouses were more vulnerable that Cathedral and Dora I due to occupation, maintainability and conservation degree. Besides, vacant Warehouses present a greater vulnerability in an emergency.

Adapted methodology helped to describe the vulnerability level of each scenario that hypothesized for Warehouse. This documentation of Warehouses should be part of the Recovery Plans for the worst-case scenario that may cause a severe loss of the Cultural Heritage due to flooding caused by heavy rain events as represented in figure 3.

It is assumed for the Cathedral the documentation is useful but not as much needed as the flood risk maps do not indicate a risk for flooding, as represented in figure 4.

Regarding Dora I**,** the documentation should be kept as a backup. And Expert Advisory Board is needed (Structural engineers, experts for conservation as the concrete shows some damages caused by deterioration, simulation specialists) in order to conserve the shared cultural heritage site.

The preliminary results obtained serve to reflect on the current risks that affect the cultural areas of Trondheim. Next step should include some strategies by keeping the heritage value of each case study in a professional stakeholder collaboration. Stakeholders have to be as holistic as needed i.e., from local, national, and international levels, as well as the users of the city e.g., citizens, employees, commuters.

## Acknowledgments

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# GROUP 4

## Heritage Identity at Risk: Three case studies in Trondheim

*C. Aguiar Botello, I. Barakat, G. Boccacci, M. Panahifar*

## [INTRODUCTION]

Nowadays, culture and Cultural Heritage represent the most important foundation for creating and maintaining identity, belonging and citizenship values. Heritage and culture, indeed, influence and are affected by the daily life of every community and its people. The value and potential of Cultural Heritage, if well managed, is a key aspect of community development and a factor of increased quality of life in societies that are in a constant state of evolution (Di Pietro, 2017: 1).

Warehouses, Nidarosdomen and Dora bunkers are the main cultural and industrial heritages in Trondheim which influence the character of the city.

In this overview we are trying to look at three heritages in Trondheim, to see why they are part of the character of the city, what risks are treating them and what are the possible solutions for reprograming these buildings.

This overview has been separated in three chapters below, where their identity and potential risks have been analyzed:

1. Identity
2. Risk Overview
3. Conclusion

We think it is important to distinguish between environment and landscape. The environment is what we observe, the purely physical elements, the biotope. The set of natural elements living and inert that make up the environment that surrounds us. This environment is observed by us and filtered by our own consciousness and experience, which generates a personal image of what we are observing.

Therefore, the landscape is a subjective image, a perception that varies depending on the person who is in front of this panorama. Gilles Clement, in his book "Gardens, Landscape and Natural Genius", defines the landscape as what you keep in your mind when closing the eyes in front of a sight. In other words, it is a perception, almost an imagination of what really exists and that has been modified by our consciousness, our experiences and our culture.

The cultural landscape could be considered as an entropized landscape, that is, a landscape in which are present elements of the culture and society of a territory and therefore speak of human activity, of a way of inhabiting, to build, to live and etc. about a culture. In this sense, the historical complex of Bakklandet has a great value, which goes beyond its mere form or aesthetics. It is a cultural and anthropological heritage, and that is where much of its value lies. Thanks to the presence of this together, we can be aware of a way of living, of a constructive

tradition, an economic system etc.
Preserving a landscape is not preserving a picture or a panorama, is preserving history, preserving heritage, preserving culture (Figure 1). This can resume somehow this reflection, that these three concepts are in a constant dialogue shaping a system from where any of them can't be taken away.

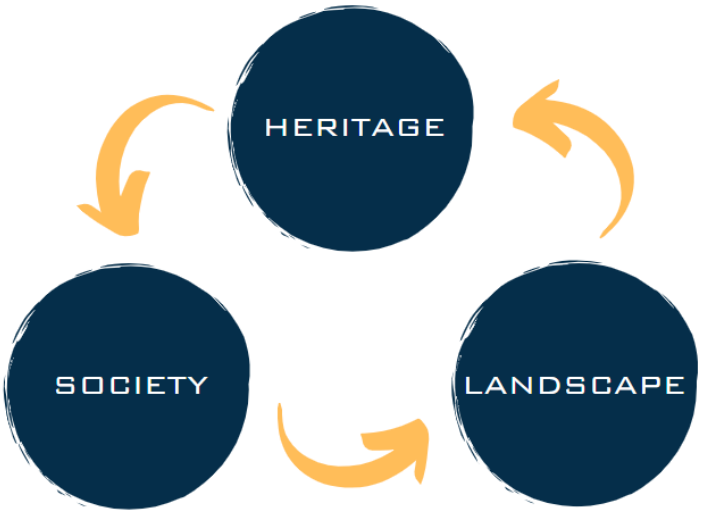



*Figure 1.* Heritage – Society – Landscape

## [IDENTITY]

What gives a building its identity? People look places with different attitudes and their perceptions are not the same. Experts in Cultural Heritage field should think differently and consider whole parameters that make an identity for a heritage.
In this overview we thought about all items which contribute the definition of the case studies. In Figure 2 are reported many aspects which influence a heritage building. We tried to organize them in categories: aesthetic, environment, society. The lack of each one will change the identity of the heritage. This means that a combination of all factors makes the identity of these three cultural heritages.

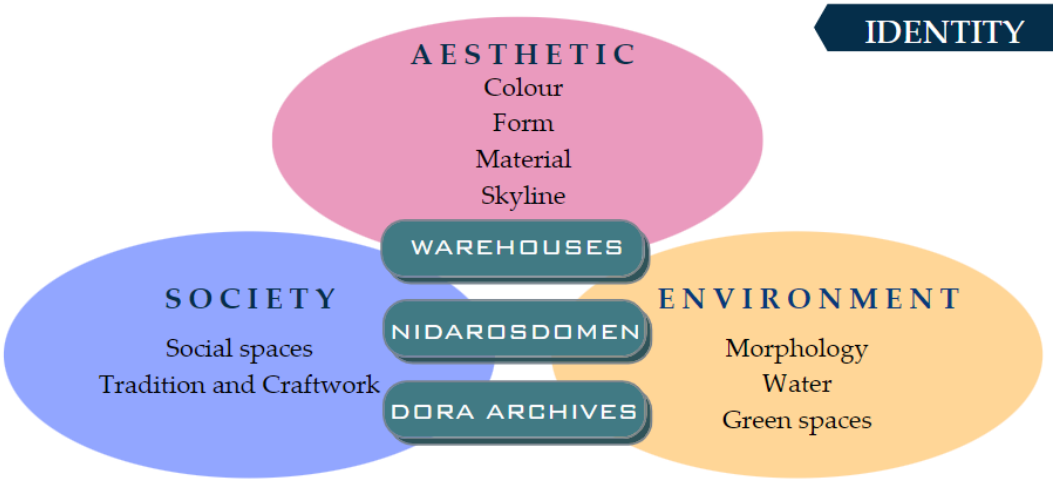



*Figure 2.* Organized categories of identification items.

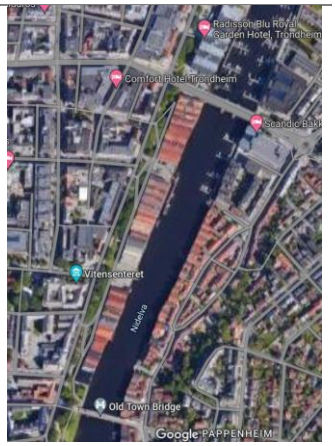
**Nidelva River Warehouses**

In table 1 are reported the identification items we found to be relevant for Nidelva river warehouses.

*Table 1.* Identification items overview of Nidelva river warehouses (Author).

| Category | Identification | Details | Picture |
|---|---|---|---|
| **Aesthetic** | Color | Various warm colors create a specific visualization |  |
| | Form | Rhythm in forms |  |
| | Material | Traditional material and structure |  |
| | Skyline | Create a unique up level view conceded with sky and sea |  |

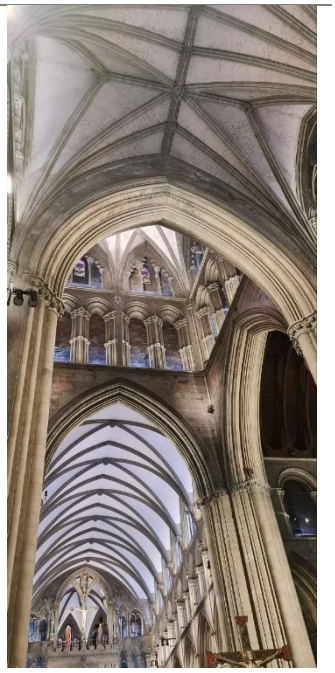
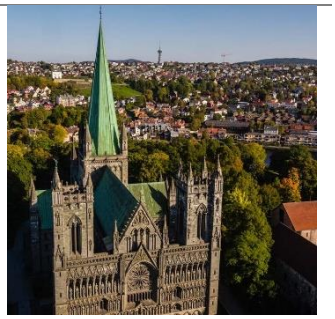
| | | | |
|---|---|---|---|
| **Society** | Social space | Beaches to relax |  URL1 |
| | | Places to work |  |
| | | Tourist attraction point |  URI2 |
| | Traditions and craftworks | Traditional structure |  |
| **Environment** | Morphology | Structured based on location |  |
| | | Located in different height from street level |  |

| | | | |
|---|---|---|---|
| | | Separated by green spaces with neighborhood |  Google maps |
| | Water | Directly connection to the sea |  |
| | | unique accessibility (boats, bridges) |  URL1 |
| | | Reflection |  |

**Nidaros Cathedral**

During the history cathedrals were the respectful places which people tried to build them skillfully because they consider them as a symbol for cities. Nidaros cathedral was not an exception of this fact and during many years while it was destroyed by fire, many times people were eager to rebuild it again and safe it. Obviously, the reason is that this building is a part of citizens' identity which is going to be discussed in detail in Table 2.

*Table 2*. Identification items overview of Nidaros Cathedral.

| Category | Identification | Details | Picture |
|---|---|---|---|
| **Aesthetic** | Material | Traditional material (soap stone) |  |
| | Form | High sharp cone structure |  URL3 |
| | Skyline | Recognized by people from all over the city |  Google Earth (3D view) |
| **Society** | Social space | Surrounded by green space to stay and rest |  URL4 |
| | Traditions and craftworks | Attractor space |  URL4 |

| | | | |
|---|---|---|---|
| | | Event center |  URL5 |
| | | Material arts |  URL4 |
| **Environment** | Morphology | Landmark of the city |  URL6 |
| | | Locating at the beginning of the way to centrum and sea |   Google map |

| | | | |
|---|---|---|---|
| | Green space | Separated by green spaces with neighborhood |  Google map |
| | | Acoustic | |

**Dora Bunker**

World war II brought a German heritage to Norway beside the dreadful results. Dora I was used as a bunker and Dora II supposed to be added to that, but it was not finished successfully. Now these huge buildings are squired Trondheim archive and Dora II is an ocean water analysis site. Based on the unique identity of Dora this heritage is kept and even it is reused as Trondheim archive. In table 3 we will discuss about the identification items regarding Dora.

*Table 3*. Identification items overview of Dora Archive.

| Category | Identification | Details | Picture |
|---|---|---|---|
| **Aesthetic** | Color | Workers community |  Google Earth (3D view) |
| | | Different color to separate the new part from the old one |  |
| | Material | | |
| | | Imported German reinforce concreate |  |

| | | | |
|---|---|---|---|
| | Form | Huge cubic form with high density |  |
| **Environment** | Morphology | effective transportation infrastructure |  Google Map |
| | | Causing a huge industrial zone | |
| | | Accessibility to sea |  Google Earth (3D view) |
| **Society** | Social space | Workers community |  Google Earth (3D view) |

Just imagine that the case studies were in different forms and colors than the real one (Figure 3). The tables are representing how each factor set a specific feature for the warehouses. Figure 4 reports an example of different locations for Nidelva's warehouses with a road in place of the river. In Figure 5 we have tried to remove the river from the satellite view of Trondheim, especially close to the cathedral zone. In Figure 6 we removed the green space surrounding the cathedral and put a huge square in place of it. In figure 7 the Dora bunker was thought as a structure far away from the sea. In Figure 8 the materials

constituting the building were replaced by other different materials to show how it would change.

*Figure 3.* Warehouses in different form and color.

*Figure 4*. Warehouses in different location.

*Figure 5*. Trondheim without its river (Google map).

*Figure 6*. Big square in place of the green area in front of Nidarosdomen (Google map).

*Figure 7*. Dora bunker far away from the sea (Google Earth 3D view).

*Figure 8*. Dora bunker with different materials.

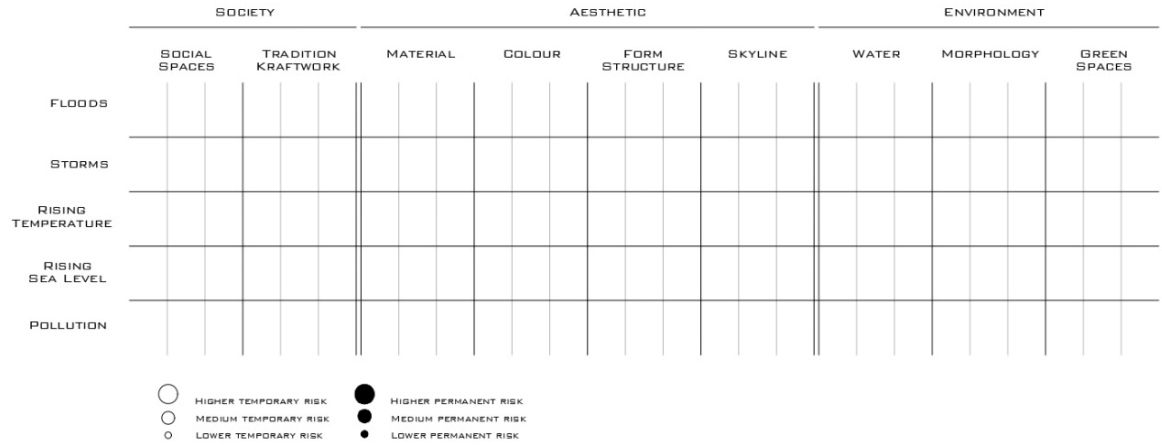
## [RISK OVERVIEW ON CASE STUDIES]

In the following tables (4-5) we tried to relate the real Climate Changes risks and the identity items we have identified to try to make connections between them and try to figure out what item would be affected by what risk. The aim was to establish strategies about what is in a more vulnerable situation, and what are the priorities, to start an active procedure to preserve the heritage, the landscape and the culture.

For this purpose, the identity items were grouped in three categories and the potential risks derived from climate changes were reported as well. A sort of icon code was used to establish the different damages that may have affected each of these items: full symbols meaning "Permanent Damage" and empty ones meaning "Temporary Damage". The different damages were also divided in three grades of severity depending on the size of the symbols (bigger ones, higher risk, medium ones for medium risk and smaller one for smaller risk) – *Table 4*. This same process was made for all the three case-

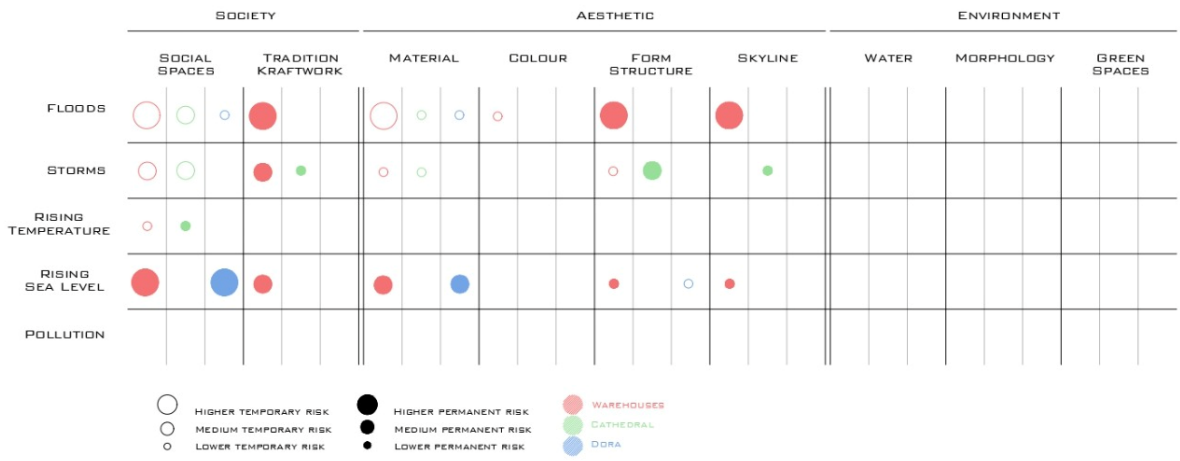
studies individually. Unfortunately, while doing this operation we faced some issues related to the lack of quantitative data to produce reliable conclusions. For this reason, we prefer to leave the table empty in order to show to the readers only the method of a possible risk analysis considering aesthetic, society and environment aspects and we really hope to have further occasions to collect data and fill out the table accurately.
Future research can consider the idea of creating one table for each of the different case studies and compare them by overlapping.
In this way, it would be possible to see analyze them as a set. This could have been the most interesting aspect of the tables because it would have allowed us to establish priorities and strategies on a preservation plan.

*Table 4.* Climate Changes risks affecting identity items (society, aesthetic, environment) in a case study.




Although it was not possible to complete the table with reliable data, the authors nevertheless tried and obtained a preliminary result (shown in Table 5). Even if not all fields are filled in, and the information contained can only be considered qualitative, it can already be noted that among the three cases taken into consideration (Warehouses, Nidarosdomen and Dora bunker), warehouses are in a more dangerous situation when we consider the possible risks associated with climate change.

*Table 5*. Preliminary results.




## [CONCLUSION]

We believe that the elements we have listed and described, categorized within the macro-areas of "aesthetic", "environment" and "society", are those that confirm and constitute the identity of these historical sites that we had the pleasure of studying and visiting during the Summer School. The identifying elements define the landscape and heritage of Trondheim and must be preserved in the final aim of preserving the landscape, society and heritage.

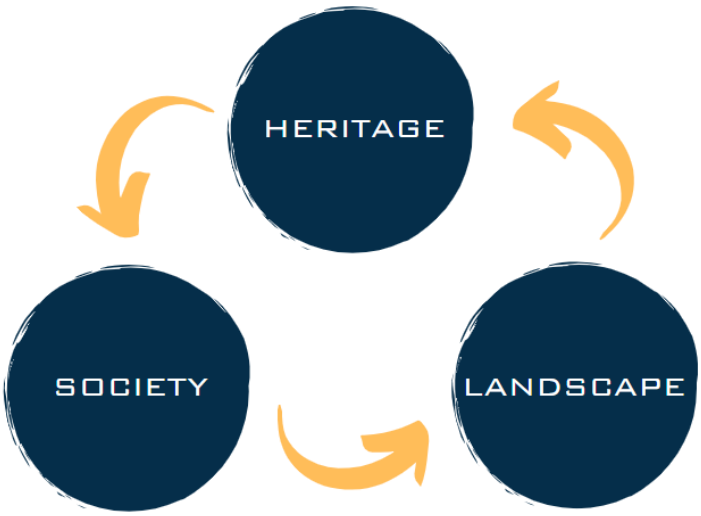



*Figure 9.* Relationship between Heritage – Society – Landscape.

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# PART IV

*C. Bertolin, A. Califano, M. Schwai*

# CONCLUSIONS

The concept of the CHePiCC Summer School and its Outputs focuses on built cultural heritage as integral part of cultural landscapes and vice versa, both seriously affected by climate change and related natural catastrophes.
Climate change itself is the connecting element and affects both cultural landscapes and cultural heritage. The concept for the summer university is applicable to any cultural landscape and its built heritage in Europe. It functions as important medium to gather practical experiences and get to know the respective built heritage and cultural landscapes on-site. HE students were given the chance to learn about applicable maintenance, preparedness and preservation measures by developing tailored measures for a given site and by implementing and actually testing their ideas.
The concept focuses on the effects of climate change in a certain climate zone, and develops possibilities to teach sustainable, eco-friendly and cost-efficient preparedness measures for built cultural heritage and maintenance measures for cultural landscapes. The whole concept is hybrid, student-centred, following a strict hands-on approach and is research based.

The project has brought significant contribution in terms of INNOVATION as it transferred the transdisciplinary approach to cultural heritage protection in climate change that is already well-established in research projects (purely academic basic research to applied and practical research in combination with different stakeholders) to the higher education level. In addition, it brought formats contemplated in research projects on cultural heritage protection and climate change into higher education, and it was developed as hybrid version of a summer school, tackling the challenges of bringing highly interactive and hands-on approaches to remote participants.
Moreover, the CHePiCC school has given HE learners the possibility to join not only lessons but even on-the-field visits and self-learning moments that stimulated the discussion on the topics of concern.

The project has brought significant contribution in terms of IMPACT has the CHePiCC School has been attended by people (both learners and teachers) from all over the world. In addition, stakeholders on local, regional and national levels were included in order to underline the complementarity of this project to high-level research projects on cultural heritage, climate change, cultural landscapes and cultural heritage protection carried out by the partners in the project consortium.

The target groups learned a transdisciplinary approach which is essential when dealing with aspects the subject in question. They can take this approach with them, establish it at their (future) working place or in their (future) research groups and therefore contribute to a professional behavioral change and further development within their own field.
An additional value for the project participants is that peer-learning possibilities were enhanced. The participants were enabled to build a high capacity in climate

change effects on different climate zones, landscapes and different types of cultural heritage.

The project has brought significant contribution in terms of TRANSFERABILITY has the CHePiCC School
set up allowed the transfer of either the entire topics or parts of them into almost any curriculum in higher education. HE learners can extract their specific needs from the and include them into already existing curricula or into near future ones. Moreover, the setup of the School allowed different levels of participation for the HE learners, thus facilitating equity and inclusion: listening to lessons and actively participating in the discussions brought up by the teachers; being tutored during self-learning activities and on-the-field visits; writing of final reports and preparation of presentations about the School topics.
In addition, the entire concept of the School can easily be transferred to other frameworks. As a matter of fact, the idea of the School was born from choosing a city (Trondheim, in this case), selecting the points of interest according to the School's topics, and finally engaging the local and international experts in the field (academics, stakeholders etc.) to deliver high-level lessons and activities. For this reason, the School main concept has a high potential and can be easily adapted to other conditions, cities and situations that may be interesting to study in the framework of the Cultural Heritage Protection.

**CHePiCC Summer School**

**"Cultural Heritage Protection in Climate Change"**

**30th May 2022 –4th June 2022**

**Trondheim, Norway**

**Supported by**