APPLICATION OF THE CLIMATE VULNERABILITY INDEX (CVI): BRYGGEN WORLD HERITAGE PROPERTY

CVI

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Images

All photos by Hege Bakke-Alisøy, World Heritage Coordinator Bryggen, unless otherwise noted

Front and back cover:	Bryggen's characteristic peak-roofed structures are distinct along the harbour in the larger urban landscape of Bergen.
Inside cover:	Pedestrian frontage on the harbourside of the Bryggen World Heritage property.

CVI

VALUES-BASED | SCIENCE-DRIVEN | COMMUNITY-FOCUSED

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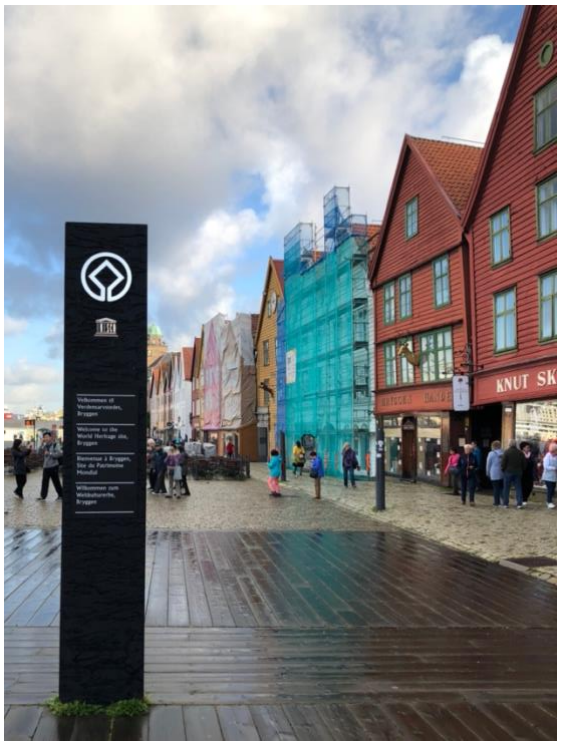

BERGEN KOMMUNE

RIKSANTIKVAREN

Norwegian Meteorological Institute

JAMES COOK UNIVERSITY AUSTRALIA

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EXECUTIVE SUMMARY

Narrow passageways between wooden buildings are a feature of Bryggen.

EXECUTIVE SUMMARY

Climate change is the fastest growing global threat to heritage places around the world, with many places already experiencing significant negative impacts and degradation. Recent observed trends in a range of climate stressors are expected to continue and accelerate as climate change intensifies.

Following the success of an application of the Climate Vulnerability Index (CVI) for the Vega Archipelago World Heritage (WH) property, the management authorities of the Bryggen WH property in Bergen sought to apply the CVI to assess the climate vulnerability of Bryggen.

Bryggen is characterised by wooden buildings with distinctive peaked-roofs that provide the setting for a complex, fragile and unique cultural heritage. While it is a small WH property in terms of size, it is far from immune to climatic influences. Bryggen's complexity relates to both its visible and subterranean heritage aspects, each of which are subject to climate impacts, and to the management innovations already underway to address those impacts.

The CVI assessment was undertaken in April 2023 during a workshop in Bergen, involving representatives from three management agencies for the property, other experts and community representatives, and guided by the co-developers of the CVI. Four key values were identified for the property, drawn from the approved Statement of Outstanding Universal Value (OUV). This report describes the outcomes of that expert appraisal of the effects of climate change on Bryggen using the best-available climate science.

Assessments of the current condition of the key values revealed that two-thirds of attributes were considered to be in Good condition and only one attribute of Significant concern. In the 44 years since inscription, all components of key values were stable (86%) or had improved condition (14%). Variability existed within each of these assessments, including recognition that some individual structures were in Critical condition.

A standardised list of climate stressors is considered in the CVI process to determine which are most likely to impact the key values. The three key climate stressors identified for Bryggen were:

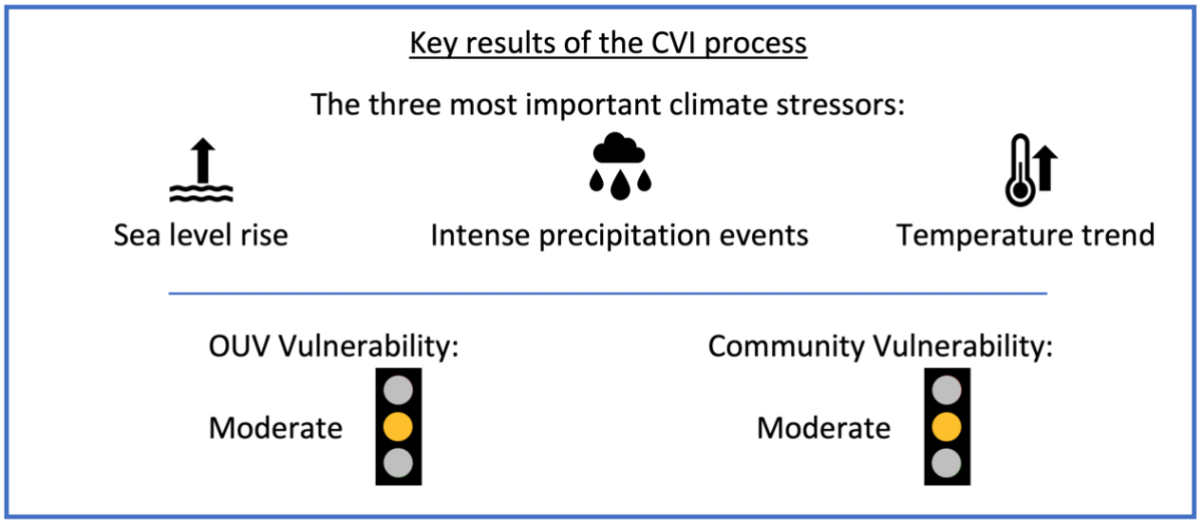
- *Sea level rise*;
- *Intense precipitation events*; and
- *Temperature trend (air and/or water)*.

Workshop participants selected ca. 2100 as the future time scale on which to assess vulnerability and chose to consider a high-emissions scenario (RCP8.5). These three key stressors are likely to interact with each other, as well as with other stressors, to increase the vulnerability of the property over this time scale.

The CVI process determined that the **OUV Vulnerability** for the property to be **Moderate** (on a three-point scale, Low/Moderate/High), indicating the potential for some decline or alteration of many of the values and attributes that comprise the OUV. However, this assessment relies heavily upon the intended mitigation of *Sea level rise* for the city, without which the OUV Vulnerability would have been in the highest category.

Six key economic activities connected with Bryggen were also identified, with varying degrees of reliance upon the values and attributes. Three of these activities (Tourism, Restoration and the Hanseatic Museum) have strong linkages to social and cultural aspects of the community.

The workshop assessed the **Community Vulnerability** to also be in the middle category (**Moderate**). Each of these assessments considered the adaptive capacity of WH values and their management, and of the community.



Various adaptive strategies were discussed to mitigate potential impacts from the key climate stressors. These were prioritised based on feasibility and likely future resourcing for their implementation. Importantly, without timely implementation of those strategies (particularly in response to *Sea level rise*), the OUV Vulnerability would revert to the highest category.

The workshop participants identified a broad range of existing and potential management actions, including:

- applying a precautionary approach to ensure that new or proposed activities do not have negative impacts on the OUV;
- minimising other stressors on the property, thereby enhancing the existing resilience of the historical and archaeological heritage;
- enhancing research and monitoring efforts to better predict and understand changes in Bryggen and address knowledge gaps;
- improving collaboration between the WH managers and researchers/academia to address the management needs; and
- including the outcomes from the CVI workshop in a review of the Bryggen Management Plan, throughout which climate change mitigation and adaptation need to be effectively integrated.

The vulnerability assessment for Bryggen addresses the effects of climate change on a significant part of the city of Bergen. Understanding how climate change will impact the values of this area may also inform other urban WH properties with similar values. Knowledge acquired at Bryggen may also be transferable directly to the management of similar cultural heritage properties in Norway and elsewhere in Europe.

Immediate global action to substantially reduce greenhouse gas emissions is critical, especially to reduce climate change impacts in the near-term. The combination of actions to address climate change (mitigation) and support climate adaptation will be essential to maintain the OUV of Bryggen.

SAMMENDRAG

Klimaendringer er i dag den raskest økende globale trusselen mot natur- og kulturarv. Mange kulturmiljøer og -minner opplever betydelige negative konsekvenser og forringelse. Ulike klimafaktorer har økende effekter og konsekvenser. Dette vil fortsette, og akselerere ytterligere, ettersom klimaendringene intensiveres.

Arbeid med klimasårbarhetsanalyse for Vegaøyan verdensarv med metoden Climate Vulnerability Index (CVI), har gitt gode erfaringer for ivaretagelse av verdensarv i møte med klimaendringer i Norge. Det var derfor ønskelig å anvende CVI-metoden for å vurdere klimasårbarhetene til verdensarvstedet Bryggen.

De karakteristiske trebygningene som utgjør verdensarvområdet Bryggen kjennetegnes av lange bryggegårder med fasadegavler mot havnen, og utgjør en sammensatt og sårbar kulturarv. Verdensarvstedet har en begrenset geografisk avgrensing, men er på langt nær immun mot klimatiske påvirkninger. Bryggens kompleksitet er knyttet til både strukturene over bakken og grunnforholdene som blir påvirket av klima på ulike måter. Dette gjenspeiles også i allerede iverksatte og gjennomførte tiltak.

Det ble gjennomført en CVI-workshop i Bergen i april 2023 med ulike aktører tilknyttet verdensarvstedet, inkludert offentlig forvaltning, eiere og ulike fageksperter. Arbeidet ble ledet av teamet som har utviklet CVI-metoden. Fire hovedverdier ble identifisert for verdensarvstedet, utledet fra beskrivelsen av Bryggens "Fremragende Universelle Verdi", eller «Outstanding Universal Value» (OUV). Denne rapporten redegjør for hvordan pågående og fremtidige klimaendringer vil påvirke Bryggen, basert på beste tilgjengelige klimadata.

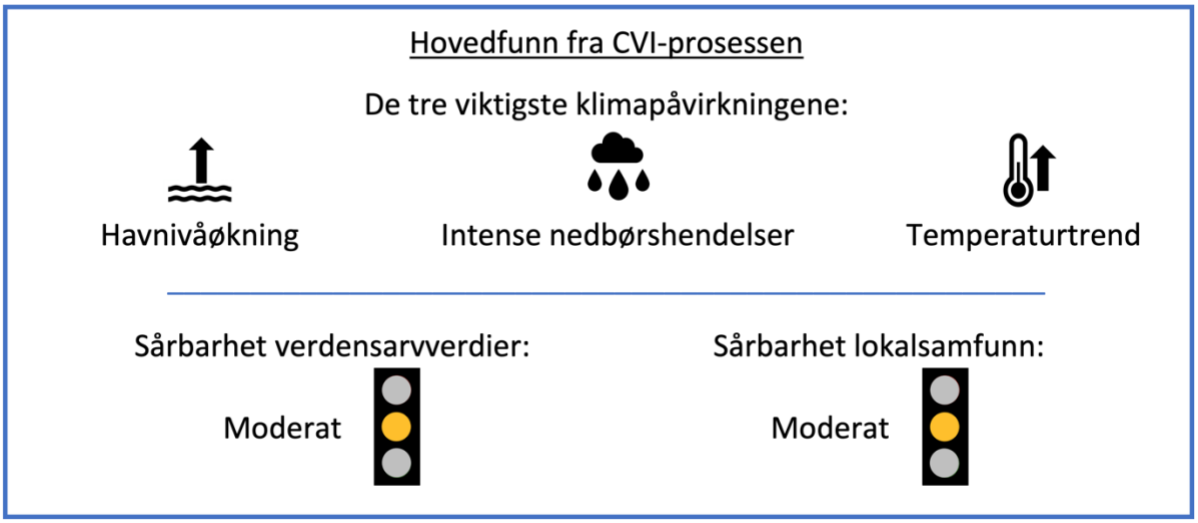
Vurderinger av nåværende tilstand for verdensarvverdiene viste at to tredjedeler av kjennetegnene for verdensarven (attributtene) ble vurdert til å være i god stand. Ett kjennetegn vurderes som sterkt truet. Siden innskrivingen på verdensarvlisten i 1979 vurderes det at alle komponenter som inngår i verdensarven samlet enten har opprettholdt (86%) eller forbedret tilstand (14%). Det er samtidig viktig å påpeke at det er variasjoner innenfor disse vurderingene, og enkelte individuelle strukturer er i en kritisk tilstand.

En standardisert liste med ulike klimafaktorer vurderes i CVI-prosessen for å avgjøre hvilke som har størst sannsynlighet for å påvirke verdensarvverdiene. De tre viktigste klimafaktorene identifisert for Bryggen er:

- *Havnivåstigning*
- *Intense nedbørshendelser*
- *Temperaturtrend.*

For å vurdere sårbarhet ble ca. 2100 valgt ut som fremtidig tidsskala med et høyutslippsscenario (RCP8.5) som premiss. De tre klimafaktorene over kan antas å ha effekter både hver for og i samspill, samt også i kombinasjon med andre klimafaktorer, som vil øke sårbarheten til verdensarvstedet i løpet av denne tidshorisonten.

CVI-prosessen fastslo sårbarheten knyttet til verdensarvverdiene, OUV, som Moderat (trepunktsskala, lav/moderat/høy). Dette indikerer potensiale for en viss degradering eller endring av verdensarvverdiene og kjennetegnene som utgjør stedets fremragende universelle verdi. Denne konklusjonen forutsetter imidlertid at planlagte avbøtende tiltak mot fremtidig *havnivåstigning* gjennomføres. Uten slike tiltak vil sårbarheten for verdensarvverdiene (OUV) være H**øy**.



Det ble også identifisert seks sentrale økonomiske faktorer knyttet til verdensarvstedet Bryggen, med varierende tilknytning til verdensarvverdiene og kjennetegn. Tre av disse faktorene (turisme, restaurering/istandsetting og Det hanseatiske museum) er lokalt både sosialt og kulturelt viktige.

Workshopen vurderte sårbarheten for lokalsamfunn også som Moderat. Sårbarhetsvurderingene tar hensyn til tilpasningsevne knyttet til verdensarvverdiene og kjennetegnene, forvaltningen av disse samt lokalsamfunnet.

Ulike strategier for tilpasning og avbøting ble diskutert for å redusere eventuelle effekter og konsekvenser av de viktigste klimafaktorene. Disse ble prioritert basert på gjennomførbarhet og sannsynlige fremtidige ressurser for gjennomføring. Det er i denne sammenheng igjen viktig å påpeke at dersom disse strategiene ikke gjennomføres (særskilt med tanke på *havnivåstigning*), vil sårbarheten for verdensarvverdiene være i den mest kritiske kategorien.

Deltagerne i klimasårbarhetsanalysen identifiserte et bredt spekter av eksisterende og potensielle tiltak, inkludert å:

- praktisere en streng tolkning av føre var-prinsippet for å sikre at nye eller foreslåtte tiltak eller aktiviteter ikke har negative virkninger på verdensarvverdiene (OUV)
- minimere andre stressfaktorer for verdensarven, og dermed styrke den eksisterende tåleevnen til den historiske og arkeologiske kulturarven
- styrke forsknings- og overvåkingsinnsatsen for å bedre forutsi og forstå endringer på Bryggen og adressere kunnskapshull
- forbedre samarbeidet mellom verdensarvforvaltningen og forskere/akademia for å ivareta forvaltningsbehovene
- inkludere resultatene fra klimasårbarhetsanalysen i rullering av forvaltningsplanen for Bryggen, og sikre at strategier for tilpasning og avbøting er integrert i planen

Klimasårbarhetsanalysen for verdensarven Bryggen ser på virkningene av klimaendringer for en betydelig del av Bergen by. Å forstå hvordan klimaendringer vil påvirke verdensarvverdiene kan være nyttig også for andre tilsvarende verdensarvsteder i byer. Kunnskap fra Bryggen kan også overføres direkte til forvaltning av tilsvarende kulturmiljøer i Norge og ellers i Europa. Umiddelbare globale tiltak for å redusere utslippene av klimagasser er avgjørende, spesielt for å redusere effekter av klimaendringer på kort sikt. Kombinasjonen av tiltak for å redusere klimaendringer generelt sammen med videre klimatilpasningstiltak vil være avgjørende for å ivareta verdensarvverdiene for Bryggen.

INTRODUCTION

Traditional wooden building techniques exist throughout the property.

SECTION 1: INTRODUCTION

1.1 Background to this report

This report outlines the results of applying the Climate Vulnerability Index (CVI) to assess the Bryggen World Heritage (WH) property[1] within the city of Bergen, one of eight UNESCO WH properties in Norway.

Climate change is the fastest growing global threat to WH properties (Osipova et al. 2017, 2020), many of which are already being impacted. The severity of current climate impacts on individual areas varies, as do the range of climate hazards causing those impacts and the rate at which they are occurring. In most cases, climate change impacts result in a degradation of the attributes that collectively convey the Outstanding Universal Value (OUV), the central concept for WH properties and the basis for inscription on the WH List.

Bryggen is a significant part of one of northern Europe's oldest ports. Today, the medieval urban structure remains as a distinct and recognisable element within the larger urban landscape of Bergen, a reminder of the city's importance as part of the Hanseatic League's trading empire from the 14th to the mid-16th century. However, Bryggen is also a unique archaeological site, not least for the urban archaeology present (and that already recorded) but also for the intensity of monitoring. Bryggen also plays a vital role in understanding and responding to the effects of climate change for a significant part of the city of Bergen.

1.2 Overview of the Climate Vulnerability Index (CVI)

The Climate Vulnerability Index (CVI) is a systematic and rapid assessment tool that is values-based, science-driven and community-focused. It was initially developed to assess the vulnerability of climate change upon all types of WH properties – natural, cultural, and mixed – but it is now being more widely applied, and through different delivery formats. The CVI is comprised of two phases assessing:

- OUV Vulnerability – based upon the exposure, sensitivity, and adaptive capacity of the key values of the property (i.e., the WH attributes that convey the OUV), assessing how they will be impacted by the three key climate stressors chosen to be the most relevant for that property; and
- Community Vulnerability – based upon the economic, social, and cultural connections of the community associated with the WH property (local, national, and international), the dependency of the community upon the property, and the capacity of the community to cope with climate change-related loss of WH values.

Both assessments of vulnerability are highly relevant for key stakeholders including site managers, management agencies, and the community that lives in and around the property. More information about the CVI is provided in Chapter 5. Through its application, the CVI enables managers and stakeholders to consider what may be appropriate strategic response actions for the management of their natural, cultural and community assets.

[1] The term World Heritage 'property' is the formal name in the international convention referring to a site or an area that is inscribed on the WH List; however, terms such as WH Site are colloquially used in other documents.

Since its initial development, input for the CVI has subsequently come from many experts around the world. This includes the International Council on Monuments and Sites (ICOMOS) and the International Union for Conservation of Nature (IUCN), the two primary advisory bodies to the WH Committee.

1.3 Why was Bryggen chosen for a CVI application?

The CVI was applied for the Vega Archipelago WH property through workshops in November/December 2021 (online) and April 2022 (in-person). The success of that application and the valuable insights gained provided the impetus to seek further opportunities to apply the CVI in Norway's WH properties. In April 2023, Dr Scott Heron and Dr Jon Day from James Cook University (JCU) in Australia were invited to Bryggen to work with the site managers and the community to assess the climate risks to the WH property and to the uses that depend upon it.

The WH property of Bryggen covers only a very small area (<1.2 ha; Figure 1.1) but the comprehensive and adaptive management approach that has been applied to the WH property over many years provides valuable lessons for other urban cultural properties combatting the effects of climate change and associated management issues. Management of the property involves a range of agencies and organisations, the primary ones being the Municipality of Bergen and its agency for Cultural Heritage Management (*Byantikvaren*); the Norwegian Directorate for Cultural Heritage (*Riksantikvaren*) and the Vestland County Council.

Bergen is renowned as Europe's rainiest city. The mountains capture the weather and are in turn shaped by the weather. The resulting rainfall provides spectacular colour and beauty to the natural environs, particularly in the spring (Bergen Kommune, 2018). The rainfall and landscape manifest in the cultural and social life of the city.

Whilst the analysis for Bryggen described here was the second CVI in a Norwegian WH property, it was the first time a wooden heritage urban-scape and associated archaeological deposits had been assessed using the CVI.

Figure 1.1 Aerial image indicating the two components of the Bryggen World Heritage property – the main section in the centre of the image (red dashed line); and the building housing the Hanseatic Museum at the right-side of the image (yellow dotted circle). *Photo: ©Mathias Falcone/visitbergen.com*

BRYGGEN WORLD HERITAGE PROPERTY

Bryggen includes a combination of traditional and 20th century building materials.

SECTION 2: BRYGGEN WORLD HERITAGE PROPERTY

2.1 The World Heritage property of Bryggen

Located on the west coast of Norway, Bergen was established in 1070, making it one of northern Europe's oldest port cities. By the 12th century, it had become an established centre for trade. Bryggen stands on a narrow stretch of land, much of it reclaimed, along the north-east side of Vågen Harbour, behind which the mountains rise steeply (Figure 1.1).

Bryggen was a main hub for the Hanseatic trade in the North Sea and Baltic regions for more than 400 hundred years. Located between the defensive Bergenhus Fortress and the medieval city centre, Bryggen became a busy and lively centre for international trade. The long, narrow tenement buildings running perpendicular to the wharf represent the typical building pattern of a northern European medieval harbour town. Bryggen has been devastated by at least seven large fires throughout the centuries. Each time Bryggen was rebuilt on top of its old foundations and refuse, leaving thick archaeological deposits under the existing structures that help to document Bryggen's 1,000-year history.

In 1978, Norway nominated Bryggen for inscription on the World Heritage (WH) List and the property was inscribed in 1979 under WH criterion (iii). Bryggen's appearance today stems from the reconstruction after the major fire in 1702, and it remains the best-preserved settlement testifying to the Hanseatic trade. That it has survived the ravages of time makes Bryggen unique.

The Bryggen WH property consists of two components (Figure 2.1). The primary area is the Hansa Quarter; the second smaller component is closer to the head of the Vågen harbour at Finnegården and currently houses the Hanseatic Museum.

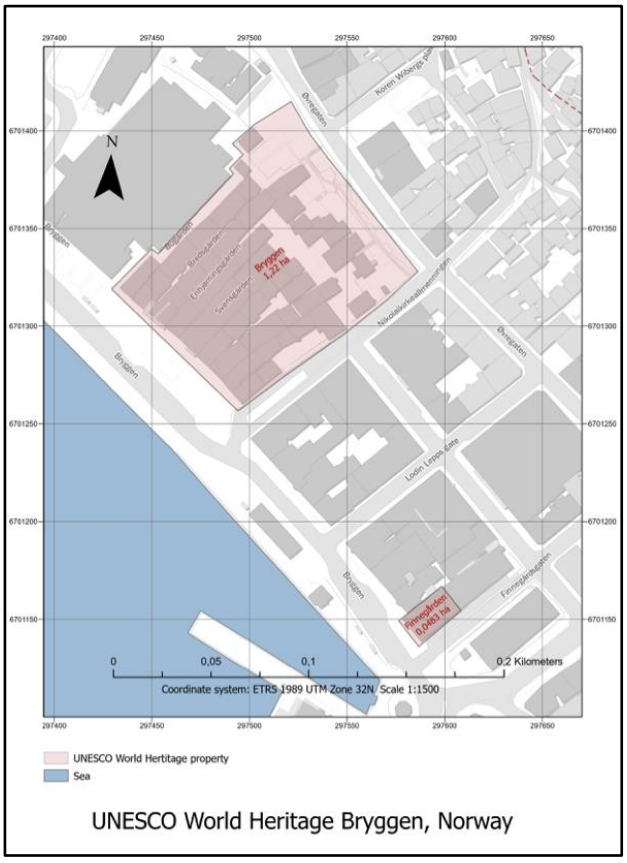


Figure 2.1 Map of the two components of the Bryggen World Heritage property (pink shading).
Source: https://whc.unesco.org/en/list/59/maps/

Conceptually, the property may be considered as three distinct but interdependent parts (UNESCO/ICOMOS 2022):

1. Most evident is the built fabric of the property. The timber and stone buildings, many dating to the years after the 1702 fire, form the primary area used historically by the Hanseatic traders in Bergen. Kitchen gardens were located at the back of the property abutting Øvregaten, while the Finnegården component consists of a single building.
2. The archaeological and cultural deposits beneath Bryggen, which are essential to the authenticity and integrity of the OUV of the property.
3. The urban context of these built structures. The relationship of these warehouses with the wharf (on the Vågen harbour), the built city and the mountains behind is both a spatial and functional relationship.

2.1.1 The visible heritage of Bryggen – the timber and stone buildings

The most obvious aspects of Bryggen are the timber and stone buildings adjoining the remains of the historic wharfs; of particular note:

> *"… some 62 buildings remain of this former townscape and these contain sufficient elements to demonstrate how this colony of bachelor German merchants lived and worked" … "rows of two- to three-storey buildings … have gabled facades towards the harbour and lie on either one or both sides of the narrow passages that have the functions of a private courtyard. The houses are built in a combination of traditional timber log construction" … "Towards the back [of the buildings] … there are small fireproof warehouses or storerooms built of stone, for protection of special goods and valuables against fire."*
>
> [excerpt from the Statement of Outstanding Universal Value – see Appendix 1]

The Advisory Body evaluation (ICOMOS 1978) included the statement that Bryggen:

> "*… bears the traces of social organization of space going back to the 14th century [and] suffered damage over the centuries, some of the most devastating of which being the fires of 1476 and 1702. The quarter nevertheless retains a medieval appearance due to the fact that it was always reconstructed in accordance with the original plan and using traditional techniques.*"

The size of the wharf complex at Bryggen has been reduced by some demolition at the turn of the 19th century and various fires, the most recent in 1955. About one-quarter of the original Hanseatic wharf precinct remains today. The medieval urban structure is still discernible; and the remaining buildings have enough elements to demonstrate Bryggen's original functioning and evidence of the Hanseatic period through the buildings, archives and artefacts.

Architectural surveys of the buildings from 1900 onwards support its authenticity. The medieval structure in the organisation of the plots of land constituting Bryggen has remained since medieval times. A notable change to the urban structure was undertaken in 1965 to create an open area for fire emergencies, by moving some buildings at the back. Since then, the urban structure has not been modified. A directed programme aimed at the preservation of the built fabric of Bryggen commenced in the 1960s and had made major progress by the time of the inscription of the property on the WH List in 1979. '*The Bryggen Project*', an extensive and long-term State-funded project, was established formally in 2000 to monitor, safeguard and restore Bryggen, including both archaeological deposits and standing buildings.

2.1.2 The less visible heritage of Bryggen – the archaeological deposits

The archaeological significance of Bryggen was uncovered following a major fire in 1955. Subject to heritage legislation, the fire-ravaged area was slated for archaeological investigations that, at the time, were assumed would be completed in six months. However, the excavations lasted continuously for thirteen years, with some follow-up excavations up until 1979. These excavations revolutionized medieval archaeology in northern Europe, both in the methods employed and the sheer size of the endeavour. Never before had so many artefacts from daily life in the Middle Ages been collected, providing a wealth of knowledge about the lives of the townspeople that lived in medieval Bergen.

These archaeological deposits were built up over many centuries to depths to 10 m, beneath and in front of Bryggen (Figure 2.2). The cultural deposits at Bryggen have a very high organic content and contain different types of organic matter as well as pottery and other invaluable artefacts (Rytter & Schonhowd 2015). They not only carry the weight of the buildings (constructed on wooden rafts) but, in and of themselves, are of unquestionable importance. The maintenance of appropriate water levels in these deposits is critical to maintaining their structural integrity and their state of conservation (see Section 2.6).

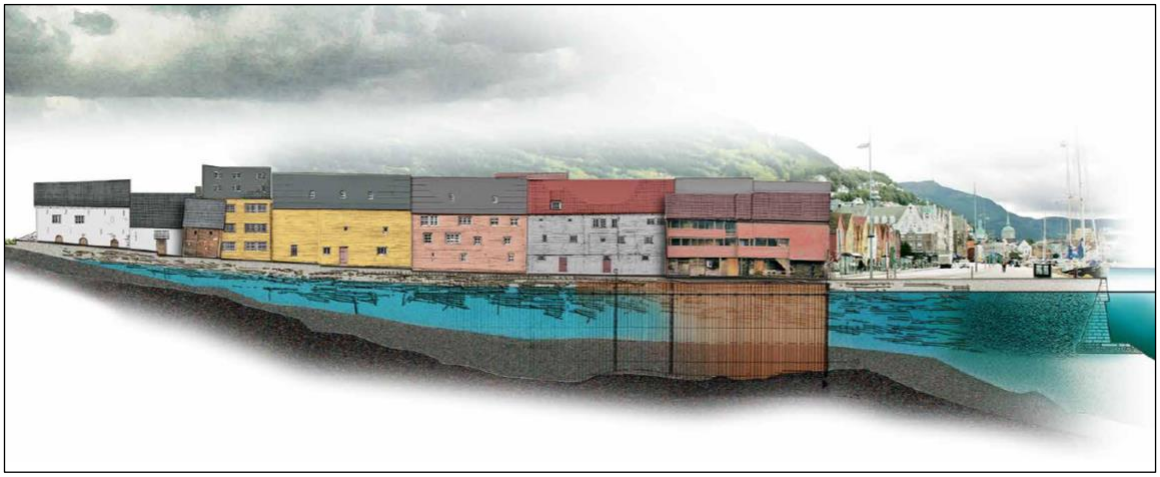


Figure 2.2 Diagrammatic cross-section of Bryggen showing the tiered wooden buildings, archaeological deposits, reclaimed wharf area and groundwater. *Drawing: T. Sponga, © Riksantikvaren*

2.1.3 The urban context of Bryggen – a harbour city surrounded by mountains

The image synonymous with Bryggen is of the row of brightly painted wooden buildings with their narrow, distinctive pointed gables along the harbourfront. The buildings were based on a common European building style, while the materials and building techniques were drawn from local Norwegian building customs (World Heritage Norway, 2020).

The historic harbourfront is today only a very small part of the city of Bergen. The waters of the harbour and the surrounding mountains provide a dramatic broad landscape setting in which the WH property is located. Bergen is known as the 'city of seven mountains' and these peaks have an influence on the city's weather and potential effects of climate change.

2.2 The Statement of Outstanding Universal Value for Bryggen

The requirements for a Statement of Outstanding Universal Value (SOUV) were introduced by UNESCO decades after Bryggen's inscription on the WH List. Consequently, a Retrospective SOUV for the property had to be prepared and was adopted by the WH Committee in 2013. Although the SOUV (Appendix 1) was approved in 2013, it was prepared based on the knowledge that was understood to exist at the time the property was inscribed. An exception is the 'Protection and management' section of the SOUV that was written using contemporary knowledge available at the time of the SOUV preparation. Among the key purposes of a SOUV are that it provides (i) the "basis for the future protection and management of the property"; and (ii) a benchmark against which the state of conservation of a WH property can be assessed.

2.3 Legislative protection

The Norwegian management system concerning cultural heritage operates from national to local levels. At the national level, the Directorate for Cultural Heritage (*Riksantikvaren*) is a government agency under the Ministry of Climate and Environment that plays an advisory role in the development of Norway's cultural heritage policy. The Norwegian *Cultural Heritage Act (1978)* is managed by this government agency and provides the strongest protection of the archaeological and built heritage in Norway. Bryggen, including its cultural deposits, was one of the first items listed under the *Built Heritage Act 1920* (which was replaced by the *Cultural Heritage Act 1978*). In addition, Bryggen is included in a larger archaeological area covering the medieval centre of Bergen, which is protected according to Section 4 of the *Cultural Heritage Act (1978)*.

Bryggen is also protected at the local level through the Norwegian *Planning and Building Act (2008)*. The City Council for Bergen, like many other Norwegian cities, has established a cultural heritage office (*Byantikvaren*) with expertise in the cultural heritage field. Within the *Planning and Building Act*, it is possible to protect objects, structures and environments with heritage value. A protection plan was adopted locally with the support of the government and the region in 2006 for the Vågen area. Several extreme weather events in Bergen in 2005 led to a greater focus on climate adaptation and, since that time, the municipality has implemented planning measures for improved surface water treatment in order to reduce the risk of floods and landslides.

The legal framework for the maintenance of the OUV, including conditions of authenticity and integrity of the WH property and its surrounding area, provides the basis for effective management and protection.

The WH property is also protected as a 'special area' (conservation area) in the municipal area plan of Bergen (*Kommuneplanens Arealdel* 2010-2021) in accordance with the Norwegian *Planning and Building Act*, with regulations and restrictions covering the historic centre of Bergen. The objective of this conservation plan is to conserve the culturally valuable buildings and their environment. In this regard, the *Kommuneplanens Arealdel* also specifies measures for the preservation of the buildings and their use.

The WH property and surrounding area was included in the 1984 general master plan for the city centre of Bergen. A revised master plan was approved in 1991 and included a long-term plan for the conservation and development of the central city. In addition, the plan shows legally protected historic buildings, as well as other areas of interest that merit protection and conservation measures.

Consequently, a wide range of governmental organisations, non-state institutions and stakeholders have an interest in the management of Bryggen including:

- *Riksantikvaren* (Directorate for Cultural Heritage)
- *Byantikvaren* (Agency for Cultural Heritage Management, Department for Urban Development, City of Bergen)
- Vestland County Regional Cultural Heritage Authority
- Bryggen World Heritage Board
- Bryggen World Heritage Advisory Board
- Bryggen Foundation (*Stiftelsen Bryggen*)
- Bryggen Private Owners
- Director of Hanseatic Museum
- Department for Mobility and Public Transport, Vestland county
- Bergen Commissioner for Climate, Environment & City Development
- NIKU (*Norsk Institutt for Kulturminneforskning*)
- Port of Bergen
- *Bybanen* project team and project managers.

In March 2021, the Bergen City Council released an updated version of the city's climate strategy. Public participation in climate planning work is not required by law in Norway (Westskog, Hovelsrud, and Sundqvist 2017), however, the new plan was co-developed with inputs from various reference groups including academia, local businesses, civil society groups and municipal interests. From the outset, Bergen's new climate plan is a highly ambitious document with the vision:

> *"Bergen is a driving force for a disruptive, radical and fair climate transition, so that everyone in Bergen can live a good life with low greenhouse gas emissions in a changed climate"*
>
> (Bergen kommune 2022, *sensu* Schrage et al. 2023).

2.4 Identifying and assessing the key values of Bryggen

A WH property is inscribed because it has values recognised as being of international significance. Those values are underpinned by attributes (tangible or intangible characteristics) that exist at the level at which management typically occurs.

A foundational component of the CVI process is an analysis of the Statement of OUV to determine the key values of the property. Excerpts from the SOUV were identified and grouped into common themes to produce a list of 'key values' for Bryggen. This was initially undertaken by the CVI developers and submitted to the Bryggen managers for review and subsequent improvement. The four key values that were identified are listed below, expanded in Table 2.1 and depicted in a series of images (Appendix 2):

1. Hanseatic heritage
2. Historic townscape and historic trading port
3. Traditional timber structures
4. Contemporary urban cityscape

These key values became foundational for the initial assessments in the CVI process. Participants in the CVI workshop assessed the current condition and recent trend (over the 44 years since inscription) of the four key values (Table 2.1, legend on p. 21).

Two-thirds (28 of 42) of the attributes were assessed to be in Good condition (dark green, Table 2.1), with a further 13 attributes evaluated as Good with some concerns (light green). The single remaining attribute (2%) was of Significant concern (orange), referring to the wooden materials of Bryggen's buildings that are susceptible to rot, insect attack and aging.

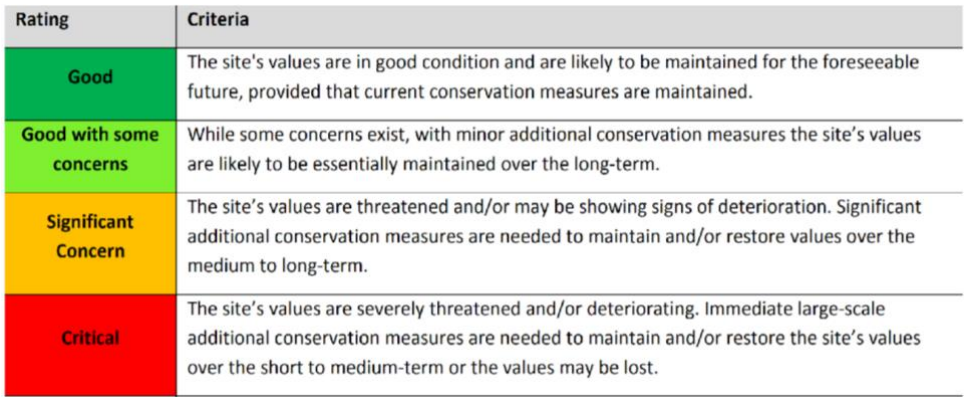
Table 2.1 Key values for Bryggen derived from the Statement of Outstanding Universal Value, together with the assessed current condition and recent trend since inscription *(refer to the legend on page 12)*

Key Values	Relevant excerpts taken directly from Statement of OUV	Attributes *(at level at which management is undertaken)*	Assessment of current condition
I. Hanseatic heritage	a reminder of the town's importance as part of the Hanseatic League's trading empire from the 14th to the mid-16th century	*Tangible attributes* • existing buildings • archives and artefacts which are well preserved for posterity • offices and dwellings at the front, warehouses in mid-section and assembly rooms, kitchen facilities and stone cellars at the back. • archaeological deposits *Intangible attributes* • importance as part of the Hanseatic League's trading empire and centre for trade • traces of social organization and illustrates the use of space • regional conservation interest • adapted to living conditions of the Hanseatic trading post. • the structure of ownership	
	established as a centre for trade by the 12th century. In 1350 the Hanseatic League established a "Hanseatic Office" in Bergen		
	They gradually acquired ownership of Bryggen and controlled the trade in stockfish from Northern Norway through privileges granted by the Crown. The Hanseatic League established a total of four overseas Hanseatic Offices		
	The German merchants took up winter residence in the small individual wooden houses and the storerooms were used as individual or collective warehouses.		
	A true colony, Bryggen enjoyed quasi-extraterritoriality which continued beyond the departure of the Hanseatic merchants until the creation of a Norwegian trading post in 1754, on the impetus of fishermen and ship owners of German origin		
	Bryggen bears the traces of social organization and illustrates the use of space in a quarter of Hanseatic merchants that dates back to the 14th century.		
	Towards the back of the gård, there are small fireproof warehouses or storerooms (kjellere) built of stone, for protection of special goods and valuables against fire. This repetitive structure was adapted to the living conditions of the Hanseatic trading post.		
	The Hanseatic period at Bryggen ended long ago, but the Hanseatic heritage is documented through buildings, archives and artefacts which are well preserved for posterity. There are also series of architectural surveys of the buildings from 1900 onwards.		
	contain sufficient elements to demonstrate how this colony of bachelor German merchants lived and worked, and illustrate the use of space in the district.		
	and the buildings include all elements necessary to demonstrate how Bryggen functioned: offices and dwellings at the front, warehouses in the midsection and assembly rooms ("Schøtstuer"), kitchen facilities and fireproof stone cellars at the back.		
	Bryggen being the only one (of four overseas Hanseatic Offices) preserved today.		

2. Historic townscape and historic trading port	… closely following the previous property structure and plan as well as building techniques	*Tangible attributes* • Ancient wooden urban structures • compact medieval urban structure • Long narrow rows of buildings separated by narrow passages • Some original buildings remain • historic harbour district • archaeological deposits • property boundaries *Intangible attributes* • adapted to living conditions of the Hanseatic trading post. • perpetuate the memory of one of North Europe's oldest ports	
	Its rebuilding has traditionally followed old patterns and methods, thus leaving its main structure preserved, which is a relic of an ancient wooden urban structure once common in Northern Europe		
	The original compact medieval urban structure is preserved with its long narrow rows of buildings facing the harbour, separated by narrow wooden passages.		
	The urban units are rows of two- to three-storey buildings signified by the medieval name "gård".		
	…heritage is documented through buildings, archives and artefacts which are well preserved for posterity.		
	Notwithstanding, the medieval urban structure is maintained …		
	It is a type of northern "fondaco", unequalled in the world, where the structures have remained within the cityscape		
	Bryggen is a historic harbour district in Bergen, one of North Europe's oldest port cities on the west coast of Norway		
	the memory of one of the oldest large trading ports of Northern Europe.		
	Appearance stems .. from time after the fire in 1702.		
	perpetuate the memory of one of the oldest large trading ports of Northern Europe.		
	Only around a quarter of the original buildings that existed in Bryggen remained after demolitions at the turn of the 19th century and several fires in the 1950s		
	Bryggen can be experienced as an entity within a larger harmonious urban landscape. It is connected more closely to the areas of small wooden dwellings beyond Bryggen and in the medieval city centre than to the larger 20th century buildings in its close proximity.		
3. Traditional timber structures	characteristic wooden houses of Bryggen. …… a relic of an ancient wooden urban structure once common in Northern Europe	*Tangible attributes* • characteristic wooden houses • long narrow rows of buildings • vernacular building traditions • gabled facades • roofs of brick tiling • building material *Intangible attributes* • craftmanship • traditional building techniques	
	The buildings are made of wood in keeping with vernacular building traditions. The original compact medieval urban structure is preserved with its long narrow rows of buildings facing the harbour, separated by narrow wooden passages.		
	It is characterized by the construction of buildings along the narrow passages running parallel to the docks		
	They have gabled facades towards the harbour and lie on either one or both sides of the narrow passages that have the functions of a private courtyard		
	The houses are built in a combination of traditional timber log construction, and galleries with column and beam construction with horizontal wooden panel cladding. The roofs have original brick tiling or sheets, a result of fast repairs after an explosion during World War II.		
	Bryggen is built of wood, which is subject to rot, insect attack and ageing		
	Since 2000, there has been an increased focus on maintaining original methods and building materials in the restoration, with careful consideration given to the choice of material, paint, plugs, nails, etc. and the use of original tools as far as possible		

4. Contemporary urban cityscape	Bryggen, the old wharf of Bergen Today, some 62 buildings remain of this former townscape. Bryggen's appearance today stems from the time after the fire in 1702. Only around a quarter of the original buildings that existed in Bryggen remained after demolitions at the turn of the 19th century and several fires in the 1950s; the property is comprised of these remaining buildings Today, Bryggen is a significant part of the historic wooden city of Bergen. Bryggen can be experienced as an entity within a larger harmonious urban landscape. It is connected more closely to the areas of small wooden dwellings beyond Bryggen and in the medieval city centre than to the larger 20th century buildings in its close proximity. The preservation of the buildings commenced on a larger scale in the 1960s and had made major progress by 1979, the year of inscription on the World Heritage List Some buildings at the back were moved in 1965 to create an open area for fire emergencies, but no further changes have been made to the urban structure since. from the 1960s the former trading in stockfish and commodities was gradually replaced by small arts and crafts businesses An increase in the number of visitors has led to the establishment of restaurants and tourist businesses Bryggen is privately owned and the majority of the buildings are owned by the Bryggen Foundation, which was established in 1962 with the objective of preserving Bryggen.	*Tangible attributes* • The old wharf and 62 buildings of former township • Historic wooden city *Intangible attributes* • historic city • World Heritage listing • national conservation interest • some parts privately-owned • the objective of preserving Bryggen	 

Legend for Table 2.1

Current condition (i.e., colour of box around arrows)	
Recent trend	

Six of the attributes were assessed to have improved since the time of inscription (upward arrow), while all others were assessed as stable through that period (no attributes were assessed overall as having deteriorated). Participants noted variability around these assessments; e.g., wooden buildings spanned the spectrum from Good to Critical condition and some had deteriorated; however, the overall assessment was of improvement since 1979 to now be Good with some concerns (noting a general rule that the deeper you look, the more issues you find).

Other comments included:

- Increased knowledge of preservation techniques has improved the quality of restoration efforts, for which continued funding support is required;
- Monitoring is required for the wooden houses;
- Original wood has greater deterioration than the new (restored) wood;
- Some foundations are no longer wood (concrete, concrete piles), whilst subterranean structures have rotted in some places;
- Underground artefacts and other archaeological deposits are an important part of the Hanseatic heritage, the preservation of which may be affected by water infiltration;
- Whilst the harbour frontage is not part of the property, it affects the medieval characteristic, including the contemporary along-harbour traffic direction (compared with the historical toward-harbour directionality);
- Notional encroachments of development around the property have occurred;
- Whilst the fact remains that Bryggen represents the history, there is on-going concern regarding continuity of the transmission of Bryggen's history.

In summary, whilst nearly all attributes were evaluated to be Good or Good with some concerns; and all had improved or remained stable in their condition since inscription, the variability within these high-level assessments is such that on-going monitoring, maintenance and improvement are essential to maintain the WH values.

While the SOUV describes the WH values, there are also property values that are not included in the SOUV but which are important locally, regionally, or nationally. They may, therefore, be recognised as 'significant' under local or regional by-laws, or national legislation or other international standards; and may reflect tangible or intangible heritage values or other values (e.g., social, cultural, economic, spiritual, environmental, scientific). Within the CVI process, these are referred to as other *Significant Property Values* (SPVs) – and these may also be subject to impacts from stressors like climate change. Appendix 3 provides a list of other SPVs developed for Bryggen.

A hierarchy of values may be helpful to distinguish WH values from other SPVs (Figure 2.2). While the other SPVs are anticipated to also experience impacts from climate change, the CVI analysis focuses on the values and attributes outlined within the SOUV.

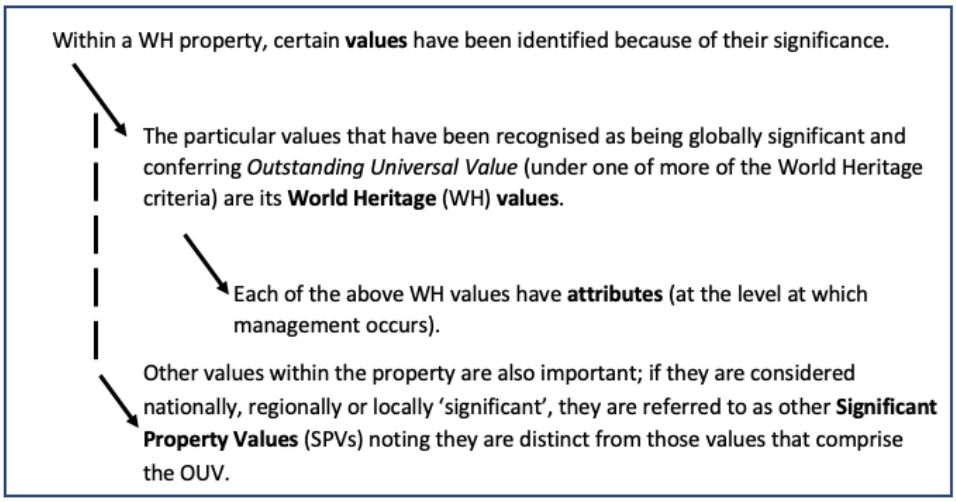


Figure 2.2 Hierarchy of terminology for values and attributes *(adapted from Heron et al. 2020)*.

2.5 Managing the World Heritage property

Today, the overall structure of the medieval harbour town remains, but the former trading areas for stockfish and commodities have been largely refurbished and gradually replaced by a variety of contemporary uses such as tourism-related businesses (giftshops, restaurants, bars, etc.), a range of professional offices and a variety of small art and craft facilities.

All the buildings of Bryggen are privately owned whereas the outdoor areas are owned and maintained by the Bergen Municipality. Of the 62 buildings within the property, 40 are owned by the Bryggen Foundation; the remaining buildings have seven private owners – some are families who have owned their building for generations and others are property developers. There is a separate association, the Bryggen Private Owners Association, established to safeguard their interests.

In 2018, a revised governance structure was approved by all stakeholders and recognised at all levels. This comprehensive management and governance structure for Bryggen has required a wider coordination between national, regional and local actors. It ensures clearly defined roles and responsibilities for its three main actors and consists of:

- a **WH Board**, responsible for the protection of Bryggen in accordance with WH requirements and the management plan. The WH Board consists of four political members (two from Vestland County Council, two from the Municipality of Bergen) appointed for four years.
- an **Advisory Board**, which strengthens cooperation between stakeholders in Bryggen with the aim of protecting its OUV and other heritage values. It consists of 10 members representing building owners, museums, university, tourism operators, cultural heritage agencies at local, regional and national level, and the friends' association. The aim is to coordinate activities and identify how each stakeholder is important for the overall management of the property.
- A full time **World Heritage Coordinator**, funded by the national government and employed at the Agency of Cultural Heritage Management, City of Bergen (*Byantikvaren*). The coordinator is the contact person for the WH property and is responsible for stakeholder involvement and site management.

A new management plan prepared for the Bryggen World Heritage Site (2021-2025) was adopted by the WH Board on 12 January 2020 (replacing the previous plan from 2005) and an action plan was adopted on 20 April 2021. The management plan offers a connection between the World Heritage Board, the Advisory Board and the political authorities at local and regional level. However, there is

no mandate to instruct either private stakeholders or public management. Hence, it is a continuous process to define the role and mandate of the local WH management structure. Stakeholders are involved through their participation in the Advisory Board and providing inputs to the overall revision of the management plan. Hence, the political acceptance of the management plan allows stakeholders to be involved in defining the framework for heritage management as well as for urban development in the adjacent area to the WH property.

The management plan contains limited information about the influence of climate change. There is a short section in the Plan on climate which briefly mentions sea level rise, expected increases in precipitation and the dangers of increased flooding. The term 'climate change' (*klimaendring*) is mentioned in the Plan but there is little in the way of strategic responses to climate concerns.

A key success factor for safeguarding the archaeological deposits at Bryggen lies in the sustainable management of the urban water balance, including groundwater. As in other cities around the world, Bergen's urban-drainage philosophy had long been focused on transporting excess water as quickly as possible off the property without realising the potential negative consequences it had on the wider surroundings. The situation at Bryggen has shown, however, that a lack of water can be just as damaging as an excess. It is now recognised that many of the previous drainage measures affected the water balance at Bryggen in a negative manner and contributed to an unbalanced situation with falling groundwater levels, decay of archaeological deposits, and subsidence.

Many measures to rectify this have now been introduced, including geological mapping, groundwater monitoring and modelling, along with geotechnical, geochemical and archaeological investigations (Rytter & Schonhowd 2015). Together these have resulted in a systematic and interdisciplinary approach to water management that has proven to be instrumental in re-establishing groundwater levels and combatting the insidious threats of subsidence and decay. Today the subsidence has been reduced to a natural rate (Rytter & Schonhowd 2015).

There was no requirement for a buffer zone when Bryggen was inscribed on the WH List in 1979 and Bryggen does not have an approved buffer zone. The setting of Bryggen, adjacent to Vågen harbour and to medieval Bergen, is an important consideration for the future management of the property. A proposal for the delineation of a buffer zone was submitted by the State Party and discussed by the WH Committee in 2019. Concurrently, the Committee recommended a Heritage Impact Assessment for the proposed light rail track to assess its potential impact on the OUV of Bryggen (which has since been undertaken). An approved buffer zone for Bryggen would be an obvious advantage as the light rail proposal and other development proposals emerge for the city of Bergen.

Bryggen is also part of the WH Cities Programme, one of the six thematic programmes approved and monitored by the WH Committee. A five-year national '*Cultural heritage for everyone'* programme was implemented from 2016 that aims to preserve intangible heritage, including reconstruction techniques, through workshops and mentoring.

By virtue of many well-coordinated efforts, Bryggen has become a unique site regarding archaeological and historical resource management in Europe. At Bryggen, considerable works have been undertaken to preserve both the visible and invisible heritage. Today, Bryggen is an exemplar of what can be achieved for preserving complex heritage resources with the help of national and local heritage management bodies and associated stakeholders.

2.6 Pressures faced in the future by Bryggen

The statement of Integrity in the approved SOUV notes that fires, excessive numbers of visitors, and global changes in climate (including more extreme weather and possibly higher sea levels), are some of the potential risks that may threaten the integrity of Bryggen. Extreme weather events in 2005 led to a greater focus on climate adaptation. Since then, the municipality of Bergen has implemented planning measures for improved surface water treatment in order to reduce the risk of floods and landslides. The wooden buildings and the organic-rich archaeological deposits provide a complex, fragile and unique cultural heritage; as such, the long-term integrity of the WH property remains under pressure.

A UNESCO/ICOMOS monitoring mission was invited to Bryggen in 2022 to provide advice to the State Party with regard to the proposed extension of the *Bybanen* light rail and its potential impacts upon the OUV of the WH property. During that visit, the mission observed a building undergoing restoration. The mission was impressed by the thoroughness with which the repairs to the foundations and stabilisation works were being undertaken whilst noting the slow pace necessitated by the application of traditional craftsmanship and available budgets.

Conservation projects that aim to guarantee the long-term integrity and authenticity of Bryggen have greatly improved the state of conservation of the property. However, a key challenge faced in undertaking restoration work is the loss of revenue for the Foundation and for the private owners from the lengthy periods during which a building cannot be used. More and faster stabilisation efforts would be welcome but should not compromise the quality of the work executed. Furthermore, the slow pace of stabilisation of the built fabric may compound the risks of the *Bybanen* project to the fragile buildings and the vulnerable cultural layers located in the property.

THE CONTEXT FOR BRYGGEN

Bryggen is one of the most popular destinations for tourists in Bergen

SECTION 3: THE CONTEXT FOR BRYGGEN

3.1 Cultural context

Bergen was originally named *Bjørgvin* ('the green meadow among the mountains') and, with a good natural port, developed to become an important European trading and maritime city in the Middle Ages. Trading from the Bergen region is thought to have begun as early as the 1020s, with the principal export of stockfish (dried cod) from the northern Norwegian coast. The earliest buildings were boathouse-like stilt houses in parallel rows up from the beach, dating from around 1000. In the middle of the 13th century, buildings in this area numbered around 30 long rows of houses. The basis for all activity was Bergen's role as a trans-shipment port to export Norwegian dried fish and other fish products abroad and as a receiving port for grain and other goods into Norway.

The increasing commercial activity at Bryggen, and ever larger vessels, led to the expansion of the quay facilities and buildings beyond the beach zone. By royal decree, Bergen was granted exclusive access to trade in items from the north of Norway in the mid-13th century. This advanced the commercial and political importance of the city, which served as the capital of Norway. The population of north German merchants was substantial from the 13th century and one of the four major foreign trading posts of the Hanseatic League[2] was founded at Bergen in 1360. The German merchants gradually gained control over all import and export of goods.

The Hanseatic merchants lived in a separate quarter of the city, which became known as *Tyskebryggen* ('the German wharf'). They adapted to the established building layout at Bryggen, with individual enterprises consisting of one or two rows of buildings along a narrow passage. Improvements to the wharfs at Bryggen led to increasingly diverse trade. As the buildings were occupied by the Hanseatic merchants, warehousing of stockfish from northern Norway and cereal from Europe was expanded to include the trade of raw materials, food supplies and other items across northern Europe. These included furs, wax, potato, flax, hemp and wood and timber products (such as wood tar). Hanseatic traders imported finished products such as cloths, spices and metal goods, especially weapons.

Whilst Bergen was not a Hanseatic town, it was one of the four 'Hanseatic offices' (together with Brügge, London and Novgorod). The Hanseatic period lasted longer in Bergen than the rest of Europe. The Hanseatic dominance of Bergen's trade gradually declined from around 1600 and trade was increasingly carried out by Norwegian merchants (many of whom had Hanseatic ancestry). When the Hanseatic office at Bryggen ceased to operate in 1754, the properties were transferred to Norwegian citizens.

Numerous fires have severely damaged the characteristic wooden buildings of Bryggen. A great fire in 1702 damaged almost the entire city. During reconstruction, the main structure of Bryggen was (where possible) preserved and rebuilding followed traditional patterns and methods, maintaining a relic of the once common wooden urban structure. In 1944, many buildings (and most roofs) in Bryggen were heavily damaged by the explosion of a Dutch ammunition ship in the harbour.

Following demolitions at the turn of the 19th century and various fires in the 1950s, only approximately one-quarter of the original buildings in Bryggen remained, which today comprise much of the WH property. These buildings preserve the medieval urban structure and include the

[2] The Hanseatic League was a medieval confederation of merchant guilds and market towns in Central and Northern Europe formed for commercial and defensive purposes. The league expanded from a few north German towns in the late 12th century to around two hundred settlements during the 13th–15th centuries, which spanned from Estonia to Poland and west to England.

elements necessary to demonstrate how Bryggen functioned with offices and dwellings facing the harbour and warehouses in the midsection, with assembly rooms ('*Schøtstuer*'), kitchen facilities and fireproof stone cellars at the back.

3.2 Social context

Throughout the 15th and 16th centuries, Bergen remained one of the largest cities in northern Europe. Today, Bergen is the second-largest city in Norway after the national capital Oslo and in 2022 had a population of approximately 289,300.

Bergen's identity with rain has become an important commercial and artistic symbol around the city, such as the Hansa brewery trucks which display the slogan 'Brewed in the rain'; local shops with names like 'Rain'; sculptures that interact with rainwater; or posters of the Philharmonic Orchestra showing the musicians holding umbrellas (Bremer et al., 2020). Bergen's identity is also shown by numerous place-specific proverbs, practices and rituals/events. One example is the locals referring to a culture of 'communal umbrella ownership', referring to the umbrellas left in public places.

Bergen is one of a growing number of cities worldwide assuming a role in climate risk governance. In 2000, Bergen was the first municipality in Norway to develop a climate plan, and the plan has been amended several times since (e.g., Bergen kommune 2022). In 2008, the city established a climate department which coordinates the work relating to climate, environment and energy. Bergen's leadership is further demonstrated through a Municipal Stormwater Management plan that prioritises water management, ensuring it is integrated into all land use planning and urban development, and ensuring that blue-green infrastructure for stormwater management is a mandatory first choice.

Bergen has a long history of international collaboration and knowledge-sharing. More than 12 years of EU projects on climate adaptation includes the ongoing BEGIN project (on blue-green infrastructure through social innovation). To further highlight the role of water management, a large interactive art installation 'The Art of Precipitation' is to be installed on the main city square as part of the BEGIN project. The installation will visualise the weather in real-time, and display precipitation data, as well as climate change information.

The city aims to be fossil fuel free by 2030, a 1.5-degree city by 2050 and have zero-emission construction sites by 2025. Expansion of the light rail system is one strategy to reduce traffic as part of urban design. Implications for (and upon) the WH values should be essential considerations within that design process. This example illustrates the complexity of factors involved in such decision processes.

Bergensers are talking about what a changing climate might mean for their city, and what their share of responsibility for tackling global environmental change might be, with their talk being translated into concrete actions in public spheres. In 2019, those actions included: school students striking; electoral debates on road tolls for reducing traffic and emissions; climate-focused music and film festivals; local businesses calculating their emissions; community garden projects; and a newspaper running daily climate articles. The "*ideas of climate change are pervasively reshaping Bergen's urban design, public narratives, cultural identity, institutions and governance; transforming it into a 'climate city'* " (Bremer et al., 2020).

Climate concern is also being created and performed by many cultural actors and institutions. Since 2008, an annual Climate Festival has been organised together with the Bergen International Film

Festival (BIFF), showing films related to climate. In February 2018, the Philharmonic Orchestra gave a free concert coupled with talks from local scientists about climate change (Bremer et al, 2020).

The social and cultural calendar is most evident in spring, with concerts and festivals in May and June. Summer (from July) is the holiday season, when Bergensers travel to their cabins or on a 'syden' (southward) trip to 'find summer' in Mediterranean climes. There are also social rhythms with the farming community around Bergen being guided by planting and harvesting seasons.

3.3 Economic context

Bergen hosts a diverse range of economic sectors, including health and social services, trade, manufacturing, tourism and transport. The more important primary industries relate to the close proximity to the coast and maritime resources, and these include aquaculture, shipping, the offshore petroleum industry and subsea technology. Non-renewable energy production (oil and gas) is a key industry for Bergen, but the region is also a leader nationally and globally in the renewable production of energy. Bergen's employment is dominated by service provision (34% in 2020, Figure 3.1; Bergen kommune 2023), followed by merchandising (18%), while the combined marine industries account for 22% of employment. Tourism is a significant industry sector, employing 8% of the work force. Bergen municipality's share of total value creation within Vestland is 63.8%, making it the engine for business development in the county (Bergen kommune 2023).

The port at Bergen is Norway's busiest in terms of both freight and passengers, with over 300 cruise ship visits a year bringing nearly a half a million passengers to Bergen, double that of 10 years prior. Bergen remains a popular destination for tourists, visited annually by some 1.8 million people (ca. 2018)[3], mostly between May and September, and Bryggen is a key drawcard for visitors.

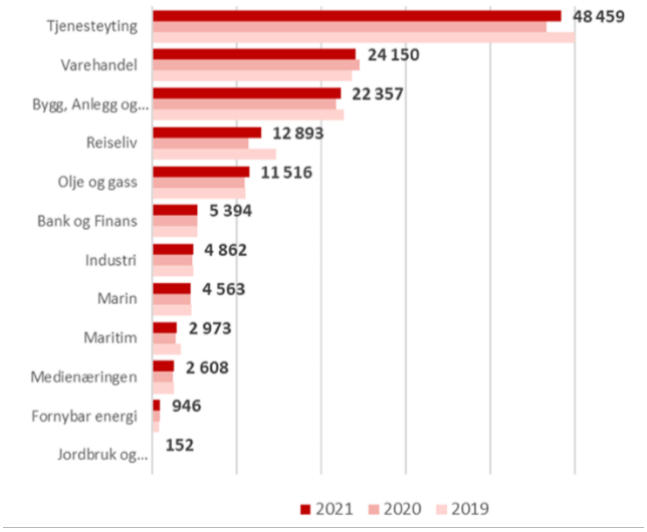


Figure 3.1 Employment by industry areas in the Bergen municipality 2019-2021 (in order from top): Service provision, Merchandise, Building/construction, Tourism, Oil/gas, Banking/finance, Other industry, Marine, Maritime, Media, Renewable energy, Agriculture).
Source: Bergen kommune (2023)

[3] In 2004, the Bryggen Foundation installed digital counting devices at the entrances to the old buildings in Bryggen. The numbers show the total number of passes, so include the passage of those who have their daily work at Bryggen. However, when "permanent residents" were deducted, figures in excess of 1.8 million visitors were estimated in 2018.

Table 3.1 Some of the activities currently, or recently, undertaken within Bryggen

Restoration services	Restoration services, construction consultancies, cultural heritage contractors, 3D artists/programming
Artisans	Potters, artists, gold and silversmiths, pipe makers, knife makers, textile artists, frame makers, leather products
Tourism	Travel guides, fishing supplies, coffee shop, gift shops, restaurants, bars, barbers, photographers, visitor centre
Hanseatic Museum	Owned by the Municipality of Bergen, the museum illustrates the work and lifestyle of the Hanseatic merchants; during restoration efforts of the museum (*Finnegården*), exhibitions were viewed at *Schøtstuene*
Professional businesses	Bryggen Foundation (*Stiftelsen Bryggen*), architects, designers, lawyers, engineers
Goods & services	Data storage, education services, illustrators, alternative medicine, tattoo studio, various consultants
Cultural aspects	Folk art, curators, art school, language school, storytellers, musicians

CLIMATE AND ITS INFLUENCE ON BRYGGEN

Changing rainfall patterns in Bryggen are projected to continue.

SECTION 4: CLIMATE AND ITS INFLUENCE ON BRYGGEN

4.1 Current climate

The climate of Bergen results from its coastal location, with mild winters and significant rainfall throughout the year. Annual average temperature increased by 0.5°C from the period 1971-2000 (7.9°C) to 1991-2020 (8.4°C), comparable with the change nationally between those periods. Monthly-average temperature ranged from 2°C in February to 16°C in August during the climatological period 1991-2020 (Figure 4.1). Annual precipitation totals averaged 2340 mm for 1971-2000 and increased to 2490 mm for 1991-2020, which was somewhat less of an increase than for Norway as a whole. The lowest monthly-average precipitation (1991-2020) occurred in May (109 mm), whilst December recorded the highest values (290 mm; Figure 4.1).

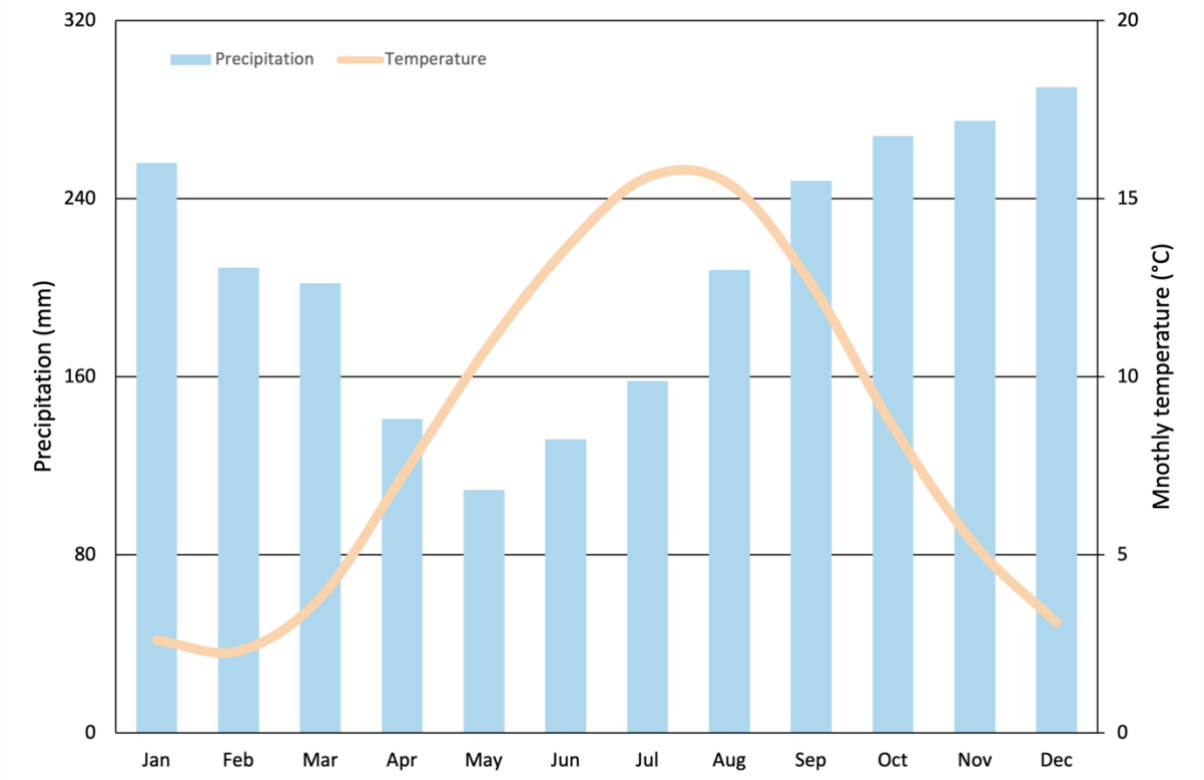


Figure 4.1 Seasonal variation in rainfall (blue bars, left axis) and temperature (orange line, right axis) for Bergen (Florida weather station) during the period 1991-2020.

4.2 Observed climate trends

Changes in the climate of the Bergen region are closely linked to changes in the climate of Vestland; however, the climate is milder. Higher rainfall occurs close to the coast than the inner fjord and valley areas that are sheltered by the mountains. Over the past century, and particularly during the most recent four decades, the temperature for Vestland has increased by more than 1°C (Figure 4.2-upper) with apparent increased variability and higher and lower extremes. Noting a general increase since 1901 with a period of faster increase during the 1960s to 1980s, the increase in annual precipitation has somewhat slowed during 1991-2020 period, however with increased interannual variability (Figure 4.2-lower).

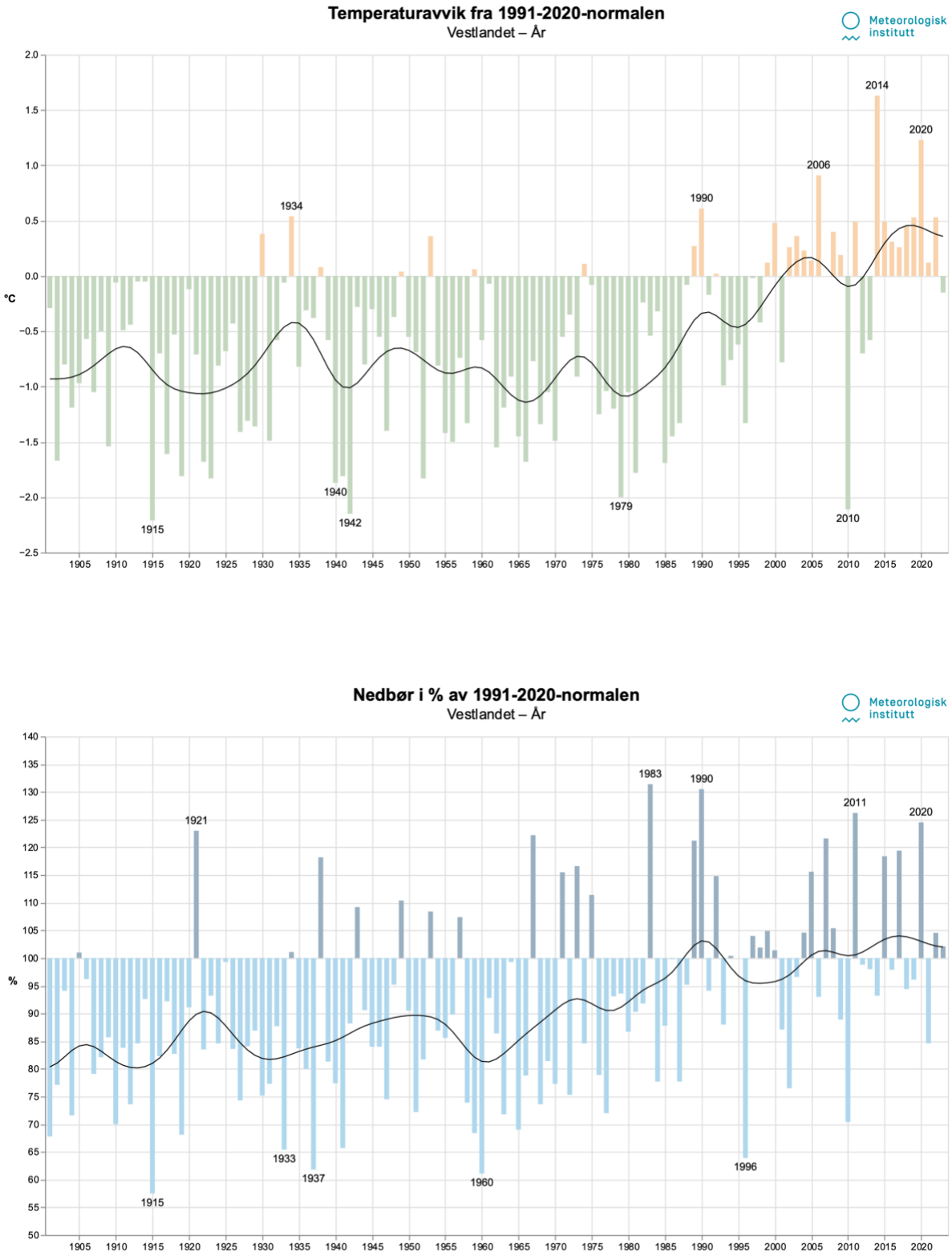


Figure 4.2 Time series of temperature anomaly (upper panel) and rainfall ratio (lower panel) for the Vestland region, 1901–2023, compared with the 1991-2020 average. *Source: Norwegian Meteorological Institute.*

4.3 Climate projections

Future impacts on marine and coastal areas are informed by reports of the Intergovernmental Panel on Climate Change (IPCC), specifically the 5th and 6th Assessment Reports (AR5 and AR6, respectively; IPCC 2013, 2021) and the Special Report on the Ocean and Cryosphere in a Changing Climate (SROCC; IPCC 2019). At the time of the workshop, AR6 outputs were not available for use in the Norwegian context. The IPCC model projections for AR5 and the SROCC were informed by the Coupled Model Intercomparison Project Phase 5 (CMIP5; Taylor et al. 2012). This defined four major scenarios for climate emissions (Representative Concentration Pathways, RCP): RCP8.5, RCP6.0, RCP4.5 and RCP2.6, where the number describes the total radiative forcing (in Watts per m^2) from each scenario in 2100. These scenarios represent various degrees of international regulations on greenhouse gas emissions. RCP8.5 is a high-emissions scenario representing a continued increase in fossil fuel dependency; RCP6.0 and RCP4.5 are scenarios in which emissions are stabilised to peak mid-century; and RCP2.6 is a low-emissions scenario in which greenhouse gas emissions are mitigated to achieve the target of the Paris Agreement to limit warming above pre-industrial levels to within 2°C (UNFCCC 2015).

The Norwegian Centre for Climate Services used information in AR5 and CMIP5 outputs to develop the report "Klima i Norge 2100"[4], from which individual fact sheets for Norway's World Heritage properties were developed[5] using projections from the RCP8.5 and RCP4.5 scenarios. For Bryggen (and Bergen), the fact sheet was informed by projections for Hordaland (now part of Vestland).

Temperature

Annual-average temperature is projected to rise by approximately 2°C (above the 1971-2000 average) by the middle of this century under the high-emissions scenario (RCP8.5; Figure 4.3-left), with only a small reduction to the warming under the RCP4.5 stabilisation scenario (Figure 4.3-right).

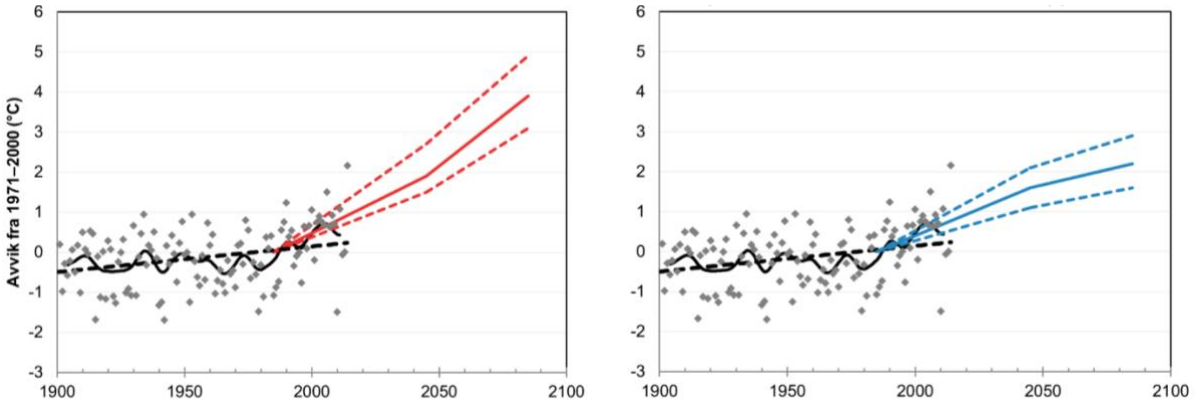


Figure 4.3 Annual-average air temperature for the period 1900–2100 as anomalies from the climatological period 1971–2000. Historical annual values (grey dots) are the same in both panels and were used to calculate trend (1900–2018; dashed black line) and smoothed 10-year variations (black curve). Projected annual temperature under Representative Concentration Pathway (RCP) 8.5 (left panel, red) and RCP4.5 (right panel, blue) based on 10 climate models. In each panel, the solid coloured line shows the median, while the dashed coloured lines indicate the range of model output.[5]

[4] Available from https://klimaservicesenter.no together with a summary in English

[5] See https://klimaservicesenter.no/kss/rapporter/klimarapport_verdensarvsteder

The largest temperature increases are projected for autumn and winter. By the end of this century, the projected warming diverges under these two scenarios – up to 4°C under RCP8.5 compared with just over 2°C under RCP4.5. As an example of anticipated effects of projected warming, the growing season is expected to increase by 1–2 months. Furthermore, the number of days with temperature exceeding 10°C ("summer days") is projected to increase under RCP8.5 from 148 days per year during the period 1991-2020 to 180 days per year mid-century and 213 days per year by the end of century.

Precipitation

Projected changes in precipitation indicate an increase in annual totals this century. This increase is projected to be 15% by the end of the century under RCP8.5 (Figure 4.4-left) and 10% under RCP4.5 (Figure 4.4-right). Projections indicate a uniform increase in precipitation across seasons. Episodes of heavy precipitation (rain and snow) are expected to become more intense, more frequent and shorter in duration in all seasons. Heavy rainfall events also bring greater potential for lightning and hail.

Due to increased temperature, the historical-average few days of snow each year are no longer expected to occur. Though heavy snow may occur in some years, a consistent snow season is no longer expected.

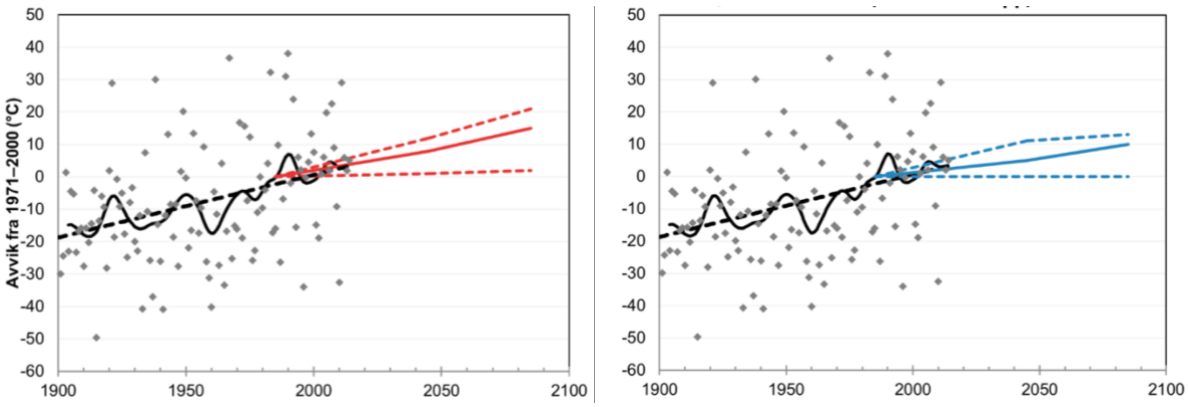


Figure 4.4 Change in annual precipitation for the period 1900–2100 as proportion of the climatological value from 1971–2000. Historical annual values (grey dots) are the same in both panels and were used to calculate trend (1900–2018; dashed black line) and smoothed 10-year variations (black curve). Projected annual temperature under Representative Concentration Pathway (RCP) 8.5 (left panel, red) and RCP4.5 (right panel, blue) based on 10 climate models. In each panel, the solid coloured line shows the median, while the dashed coloured lines indicate the range of model output.[5]

Hydrology

Although rainfall increases in all seasons, higher temperature and resulting increased evaporation lead to a relatively small projected increase in the average annual water flow in Hordaland towards the end of the century. Increased temperature will also affect water flow throughout the year because of its influence on snow accumulation, snow melting and evaporation.

Extreme water flows (including flash floods) are also anticipated to change with increase in heavy rainfall. In general, increased flood size is expected in areas where flooding is predominated by rain, particularly in small watercourses that experience more frequent episodes of heavy rainfall.

Sea level

Sea level is monitored by the Norwegian Mapping Authority[6]. Projected sea level indicates an end-of-century 56-72 cm increase under RCP8.5 for the Hordaland region (above 1981-2010 levels). No significant change in wave conditions is anticipated; however, a rise in sea level may cause waves and storm surge to extend further inland than at present. This has the potential for severe effects upon Bryggen (Figure 4.5).

Figure 4.5 Modelled impacts of a 1-in-200-year flood event upon Bryggen at the end of the century under Representative Concentration Pathway (RCP) 8.5.[5]

Wind

Projections of future wind are very uncertain and contain no statistically robust answers. The best available information suggests a minor increase in the severity of extreme winds. Improved information is expected in the next national climate report, due to be in launched in late-2025.

[6] https://www.kartverket.no/sehavniva/

Other natural hazards

The changing climate, particularly changing precipitation in the context of the mountains surrounding Bergen, may adjust the risk of other natural hazards like landslides, mudslides and avalanches. Regarding quick-clay landslides, whilst these are not specifically mapped (nor projected), the marine boundary can be used as a general caution guide. As Bryggen is located at the harbourside with significant parts below sea level, continuous depositing of marine clay, including quick clay, is possible. Most of other hazards have a probable slight increase due to more precipitation; however, changes were not quantified.

Rot risk

The changing climate will also affect the built environment, which is particularly pertinent for Bryggen. Increased rainfall and warmer temperature lead to periods of increased humidity that increase the impacts of water ingress on wooden constructions. Whilst already at a high level historically, estimated rot risk is amplified in RCP8.5 projections (Figure 4.6).

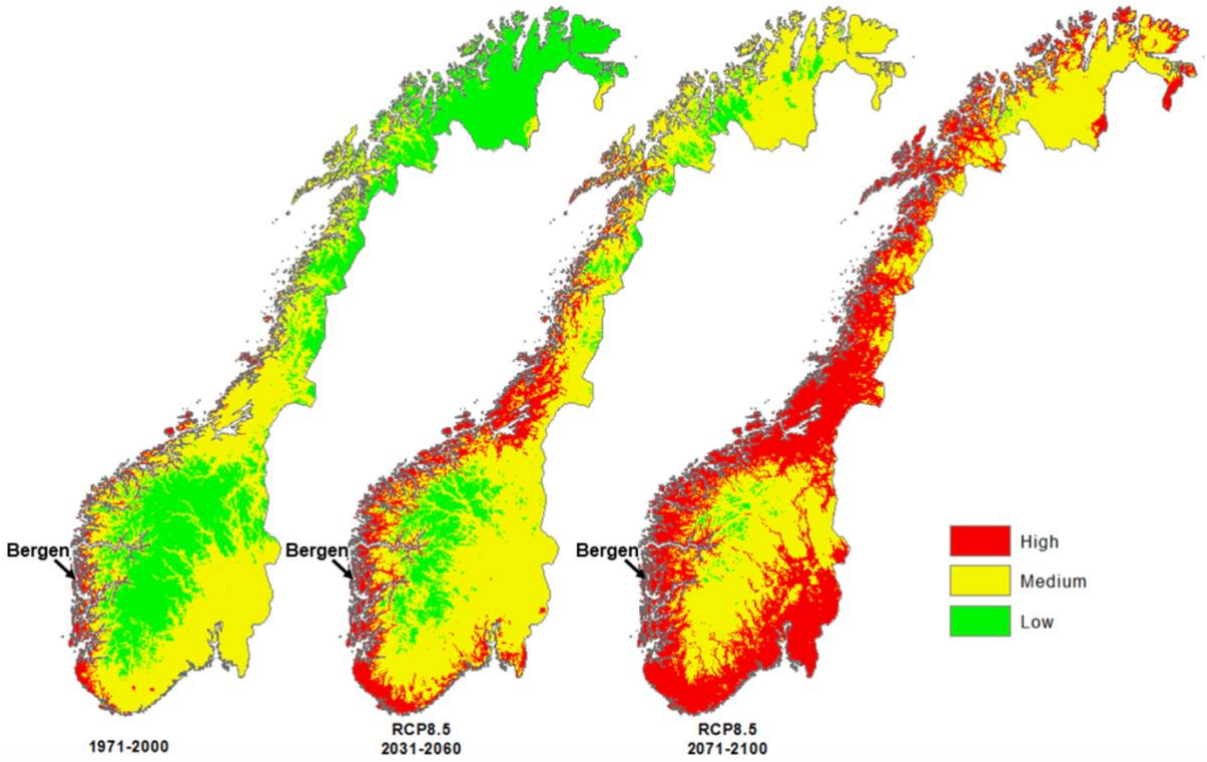


Figure 4.6 Estimated rot risk historically (left) and projected under Representative Concentration Pathway (RCP) 8.5 for mid-century (middle) and end-of-century (right), with the location of Bergen shown in each.

Other factors

Whilst modelled climate projections indicate incremental future changes to the climate system, there remains the potential for encountering major 'tipping points' that would cause rapid transitions of the global system. Relevant to Norway is the potential collapse of the Atlantic Meridional Overturning Circulation – a system of currents in the north Atlantic (including the Gulf

Stream) by which oceanic heat is transported northwards. It has been estimated that the AMOC has decreased by approximately 15% since the mid-20th century (Caesar et al. 2018), a trend predicted to continue; however, a mid-century collapse of the AMOC has also been posited (Ditlevsen & Ditlevsen 2023), which would dramatically alter the climate future for Norway. However, the climate projections presented in this section represented the best available current knowledge of future climate change and so were used in the analysis undertaken during the CVI workshop.

APPLYING THE CLIMATE VULNERABILITY INDEX TO BRYGGEN

Traditional peaked roofs minimise snow accumulation.

SECTION 5: APPLYING THE CLIMATE VULNERABILITY INDEX TO BRYGGEN

5.1 Background

The CVI framework builds upon the vulnerability framework approach described in the 4th Assessment Report of the Intergovernmental Panel on Climate Change (IPCC 2007). Vulnerability of OUV is determined by assessing the exposure, sensitivity and adaptive capacity with respect to determined climate stressors (Figure 5.1). The OUV Vulnerability becomes the starting point to assess the vulnerability of the community associated with the property, through considering economic-social-cultural connections to the WH values (Figure 5.1). A customised spreadsheet-based worksheet is used to determine outcomes based on user inputs.

The foundation for the CVI process is the Statement of OUV for a property (Appendix 1), from which key WH values are summarised (Table 2.1). Three climate stressors most likely to impact the key values (and attributes) are identified for a defined and agreed time scale (e.g., by 2050) from a list of possible stressors (Table 5.1). With this foundation established, the CVI process is initiated (for a more detailed outline of the CVI process, see Day et al. 2020).

The first phase of the CVI process (assessing the OUV Vulnerability) becomes the exposure term to assess the vulnerability of the community associated with the property (the second phase), combining with assessments of economic-social-cultural dependency (sensitivity) and adaptive capacity.

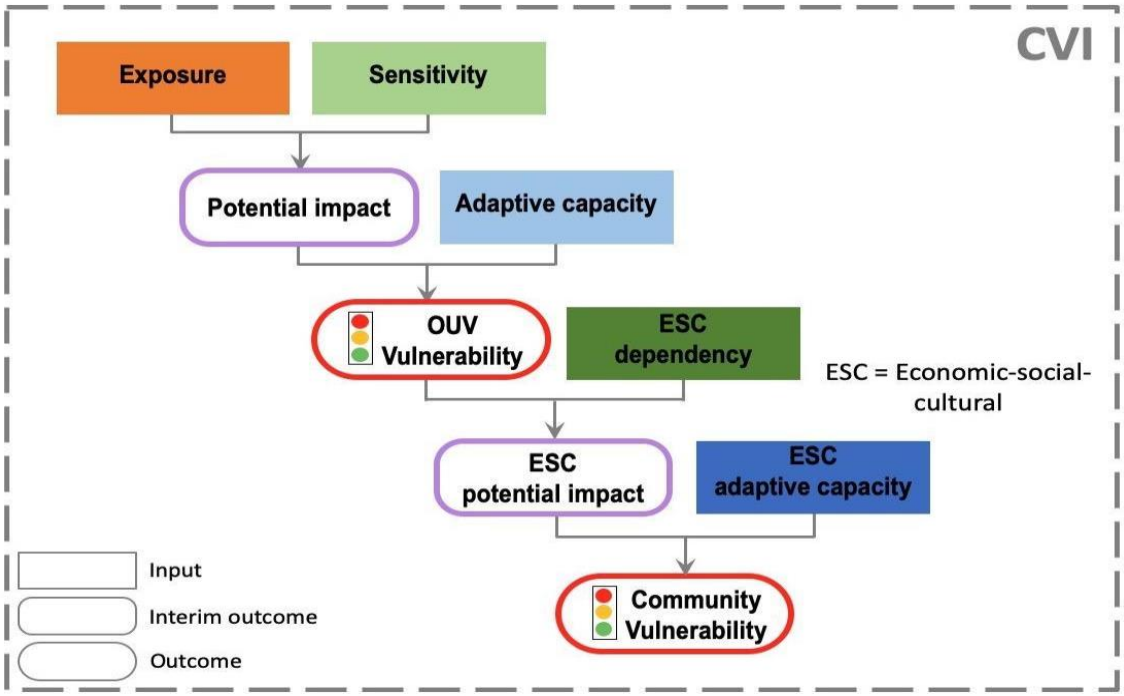


Figure 5.1 The CVI framework used to undertake rapid assessment of climate change vulnerability of World Heritage properties and the associated community

5.2 The CVI process for Bryggen

Prior to application of the CVI framework in Bryggen, various preparatory steps were undertaken:

1. The Statement of OUV for Bryggen was analysed and 'broken-down' into key values and their accompanying attributes (see Table 2.1);
2. Background information was prepared outlining key aspects of climate change;
3. A list of other Significant Property Values (SPVs) was compiled (see Appendix 2); and
4. An overview of information related to economic, social and cultural connections was compiled.

The CVI application for Bryggen was undertaken through a workshop held 12–14 April 2023. The workshop was undertaken in a 'blended' mode, in which the facilitators and most participants attended in-person (at the Byantikvaren office in Bergen) and some participants joined online (using the Zoom platform). The workshop employed a series of plenary and breakout sessions (Figure 5.2), in which information was presented and assessments were undertaken and discussed. Two breakout groups were conducted fully in-person, whilst the third was undertaken on Zoom with participants both on-site and online. Though fairly stable, there was a small amount of variation in the make-up of the breakout groups due to participant availability and illness.

All assessed outputs from the groups were reported back to subsequent plenary sessions for discussion and synthesis. Outcomes for each component were recorded in the customised worksheet to determine final results.

Figure 5.2 One of the breakout groups assessing a component of the CVI during the workshop. *Photo: Jon C. Day, CVI.*

5.3 Key climate stressors

A list of 15 climate stressors typically considered in the CVI process was provided to participants at the workshop (Table 5.1). Participants analysed those likely to have the most impact on each of the key values of OUV (Table 2.1). The workshop selected the timescale to consider impacts as ca. 2100, based on the longevity of the historical use of Bryggen and the required timescale for protection from likely climate threats. Participants elected to consider future effects under a high-emissions climate scenario (RCP8.5, SSP5-8.5) as this was deemed most likely to reflect future conditions amongst the available options.

Breakout groups evaluated which three of the climate stressors are most likely to affect each key value. After collating the selections from the three groups, stressors appearing in the top two identified for each value (including equal-second) were used to rank the stressors (Table 5.1; Figure 5.3). *Sea level rise* was identified through the selection process as likely to have a high degree of impact on all four key values (Table 5.1) and was unanimously selected by the breakout groups as likely to impact three of the key values. The exception was Traditional timber structures, for which *Temperature trend* was identified by all groups as among the top-three stressors. *Intense precipitation events* and *Coastal flood* were selected by two breakout groups for each of two key values.

Noting the connection between *Coastal flood* and *Sea level rise*, and the consensus of impacts on the wooden buildings linked to temperature increase, participants selected *Temperature trend* (rather than *Coastal flood*) as one of the three key climate stressors to provide focus for the subsequent analysis. In summary, the three climate stressors identified for the CVI analysis were:

- *Sea level rise* (trend) – SLR;
- *Intense precipitation events* – IPE; and
- *Temperature trend (air and/or water)* – TT.

Table 5.1 Climate stressors identified as likely to have the greatest impact for each of four key values of OUV. Marked cells indicate that the climate stressor was in the top two responses (including equal-second) for each key value. Stressor impacts were assessed for ca. 2100 and a high-emissions climate scenario.

	Temperature trend (air and/or water)	Extreme temperature events	Precipitation trend	Intense precipitation events	Flooding (fluvial, pluvial)	Drought (severity, duration, frequency)	Mean wind trend	Storm intensity and frequency	Sea/lake ice change	Snow cover change	Sea level rise (trend)	Coastal flood	Storm surge	Coastal erosion	Changing currents
Key values of OUV	**Climate stressors**														
Hanseatic heritage				x							x				
Medieval townscape and historic trading port											x	x			
Traditional timber structures	x										x				
Contemporary urban cityscape				x							x	x			
Total	1	0	0	2	0	0	0	0	0	0	4	2	0	0	0

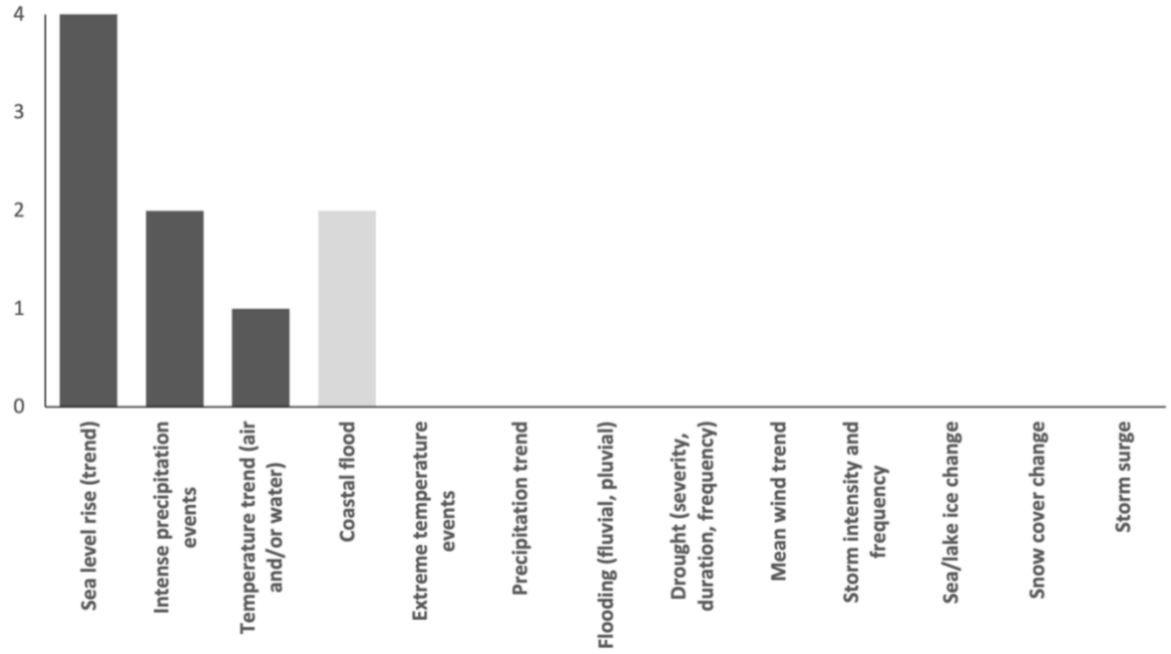


Figure 5.3 Histogram of the number of key values of OUV for Bryggen for which each of 15 climate stressors were among the top three likely to cause impacts (ca. 2100, high-emissions scenario).

Notably, the impacts resulting from these three key climate stressors are likely to unveil at different timepoints. While effects of all three may be apparent to some degree, increasing *Temperature trend* and frequency and intensity of *Intense precipitation events* (and the associated impacts) are already apparent. In contrast, the greatest impacts from *Sea level rise* are not projected to occur until later this century.

5.4 OUV Vulnerability

Assessments of **exposure** and **sensitivity** of the OUV system to each of the identified three key climate stressors were undertaken using a five-point categorical scale, adapted from categories used by IPCC and IUCN analyses (see Day et al. 2020 for details). Modifiers were applied to the initial assessments to include effects of temporal scale and trend (for exposure), and spatial scale and compounding factors (for sensitivity).

The compounding factors were considered to be of moderate likelihood for *Sea level rise* and *Intense precipitation events* and of high likelihood for *Temperature trend*. Participants determined that the three key stressors would interact with each other, as well as with other stressors, to increase risk of impacts and lead to unforeseen consequences; e.g.,

- The combination of higher temperatures with saltwater intrusion could lead to accelerated decay of timber structures.
- With increased overall precipitation, there is less time for the property to dry, which leads to less time for maintenance and could require additional surface treatment of wood.
- Higher temperatures would exacerbate impacts of rot in the timber structures through increased microbial activity.
- Warming and increased rainfall may be more likely to cause sewage to leak, which would impact archaeological layers.

- While warming also brings increased risk of fire events, it is likely to also lead to increased tourism (due to preferred conditions compared with southern Europe) and associated increase is impacts from visitor volume.

Participants noted varying degrees of certainty in these interactions, from well-understood to highly-uncertain.

Results from **exposure** and **sensitivity** assessments undertaken in breakout groups were synthesised in plenary. After including modifiers, the **exposure** was determined as Very Likely (>90%, highest category; Table 5.2) for each of the three key climate stressors. **Sensitivity** of OUV to *Temperature trend* and *Sea level rise* was determined as high (second highest category), indicating potential for some loss of some of key WH values, whilst the sensitivity to Intense precipitation event was moderate (middle category), indicating loss or alteration of key WH values will occur. Notably, the application of modifiers incremented the assessed **sensitivity** with respect to *Sea level rise* and *Temperature trend* (from moderate/high and moderate, respectively). The **potential impact**, derived from **exposure** and **sensitivity**, was determined as extreme (highest on a four-point scale, low to extreme) for all three key climate stressors (Table 5.2).

The **adaptive capacity** of a system to respond to stress can reduce the potential impacts. **Adaptive capacity** of the OUV system was assessed for each key climate stressor by considering the levels of local management response and scientific/technical support (four-point scale), as well as the effectiveness of these to address impacts from each stressor (four-point scale). Workshop participants first brainstormed adaptive capacity options (Table 5.3). The strategies were prioritised as High (for existing strategies that could be expanded upon or those under consideration), Potential (for those feasible but not yet in consideration) and Low (not currently feasible). The assessments of **adaptive capacity** were informed by the adaptive strategies in the High category.

Table 5.2 Rapid assessment of OUV Vulnerability to identified three key climate stressors. Assessed values of exposure, sensitivity and adaptive capacity contribute to derived outcomes for potential impact and OUV Vulnerability. Colours refer to the elements of the CVI framework (Figure 5.1)

Key Climate Stressors:	Sea level rise	Intense precipitation events	Temperature trend (air and/or water)
Exposure	Very likely	Very likely	Very likely
Temporal scale	On-going	Frequent/On-going	On-going
Trend	Slow increase	Slow increase	Moderate increase
Exposure	Very likely ○○○○●	Very likely ○○○○●	Very likely ○○○○●
Sensitivity	Moderate/High	Moderate	Moderate
Spatial scale	Extensive	Extensive	Widespread
Compounding factors	Moderate probability	Moderate probability	High probability
Sensitivity	High ○○○●○	Moderate ○○●○○	High ○○○◑◐
Potential impact	Extreme ○○○●	Extreme ○○○●	Extreme ○○○●
Local management response	Low	Moderate	Moderate
Scientific/technical support	Low	High	Moderate
Effectiveness	High	Moderate	Low
Adaptive capacity	High ○○○●	High ○○○●	Low ○●○○
OUV Vulnerability	Low ●○○	Low ●○○	High ○○●
Combined OUV Vulnerability	Moderate ○○○		

Table 5.3 Strategies for adaptive capacity brainstormed during the workshop, prioritised by feasibility or likelihood for implementation, noting the relevant key climate stressors (SLR: *Sea level rise*; IPE: *Intense precipitation events*; TT: *Temperature trend*) and key values (numbered in Table 2.1) for each.

Feasibility/ likelihood	Adaptation strategy	Key climate stressors			Relevant key value/s			
		SLR	IPE	TT	1	2	3	4
High	Develop an overarching, climate-specific strategy for restoration projects (heights, eavesdrops, materials, etc.)	X	X	X				
	Construction of sluice gate, dykes or floodgates (part of long-term plan for Bergen, will offer protection to Bryggen as part of the city)	X						
	Lift buildings and parts of buildings (already being undertaken, with more application in the future; all buildings will need restoration and lifting).	X						
	Clean the eavesdrop/drip gap and passageways, add perforated plastic pipes in gravel (responding to heavy rainfall and temperature-related rot)		X	X				
	Visitor management (benefits for and challenges to values co-exist)			X				
Potential	Reintroduce turf roofs and investigate green roofs (with livestock grazing)		X					
	For surface water, increase collaboration between WH site management and the municipal authorities[†]		X					
	Increase capacity of drainage system from buildings		X					
	Increase capacity of infiltration/transport system for groundwater	X	X					
	A permanent and increased capacity non-rinsed water source for the groundwater			X				
	Create a quayside barrier to shield the city from sea level rise	X						
	Improve ventilation of buildings			X				
	Install a pile wall to separate freshwater and saline water (noting several issues)	X						
Low	Lift the entire quayside area in front of Bryggen	X						
	Install a large roof over the property		X	X				

[†]e.g, share monitoring data, control and add water flows into catchment systems, groundwater stabilisation

The first item on the adaptation strategy list, to develop a climate strategy for restoration, was not included in the assessment process as it would not (in and of itself) lead to any mitigation of impacts. With respect to *Sea level rise*, the **adaptive capacity** was determined to be High (highest on a four-point scale, Very low to High). This was specifically in response to the expectation of participants that the vision of the Bergen kommune to implement a city-wide mitigation plan in response to *Sea level rise* (e.g., through sluice gates, dykes) would be realised – and that existing capacity to lift buildings would be a sufficient response in the period leading to that. Similarly, proposed actions to promote better drainage of eaves and passageways were deemed sufficient to effectively respond to

the threat from *Intense precipitation events*, also resulting in a High **adaptive capacity**. In contrast, adaptation strategies related to *Temperature trend* were considered to have a low level of effectiveness in addressing impacts, which led to an assessment of Low **adaptive capacity** with respect to this climate stressor.

As a result, the OUV Vulnerability (three-point scale, Low to High) was determined to be High for *Temperature trend* and Low for *Sea level rise* and *Intense precipitation events*. The combined **OUV Vulnerability** for Bryggen was determined as Moderate (Table 5.2).

However, it is important to note the high degree of reliance upon the stated adaption strategies to mitigate the extreme level of **Potential impact** without timely planning for and implementation of those strategies (particularly the planned city-wide response to *Sea level rise*), the **OUV Vulnerability** would have been assessed in the highest category.

5.5 Community Vulnerability

The assessment of Community Vulnerability considers the economic, social, and cultural (ESC) aspects of the community associated with the property using two metrics. **Dependency** reflects the extent to which a decline in WH values will affect ESC indicators in the future. These effects can be positive or negative. Separate assessments for economic, social and cultural dependency are combined to give an overall ESC dependency. **Adaptive capacity** reflects the current level of capacity within each component to adapt in the face of a decline in WH values due to key climate stressors, and only has a positive directionality. As for **dependency**, separate assessments for economic, social and cultural adaptive capacity are combined to give an overall **ESC adaptive capacity**. Assessments were undertaken in small breakout groups, which again resulted in a spectrum of responses for each that was discussed and resolved in plenary.

A specific scenario was provided to participants to guide assessment of likely climate change impacts on the economic, social and cultural aspects. The selected scenario elements, based on projections of the key climate stressors for ca. 2100 (Section 3), were:

(i) *Sea level rise*: 72 cm increase above the 1986-2005 average level, which represents the upper end of projected conditions for the end of century;
(ii) *Intense precipitation events*: an increase by 30-40% from historical heavy rainfall events; and
(iii) *Temperature trend*: an increase in air temperature by 4°C from the 1971-2000 climatology.

The economic component considers the economic effects on economic activities/business types that are directly associated with the WH property. In preparation for the workshop, the steering committee developed a list of six sectors: Artisans, Professional businesses, Tourism, Restoration, the Hanseatic Museum and Goods & services (see Table 3.1 for examples within each type).

During the assessment process, workshop participants determined that Tourism, Restoration and the Hanseatic Museum were the most reliant upon the WH values (Figure 5.4). **Economic dependency** was assessed as Moderate-negative (i.e., a negative impact at a moderate level), whilst the **adaptive capacity** was evaluated as Low (Table 5.4). These outcomes were consistent whether considering all six business types or by focusing on the three sectors most-reliant upon WH values.

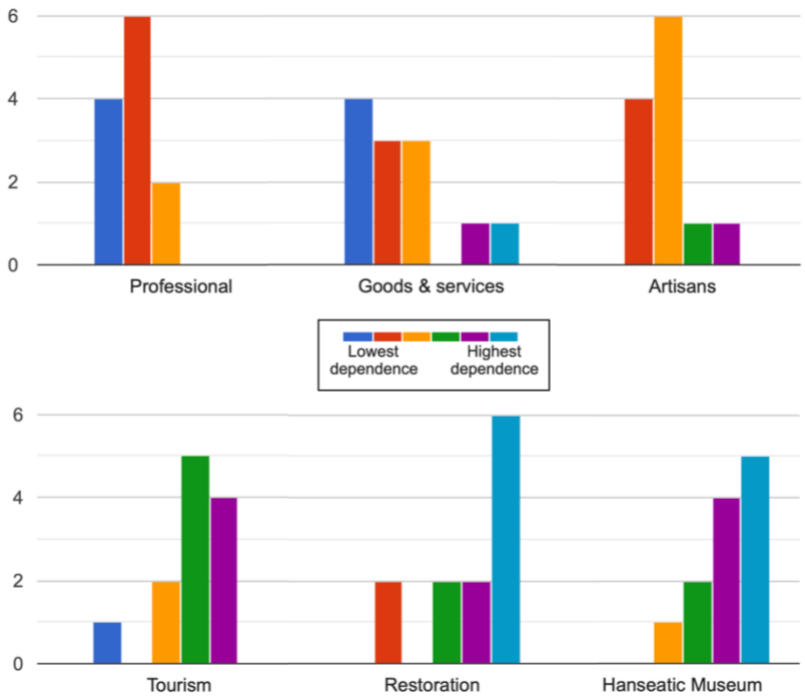


Figure 5.4 Participant rankings of six economic sectors by their dependence upon the Bryggen key values.

Table 5.4 Rapid assessment of Community Vulnerability to identified three key climate stressors. Assessed values of economic, social and cultural (ESC) dependency (sensitivity, ranging from negative to positive) and adaptive capacity contribute to derived outcomes for ESC potential impact and Community Vulnerability.

Economic	*Moderate-negative*
Social	*Moderate-negative*
Cultural	*Moderate-negative*
ESC dependency	[-] ○ ● ○ ○ *Moderate-negative* ○ ○ ○ ○ [+]
ESC potential impact	**Moderate** ○ ● ○
Economic	*Low*
Social	*Moderate*
Cultural	*Moderate*
ESC adaptive capacity	**Moderate** ○ ● ○
Community Vulnerability	**Moderate** ○ ● ○

Social indicators used to inform the assessments were introduced as representing four categories: Human capital; Social capital; Natural capital; and Built capital (after Costanza et al., 2007). Workshop participants considered three people groups for the assessment (locals, other Norwegians, internationals) and determined that social connections should be considered across all groups. **Social dependency** was assessed as Moderate-negative, whilst the existing **adaptive capacity** to future changes was deemed Moderate (Table 5.4).

Cultural indicators were also considered within four categories pertaining to: Self; People; Pleasure; and Environment (after Marshall et al. 2019). Cultural connections of locals were considered by the workshop participants to be of greatest importance, noting the identity connection of Bergensers with Bryggen, and this was taken into consideration for the final assessment. **Cultural dependency** was assessed as Moderate-negative, whilst the **adaptive capacity** was Moderate (Table 5.4).

Combining the three components, the overall **ESC dependency** was determined as Moderate-negative, which, combined with the OUV Vulnerability (as the exposure term), resulted in the **ESC potential impact** being assessed as Moderate (three-point scale, Low to High; Table 5.4). The combined ESC adaptive capacity was assessed as Moderate (three-point scale, Low to High). These outcomes determined the **Community Vulnerability** as Moderate (three-point scale, Low to High; Table 5.4).

5.6 Summary – application of CVI online and in-person

Sea level rise, *Intense precipitation events* and *Temperature trend* were identified as the three climate stressors likely to most impact the WH values of Bryggen. **Potential impact** from each of these key stressors was scored as Extreme for each, with **adaptive capacity** to mitigate impacts assessed as High for *Sea level rise* and *Intense precipitation events* and Low for *Temperature trend*. As a result, the **OUV Vulnerability** was determined to be in the middle category (Moderate). Impacts from the key climate stressors were judged as likely to lead to a negative future impact at a Moderate level on the economic, social and cultural aspects of the community associated with Bryggen. As the **adaptive capacity** of the community to the climate stressors was determined to be at a Moderate level, the overall **Community Vulnerability** was assessed to be in the middle category (Moderate).

The workshop results indicate the changes that might be expected over the next 70 years (ca. 2100 scenario) have the potential for significant impacts on the values that comprise the OUV of the property unless mitigated through effective adaptation strategies. In the absence of those, the vulnerability of the property and the community would be exacerbated.

5.7 The public event

Following the CVI workshop, a public event was held in which the WH property, the issues affecting it and outcomes of the CVI process were described. Five presentations were given reflecting expertise in: Norway's World Heritage, with specific focus on the values of Bryggen (Hege Bakke-Alisoy); the timber buildings (Gunnbjorg Hole); archaeology within the property (Hanne Merete Moldung); a climate change for Bryggen (Stephanie Mayer); and the CVI workshop and outcomes (Scott Heron). The high quality of the presentations was roundly observed by those present (Figure 5.5).

Figure 5.5 Bryggen World Heritage coordinator, Hege Bakke-Alisøy, presenting to the public meeting at the Bryggen Byantikvaren on 19 April 2023. *Photo: Scott F. Heron, CVI.*

NEXT STEPS

Bryggen maintains its architectural heritage with modern usage.

SECTION 6: NEXT STEPS

At a general level and in the short term, the projected vulnerability to climate change impacts is less severe in Norway than in many other parts of the world, and potentially economically positive for some sectors, such as the benefit of warming for agriculture (Kvalvik et al. 2011; Hovelsrud et al. 2011). Many Norwegians seem to be anxious (Ryghaug et al. 2011) and accept climate changes as a reality (Lowe et al., 2006; Palutikof et al., 2004); however, the potentially severe consequences of climate change are perceived of secondary importance in comparison with everyday life issues (Lorenzoni and Pidgeon, 2006).

However, the implications for some municipalities, and in particular some key heritage assets, could be significant. This is especially true in the absence of acknowledgement that such climatic changes will occur and effective understanding of (and response to) future consequences for key assets. Such changes could have societal, economic and cultural consequences due to the complex interlinkages between climate change impacts and the community.

Furthermore, whilst incremental changes in the climate system may pose a lesser perceived threat, rapid transitions would likely present greater challenges to Norway broadly. The posited collapse of the Atlantic Meridional Overturning Circulation (as discussed in Section 4.3) would present a vastly different future climate for Norway than those from current global modelling efforts; however, it is these models that provide the best available, current information that underpins the analysis and recommendations presented here.

6.1 Recommendations in a changing climate

Climate projections for Bergen to 2100 confirm that increasing *Sea level rise*, *Intense precipitation events* and *Temperature trend* will have an adverse impact on the WH property of Bryggen and its values. However, as mentioned in Section 2.5, the 2021-2025 Plan of Management for Bryggen provides minimal advice or direction for adaptive strategies to address climate change.

The CVI process has shown that the property and the local community are vulnerable to the effects of expected climate change and that the ability to adapt to climate change is limited. Impacts on heritage buildings (wood rot and paint types) have been studied but there may be other factors that will affect built heritage. No positive effects of climate change for Bryggen were revealed through the analysis.

Conservation decisions that respond to the threats of climate change begin with understanding the key areas of climate vulnerability. Heritage impact assessments need to identify all possible unintended consequences from all proposed adaptive measures. For example, in the coming years, a comprehensive risk-based plan for Bergen with regards to the forecast sea level rise is being developed, considering the greater need for physical ocean barriers. It will therefore be important to avoid measures that add further stress to the natural and historic environment. The identified key values (and other SPVs; Appendix 3) must be considered to ensure such impact assessments are comprehensively undertaken. This is especially true of activities that might amplify the negative effects of climate change. A precautionary approach must be the rule – new activities must not be implemented before there is sufficient knowledge of the potential impacts.

The CVI process has resulted in the following suggestions for further investigation:

Management needs:

- Review the wording of the WH key values
- Review the requirement for an effective buffer zone (and impacts on attributes in the buffer zone); determine and gain approval for an appropriate buffer zone for the WH property
- Address illegal removal of wood as souvenirs by visitors (e.g., possibly through the sale of pieces of wood that have been removed during restoration, with the side benefit of promoting conservation)
- Recognise there is a high level of 'adaptability' of the existing buildings over time
- Effective monitoring of all adaptive strategies.

Research and monitoring priorities

- Quantify/document the extent and depth of the archaeological deposits (which may add to the WH significance)
- Evaluate changes to microbiology in archaeological deposits (currently unknown)
- Analyse the weather station data from the nearby museum
- Research the consequences of increasing saltwater intrusion into the property
- Research changes in ventilation in the buildings (will it help or potentially create a problem?), including the implications for humidity and air temperature change.

Precautionary approach and knowledge gaps

- Investigate 'green roofs' (i.e., turf roofs).
- Investigate impacts of visitor footfall on the WH values
- Improve understanding of potential flooding impacts of the entire city of Bergen, which would include (and therefore provide benefit to) Bryggen.

Previous events of severe, long-term subsidence at Bryggen caused by changes to groundwater drainage appears to have been addressed, and today the subsidence has been reduced to a natural rate (Rytter & Schonhowd 2015). However, increased precipitation and extreme weather events in the area increase vulnerability to water-related risks and indicate the need for ongoing monitoring.

The water content and quality in the soil governs the availability of oxygen for the microorganisms that live there. The decay of the organic components of the Bryggen foundations is highly dependent on the availability of oxidants. Consequently, a range of monitoring equipment has been installed at different depths including sensors for oxygen, water content and temperature.

There is currently some liaison between the site managers and experts/researchers (e.g., universities and research agencies) for monitoring and research, which could be improved. This should begin with a comprehensive assessment of the current management needs and research gaps. Effective and ongoing communication with researchers regarding a prioritised list of research activities to support management is essential. The research opportunities identified above are a starting point only and these will require appropriate resourcing, as will the management activities informed by research outcomes. Continuing to link research with management-relevant outcomes is fundamental.

The workshop participants identified a broad range of existing and potential management actions, including:

- applying a precautionary approach to ensure that new or proposed activities do not have negative impacts on the OUV
- minimising other stressors on the property, thereby enhancing the existing resilience of the historical and archaeological heritage
- enhancing research and monitoring efforts to better predict and understand changes in Bryggen and address knowledge gaps
- including the outcomes from the CVI workshop in a review of the Bryggen Management Plan (noting that climate change mitigation and adaptation both need to be more effectively integrated throughout the entire Plan).

Other opportunities identified during the workshop included:

- the need to identify key adaptation strategies for the key values and the community
- that existing resources might be used to respond to identified issues; e.g., through citizen science.

Climate change and climate adaptation are dynamic, nonlinear, and with a high degree of uncertainty both with respect to projected changes and impacts. Climate change therefore requires a proactive adaptation policy that is capable of adjusting to changes in multiple conditions. Adaptive co-management processes that involve local knowledge in the decision-making process provide an effective method to deal with change by incorporating local input in management (Fidel et al. 2014). As Sethi et al (2020) observed, *"A growing number of researchers and stakeholders have started to address climate change from the bottom up: by devising scientific models, climate plans, low-carbon strategies and development policies with climate co-benefits".*

6.2 Management implications – local, national and international

Bryggen, with its wooden buildings and its thick, organic-rich archaeological deposits, is a complex, fragile and unique archaeological and historical site. It is significant for the amount of urban archaeology present but also for the comprehensive environmental monitoring program.

Some of the knowledge acquired at Bryggen can be transferred directly to the management of similar cultural heritage properties in Norway and elsewhere in Europe. Methods for establishing the state of preservation and the optimum preservation conditions have been developed as part of the works at Bryggen. Bryggen was the first location where oxygen has been monitored in archaeological deposits for a prolonged period, and this has yielded considerable knowledge about oxygen dynamics. The equipment used has produced reliable results for years and the use of model experiments and laboratory measurements of decay have proven very useful for interpreting the monitoring data. The installation of similar equipment at other heritage sites has been recommended to get more experiences from different deposits. In addition, the effects of temperature on the decay rate are highly relevant not only at urban sites but also at other sites where average annual temperatures in the soil may increase due to climate change.

A workshop to train young craft persons in traditional timber construction, as is required to maintain the built fabric of such heritage assets, was held in Bergen in 2018. Given the current slow rate of restoration necessitated by the application of traditional craftsmanship and the available budgets, further resources in this area would be beneficial.

6.3 Revisiting the CVI process for Bryggen

As a result of the CVI process, Norway now has an improved basis for reporting to UNESCO on the status of climate vulnerability for two WH properties (Vega Archipelago and Bryggen) via WH Periodic Reporting. This will contribute to the mobilisation of global efforts on climate action and the role of the WH Convention in climate mitigation and adaptation efforts. Further CVI applications in Norway and across the Nordic/Baltic region have occurred.

The results from the CVI workshop for Bryggen are important for the review of the existing Management Plan. The Management Plan must ensure that climate change mitigation and adaptation are addressed throughout the entire plan and not just a single stand-alone objective.

The CVI assessment for Bryggen is timely considering the proposal for the light rail and potential impacts for the WH values (see Sections 2.6 and 3.2), together with increasing concerns about climate impacts. The CVI outcomes will also give important knowledge to several plans under the *Planning and Building Act*, including for the Municipal Master Plan. The CVI outcomes should be reflected in the updating of the Coastal Plan for Bergen municipality. It is important to recognise the context for management activities of the political systems and regulations in Norway (see Section 2.5), which will inform and help prioritise actions at different levels.

It is recommended that the CVI process be repeated on an approximately six-yearly cycle, aligned with (and in advance of) Periodic Reporting, to assess system changes as well as effectiveness of management responses. This may involve one of the shorter CVI delivery modes (Snapshot, Consult) rather than repeating the full Workshop mode, and with local facilitation. In order to ensure that trends and results are easily comparable, it is proposed that any future CVI workshops apply the same methodology, beginning with a systematic review of the 2023 workshop information.

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Whilst endearing, the angled walls demonstrate the vulnerability of the wooden buildings.

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- The presenters for the public meeting and the representatives of the Bergen community who participated.
- The World Heritage Board and Advisory Board of Bryggen for their involvement, support and participation.

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View from the gardens at the rear of the property.

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APPENDICES

Stone cellars and kitchen buildings are located near the gardens at the back of the property

Appendix 1 – Statement of Outstanding Universal Value, Bryggen World Heritage property

Brief synthesis

Bryggen is a historic harbour district in Bergen, one of North Europe's oldest port cities on the west coast of Norway which was established as a centre for trade by the 12th century. In 1350 the Hanseatic League established a "Hanseatic Office" in Bergen. They gradually acquired ownership of Bryggen and controlled the trade in stockfish from Northern Norway through privileges granted by the Crown. The Hanseatic League established a total of four overseas Hanseatic Offices, Bryggen being the only one preserved today.

Bryggen has been damaged by a number of fires through the centuries and has been rebuilt after every fire, closely following the previous property structure and plan as well as building techniques. Bryggen's appearance today stems from the time after the fire in 1702. The buildings are made of wood in keeping with vernacular building traditions. The original compact medieval urban structure is preserved with its long narrow rows of buildings facing the harbour, separated by narrow wooden passages. Today, some 62 buildings remain of this former townscape and these contain sufficient elements to demonstrate how this colony of bachelor German merchants lived and worked, and illustrate the use of space in the district. It is characterized by the construction of buildings along the narrow passages running parallel to the docks. The urban units are rows of two- to three-storey buildings signified by the medieval name "gård". They have gabled facades towards the harbour and lie on either one or both sides of the narrow passages that have the functions of a private courtyard. The houses are built in a combination of traditional timber log construction, and galleries with column and beam construction with horizontal wooden panel cladding. The roofs have original brick tiling or sheets, a result of fast repairs after an explosion during World War II. Towards the back of the gård, there are small fireproof warehouses or storerooms (kjellere) built of stone, for protection of special goods and valuables against fire. This repetitive structure was adapted to the living conditions of the Hanseatic trading post. The German merchants took up winter residence in the small individual wooden houses and the storerooms were used as individual or collective warehouses. A true colony, Bryggen enjoyed quasi-extraterritoriality which continued beyond the departure of the Hanseatic merchants until the creation of a Norwegian trading post in 1754, on the impetus of fishermen and ship owners of German origin. Today, Bryggen is a significant part of the historic wooden city of Bergen.

Criterion (iii): Bryggen bears the traces of social organization and illustrates the use of space in a quarter of Hanseatic merchants that dates back to the 14th century. It is a type of northern "fondaco", unequalled in the world, where the structures have remained within the cityscape and perpetuate the memory of one of the oldest large trading ports of Northern Europe.

Integrity

Only around a quarter of the original buildings that existed in Bryggen remained after demolitions at the turn of the 19th century and several fires in the 1950s; the property is comprised of these remaining buildings. Notwithstanding, the medieval urban structure is maintained and the buildings include all elements necessary to demonstrate how Bryggen functioned: offices and dwellings at the front, warehouses in the midsection and assembly rooms ("Schøtstuer"), kitchen facilities and fireproof stone cellars at the back.

Bryggen can be experienced as an entity within a larger harmonious urban landscape. It is connected more closely to the areas of small wooden dwellings beyond Bryggen and in the medieval city centre than to the larger 20th century buildings in its close proximity.

The risk of fire, excessive numbers of visitors as well as global climate changes with more extreme weather and possibly higher sea levels are some of the potential risks Bryggen faces today.

Authenticity

The Hanseatic period at Bryggen ended long ago, but the Hanseatic heritage is documented through buildings, archives and artefacts which are well preserved for posterity. There are also series of architectural surveys of the buildings from 1900 onwards.

The preservation of the buildings commenced on a larger scale in the 1960s and had made major progress by 1979, the year of inscription on the World Heritage List. Some buildings at the back were moved in 1965 to create an open area for fire emergencies, but no further changes have been made

to the urban structure since. The solutions and methods chosen have been well documented, and limiting the replacement of original materials has been an objective. Bryggen is built of wood, which is subject to rot, insect attack and ageing. Since 2000, there has been an increased focus on maintaining original methods and building materials in the restoration, with careful consideration given to the choice of material, paint, plugs, nails, etc. and the use of original tools as far as possible.

As the activity at Bryggen decreased after 1900, the buildings became derelict. However, from the 1960s the former trading in stockfish and commodities was gradually replaced by small arts and crafts businesses. An increase in the number of visitors has led to the establishment of restaurants and tourist businesses. This has resulted in inevitable changes in the spirit of the place, particularly along the front facades, whereas the atmosphere of the Hanseatic period can still be sensed in the more secluded area further back.

Protection and management requirements

Bryggen, including its cultural deposits, is listed pursuant to the Norwegian Cultural Heritage Act and is also protected through the Norwegian Planning and Building Act. The adopted protection plan includes an extensive area that functions as a buffer zone.

Bryggen is privately owned and the majority of the buildings are owned by the Bryggen Foundation, which was established in 1962 with the objective of preserving Bryggen. The remaining owners have established a separate association to secure their interests. The stakeholders at Bryggen collaborate in different constellations of owners and authorities.

"The Bryggen Project" was established formally in 2000. This is an extensive and long-term project for monitoring, safeguarding and restoring Bryggen, including both archaeological deposits and standing buildings.

Bryggen is managed according to a management plan that is revised regularly. A fire protection system with detection and suppression has been installed and is continually being improved. Climate conditions are a key issue and measures have been taken to prepare for future changes. Possible impacts resulting from tourism are monitored.

There is ongoing pressure for urban development in the vicinity of Bryggen. Any development which may have visual impact on the World Heritage property is monitored closely by the cultural heritage authorities.

Appendix 2 – Images illustrating the key values for Bryggen

Images depicting Key Value #1 - Hanseatic heritage (page 55)

- Figure A – Historical depiction of the trading port of Bryggen (Tyskebryggen - German wharf). *Image: R. Christiansen, Marcus Special Collection University Library, Bergen.*
- Figure B – Reconstruction showing a room inside the Hanseatic Museum. *Photo: Jiri Havran*
- Figure C – Reconstruction of sleeping cubicles inside the Hanseatic Museum. *Photo: Jiri Havran*
- Figure D – The Hanseatic Museum, part of the Bryggen WH property.

Images depicting Key Value #2 - Historic townscape and historic trading port (page 56)

- Figure A - Historic image of Bryggen taken between 1890-1910. *Credit: Marcus Special Collection University Library, Bergen*.
- Figure B – Narrow wooden walkways between the buildings.
- Figure C – Long narrow rows of buildings and traditional peaked-roofs.
- Figure D – The historic urban structure had offices and dwellings adjoining the wharf, warehouses in the midsection and kitchen facilities and fireproof stone cellars and gardens at the back.

Images depicting Key Value #3 - Traditional timber structures (page 57)

- Figure A – Use of wood buttresses for supports; note also the red water pipe for fire suppression (top left).
- Figure B – One of the wooden buildings showing deterioration due to rising damp and weathering. *Photo: Jon C. Day, CVI.*
- Figure C – New construction of inner walls. *Photo: Leif Holmsen, Bergen kommune*
- Figure D – Restoration works showing evidence of the 1955 fire.
- Figure E – Restoration phases in Bryggen, adjacent old and new wood.
- Figure F – A craftsman applying traditional wood-working techniques for restoration in Bryggen, maintaining original building methods and materials. *Photo: ©Guri Dahl, Norges Verdensarv*.

Images depicting Key Value #4 - Contemporary urban cityscape (page 58)

- Figure A – Shops that today cater to tourists in areas formerly used by merchants for stockfish and commodity trading.
- Figure B – Broader setting of the WH property on the waterfront against the surrounding urban cityscape and mountains.
- Figure C – The stone houses have been maintained at the rear of the property; the addition of the rainwater gardens is part of the complex water management measures.

Photos by Hege Bakke-Alisøy, World Heritage Coordinator Bryggen, unless otherwise noted.

Images depicting Key Value #1 – Hanseatic heritage

Images depicting Key Value #2 – Historic townscape and historic trading port

Images depicting Key Value #3 – Traditional timber structures

Images depicting Key Value #4 – Contemporary urban cityscape

Appendix 3 – List of other Significant Property Values (SPVs) that are locally, regionally or nationally significant

Broad groupings of SPVs	**Key SPVs** (list in a prioritised order based on significance)	**Additional justification** (Why is the value significant? Locally, regionally or nationally?)
Other historic/cultural values (e.g., features or locations that represent history or are otherwise significant)	Organic material	The organic material is a rich source of historical information, and the vast volume of organic deposits laid down throughout the settlements almost thousand-year-long existence makes it unique.
	The extent of the archaeological deposits (100 000 m^3)	There are more than 10 major settlement levels at Bryggen, and the archaeological deposits have accumulated to thickness exceeding 10 metres in places. This is unique at a national level as well as international context.
	The archaeological deposits are fundaments for the present city	Large parts of the historic city centre are built directly on top of archaeological deposits.
	Traces of the medieval city, both underground (the archaeological deposits) as well as churches, ruins, streets and open places	These are vital for an understanding and experience of the medieval city as a whole.
	Plot structure and commons (the Town law 1276)	The plot structure can be traced back to the earliest days of Bryggen. The Town Law from 1276 regulated the city and the use of different areas. Bryggen was earlier defined as an area for trade, separate from the king and the church.
	Historic gardens	The gardens were an important part of the historic city. Very few gardens have been preserved. These are also important at a national level.
	World War II references	The Theta Museum was a location for the local war-time resistance. Large damage occurred due to a huge explosion in the harbour in 1944, from which traces of the repairs are still seen in the property.
Aesthetic values or phenomena (e.g., any special scenic qualities or phenomena that are significant)	The overall landscape	Bryggen is part of an overall landscape with the sea, Vågen harbour, the residential areas on the mountain slopes (Fjellsiden) and the mountains behind.

Broad groupings of SPVs	**Key SPVs** (list in a prioritised order based on significance)	**Additional justification** (Why is the value significant? Locally, regionally or nationally?)
Economic values (e.g., provide income or employment opportunities through tourism, fishing, or other commercial activities, etc.)	Marketing/branding	A very important part of marketing as Bryggen is among the most popular tourist destinations in Bergen.
	Dissemination activities	Museums and various tour-guiding companies.
	An area for trade and commerce	A wide range of different commercial activities within the property.
Social values (e.g., provide for social/recreational activities like opportunities to meet, hold events, etc.)	A setting for large social gatherings and happenings in Bergen	An important social arena for the city – a popular location for events.
	A place to gather during sunny days during summer (for beer and ice cream)	A place where people gather, both those living nearby and for local people in general.
Learning/ Scientific values (e.g., opportunities for scientific research, nature interpretation, etc.)	The ground water project	Source of knowledge and understanding of the connection between preservation of cultural heritage, both archaeology as well as standing buildings, and groundwater and surface water, through research at Bryggen. Vital knowledge for all medieval cities in Norway.
	Climate monitoring of wooden buildings	A national monitoring program, of which Bryggen is one of the selected locations, provides knowledge about how climate change affects wooden structures.
	Craft skills	Maintains traditional knowledge vital for the preservation of the wooden buildings; e.g., tools, use of material, different qualities of the different materials, technical skills.
Health/ therapeutic values (e.g., areas that enable people to feel better physically or mentally, etc.)	Peace and quiet	Especially important for those living in the vicinity.
	Therapeutic value	There is a selection of various small businesses offering healing, aromatherapy, acupuncture, etc.

This list is not intended to be complete but, rather, should continue to evolve.

Appendix 4 – Outline of the CVI workshop agenda for Bryggen, April 2023

Wednesday 12th April 2023

1. Welcome, overview of aims, workshop logistics.

AIM 1: Understand the Climate Vulnerability Index (CVI) framework and its application in Bryggen.

2. Brief overview of the CVI process.
3. Introductions of workshop participants.

AIM 2: Understand the significant values that comprise the OUV for Bryggen; and assess condition and trend. Discuss other significant values (i.e., Significant Property Values, SPVs).

4. Ensure all participants are aware of the Statement of OUV for Bryggen and how the table of key values and attributes were derived from the Statement of OUV
5. Undertake high-level assessment of current condition of key values and the recent trend in those values (i.e., since the date of inscription, 1979).
6. Discuss other Significant Property Values (SPVs) that are not part of the OUV but important locally/regionally/ internationally.

AIM 3: Understand future climate change facing Bryggen.

7. Introduction to climate change issues globally, in Vestland and for Bryggen.
8. Provide overview of climate change projections for Bryggen, differences in projected impacts from projection scenarios including timescales, and geographically-specific projections.

AIM 4: Assess the climate stressors impacting the values of Bryggen and select key climate stressors.

9. Show list of climate stressors – check for (i) understanding? (ii) timescales? Agree upon the climate scenario and time scale for the assessment (e.g., Business-as-usual for 2050).
10. Using the list of climate stressors provided, small groups to brainstorm what are the top three climate stressors impacting the key values of OUV.
11. Bring outputs from #10 back to plenary and ensure all participants agree on which climate change stressors are impacting the attributes of OUV (interactive session); compare with pre-workshop.
12. Wrap-up discussion, review Day 1, preview Day 2.

Thursday 13 April 2023

AIM 5: Evaluate vulnerability of OUV to key climate stressors, considering exposure, sensitivity and adaptive capacity for the selected climate scenario.

13. Brief recap of Day 1; overview of Day 2.
14. Revisit process for exposure, including detail of categories, and review modifiers.
15. Participants in breakout groups assess the exposure term (and modifiers) for each of the three key climate stressors.
16. Bring outputs from #15 back to plenary and discuss any variation in assessments of exposure.
17. Introduction to CVI process for sensitivity (including categories; and modifiers) and review the potential impact matrix that combines sensitivity with exposure. Remind of climate scenario for analysis (e.g., BAU 2050).
18. Participants in breakout groups assess the sensitivity (and modifiers thus determining potential impact) for the key climate stressors.
19. Bring outputs from #18 back to plenary and plenary and discuss any variation in assessments of sensitivity.

20. Introduction to adaptive capacity and brainstorming task to identify existing strategies used to mitigate climate-related impacts and potential adaptive capacities.
21. Participants in breakout groups brainstorm existing strategies used to mitigate climate-related impacts and potential adaptive capacities, identifying which key climate stressors and key values they respond to.
22. Bring outputs from #21 back to plenary. Prioritise these in terms of feasibility. Introduce adaptive capacity assessment.
23. Participants in breakout groups assess the adaptive capacity (thus determining OUV Vulnerability) for the key climate stressors.
24. Bring outputs from #23 back to plenary and discuss any variation in assessments of adaptive capacity.
25. Plenary discussion of assessments of exposure, sensitivity and adaptive capacity, and resulting OUV Vulnerability.

AIM 6: Consider economic, social and cultural dependencies (sensitivity) and adaptive capacity, to determine Community Vulnerability.

26. Revisit process for analysing economic, social and cultural (ESC) dependency. Review the ESC potential impact matrix that combines these. Revisit process for analysing economic, social and cultural adaptative capacity.
27. ESC overview.
28. Discussion of business types for analysis and introduction to Economic breakout group.
29. Participants in breakout groups assess the economic dependency and adaptive capacity for Bryggen.
30. Wrap up discussion, review Day 2, preview Day 3.

Friday 14 April 2023

31. Brief recap of Day 2 and overview of Day 3
32. Bring outputs from #29 back to plenary and discuss any variation in assessments of economic dependency and adaptive capacity.
33. Introduction to Social breakout group
34. Participants in breakout groups assess the social dependency and adaptive capacity for Bryggen.
35. Bring outputs from #34 back to plenary and discuss any variation in assessments of social dependencies and corresponding adaptive capacities.
36. Introduction to Cultural breakout group.
37. Participants in breakout groups assess the cultural dependency (thus determining ESC potential impact) and adaptive capacity (thus determining Community Vulnerability) for Bryggen.
38. Bring outputs from #37 back to plenary and discuss any variation in assessments of cultural dependencies and corresponding adaptive capacities.

AIM 7: Summary, feedback and next steps.

39. Plenary discussion on the resulting Community Vulnerability.
40. Summarise outcomes from workshop, following final analysis worksheet.
41. Recap on those items that had been 'parked' during the workshop.
42. Discussion of next steps.
43. Receive feedback on CVI framework and workshop process.
44. Complete workshop evaluation forms; receive other feedback from participants.
45. Thanks and close workshop.

Appendix 5 – List of participants in the CVI workshop for Bryggen

* Steering Committee/*Styringsgruppe*

Name/*Navn*	Institution/*Institusjon*	Participation mode
Hege Bakke-Alisøy *	*Verdensarvkoordinator Bryggen i Bergen*/WH coordinator, Bryggen	In person
Astrid Berge	*Klimaetaten, Bergen kommune*/Climate Agency, City of Bergen	In person
Vegard Berggård	*Riksantikvaren*/Directorate for Cultural Heritage	In person
Arlen Bidne	*Vestland fylkeskommune*/Vestland County Council	In person
Jon Day *	CVI, James Cook University, Australia	In person
Hans DeBeer	*Norges geologiske undersøkelser*/The Geological Survey of Norway (NGU)	Online
Rory Dunlop	*Norsk institutt for kulturminneforskning* (NIKU)/ Norwegian Institute for Cultural Heritage Research	In person
Ole Søe Eriksen*	*Riksantikvaren*/Directorate for Cultural Heritage	In person
Hanna Gjerdi	*Riksantikvaren*/Directorate for Cultural Heritage	Online
Åslaug Hansegård	*Verdensarvkoordinator Urnes stavkyrkje*/WH coordinator Urnes Stave Church	Online
Scott Heron *	CVI, James Cook University, Australia	In person
Hogne Hjelle	*Bergen Vann, Bergen kommune*/Agency for water infrastructure, City of Bergen	In person
Erlend Hofstad	*Vestland fylkeskommune*/Vestland County Council	In person
Gunnbjørg Andersen Hole	*Restaureringsarkitekt Stiftelsen Bryggen*/restoration architect, Bryggen Foundation	In person
Hans Olav Hygen	*Metrologisk institutt*/Norwegian Meteorological Institute	In person
Geir Ivar Johansen	*Verdensarvkoordinator Struve*/ WH coordinator Struve Geodetic Arch	Online
Marianne Knutsen	*Byantikvaren, Bergen kommune*/Agency for Cultural Heritage Management, City of Bergen	In person
Endre Leivestad	*Byantikvaren, Bergen kommune*/Agency for Cultural Heritage Management, City of Bergen	In person
Gudrun Mathiesen	*Styremedlem Stiftelsen Bryggen*/Board Member, Bryggen Foundation	In person
Stephanie Mayer	NORCE	In person
Hanne-Merete Moldung	*Riksantikvaren*/Directorate for Cultural Heritage	In person
Erling Oppheim	*Verdensarvkoordinator Vestnorsk fjordlandskap, Nærøyfjorden*/ WH coordinator Western Fjords, Nærøyfjorden	Online
Ambjørg Reinsnos	NIKU	Online
Jens Rytter	*Riksantikvaren*/Directorate for Cultural Heritage	Online
Odd Sletten	*Verdensarvkoordinator Røros*/ WH coordinator Røros	Online

Appendix 6 – Glossary and Acronyms

Adaptive capacity	The ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.
Anthropogenic	Resulting from or produced by human activities.
Climate	The composite or generally prevailing weather conditions of a region, as temperature, air pressure, humidity, precipitation, sunshine, cloudiness, and winds, throughout the year, averaged over a series of years.
Climate change	A change in the pattern of weather, and related changes in oceans and land surfaces, occurring over time scales of decades or longer.
Climate projection	A projection of the response of the climate system to emission or concentration scenarios of greenhouse gases and aerosols, or radiative forcing scenarios, often based upon simulations by climate models. Projections from the Coupled Model Intercomparison Project Phase 6 (CMIP6) are referred to in this report.
Exposure	A measure of the contact between a system (whether physical or social) and a stressor.
Sensitivity	The degree to which a system is affected, either adversely or beneficially, by climate variability or change.
Extreme weather event	A weather event that is rare at a particular place and time of year. Definitions of 'rare' vary, but an extreme weather event would normally be as rare as or rarer than the 10th or 90th percentile of the observed probability.
Intergovernmental Panel on Climate Change (IPCC)	The United Nations body, established in 1988, for assessing the science related to climate change; it was created to provide policymakers with regular scientific assessments on climate change, its implications, and potential future risks, as well as to put forward adaptation and mitigation options. The IPCC is the most authoritative international body on climate science and is an essential component of the world's response to climate change.
Mitigation (of climate change)	A human intervention to reduce emissions or enhance the sinks of greenhouse gases (GHGs). Mitigation measures in climate policy are technologies, processes or practices that contribute to mitigation, for example renewable energy technologies, waste minimisation processes, public transport commuting practices, etc.
Restoration (in a cultural heritage context)	Involves human interventions to authentically maintain the values of cultural heritage that has been degraded, damaged or destroyed.
Weather	The state of the atmosphere – its temperature, humidity, wind, rainfall and so on – over hours to weeks.

CVI	Climate Vulnerability Index
ICOMOS	International Council on Monuments and Sites
IPCC	Intergovernmental Panel on Climate Change
IPE	Intense precipitation events
IUCN	International Union for Conservation of Nature
NIKU	Norsk institutt for kulturminneforskning/ Norwegian Institute for Cultural Heritage Research
NGU	Norges geologiske undersøkelser/The Geological Survey of Norway
OUV	Outstanding Universal Value
SLR	Sea level rise
SOUV	Statement of Outstanding Universal Value
SPVs	(Other) Significant Property Values
TT	Temperature trend
WH	World Heritage

BERGEN KOMMUNE

RIKSANTIKVAREN

Norwegian Meteorological Institute

JAMES COOK UNIVERSITY AUSTRALIA

CVI