CLIMATE VULNERABILITY INDEX ASSESSMENT FOR RØROS MINING TOWN AND THE CIRCUMFERENCE WORLD HERITAGE PROPERTY

CVI

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Images

All photos by Odd Sletten, unless otherwise noted

Front and back cover: Storwartz mining area.

Inside cover: Hyttstuggu, the smelter administration building, in winter.

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EXECUTIVE SUMMARY

The small houses in Sleggveien, a small street within the town

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 applications of the Climate Vulnerability Index (CVI) for the Vega Archipelago and Bryggen World Heritage (WH) properties, the CVI was applied to assess the climate vulnerability of Røros Mining Town and the Circumference WH property.

Røros is characterised by three related sections: 1. the Røros mining town (originally inscribed in 1980), with its farms and agricultural areas around the initial main smelter; 2. the Femundshytta smelter, exemplifying subsequent smelters and associated communities that were developed across the Circumference; and 3. a Winter Transport Route exemplifying those that served mining operations and communities, using horse- or bullock-drawn sledges across frozen rivers and lakes.

The CVI assessment was undertaken in August 2024 through a workshop held in Røros, involving representatives from management agencies for the property and relevant municipalities, other experts and community representatives, 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 the Røros property using the best-available climate science.

Assessments of the current condition of the key values revealed that one-fifth of the indicators were considered to be in *Good* condition and a further 56% assessed as *Good with some concerns*; however, the remaining 24% were of *Significant concern*. In the 44 years since the original inscription (in 1980), just over half of the components were stable (52%) or had improved condition (12%); nearly one-third of indicators were determined to have deteriorated. Variability existed within many of these assessments, including recognition that parts of some indicators 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 the Røros property were:

- *Temperature trend*;
- *Intense precipitation events*; and
- *Ice change*.

Workshop participants selected ca. 2070 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 threats through the implementation of adaptation strategies, without which the OUV Vulnerability would have been in the highest category.

Seven key economic activities connected with the Røros property were also identified, with varying degrees of reliance upon the values and attributes. Two of these activities (Tourism, Retail) have strong linkages to social and cultural aspects of the community.

Key results of the CVI process

The three most important climate stressors:

Temperature trend | Intense precipitation events | Ice change

OUV Vulnerability: Moderate

Community Vulnerability: Moderate

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. Importantly, without timely implementation of those strategies, the OUV Vulnerability would revert to the highest category.

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

- enhance and expand monitoring of heritage and of the environment;
- develop policy around forest re-growth within the Circumference that embodies heritage and economic considerations;
- improve fire protection and cooperative management of fire for built heritage and the broader landscape;
- increase strategic planning activities between municipalities and agencies regarding climate change and sustainable tourism; and
- continue to document intangible knowledge as a resource.

The vulnerability assessment for the Røros property addresses the effects of climate change across the property's heritage values. Understanding how climate change will impact the values of this area may also inform other mining landscapes with similar values. Some of the knowledge compiled at Røros may inform the management of similar industrial cultural heritage properties.

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 Røros.

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.

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

Verdensarvstedet Røros bergstad og Circumferensen består av tre elementer: 1. Bergstaden Røros (opprinnelig innskrevet i 1980), med sine gårder og jordbruksområder rundt den første smeltehytta; 2. Femundshytta, en mindre smeltehytte, som eksemplifiserer de mange smeltehyttene og tilhørende samfunn som oppstod i hele Circumferensen; og 3. en vintertransportrute som eksemplifiserer transporten som var nødvendig for gruvedrift og lokalsamfunn, med heste- eller oksetrukne sleder over frosne elver og innsjøer.

Det ble gjennomført en CVI-workshop i Røros i august 2024 med ulike aktører tilknyttet verdensarvstedet, inkludert offentlig forvaltning, lokalsamfunnet og ulike fageksperter. Arbeidet ble ledet av teamet som har utviklet CVI-metoden. Fire hovedverdier ble identifisert for verdensarvstedet, utledet fra beskrivelsen av Røros bergstad og Circumferensens "Fremragende Universelle Verdi", eller «Outstanding Universal Value» (OUV). Denne rapporten redegjør for hvordan pågående og fremtidige klimaendringer vil påvirke verdensarvområdet, basert på beste tilgjengelige klimadata.

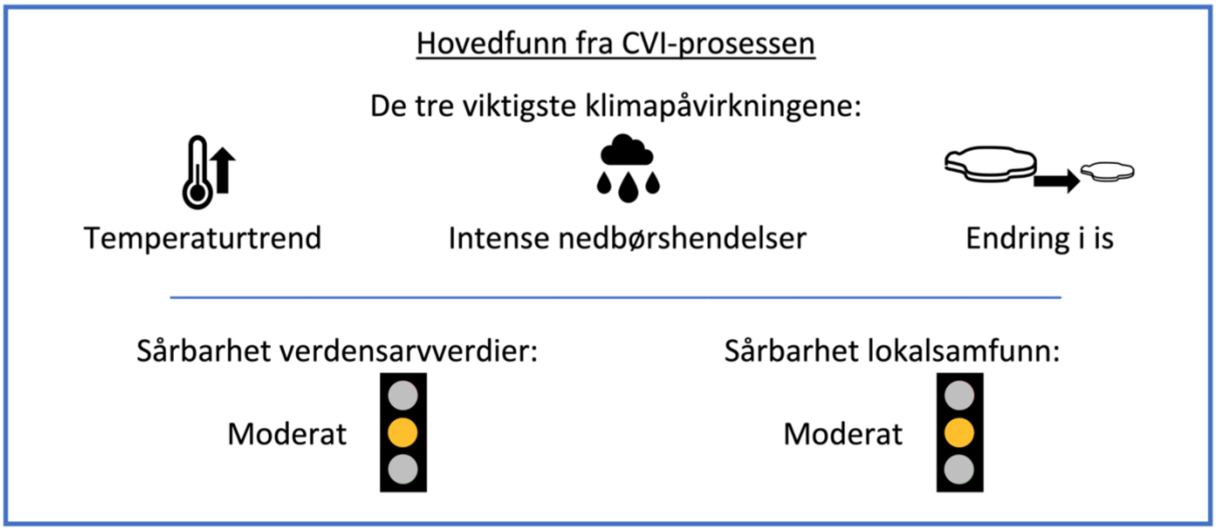
Vurderinger av den nåværende tilstanden til hovedverdiene viste at en femtedel av indikatorene ble ansett som i *god* stand, og ytterligere 56 % ble vurdert som *gode med noen* bekymringer; de resterende 24 % var imidlertid av *betydelig bekymring*. I de 44 årene siden den opprinnelige inskrivingen (i 1980) var litt over halvparten av komponentene stabile (52 %) eller hadde forbedret tilstand (12 %); Nesten en tredjedel av indikatorene ble vurdert å ha forverret seg. Det var variasjon i mange av disse vurderingene, inkludert erkjennelsen av at deler av noen indikatorer var i *kritisk* tilstand.

En standardisert liste over klimafaktorer vurderes i CVI-prosessen for å avgjøre hvilke som har størst sannsynlighet for å påvirke verdensarvverdiene. De tre viktigste klimafaktorene identifisert for Røros bergstad og Circumferensen er:

- *Temperaturtrend*;
- *Intense nedbørshendelser*; og
- *Endring i is.*

Deltakerne i verkstedet valgte ca. 2070 som fremtidig tidsskala for å vurdere sårbarhet, og valgte å vurdere et scenario med høye utslipp (RCP8.5). De tre klimafaktorene over vil sannsynligvis samhandle med hverandre, samt med andre klimafaktorer, som vil øke sårbarheten til verdensarvstedet i løpet av denne tidshorisonten.

CVI-prosessen fastslo sårbarheten knyttet til verdensarvverdiene, **OUV-sårbarheten**, 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 vurderingen er imidlertid sterkt avhengig av at truslene reduseres ved gjennomføring av tilpasningsstrategier. Uten slike tiltak vil sårbarheten for verdensarvverdiene (OUV) være Høy.



Syv sentrale økonomiske aktiviteter knyttet til verdnesarvområdet ble også identifisert, med varierende tilknytning til verdensarvverdiene. To av disse aktivitetene (turisme, detaljhandel) er sterkt knyttet til både sosiale og kulturelle aspekter ved lokalsamfunnet.

Workshopen vurderte **også sårbarheten** i samfunnet til å være i midtkategorien (**moderat**). Sårbarhetsvurderingene tar hensyn til tilpasningsevne knyttet til verdensarvverdiene, og forvaltningen av disse, samt lokalsamfunnet.

Ulike tilpasningsstrategier ble diskutert for å redusere mulige konsekvenser fra de viktigste klimafaktorene. Dersom disse strategiene ikke blir gjennomført i tide, vil sårbarheten for verdensarvverdiene øke til den høyeste kategorien.

Workshopdeltakerne identifiserte et bredt spekter av eksisterende og mulige forvaltningstiltak, inkludert:

- forbedre og utvide overvåkingen av kulturarv og miljø;
- utvikle politikk rundt gjenvekst av skog innenfor Circumferensen som omfatter både kulturminner og økonomiske hensyn;
- forbedre brannvern og samarbeid om brannforvaltning for bygningsarv og landskap;
- øke strategiske planleggingsaktiviteter mellom kommuner og etater angående klimaendringer og bærekraftig turisme; og
- Fortsette å dokumentere immateriell kunnskap som en ressurs.

Klimasårbarhetsanalysen for verdensarvområdet Røros bergstad og Circumferensen tar for seg effektene av klimaendringer på verdensarvområdets kulturverdier. Å forstå hvordan klimaendringer vil påvirke verdiene i dette området kan være nyttig for andre gruveområder med lignende verdier. Noe av kunnskapen som samles i Circumferensen kan overføres til forvaltningen av lignende industrielle kulturmiljøer.

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 Røros.

INTRODUCTION

The smelter bell was used to give notice to workers of the start of a new shift

1.1 Background to this report

This report outlines the application of the Climate Vulnerability Index (CVI) to assess the Røros Mining Town and the Circumference World Heritage (WH) property, one of eight UNESCO WH properties[1] in Norway (Bryde 2020). The original WH inscription for Røros in 1980 comprised only the central elements of the mining town including the main smelter and slag heaps from the smelting process.

In 2010, the WH property was extended to include the agricultural landscape around Røros Mining Town and incorporate two associated areas that contribute to the Outstanding Universal Value (OUV). The two areas, the Femundshytta smelter and the Winter Transport Route, each represent functions that were characteristic of mining activities at Røros for over 330 years; both have remained relatively untouched by encroachments and consequently preserve the integrity of the area.

The Femundshytta smelter was added to the property to exemplify small smelters and associated communities established in the area. After 50 years of smelting activities at Røros, most of the timber around the main town had been consumed and new smelters were established in nearby densely forested areas. The ore was then transported to smelters like Femundshytta but, as resources were depleted, the distance between the mines and the smelters steadily increased and small communities grew up around the new smelters. Twelve smelters associated with the Røros Copper Works were established, although they were not all in use at the same time and some are outside the Circumference.

Mining operations and the mining communities created an enormous need for transport, but for many years there were no roads. Everything had to be transported over long distances, so most of the transport took place using horses or bullocks pulling sledges in the wintertime. Frozen rivers and lakes were used as long as was possible but often mountain passes had to be crossed between the waterways. The Winter Transport Route from Tufsingsdal valley crossing Lake Siksjøen, over Holla and Lake Korssjøen to Røros exemplifies this form of transport.

The agrarian and industrial cultural landscapes are encompassed within a large buffer zone, coincident with 'the Circumference', an area of privileges granted by royal decree to the copper works in 1646, formed by a circle of approximately 45 km radius with the first workable mine (Old Storwartz) at its centre. The three components of the property (Røros mining town and cultural landscapes, Femundshytta and the Winter Transport Route) are all located within the Circumference. Collectively they show how the Røros copper works came into existence in a remote region with a harsh climate, and how the area developed and functioned to become a financial and cultural hub.

Today, a wide range of pressures, including climate change and unsustainable practices, threaten the values for which the area has been internationally recognised. This vulnerable cultural landscape continues to evolve, modified by extreme weather and human activities and remains subject to a variety of climatic conditions that have and will continue to change.

[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.

1.2 Overview of the Climate Vulnerability Index (CVI)

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

The Climate Vulnerability Index (CVI) is a systematic and rapid assessment tool that is values-based, science-driven and community-focused (Day et al. 2020). 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 in different formats. The CVI is comprised of two phases assessing:

- **OUV Vulnerability** through use of a modified version of the IPCC vulnerability framework to evaluate the exposure, sensitivity, and adaptive capacity of identified key values of the property (i.e., the WH attributes that convey the OUV). Application of this process determines to what degree the key values may be impacted by three key climate stressors chosen to be the most relevant for that property; and
- **Community Vulnerability** through consideration of economic, social, and cultural connections of the community associated with the WH property. The dependency of the community upon the property and the capacity of the community to cope with climate change-related decline in the key values are each evaluated.

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. Through its application, the CVI enables managers and stakeholders to consider what may be appropriate adaptive capacities for the management of their natural, cultural and community assets.

1.3 Why was Røros chosen for a CVI application?

Following successful applications of the CVI for Vegøyan – the Vega Archipelago (Heron et al. 2023) and Bryggen (Day et al. 2024) WH properties, opportunities for further applications of the CVI continued to be sought. Discussions between the Norwegian Directorate of Cultural Heritage (*Riksantikvaren*) and the Ministry of Culture of the Republic of Lithuania led to preparations for a CVI application for the Curonian Spit WH property (Heron et al. 2025) , with funding from the *EEA and Norway Grants*. Planning the Røros and Curonian Spit applications together provided an opportunity to streamline the resourcing needed to assess the impacts of climate change upon both WH properties. Funding support for the Røros CVI workshop was provided by *Riksantikvaren*.

A project Steering Committee was appointed representing different interest groups (in the fields of cultural heritage and climate change, see Appendix 4), which was tasked to collate relevant data and organise the workshop. The CVI assessment was undertaken in August 2024 for Røros, making it the third CVI application undertaken in Norway – and the first time an industrial mining landscape had been assessed using the CVI.

RØROS MINING TOWN AND THE CIRCUMFERENCE

Cable car system for ore transport in the Storwartz area

2.1 The geography of Røros

Røros Mining Town and the Circumference WH property is in south-central Norway, 100 km southeast of Trondheim, next to the Swedish border. The site is a large cultural landscape, approximately 165 km^2, with a buffer zone of approximately 5,000 km^2 (Figure 2.1). Røros Mining Town was established in 1644, when the first copper mine in the region was discovered. Before this, only a few farmers and the Sámi people lived in the area.

For 333 years, the Røros Copper Company was extracting and processing copper in the region. The town grew quickly and became a main hub for the copper industry in the region. It was also an important centre for trade between the coast and inland, as well as for areas in Sweden.

In the first hundred years of operations, the summer roads were poor and not fit for heavy transport. Most of the transportation of goods was done by horses and sledges during the long winters. The railway through Røros, finished in 1877, made the region much more accessible and had huge influence on both import to and export from the region.

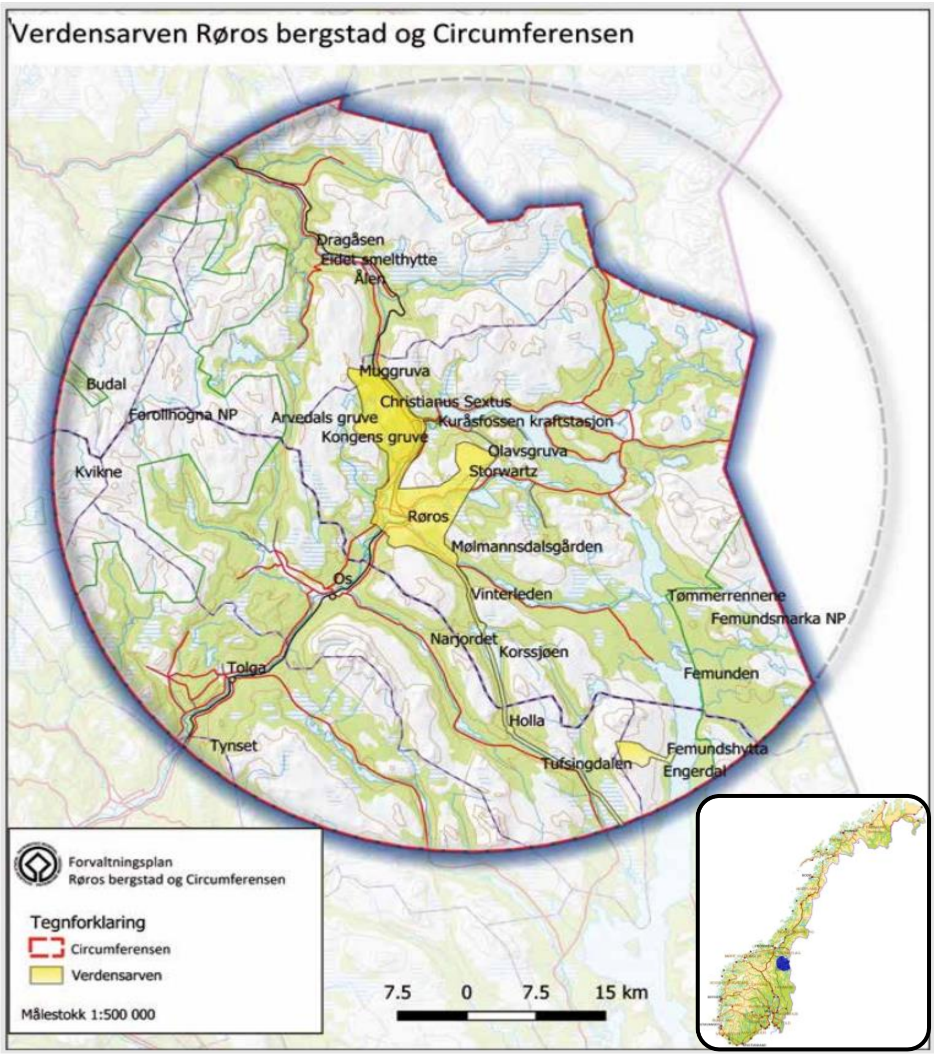


Figure 2.1 Map of the Røros World Heritage property (inset shows location within Norway). [adapted from Management plan Røros Mining Town and the Circumference, 2019-2023[2]]

[2] https://roros.kommune.no/wp-content/uploads/2021/01/Forvaltningsplan-for-verdensarven-R%C3%B8ros-bergstad-og-Circumferensen-2019-2023_.pdf

The property consists of three sections:

- **The town and surrounding cultural landscapes** cover a large contiguous area that includes the mining town, the urban and surrounding agricultural areas and the most important mining landscapes where copper work operations were carried out.
- **Femundshytta** is a largely relict industrial cultural landscape with the remains of a smelter and water management systems, around which the associated community developed.
- **The Winter Transport Route** is made up of a sequence of lakes, rivers and creeks in an almost untouched landscape that was used from November to May.

Each of these sections are within the Circumference (i.e., the area of privileges awarded by the Danish-Norwegian King to Røros Copper Works in 1646), which defines the buffer zone for the property.

The WH property lies between 700 and 900 metres above sea level, while the buffer zone spans from 250 metres above sea level in Gauldalen to the mountain peak Storviglen (1,561 metres). A large part of the buffer zone is mountainous areas that are too high above sea level for forests to grow.

The area has long winters and cold temperatures. In Røros, temperature has been measured as low as -50.4°C. The high altitude and remoteness of the area, with long winters and a short growing season, are important characteristics of the inscription on the WH List.

2.2 The Røros World Heritage property

Røros Mining Town was inscribed on the WH List in 1980, under criteria *iii*, *iv* and *v*. The WH property included the old parts of the town, the industrial area around the smelter and the slag heaps (covering approximately 1 km^2).

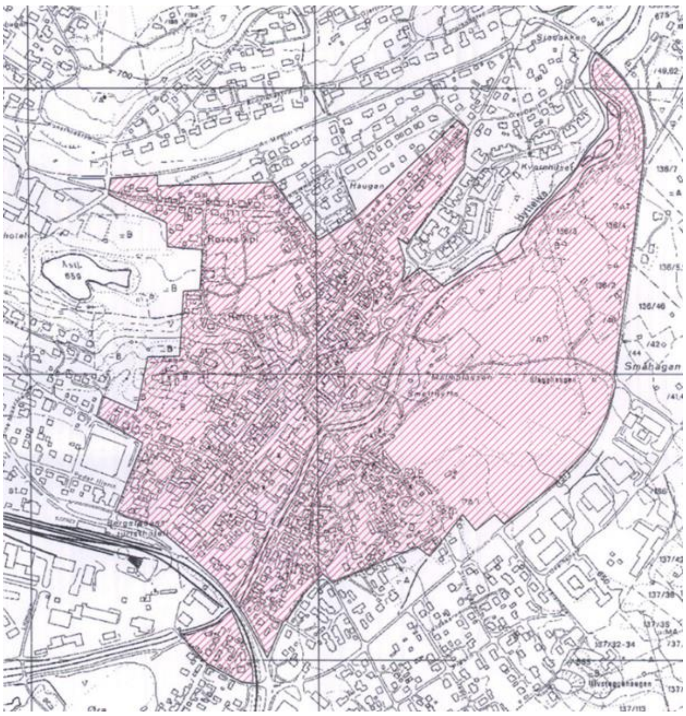


Figure 2.2 Map of the 1980 inscription of 'Røros Mining Town' [source: UNESCO[3]]

[3] https://whc.unesco.org/en/list/55/maps/

In 1993, an ICOMOS evaluation recommended an extension of the property to emphasize the context of the town as an industrial centre of a vast resource area. This started a long process of documentation and evaluation, resulting in a new inscription in 2010. This extension was a major change with huge implications, both in geography, values and management challenges. The property was extended to include cultural monuments and landscapes beyond the town centre and was renamed Røros Mining Town and the Circumference. The property is now approximately 165 km^2, with a buffer zone of approximately 5,000 km^2.

The Circumference represents the resource area granted to Røros Copper Works (1644–1977) by royal 'privilege' in 1646. Within the Circumference, of radius 45 km (4 old Norwegian miles, *mils*) and centred on Old Storwartz mine, the company was granted rights to utilise all resources. In this area, there are examples of traditional houses and traces of the extensive operations of the Røros Copper Works – mining, smelting, transport, forestry and charcoal burning, waterways and dams.

Based on the extensive use of natural resources and labour, Røros Copper Works contributed to the wealth of the country for more than 300 years. This was a period of rapid technological development and strict organisation of the community and of the company's own business. The property provides a unique witness to this era and shows how both settlement and mining were adapted to a demanding climate and remote location. The history and culture of the population tell of barren conditions and frugal living.

Beyond mining, agriculture was a major part of peoples' livelihoods and this continues today. In addition, trade with the Sámi people in the area brought important resources from reindeer herding.

The property is made up of three sections:

- **The mining town of Røros together its surrounding historical and cultural landscape**
  This section consists of the town, built around the main smelter, with farms within the town and the agricultural areas around the town. Connected to the smelter there are several buildings, constructions and water management systems, as well as slag heaps made of waste material from the copper smelting process. The section also contains the two main mining areas, the Storwartz area and the Northern mines; the transportation system between the mines and the town; and the first power station, Kuråsfossen (built in 1896).
- **Femundshytta smelter**
  After 50 years of smelting activities at Røros, most of the timber around the town had been consumed. The smelter was still in operation, with firewood and charcoal transported to Røros. It gradually became clear that it would also be profitable to establish new smelters in densely forested areas of the Circumference. This was undertaken and ore was then transported to the new smelters, around which small communities grew. Femundshytta was chosen to exemplify these smelters.
- **Vinterleden – the winter transport route**
  Mining operations and the mining communities created an enormous need for transport. Everything had to be transported over long distances and, for a considerable period of time, there were no roads. Up to the 1880s, most of the transport took place using horses or bullocks and sledges in the wintertime. Frozen rivers and lakes were used for as long as was possible each year but often mountain passes had to be crossed between the waterways. The Winter Transport Route from Tufsingsdal valley over Holla and Lake Korssjøen to Røros represents this form of transport.

2.3 Geology and physical geography

The geology in the region is roughly divided into two types. In the northwestern part, the Trondheim Cover mainly consists of schist. It is in this area that the largest ore deposits of copper and zinc are found and, therefore, most of the mines. Because the schist disintegrates easily, much of the area has fertile soil and varied flora. The southern and eastern parts consist of arkose and feldspar-rich quartzite. Therefore, the soil is mostly poor, and this also leads to vegetation with few species. The southeast part of the region is more than 600 metres above sea level. This area has open mountain landscapes divided up with lakes, rivers, hills, valleys and mountains.

Much of the landscape is dominated by traces from the last ice age. Glaciers formed systems of ridges, eskers, hillsides and deposits of moraine materials. Kvitsanden, close to Røros Mining Town, consists of well-sorted materials from glacial rivers.

Water features are present across the Røros landscape. The Glomma is Norway's longest river, stretching some 600 km from its source, near Lake Aursunden (northeast of Røros), to Fredrikstad at Norway’s south coast. Lake Femunden (Norway's third largest of area 203 km^2) is located south of Røros. A logging canal system, the Hådal waterway, was established by the Røros Copper Works in the 18th century to connect Lake Femunden to Lake Feragen for the purpose of log transportation. The waterway, which runs through Hitterdalen and Djupsjølia, was regulated in the 1670s to provide waterpower for the smelting works in Røros.

2.4 Human habitation

There are traces of human activity, hunting and fishing back to the Stone Age in the region. Farms were established in the fertile soil in the eastern part of the region in the Middle Ages, while the barren areas in the east mostly were used for gathering, hunting and fishing, both by the farmers and the Sámis until the copper works started.

As the copper works demanded a lot of manpower, the population grew quickly from the 17th to the middle of the 20th century. Small residential farms were established by the workers around the mines, around the smelters and along the transport routes. In 1769, the number of inhabitants within the municipalities in the Circumference had passed 6,000 and continued to grow rapidly until the Second World War, only disrupted by the hard times during the Napoleonic wars (1802-1815) and low copper prices in the 1920s (Figure 2.3).

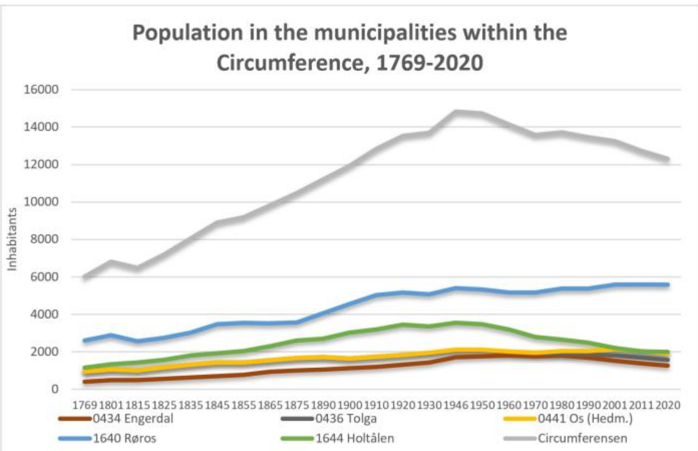


Figure 2.3 Population in the municipalities within the Circumference, 1769-2020 [source: Statistics Norway[4]]

[4] https://www.ssb.no/statbank/table/09501

In 1946, the population within the Circumference peaked at almost 15,000 inhabitants. After the Second World War, the mechanisation of farming and forestry reduced the demand for labour in the region and the population declined slowly to today's approximately 12,000 inhabitants.

2.5 The values of Røros

A WH property is inscribed because it has values recognised as being of international significance, which are described in the Statement of Outstanding Universal Value (SOUV). However, there are additional values that may not be included in that assessment, which are also of significance – these are referred to as 'other Significant Property Values' (SPVs). Each of these values are underpinned by attributes (tangible or intangible characteristics) that may be at the level at which management typically occurs (Figure 2.4).

Within a WH property, certain **values** have been identified because of their significance.

The particular values that have been recognised as being globally significant and conferring *Outstanding Universal Value* (under one of more of the World Heritage criteria) are its **World Heritage** (WH) **values**.

Each of the above WH values have **attributes** (at the level at which management occurs).

Other values within the property are also important; if they are considered nationally, regionally or locally 'significant', they are referred to as other **Significant Property Values** (SPVs) noting they are distinct from those values that comprise the OUV.

Figure 2.4 Hierarchy of terminology for values and attributes *(adapted from Heron et al. 2020)*.

2.5.1 Key values derived from the OUV

When formally listing an area as a WH property, UNESCO's WH Committee summarises the significant values and attributes in a SOUV, a fixed description of the values of the property referenced to the date of inscription. The SOUV for Røros Mining and the Circumference (Attachment 1) forms part of the property's UNESCO webpage.

Prior to the CVI workshop, excerpts from the SOUV for Røros Mining and the Circumference were identified and grouped together to form four 'key values' (listed here and expanded in Table 2.1). This was initially compiled by the CVI developers and subsequently endorsed by the Steering Committee. The key values are underpinned by associated 'attributes', which are the elements of a heritage place that convey its heritage/conservation values and enable an understanding of those values. Attributes can be physical qualities, material fabric and other tangible features but can also be intangible aspects such as processes, social arrangements, cultural practices, associations and relationships that can be reflected in physical elements of the property. Management is typically undertaken considering the tangible attributes.

The four key values identified for Røros Mining Town and the Circumference are:

1. Outstanding cultural landscapes
2. Complex and interlinked system
3. Unique culture and knowledge
4. Extreme climate conditions, topography and distances.

These key values became a foundation for the initial assessments in the CVI process.

Participants in the CVI workshop assessed the current condition of the four key values and their recent trend (over the 44 years since the original inscription in 1980; Table 2.1). These were undertaken for each excerpt of the Statement of OUV identified within each of the four key values; for the excerpts related to 'way of life' and 'technology' (in the fourth key value), participants made assessments for both traditional and modern aspects. One-fifth of the current condition assessments (5 of 25) were described to be in *Good* condition (dark green, Table 2.1), with a further 14 evaluations of *Good with some concerns* (light green, 56%). The remaining six assessments (24%) indicated *Significant concern* (orange). Just over half of the value descriptors were determined to have had a *Stable* trend (13 of 25, 52%) since the 1980 inscription and three (12%) had *Improved*; however, around one-third (8 of 25, 32%) of recent trend assessments involved Deteriorated values. There were related to the mining operation, transportation (particularly the Winter Transport Route), traditional technology and traditional way of life (the last of which was indicated by participants to be of *Significant concern* and potentially be in *Critical* condition). For one descriptor, the trend could not be determined (*Unknown*).

Participants specifically noted that the three sections within the property boundary do not encompass all heritage attributes, with key exemplars of the last preserved smelter, some water transport systems and charcoal production areas not being within the boundary (however, these are within the Circumference and, thus, the buffer zone). Some built areas within the property have improved through repair and restoration works (e.g., hayshed, mining buildings, stone walls), though this has been balanced by a lack of change (such as at Femundshytta) and deterioration in other built areas.

Moreover, the viewshed of the property has changed as a result of modern development activities, for which careful management was noted as necessary to ensure that the property integrity is maintained. The viewshed across the property, particularly connecting mining areas, has also been negatively affected by forest re-growth. This topic requires a perspective, potentially unique to Røros, regarding the balance between maintaining the integrity and authenticity of a cultural landscape fashioned through the near-complete extraction of the forest resources and the regeneration of nature. Forest re-growth has also affected some aspects of farming around the town, has occurred at higher altitudes (a result of warmer conditions) and has obstructed some of the summer transportation routes.

Winter transportation has also been affected by observed changes in waterways, related to electricity generation and changing climate conditions (e.g., a decline in ice). Elsewhere, water management systems have varying implications for heritage across the property, with concerns discussed for the mining areas but also recognition that there are no such concerns for the town.

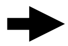
Table 2.1 Key values for Røros Mining Town and the Circumference derived from the Statement of Outstanding Universal Value, together with the assessed current condition and recent trend since the 1980 original inscription *(refer to the full legend on page 21)*

Key Values	Relevant excerpts taken directly from Statement of OUV	**Attributes** *(at level at which management may be undertaken)*	Assessment of current condition
1. Outstanding cultural landscapes -Mining landscapes -Smelting landscapes -Resource, transport and agrarian landscapes	Røros Mining Town and the Circumference consist of three sites within the Circumference	*Tangible attributes:* • Mining landscapes with miners' accommodation/farms -Mines -Production buildings and constructions -Water management systems -Miners' farms • Smelting-/smelter landscapes with farms within the town or village. This landscape category also includes Røros Mining Town -Smelters, slag heaps, production buildings and constructions -Townscape and agrarian landscape -Farming landscape around smelters -Water management systems • Resource, transport and agrarian landscape -Winter transport routes -Summer roads -Charcoal production landscapes -Farms connected to transport and resource exploitation *Intangible attributes* • way of life needed to be adapted • shaping of a cultural landscape	
	The town and the cultural landscapes cover a large continuous area which includes the landscape surrounding the mining town, the urban agricultural areas, and the most important mining landscapes where agricultural practices and copper work operations were carried out.		
	Femundshytta is a largely relict landscape which includes the industrial cultural landscape with the remains of a smelter, water management systems, and the community that grew up around them		
	The Winter Transport Route is made up of a sequence of lakes, rivers, and creeks in an almost untouched landscape.		
	Røros Mining Town (...) interlinked with a cultural landscape that shows in an outstanding and almost complete manner how mining operations, transportation, and the way of life had to be adapted to the requirements of the natural environment – the mountain plains, the cold climate, the remote location without roads and with marginal growth conditions for forests and agriculture		
	Røros townscape and its related industrial and rural landscapes, with their interlinked industrial activity and domestic and agricultural accommodation within an urban environment		
	These activities have shaped a cultural landscape that provides a unique picture of how the mines and the mining town functioned as a complex and at times vulnerable system that verged on the limits of what was possible in an inhospitable environment with a harsh climate.		
	The mining landscape is relict in nature, but almost no transformations or encroachment occurred after the closure of the copper works.		

Legend for Table 2.1 (see definitions of colour categories on page 21)

Good	Good with some concerns	Significant concern	Critical

Improved 

Stable 

Deteriorated 

Unknown ?

Key Values	Relevant excerpts taken directly from Statement of OUV	**Attributes** *(at level at which management may be undertaken)*	Assessment of current condition
2. Complex and interlinked system -The Copper Works production system -Transport system -Settling and self-sufficient system -Management and social system	..how mining operations, transportation, and the way of life had to be adapted to the requirements of the natural environment – the mountain plains, the cold climate, the remote location without roads and with marginal growth conditions for forests and agriculture.	*Tangible attributes:* • Røros Mining Town • Traces of mining, smelters, and water management systems • Traces of transport system (Winter roads, summer roads, cable transport systems, water transport systems) • Traces of self-sufficient system (farms, fields, summer pasture farms, traces of herding and gathering) *Intangible attributes* • functioned as a complex and vulnerable system • social connections of the settlement	
	...Røros Mining Town and the traces of mining, smelters, transport, and water management systems		
	...interlinked industrial activity and domestic and agricultural accommodation within an urban environment		
	Technologically, their buildings and installations evolved through the use of available indigenous materials to functionally satisfy the combined approach of mining and agrarian practices		
	...how they used the available indigenous resources to provide shelter, produce food for their sustenance, and contribute to the national wealth of the country		
	...traditional settlement and land-use.		
	...a coherent and interdependent unit		
	...a complex and at times vulnerable system		
3. Unique culture and knowledge	On this basis a unique culture developed that has partly disappeared, but an outstanding testimony of the existence of which has been preserved.	*Tangible attributes:* • Archives documenting the copper company's history *Intangible attributes* • The Winter Market • Transport by horse and ox drawn sledges • Music and dancing ("pols") • International impulses on culture and language • Imported German mining technology • Food traditions • Clothing traditions • Traditional crafts and building techniques • Traditional agrarian practices • Adaption of way of life and production to inhospitable environment: Widely spread/scattered production landscapes with related settlements	
	From the time copper ore was found in the mountains at Røros in 1644 until the copper works went bankrupt in 1977, with German mining technology as a starting point, employing German, Danish, Swedish immigrants, and Norwegian nationals, a unique culture developed to extract the valuable copper in a remote and sparsely inhabited area.		
	The authenticity of the property is expressed in almost all its aspects and features. All the remains bear credible witness to the history and development of the site. This is also reinforced by the rich archive documenting the copper company's history.		

4. Extreme climate conditions, topography and distances	The Winter Transport Route … was used from November to May	*Tangible attributes:* • The mountain plains • Widely spread/scattered production landscapes with related settlements – Charcoal landscapes – Deforesting • The remote location without roads • Traces of transport system (Winter roads, summer roads, cable transport systems, water transport systems) • Traces of self-sufficient system (farms, fields, summer pasture farms, traces of herding and gathering) • Traces of paths between settlements/miners farms and the mines	↘
	…the way of life had to be adapted to the requirements of the natural environment – the mountain plains, the cold climate, the remote location without roads and with marginal growth conditions for forests and agriculture.		*Traditional* ↘ *Modern* →
	…in a remote and sparsely inhabited area		→
	…the adaptation of technology to the requirements of the natural environment and the remoteness of the situation.		*Traditional* ↘ *Modern* →
	…how people adapted to the extreme circumstances in which they had to live		→
	…whilst at the same time accommodating the consequences of dealing with extreme climatic conditions.		→
	…as a complex and at times vulnerable system that verged on the limits of what was possible in an inhospitable environment with a harsh climate.	*Intangible attributes* • The cold climate • Marginal growth conditions • An inhospitable environment with harsh climate • Sparsely inhabited	?

Legend for Table 2.1

Good
The property's values are in good condition and are likely to be maintained for the foreseeable future, provided that current conservation measures are maintained

Good with some concerns
While some concerns exist, with minor additional conservation measures the property's values are likely to be essentially maintained over the long-term.

Significant concern
The property's values are threatened and/or may be showing signs of deterioration. Significant additional conservation measures are needed to maintain and/or restore values over the medium to long-term.

Critical
The property's values are severely threatened and/or deteriorating. Immediate large-scale additional conservation measures are needed to maintain and/or restore values over the short to medium-term or the values may be lost.

Improved ↗

Stable →

Deteriorated ↘

Unknown ?

Participants reported that the cultural heritage within Røros has generally improved, specifically noting the growth in knowledge and practice of music, dance, food and clothing, particularly through the celebration of the Winter Market. This is directly connected with the efforts undertaken to document customs, traditions and historical ways of living and to make records of traditional techniques and technologies (whilst also noting that documentation does not guarantee practical capability – both must be actively pursued). However, some aspects (e.g., farming practices) have not had sufficient investment and are at risk of being lost, noting also that the opportunities for living testimony have diminished with the passing on of practitioners of the traditional methods.

In summary, whilst nearly all attributes were evaluated to be *Good* or *Good with some concerns*; and most 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.

A comprehensive report (Court 2025) published after to the CVI workshop, provides a wide-ranging analysis of the values and attributes of the existing WH property. This report outlines some shortcomings with the current SOUV; suggests various attributes that should be better protected, including within the large buffer area of the Circumference; and recommends greater recognition of the significant role of the Sámi people, showing a direct connection between the Sámi community and the OUV in the Røros area.

2.5.2 Other Significant Property Values

While the SOUV describes the WH values, there are other values of significance that may exist within the inscribed boundary of the WH property or in the adjacent areas that are not included in the SOUV but are important locally, regionally, or nationally. They may, therefore, be recognised as 'significant' under local or regional by-laws, 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). These are tabulated in Appendix 2 with some examples briefly described here:

<u>Values in the Buffer Zone</u>
The buffer zone surrounding the Røros WH property boundary is defined by the Circumference and plays a crucial role in supporting the OUV of the property. It includes historically significant elements, such as transport systems, timber slides and the Glomma River corridor through Os and Tolga. Other key features include the hamlet of Feragsgrenda, the Gammelallmannaveien road, the Gruvåsen mining area and the Narjordet coal production site. These elements reflect the broader industrial and cultural landscape that supported the copper works. The buffer zone also holds unique values not found in the property and Sámi reindeer grazing lands, still used by approximately 12,000 reindeer each winter (SOUV; Appendix 1).

<u>Archaeology and Prehistoric Sites</u>
Archaeological evidence across the region reveals continuous human activity from the Stone Age onward. Sites include hunting systems, burial grounds, iron production facilities and Sámi sacrificial sites. Tools, weapons and house ruins in mountain areas reflect adaptation to harsh environments. However, many prehistoric remains cannot be definitively linked to specific ethnic groups, posing challenges for interpretation. Despite this, they offer invaluable insights into the region's long-term human presence and cultural evolution.

Other Cultural Heritage

The region has a rich cultural history shaped by agriculture, hunting, fishing, trapping and settlements predating the copper works. More recent cultural monuments reflect rural livelihoods and industrial development, though it is often difficult to distinguish between those linked to the copper works and those from other societal activities.

Southern Sámi Culture and Reindeer Husbandry

The Southern Sámi have a long-standing presence in the region (Figure 2.5), though their history is underrepresented due to a lack of written sources. This stands in contrast to the mining community in Røros, which has left behind extensive written archival material. This can lead to a skewed understanding of history, as historical interpretation is often based on written documentation (Røros Museum 2016)[5].

Much of what is known comes from legal documents detailing conflicts over grazing rights with the copper works. The Sámi traditionally led a nomadic lifestyle, leaving behind cultural traces such as turf hut remains, tent rings and milk pits. Many prehistoric cultural remains, such as pitfall traps and hearths, lack clear ethnic markers, making it difficult to attribute them to specific groups. Nonetheless, these traces are vital for understanding Sámi land use and cultural continuity.

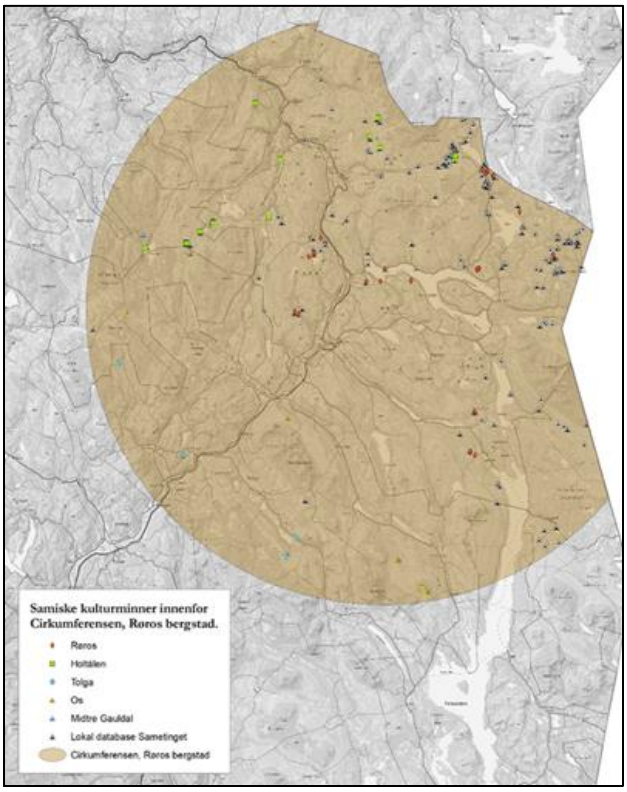


Figure 2.5 Known Sámi traces within the Circumference (beige shading) [source: Sámi Parliament local database[6]]

[5] Røros Museum 2016: Archival research and new insights into documents concerning encounters between Sámi people and mining communities in the Røros Sámi area. A pilot project.

[6] https://saemiensijte.no/

<u>Nature</u>

The Circumference includes several protected areas under the *Nature Diversity Act*[7] (Figure 2.6). Femundsmarka and Forollhogna National Parks are key conservation areas, preserving large, relatively untouched forest and mountain landscapes. Femundsmarka is known for its wilderness, cultural heritage and canoeing routes[8], while Forollhogna supports one of the world's most productive wild reindeer populations[9]. Skardsfjella and Hyllingsdalen landscape conservation area protect the Glomma River's headwaters and Sámi cultural sites[10]. Kvitsanden landscape conservation area, an inland dune system shaped by post-glacial processes and mining-related deforestation, hosts rare insect species and has both geological and cultural significance[11]. These areas are vital for biodiversity, traditional land use and recreation.

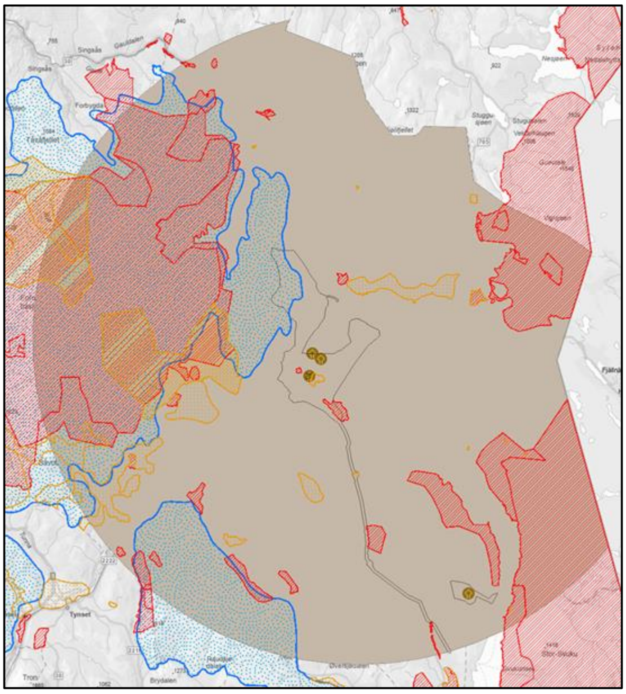


Figure 2.6 Protected areas within the Circumference: under the *Nature Diversity Act* (red); valuable cultural landscapes and selected cultural landscapes (yellow); and wild reindeer areas (blue). [source: Naturbase[12]]

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[7] https://www.regjeringen.no/en/documents/nature-diversity-act/id570549/

[8] https://lovdata.no/dokument/LF/forskrift/1971-07-09-6

[9] https://faktaark.naturbase.no/?id=VV00000597

[10] https://lovdata.no/dokument/LF/forskrift/2009-01-09-21

[11] https://faktaark.naturbase.no/?id=VV00002336

[12] https://www.miljodirektoratet.no/tjenester/naturbase/

MANAGEMENT AND CONTEXT OF RØROS

The area around the Smelter in Røros, with the slag heaps and the agricultural landscape in the background

3.1 Management and governance of Røros

Norway has a responsibility to protect and manage the WH property. Norway ratified the World Heritage Convention in 1977 and endorsed the nomination of the property to be listed as World Heritage, both in 1980 and in 2010. The Norwegian Government is also responsible for reporting on Norwegian WH properties to UNESCO, through the National Focal Point situated within The Directorate for Cultural Heritage (*Riksantikvaren*).

The legal protection of the property is mainly ensured through the *Planning and Building Act*[13] and managed by the municipalities. Municipal plans are therefore very important tools for WH management. Parts of the property are protected by the *Cultural Heritage Act*[14], which is managed by the county municipalities.

Most of the property is privately owned and the owners are responsible for the inspection and maintenance of their properties, within the legal framework for the area. Some parts of the property, including the area around the smelter in Røros and some mining areas, are owned by the state, which manages the area in collaboration with Røros Museum. Parts of these areas are protected under the *Cultural Heritage Act*. There are also some properties and buildings owned by the municipalities.

Activities are coordinated through the World Heritage Council, which is composed of the mayors of the five WH municipalities, a political representative for each of the two county municipalities (Trøndelag and Innlandet) and a representative from the Sámi Parliament. The National Agency for Cultural Heritage is an observer on the council. The World Heritage Council also has an administrative expert group, with representatives from, among others, the municipalities, the county municipalities, the County Governor and the regional tourism organisation. This group is important for coordinating ongoing WH activities.

There are many stakeholders who have partial responsibility for the WH property, both as owners and as authorities. The management plan from 2019 provides an overview of the stakeholders and, through the World Heritage Council and the expert group, WH activities are coordinated as best as possible.

The Norwegian Government contributes annually with financial grants to safeguard the WH values. Support has been provided to Røros to safeguard the industrial cultural landscape, the outbuildings in the WH property and, to some extent, important elements of residential buildings. Some support has also been given to maintain the operation of agriculture in the area.

Two main programs have been established to maintain the Røros WH values:

- **The Outbuilding project, managed by Røros Municipality**. This project has, since 1995, repaired outbuildings and other small constructions (gates, brick walls, etc.) within the WH property and buffer zone. The project contracts small craftsman businesses and the house owner for each project element.
- **The Copperworks property, managed by Røros Museum together with the property owner, Statsbygg**. This program has been ongoing since 1980 (with some organisational changes during the years) to take care of the industrial buildings and constructions within the Storwartz mine area and around the smelter in Røros.

[13] https://lovdata.no/dokument/NLE/lov/2008-06-27-71

[14] https://lovdata.no/dokument/NLE/lov/1978-06-09-50

3.2 Røros Management Plan

The management plan (2019-2023) describes the complexity in managing the property. This includes the legal framework and authorities, the planning system, the stakeholders and sources of financial grants. The plan provides a framework for the preservation of the OUV and gives direction for the municipalities, the County Authorities and other stakeholders. It documents the vision for the WH property in 2030 and outlines goals and strategies to fulfil the vision. The plan also describes the condition and trends of a wide set of attributes within the property, as well supplementary elements in the buffer zone.

Both the management plan and the UNESCO Periodic reporting (2023) describe key threats to the OUV and the management of the Røros Mining Town and the Circumference property:

- Climate change issues;
- Maintaining capacity and competence amongst skilled heritage craftsmen;
- Spatial planning issues – contemporary society needs vs historical buildings and surroundings;
- Changes in agricultural cultural landscape due to demand of more efficient tillage;
- Plans for new mining and pollution issues in the old mining fields;
- Plans for wind power plants; and
- Lack of sufficient monitoring and documentation systems.

Many of the WH values are linked to wooden buildings and structures. Climate change is expected to increase the decay of these constructions. Monitoring of changes and development of strategies to maintain these constructions in a more humid climate are both required.

The ‘Green Shift’ and measures to help reduce carbon emissions are creating pressure on both the development of more clean energy and the production of minerals. Expectations of more mining and power development are creating challenges within the buffer zone, as these measures may themselves be threats to the WH values.

3.3 Economic context

The Røros Mining Town and the Circumference property is situated quite far from the larger populations in Norway. Around 5,700 persons are living within Røros municipality and approximately 10,000 persons within the Circumference, including the municipalities of Holtålen, Os, Tolga and Engerdal. This means that Røros, despite its relatively small size, functions as a regional centre (Figure 3.1), with a significant number of the residents in the surrounding municipalities commuting to work in Røros.

In the late 1800s and throughout the 1900s Røros transitioned from primarily being a mining community into having a more diversified economy. Various industries were developed in Røros, as farming became more important in the neighbouring municipalities when the copperworks reduced their demand for workforce.

Approximately one-third of the working population of Røros is in the public sector, similar to the Norwegian average. This includes most of the education, human health and social work sectors (Table 3.1).

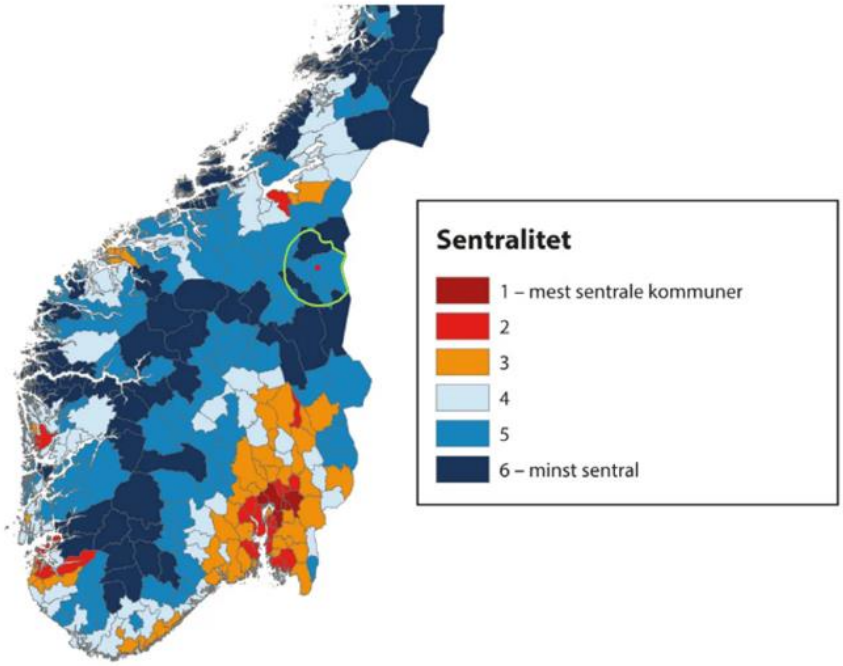

Figure 3.1 Centrality of municipalities in southern Norway, with the Circumference outlined in green [source: Meld. ST 27 (2022-2023), Distriktsmeldingen[15]]

The private sector today is widely diversified; however, there are strong differences between Røros municipality and the other municipalities in the Circumference (Table 3.1). In Røros, the manufacturing industry employs nearly one-fifth of the workforce, 12% is working within wholesale and retail trade (mostly retail), followed by construction (9%) and accommodation and food service (6%). In the other municipalities, the main industries are construction (14%) and agriculture (12%). Approximately one-quarter of the manufacturing industry across all five municipalities produces food products and has a strong connection to the agricultural sector.

Statistics of tourism activities are categorised across multiple industry divisions (e.g., hotels and restaurants in *Accommodation and food service activities*, Travel agencies in *Administrative and support service activities*, museums and artists in *Other service activities*; Table 3.1). Even though the tourism industry is relatively small, considering that Røros is a well-known tourist destination, it is important to recognise that a lot of the retail businesses are dependent on tourism (Askheim 2022b). In addition to the accommodation industry, there are more than 7,000 private holiday homes within the Circumference, half of them within Røros municipality. The users of these cabins have significant demand for goods and services throughout the year – it was estimated in 2020 that, within Røros municipality, visitors (both commercial and in private cabins) generated an annual demand in the municipality of approximately 450 million NOK (Askheim 2022a).

Management, maintenance and repair of houses and constructions within the WH property have generated a strong sector of craftsmen and heritage workers. It was estimated in 2018 that approximately 100 persons had their main occupation connected to heritage work in the region (Ruud and Skogheim 2018); this includes the national Cultural Heritage Fund, a public institution located in Røros that funds heritage work all over the country.

[15] https://www.regjeringen.no/no/dokumenter/meld.-st.-27-20222023/id2985545/

Businesses associate strongly with the characteristics of Røros, including the WH values (Helseth et al. 2017). In 2019, a brand survey of Røros was conducted, in which 2,000 Norwegian respondents were asked how they perceived Røros (Askheim 2019). The main associations connected to Røros were *Mines, History, Wooden houses, Cold, Cultural Heritage, Winter, World Heritage, Nature, Christmas Spirit* and *National Treasure*. These associations are heavily employed in the advertising of several businesses in the region and used to build a strong brand based on the name "Røros". The travel industry, food industry and several other businesses have deliberate and strategic use of this "common place branding".

Table 3.1 Distribution of employment by industry division in 2023 for Røros and the other municipalities within the Circumference as counts and percentage, with the latter also shown for the whole of Norway [source: Statistics Norway, Statistikkbanken Table 13470]

Industry	Røros Municipality	Other Municipalities in Circumference	Røros Municipality	Other Municipalities in Circumference	Norway
	Number	Number	%	%	%
01-03 Agriculture, forestry and fishing	143	311	4 %	12 %	2 %
05-09 Mining and quarrying	3	18	0 %	1 %	2 %
10-33 Manufacture	637	197	19 %	8 %	8 %
35-39 Electricity, water supply, sewerage, waste management	38	83	1 %	3 %	1 %
41-43 Construction	307	349	9 %	14 %	9 %
45-47 Wholesale and retail trade: repair of motor vehicles and motorcycles	401	164	12 %	6 %	13 %
49-53 Transportation and storage	131	45	4 %	2 %	5 %
55-56 Accommodation and food service activities	205	45	6 %	2 %	4 %
58-63 Information and communication	59	10	2 %	0 %	4 %
64-66 Financial and insurance activities	53	42	2 %	2 %	2 %
68-75 Real estate, professional, scientific and technical activities	93	129	3 %	5 %	7 %
77-82 Administrative and support service activities	102	66	3 %	3 %	5 %
84 Public adm., defence, soc. security	156	170	5 %	7 %	6 %
85 Education	203	195	6 %	8 %	8 %
86-88 Human health and social work activities	608	654	19 %	25 %	21 %
90-99 Other service activities	136	100	4 %	4 %	4 %
TOTAL	3275	2578			

3.4 Social and cultural context

In its early stages, Røros was a class-divided society. The copperworks management (the upper class) had large farms and governed the town. During the 1800s, merchants also became a part of the upper class. The working class also had their own farms but they were smaller and provided less economic independence. Even so, there was no strict geographical division between the classes – small and large farms could be located next to each other.

In the 1900s, the labour movement grew stronger and society gradually changed from being class-divided to being much more egalitarian. This change can be exemplified by the fact that, since 1914, 19 of the 23 mayors has been member of the labour party (*Arbeiderpartiet*).

The indigenous Sámis used the land before the copperworks was established and the Sámi society has coexisted with the mining society. Through these 350 years there have been both cooperation and conflicts between the Sámi society, the mining company and the farmers in the area. The national Sámi assimilation policy (from approximately 1850 and lasting for around 100 years) and local conflicts connected to land use rights made the existence for the Sámis difficult and has also been a threat to their language and culture. Nationally, these issues have been addressed in the report of the Truth and Reconciliation Commission, presented to the Parliament in June 2023.

The cultural heritage of Røros began to be recognised in the early 1900s. The first protection of single buildings occurred in 1923, starting with the wooden houses of the town. From the 1970s, the industrial heritage and a broader scope of the townscape were also acknowledged. The properties owned by the bankrupt copper company (the smelter area and the Storwartz mines) were bought by the state in 1980 for heritage purposes, the same year that Røros Mining town was first inscribed as World Heritage. The perception of Røros as an important heritage area was strongly influenced by the work of artists during the 1900s. The paintings of Røros by Harald Solberg, which directly influenced the first protection of buildings, and the books written by Johan Falkberget have made a strong impact on the national perception of Røros.

The inscription of Røros Mining Town on the World Heritage List in 1980 was a nationally-driven process, in which the local community were informed but not particularly participating. The local storytelling of this process is that, once again, the national authorities made decisions with big impacts for the society, without listening to the local voice. The process of extension of the property, preparing for the new inscription in 2010, was different. At that time, all municipalities were a part of the process and this created a local ownership – of the process, the values and the WH status.

Most of the people living both within the property and the Circumference have a strong connection to the history of the region, the cultural landscape and the nature. There is pride in being inscribed as World Heritage but also a strong connection to the landscape for daily life and leisure activities. Hiking, biking, hunting and fishing are popular activities.

Røros is widely renowned amongst the Norwegian population. Almost 60% of adults in Norway have visited Røros and have strong associations to Røros as important heritage, even if not all of them are aware that it is a WH property.

In Røros today, there is a high level of cultural activities. During the year there are several cultural events, where both locals and visitors are involved. Some of them, like the Winter Market and "Elden" (a historical play of the Swedish invasion in 1718), are strongly connected to the story of Røros and the WH values. From 2012–2021, Røros municipality was scored as Norway's best cultural municipality all 10 years (and judged second best in 2022 to 2024)[16].

[16] https://kulturindeks.no/indeks

CLIMATE AND ITS INFLUENCE ON RØROS

The Winter Transport Route from Røros to Falun
Svein Arild Johnsgård

4.1 Current climate

The relatively dry climate of Røros results from its inland location and features temperature extremes in both summer and winter. The lowest recorded temperature for the area was -50.6°C in January 1914 (the coldest temperature recorded in southern Norway), with a lowest value in recent decades of -40.0°C in February 1997. In contrast, the record high temperature was 30.7°C in July 2008. These records illustrate the variability about monthly-average temperature (from the period 1991-2020) that show an annual range from -9.0°C in January to 12.6°C in July (Figure 4.1). Annual precipitation totals averaged 529 mm for 1991-2020, with monthly-average precipitation (1991-2020) lowest in April (25 mm) and highest in August (83 mm; Figure 4.1).

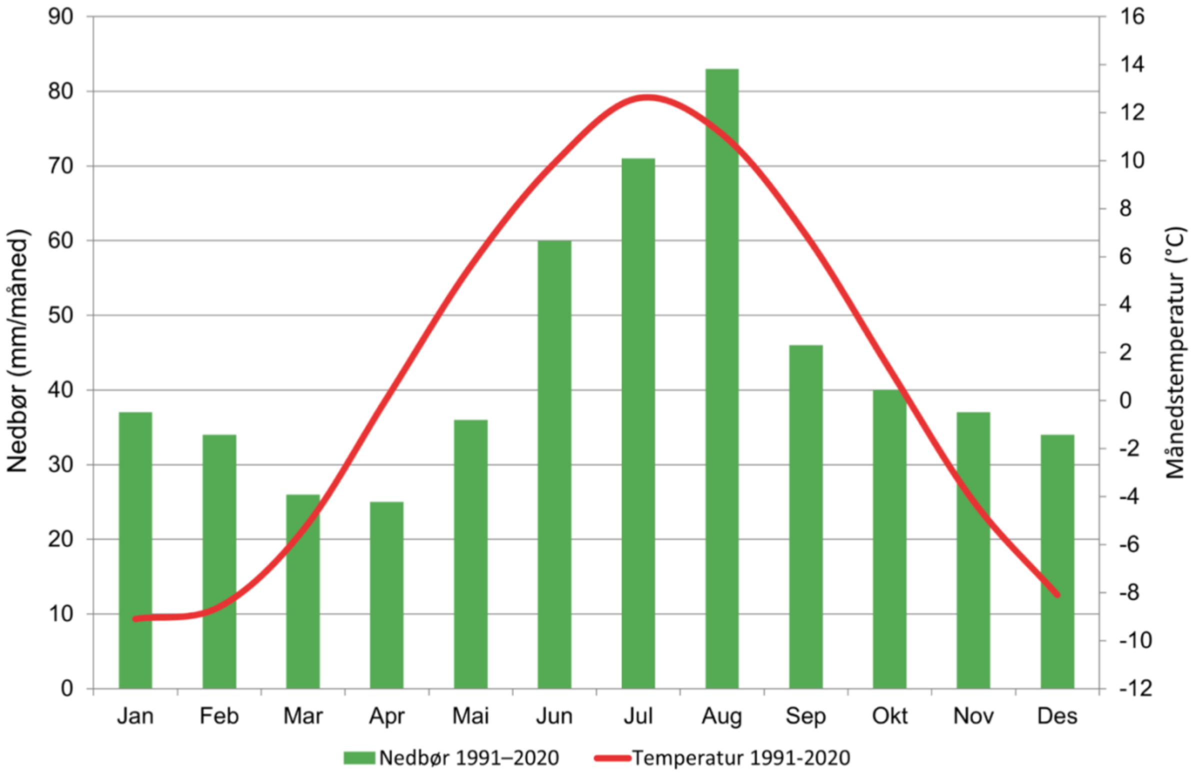

Figure 4.1 Seasonal variation in temperature and rainfall for Røros, averaged for the period 1991-2020.

4.2 Observed climate trends

Changes in the climate of the Røros property are informed from data describing the Trøndelag region, noting that the climate is drier and with more extreme temperature variation near Røros than along the coast. Over the past century, and particularly since 1980, the temperature for Trøndelag has increased by more than 1.5°C (Figure 4.2-upper). Annual precipitation also increased, with years of extreme high and low values interspersed throughout the 123-year record (Figure 4.2-lower).

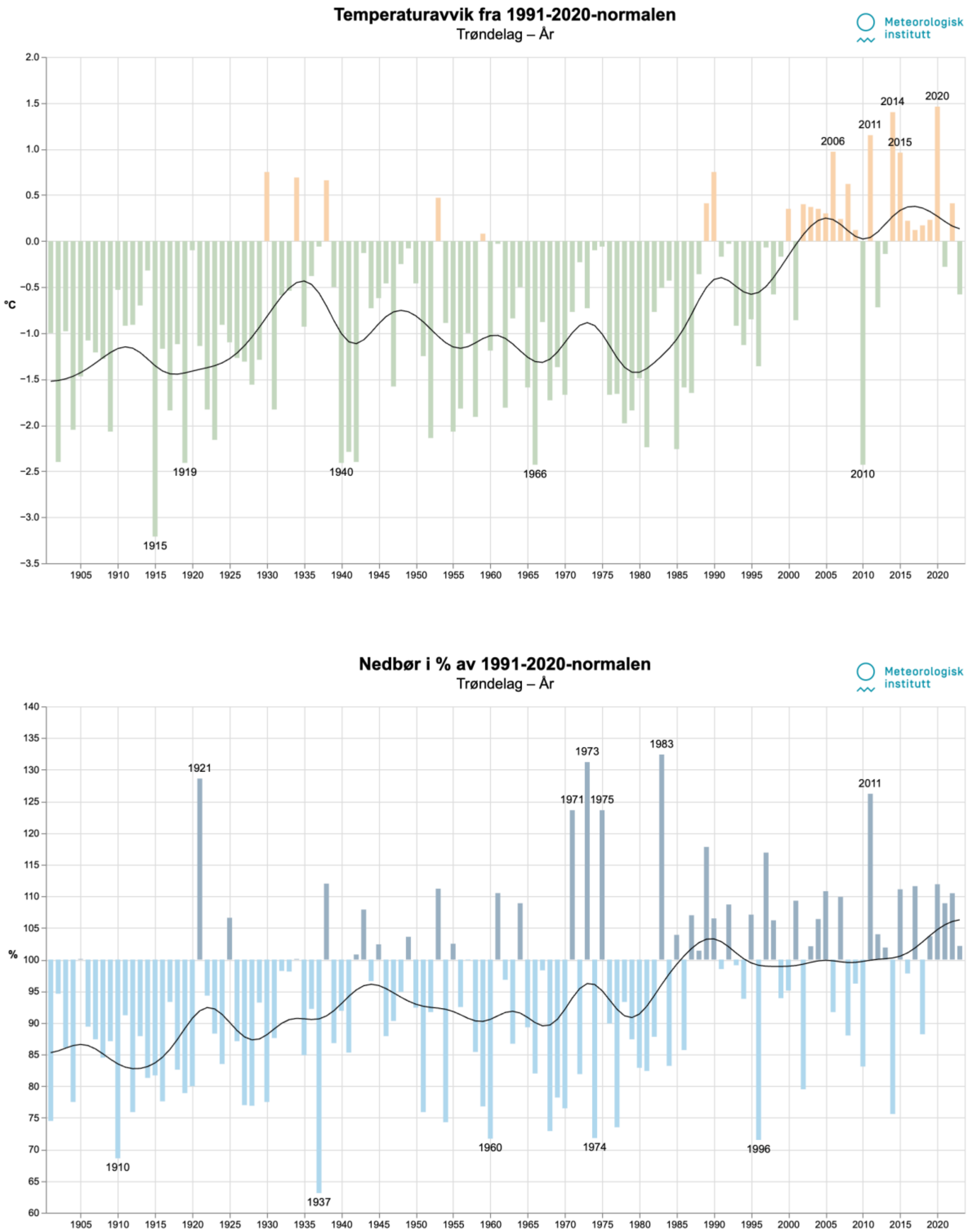

Figure 4.2 Time series of temperature anomaly (upper panel) and rainfall ratio (lower panel) for the Trøndelag region, 1901–2023, compared with the 1991-2020 average. Source: Norwegian Meteorological Institute[17].

[17] https://www.met.no/vaer-og-klima/klima-siste-150-ar/regionale-kurver/trondelag-siden-1900

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 W/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"[18], from which individual fact sheets for Norway's World Heritage properties were developed[19] using projections from the RCP8.5 and RCP4.5 scenarios. For Røros, the fact sheet was informed by projections for Sør-Trøndelag (now part of Vestland).

<u>Temperature</u>

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). Projected temperature increases for autumn, winter and spring are greater than for summer. By the end of this century, the projected warming diverges under these two scenarios – over 4°C under RCP8.5 compared with approaching 2.5°C under RCP4.5.

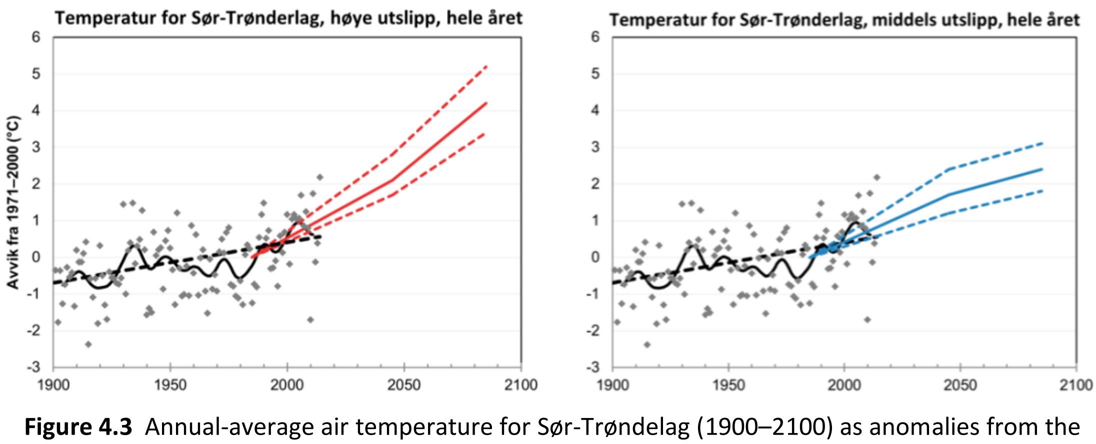

Figure 4.3 Annual-average air temperature for Sør-Trøndelag (1900–2100) as anomalies from the climatological period 1971–2000[20]. Historical annual values (grey dots) were used to calculate trend (1900–2014; black dashed line) and smoothed 10-year variations (black curve). Projected annual temperature under Representative Concentration Pathway (RCP) 8.5, showing the median (coloured solid line) and range (coloured dashed lines) of output from 10 climate models.

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

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

[20] Adapted from https://klimaservicesenter.no/kss/klimaprofiler/sor-trondelag

As an example of anticipated effects of projected warming, the growing season is expected to increase by 1–3 months. Furthermore, the number of 'winter days', with temperature staying below 0°C, is projected to reduce by more than one-quarter from the reference period 1991-2020 to the end of century under a high-emissions scenario (RCP8.5), coinciding with a near-doubling of the number of summer days (exceeding 10°C). Of particular relevance for Røros, increased temperature will lead to shorter period of ice formation in water bodies, thus limiting the use of historical ice passages and potentially requiring alternative (e.g., high-altitude) routes for ice transport.

Table 4.1 Change in the number of winter days and summer days projected under a high-emissions scenario (RCP8.5).

Period	**Winter days (<0°C)**	**Summer days (>10°C)**
Reference period (1991-2020)	174	71
Mid-century projection	150	104
End-of-century projection	127	131

Precipitation

Projected changes in precipitation indicate an increase in annual totals this century. This increase is projected to be nearly 20% by the end of the century under RCP8.5 (Figure 4.4-left) and more than 10% under RCP4.5 (Figure 4.4-right). Projections for Roros indicate the greatest increase in summer then autumn, followed by winter, with no increase projected in spring. Episodes of heavy precipitation 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 amount of snow is expected to decrease, with the number of days with snow reduced by more than 20 days per year by mid-century under both high-emissions (RCP8.5) and stabilisation (RCP4.5) scenarios. Though heavy snow is still expected in some years, the snow season is expected to be shorter by as much as two months.

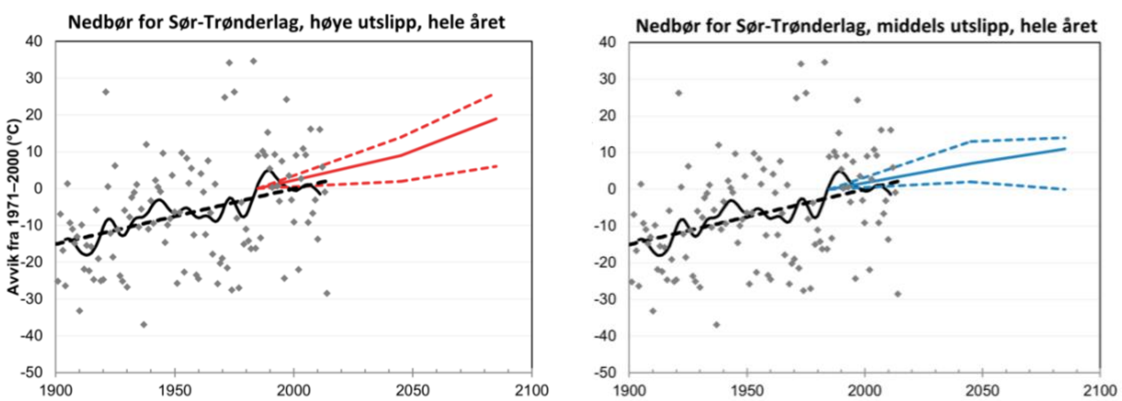

Figure 4.4 Change in annual precipitation for Sør-Trøndelag (1900–2100) as proportion of the climatological value from 1971–2000[20]. Historical annual values (grey dots) are the same in both panels and were used to calculate trend (1900–2018; dashed black line) and smoothed 10-year variations (black 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 coloured solid line shows the median, while the coloured dashed lines indicate the range of model output.

Hydrology

With the projected decrease in the amount of snow, snowmelt floods will progressively become smaller; however, the corresponding increase in rain will increase the potential for rainwater floods. This is especially true in built-up areas and small, steep watercourses that quickly respond to rainfall. Extreme water flows (including flash floods) are also anticipated to change with increase in heavy rainfall.

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 Sør-Trøndelag towards the end of the century. Increased water flow is expected in autumn, winter and spring because future warming will increase the proportion of precipitation as rainfall, whilst greater evaporation in summer is predicted to decrease water flow.

Wind

Projections of future wind reveal little or no change this century with very high levels of uncertainty. The best available information suggests a minor increase in the severity of extreme winds.

Rot risk

The changing climate will also affect the built environment, which is particularly pertinent for Røros. 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 4.5).

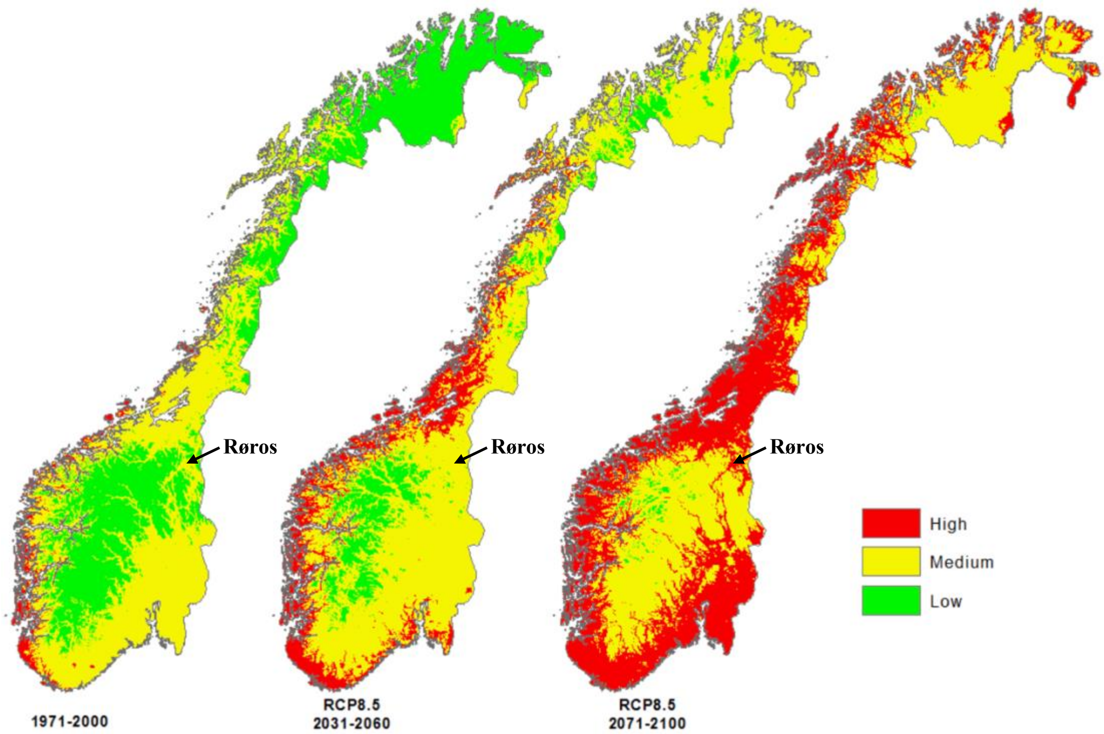

Figure 4.5 Estimated rot risk historically (left) and projected under Representative Concentration Pathway (RCP) 8.5 for mid-century (middle) and end-of-century (right), with the location of Røros shown in each panel (after Tajet and Hygen 2017).

APPLYING THE CLIMATE VULNERABILITY INDEX

Skilled workers in heritage crafts learning from each other

5.1 Background to the CVI

The Climate Vulnerability Index (CVI) is a systematic and rapid tool that was developed to assess the vulnerability to climate change for all types of WH properties (natural, cultural and mixed). It considers the vulnerability of the Outstanding Universal Value (OUV) and of the associated community (local, national and international). The CVI framework (Figure 5.1) builds upon the vulnerability framework approach described in the 4th Assessment Report of the Intergovernmental Panel on Climate Change (IPCC 2007). As the CVI was being developed, input was sought from many experts around the world, including from within 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.

The OUV Vulnerability is determined by assessing the exposure, sensitivity and adaptive capacity with respect to prioritised climate stressors. The OUV Vulnerability becomes the exposure term to assess the vulnerability of the community associated with the property, combining with assessments of economic-social-cultural dependency (sensitivity) and adaptive capacity (Figure 5.1). A customised spreadsheet-based worksheet is used to determine outcomes based on user inputs. A more detailed outline of the CVI methodology is provided by Day et al. (2020).

The foundation for the CVI process is the Statement of OUV for a property (Appendix 1), from which key values are summarised (Table 2.1). The key 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). Once this foundation is established, the CVI process is initiated.

As the first phase of the CVI process (assessing the OUV Vulnerability) leads into the second phase (assessing the Community Vulnerability), this second assessment considers the impact on the community of a decline in WH values (i.e., it is not evaluating direct impacts of climate change upon the community).

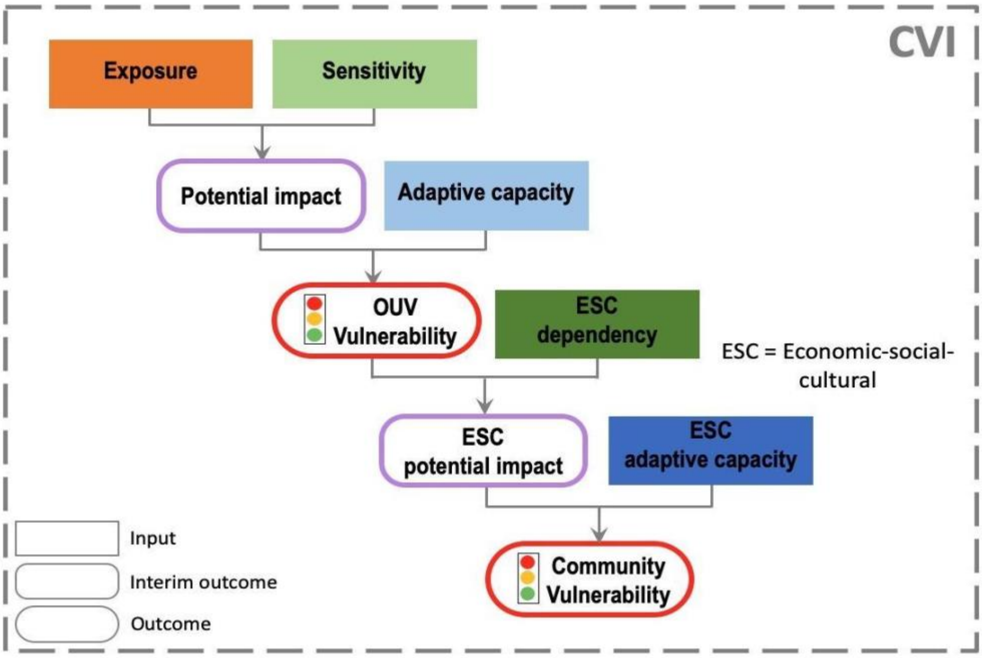

Figure 5.1 The CVI framework used to undertake rapid assessment of climate change vulnerability of World Heritage properties and the associated community. (Adapted from Day et al. 2020)

5.2 Preparatory steps and the CVI workshop

Prior to application of the CVI framework for Røros, the following preparatory steps were undertaken:

1. The Statement of OUV for the Røros property was analysed and distilled into four key values and their accompanying attributes (see Table 2.1);
2. Background information was prepared outlining key aspects of climate change for the area;
3. A list of other Significant Property Values (SPVs) was commenced prior to the workshop (and continued during and following the workshop; see Appendix 2);
4. An overview of information related to economic, social and cultural connections was compiled for presentation during the workshop; and
5. A diverse array of participants was identified by the Steering Committee for the workshop (see list at Appendix 4).

The CVI workshop for Røros was conducted at the Røros Storstuggu (Cultural Centre), 21st – 23rd August 2024 (see Appendix 3). Information presented during the workshop enabled the OUV Vulnerability and the Community Vulnerability to be assessed. The workshop used four breakout groups to assess preliminary outputs which were then reported back to subsequent plenary sessions for discussion and synthesis. Outcomes for each component were recorded in a customised spreadsheet to determine the final results.

5.3 Key climatic stressors

A list of 15 climate stressors typically considered in the CVI process was provided to participants at the workshop (Table 5.1). An additional climate stressor (Wildfire) was determined as potentially relevant to the specific context of Røros and therefore was also considered. Participants analysed those stressors likely to have the most impact on each of the key values (Table 2.1). The workshop selected the time scale to consider impacts as ca. 2070 and considered future effects under a high-emissions climate scenario (RCP8.5, SSP5-8.5).

The climate stressors were ranked by considering the top three stressors likely to impact each key value (Table 5.1; Figure 5.2). Workshop participants assessed Temperature trend as likely to impact all four key values. Three other climate stressors (Intense precipitation events, Ice change and Snow cover change) were assessed as likely to impact two key values and a further two stressors affecting one key value each (Flooding and Wildfire). Discussion around these stressors included reflections on the presented climate data and projections (see Section 4), connections between some stressors (e.g., flooding associated with heavy rainfall; reduced snow cover and wildfire risk each linked to long-term warming) and combined impacts of stressors (e.g., from sequential drought and wildfire events). Ultimately, the workshop participants selected the three key climate stressors to be considered in the CVI analysis for Røros as:

- Temperature trend – TT;
- Intense precipitation events – IPE; and
- Ice change – IC.

Participants noted the importance of snow for the heritage values of Røros and that changes in snow cover are distinct from those of ice. It was decided that snow cover change would be considered within the auspice of the Temperature trend stressor. It is also important to recognise that impacts resulting from each of the three key climate stressors (i.e., long-term changes in temperature and ice, as well as changes to heavy rainfall and snowfall events) have already occurred to some degree. For example, reports of lake ice thickness indicate a decline from ~1 m at the time of WH inscription

(1980) to only ~0.1 m in recent years illustrate the magnitude of change, whilst the context of the recognised safe limit of 0.2 m for use as part of the Winter Transport Route indicates the impact upon the heritage values.

Table 5.1 Climate stressors identified as likely to have the greatest future impact upon each of four key values of OUV. Marked cells indicate that a climate stressor was in the top three responses for each key value. Stressor impacts were assessed for ca. 2070 and a high-emissions climate scenario.

Key values of OUV	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	Wildfire
	Climate stressors															
Outstanding cultural landscapes	x			x												x
Complex and interlinked systems	x			x	x											
Unique culture and knowledge	x								x	x						
Extreme climate conditions, topography and distances	x								x	x						
Total	4	0	0	2	1	0	0	0	2	2	0	0	0	0	0	1

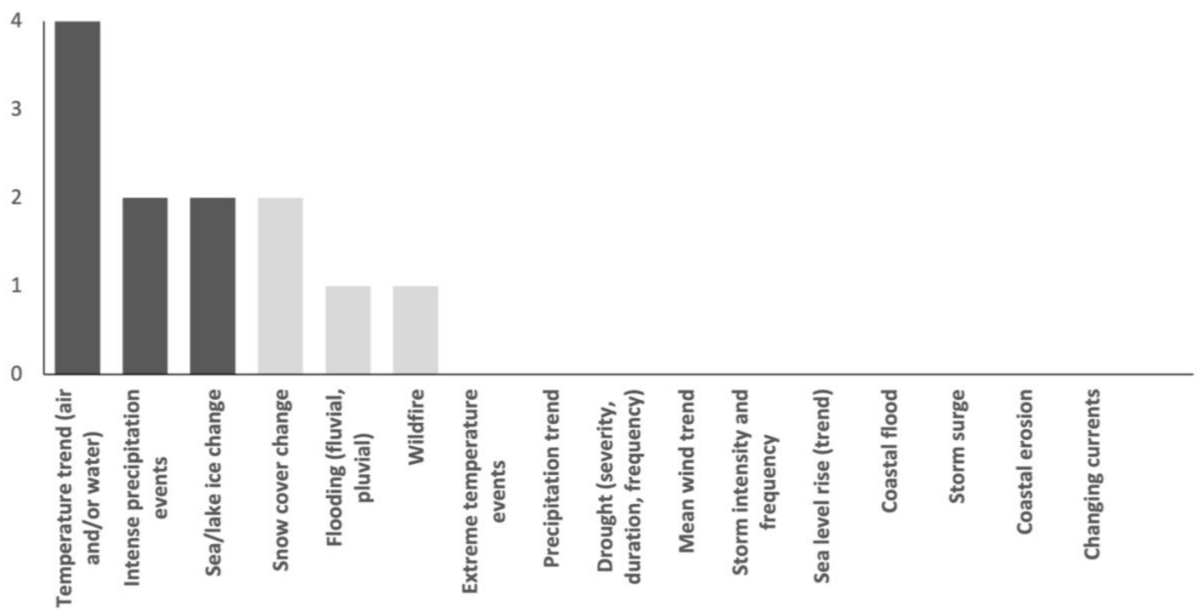

Figure 5.2 Histogram of the number of key values of OUV for the Røros property for which each of 16 climate stressors was among the top three likely to cause impacts (ca. 2070, high-emissions scenario).

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 (Day et al. 2020). 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). Results from exposure and sensitivity assessments undertaken in breakout groups were synthesised in plenary. Exposure was assessed to be Very likely (>90%, highest category) for Temperature trend and Ice change. The initial exposure assessment for Intense precipitation events was determined to be Likely (67-90%, second highest category); the inclusion of modifiers, incremented this assessment to the transition point between the Likely and Very likely categories (Table 5.2). There was no change to the categorisation for the other two key stressors (both of which were already in the highest category).

Sensitivity of OUV to Temperature trend and Intense precipitation events was initially determined at the transition point of the Moderate and High categories; after including modifiers, these were both incremented to High (the second highest category), indicating potential for loss or alteration of many key values (Table 5.2). The Sensitivity assessment for Ice change was at the Moderate level (middle category of five), indicating potential for some loss or alteration of some key values (but not causing a significant reduction to OUV), and was not altered with the inclusion of modifiers. The assessments process noted that Intense precipitation events could have a widespread spatial scale (greater than extensive) of impacts but also that most of the property area is undeveloped and without human activity; continued monitoring of impacts during future events will be important to discern the measure of sensitivity.

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 correspond with elements of the CVI framework (Figure 5.1).

Key Climate Stressors:	**Temperature trend**	**Intense precipitation events**	**Ice change**
Exposure	Very likely	Likely	Very likely
Temporal scale	On-going	Frequent	On-going
Trend	Moderate increase	Moderate increase	Moderate increase
Exposure	**Very likely** ○○○○●	**Likely/V. likely** ○○○◑◐	**Very likely** ○○○○●
Sensitivity	Moderate/High	Moderate/High	Moderate
Spatial scale	Widespread	Extensive	Restricted/Localised
Compounding factors	Mod/High probability	Mod/High probability	Low probability
Sensitivity	**High** ○○○●○	**High** ○○○●○	**Moderate** ○○●○○
Potential impact	**Extreme** ○○○●	**Extreme** ○○○●	**Extreme** ○○○●
Local management response	Low/Moderate capacity	Low/Moderate capacity	Low/Moderate capacity
Scientific/technical support	Moderate capacity	Moderate capacity	Moderate capacity
Effectiveness	Moderate	Moderate	Low/Moderate
Adaptive capacity	**Moderate** ○○●○	**Moderate** ○○●○	**Moderate** ○○●○
OUV Vulnerability	**Moderate** ○●○	**Moderate** ○●○	**Moderate** ○●○
Combined OUV Vulnerability	**Moderate** ○●○		

Compounding factors discussed by participants included increasing risk of invasive species across the property linked to warming; pressure from increased tourist visitation, especially for impacts related to heavy rainfall and reduced ice; diminished capacity for the use of ice areas during periods of heavy rainfall; and flood events increasing pollution from mining areas (and resultant impacts on people and agriculture). 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).

In breakout groups, workshop participants brainstormed adaptation strategies; where similar ideas were proposed, these were subsequently grouped in plenary. Ten adaptation strategy groupings were identified (Table 5.3) and used for the adaptive capacity assessment. Several of these were related to improving monitoring of the environment and of built heritage; others related to urban areas, visitation or management interventions across the broader landscape. Participants specifically stressed that a good planning strategy would be essential for the successful implementation of the management actions discussed.

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

	Activities	Key climate stressors			Relevant key value/s			
		TT	IPE	IC	1	2	3	4
Adaptation strategies	Enhance systematic environmental monitoring, including of precipitation and pollution; and improve maintenance of monitoring system	X	X					
	Develop early warning system based on environmental monitoring	X	X					
	Improve monitoring of built heritage	X	X					
	Increase building use, protection and the level of climate adaptation in restoration	X	X					
	Manage urban drainage; and store water in dry periods	X	X					
	Manage use of paths and tracks in wet areas (through information, physical measures, directing visitors)	X	X					
	Increase traditional grazing to prevent regrowth of landscape (reducing wildfire risk) and increasing economic viability and self-sufficiency of agriculture	X	X					
	Harvest tree regrowth for economic profit through energy industry (and reducing wildfire risk)	X						
	Produce/pack snow in key locations and for the winter market	X		X				
	Document of immaterial knowledge and experience of winter transport systems (knowledge of waterways, ice, alternative routes, farms, outfield haysheds, seasonality of transport systems use)	X		X				

The adaptive capacity was determined to be Moderate (second highest on a four-point scale, very low to high) with respect to all three key climate stressors. Whilst in that category, the capacity to respond to threats from Ice change was assessed to have a lower effectiveness than for the other key stressors.

Whilst not considered in the assessment, several other brainstormed ideas (beyond those shown in Table 5.3) were identified in the workshop. These included agricultural vegetation management (with a potential economic benefit from goat's milk production); fire management actions; developing new winter transportation methods (re-routing away from historically frozen lakes and rivers or using boats along existing routes); and increasing training (including for traditional wood crafts) and education (especially through school activities). These may be revisited and prioritised in the future, including as part of a proposed planning strategy.

Combining the determined Potential impact with the assessed Adaptive capacity for each climate stressor revealed the OUV Vulnerability (three-point scale, low to high) as Moderate with respect to all three key climate stressors. As a result, the combined **OUV Vulnerability** for the Røros property was determined as **Moderate** (Table 5.2).

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 may 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 group that was 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 climate projections for ca. 2070 under a high-emissions projection scenario (Section 4), were:

- Temperature trend: an increase in air temperature of 2.0°C above 2024 levels, with an associated increased risk of wildfire and decreased snow cover
- Intense precipitation events: a 40% increase above 2024 levels, consistent with a description of "more frequent and intense"
- Ice change: a reduction in ice with an average of 22 fewer days per year remaining below 0°C than in 2024

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 seven such activities:

- Tourism-related (e.g., accommodation, tours)
- Retail and other services (e.g., shops, transportation)
- Agriculture, forestry & fishing

- Manufacturing industries
- Construction (including heritage-related)
- Professional services (e.g., financial, scientific, technical)
- Public sector (e.g., health, education, administration)

Participants confirmed these seven activities, noting that Agriculture should include reindeer raising and hunting; and that there is interdependency between the various activities. An online poll, conducted at the end of the third workshop day, invited participants to rank these economic activities by their reliance upon the WH values. This analysis revealed Tourism and Retail and other services as the most reliant on the values, whilst Professional services and the Public sector were the least reliant (Figure 5.4).

Assessments of economic dependency and adaptive capacity were undertaken by each breakout group, drawing upon baseline information on economic valuation that had been presented to the workshop. Economic dependency was assessed for each business type on an eight-point scale with four categories from High-positive down to Minimal-positive, then four more categories from Minimal-negative down to High-negative; adaptive capacity was assessed only with a positive directionality with the four-point scale from High down to Minimal. Participant rankings of relative dependency (Figure 5.4) were considered for the final assessment (in plenary). Six of the seven business types were assessed as likely to experience a negative economic effect (ranging from minimal to moderate levels) from a decline in the key values, with only Agriculture, forestry & fishing assessed to experience a (minimal) positive effect. Noting the higher reliance of Tourism and Retail

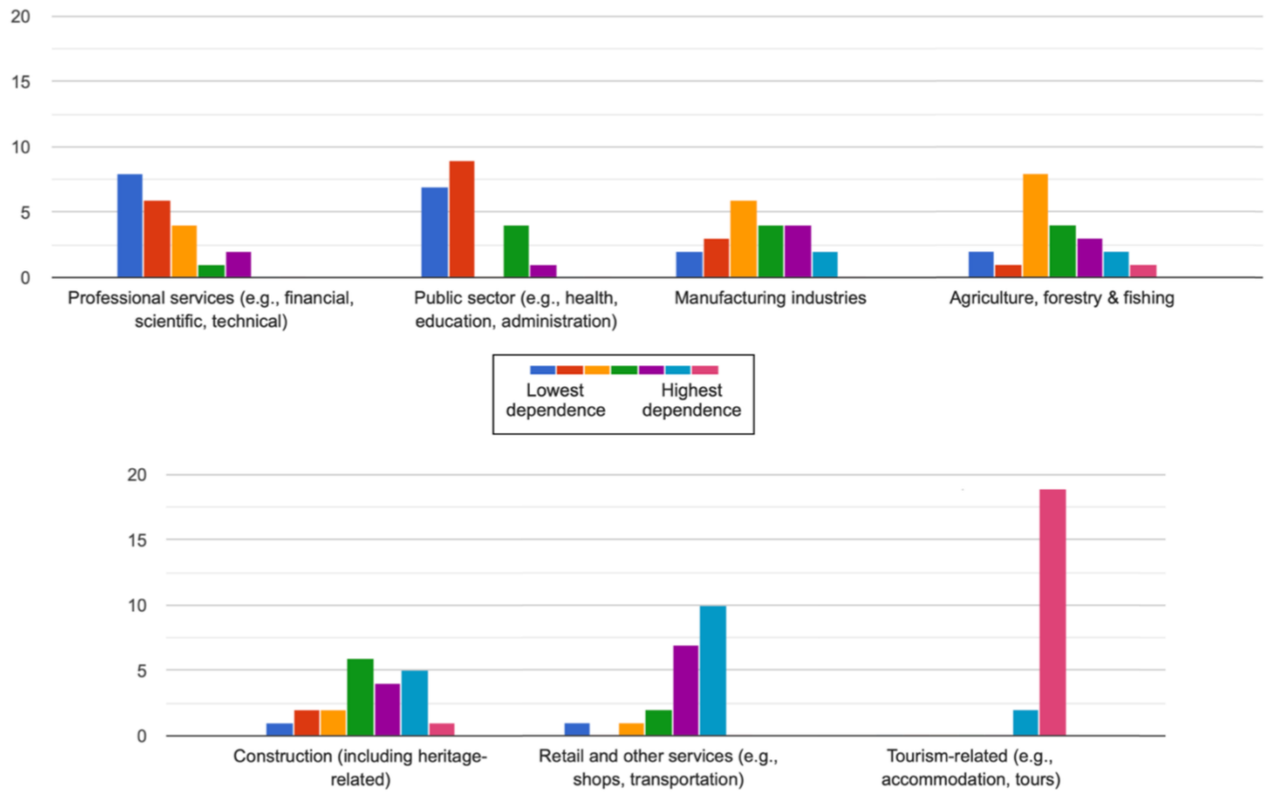

Figure 5.4 Participant rankings of seven areas of economic activity by their dependence upon the Røros key values.

services upon the key values, participants apportioned a higher weighting to those responses, leading to an overall assessment of the economic dependency as Moderate-negative (i.e., a negative impact at a moderate level).

The adaptive capacity varied across the business types, from low capacity (Fisheries) to high capacity (Professional services), with substantial variation among the assessments by each breakout group. Subsequent discussion in plenary led to the overall assessment of economic adaptive capacity as Low, based on the importance of Tourism, the interdependence of the economic activities and to adopt a precautionary approach (Table 5.4).

Intangible effects (e.g., social cohesion, aesthetics) were considered within the social and cultural components. An important distinction between these components is that social connections require a physical interaction with the property (i.e., a visit), whereas cultural connections can exist without a physical interaction. For each component, three groupings of people (local, domestic, and international) were considered to assess dependency and adaptive capacity. Importantly, the definition for 'locals' was agreed to include those residing within the circumference but not cabin owners whose occupancy is only occasional. Workshop participants determined that it was valuable to give greater consideration in the assessments to locals, upon whom future effects would be greater than for other Norwegians and internationals.

From a social perspective, participants described WH as the 'glue' for the Røros community. Social indicators used to inform the assessments can be considered within four categories: Human capital; Social capital; Natural capital; and Built capital (after Costanza et al. 2007). Social dependency (eight-point scale, as for economic) assessments were consistently negative for all people groupings across the breakout groups; however, variability in the assessed levels of the effects of a future decline in WH values for each (ranging from low to high) required discussion and resolution in plenary. These culminated in an overall social dependency assessment of Moderate-negative (Table 5.4).

Table 5.4 Rapid assessment of Community Vulnerability linked to the 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 ○ ● ○**

Participants noted that other values (e.g., natural attributes) are as important for social connections as the WH values. Social adaptive capacity responses (4-point scale, positive-only) were also variable between group with the overall assessment of social adaptive capacity being Moderate (Table 5.4). Participants described the local community as incredibly strong and close-knit, who would 'roll up their sleeves to address issues'.

When considering cultural connections, participants noted the pride in the Røros name, as well as in the extreme cold. Cultural indicators were also considered within four categories pertaining to: Self; People; Environment; and Pleasure (after Marshall et al. 2019) and assessed across the three people groupings. While cultural connections can exist irrespective of location, participants emphasised the effects on locals and other Norwegians (dependency term) would be greater than for internationals. Breakout groups consistently assessed negative effects with respect to cultural connections, noting that the gradual effects of climate change observed and anticipated may not have the same impact as a sudden event (e.g., from a fire) but that the persistent threat can consolidate feelings. The overall assessment of cultural dependency was Moderate-negative (Table 5.4). Assessments of adaptive capacity were among the most consistent across the breakout groups, resulting in a assessment of Moderate adaptive capacity (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

The workshop results indicate the changes that might be expected over the next 50 years (ca. 2070 scenario) are anticipated to have significant effects on the values that comprise the OUV of the property. Temperature trend, Intense precipitation events and Ice change were identified as the three climate stressors likely to pose the greatest threat to the WH values of Røros Mining Town and the Circumference. Potential impact from the key stressors was scored in the Extreme category for each, with adaptive capacity to mitigate impacts being assessed as Moderate. As a result, the **OUV Vulnerability** was determined to be in the middle category (**Moderate**). Impacts from the key climate stressors upon WH values were assessed as likely to lead to a negative future impact at a Moderate level on the economic, social and cultural aspects of the wider community associated with the Røros Mining Town and the Circumference. 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 **Moderate** (middle category).

The workshop results indicate the changes that might be expected over the next 50 years (ca. 2070 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

The CVI workshop ran in parallel with a national craftsman course in Røros. On the penultimate day of the workshop, a joint public event was arranged, in which climate and craftmanship perspectives were shared among the group of approximately 60 attendees. Following presentations on climate change (Hans Olav Hygen) and the CVI process (Scott Heron), four craftsmen who daily work with cultural heritage offered their reflections. The ensuing interesting discussion included a variety of insights on the effects of climate change on the cultural heritage of the WH property.

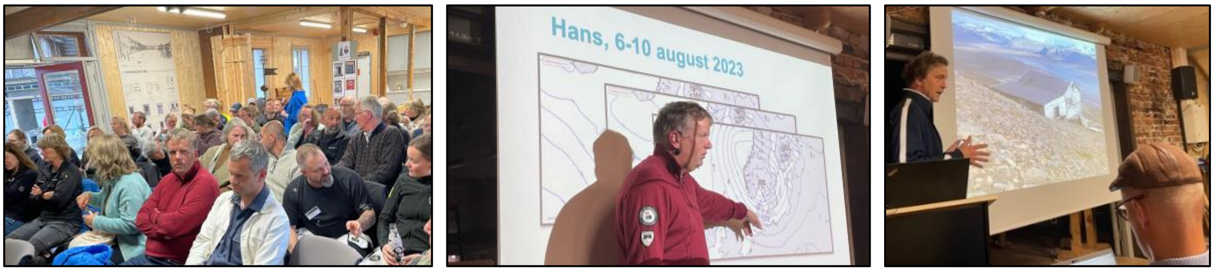

Figure 5.4 The Røros public event featured presentations from World Heritage, climate and local crafts experts.

NEXT STEPS

Sagdammen provides power to the sawmill next to the smelter

At a general level and in the short term, climate warming is occurring faster in Norway than the global average. Observed changes have included an order of magnitude reduction in ice thickness along sections of the Winter Transport Route and the existence of changing microclimates in forest re-growth areas. However, the effects of climate change may be 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 have accepted the reality of climate change (Palutikof et al. 2004) and have exhibited anxiety (Ryghaug et al. 2011); however, the potentially severe consequences of climate change are perceived of secondary importance in comparison with everyday life issues (Lorenzoni and Pidgeon 2006).

Despite that, the implications for some municipalities, and in particular some key heritage assets, could be significant – some are already being impacted. 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. Whilst current models indicate continued warming, a posited collapse of the Atlantic Meridional Overturning Circulation from some analyses presents a vastly different future climate for Norway of colder winters, less rainfall and more severe winter storms than indicated in current global modelling efforts (van Westen et al. 2025), which could lead to a sharp decline (and potentially local extirpation) of many Scandinavian tree species (Heubel et al. 2025). However, the best available, current information (presented in Chapter 4 and underpinning the analysis and recommendations in Chapter 5 and here) projects future warming.

6.1 Recommendations in a changing climate

Analysis of heritage values and attributes in the context of climate projections for Røros to ca. 2070 indicate that the *Temperature trend, Intense precipitation events* and *Ice change* will adversely impact on the WH property and its values. The analysis reveals that expected climate change over the next 50 years has 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.

The CVI process has shown that the property and the local community are at risk of impacts from expected climate change and that there is limited ability to adapt to climate change. Some impacts on the mining town, surrounding landscape and the Winter Transport Route have already been observed.

Responding to climate change begins with understanding the key threats and assessing the associated vulnerabilities and risk. Proposed adaptive measures may have unintended consequences, which should be evaluated (e.g., through Heritage Impact Assessments) to avoid compounding stress on heritage and the natural environment. The identified key values (and other SPVs; Appendix 2) 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 is essential – new activities should not be implemented before there is sufficient knowledge of their potential impacts.

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

Management and policy needs:

- Develop policy around forest re-growth within the Circumference, potentially allowing re-growth in some areas whilst maintaining the human-modified landscape (and therefore heritage narrative) in others; and particularly as tree harvesting could be a potential economic input for conservation activities
- Continue and expand repair and restoration work on built heritage anticipating future climate threats, including through increasing building usage
- Enhance fire protection of wooden houses within the town centre (dense built area)
- Increase funding to maintain and further develop fire protection measures
- Cultivate a more formalised cooperation on fire management between the cultural heritage manager, the Municipality fire department and the Directorate of Cultural Heritage
- Improve planning strategies within the municipalities to better integrate with projected effects of climate change
- Initiate discussion on the implementation of sustainable tourism activities and adaptation strategies within the context of economic, social, cultural and environmental considerations
- Determine how to better involve the community (including local and regional companies) in activities that preserve the WH values.

Research and monitoring priorities:

- Improve maintenance of the existing environmental monitoring system
- Enhance systematic monitoring of precipitation and pollution, especially at the local scale
- Undertake effective monitoring of implemented adaptive strategies in response to climate change threats
- Evaluate the potential use of goats (and other livestock) in reducing forest re-growth whilst simultaneously benefitting the agriculture industry
- Investigate the potential range spread of termites, wood worms and other damage-causing species
- Develop purification technology for water draining from mines, ore yards and slag heaps
- Analyse farmers' diaries to identify historical changes and variations in climate and agriculture
- Extract information on World Heritage values from historical literature of the area (e.g., Johan Falkberget).

Precautionary approach and knowledge gaps:

- Evaluate the consequences for the World Heritage values of Røros resulting from the 'Green Shift' in mining and electricity industries (e.g., wind- and river/lake-based power generation)
- Expand the documentation of intangible knowledge and experience of winter transport systems.

Cooperation between the site managers, national government bodies and experts/researchers (e.g., universities and research agencies) for monitoring and research can respond to identified issues and opportunities. Effective and ongoing communication with researchers regarding a prioritised list of research activities to support management is essential. The research priorities 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.

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.

6.2 Management implications – local, national and international

Potential climate impacts on wooden buildings are a shared issue for several Norwegian WH properties (e.g., Bryggen, Urnes Stave Church) and beyond. Sharing of information within this thematic group of properties could prove beneficial for each. Similarly, some of the knowledge acquired at Røros may be transferable to inform the management of similar industrial cultural heritage properties. In particular, responding to the challenge of maintaining cultural heritage values and attributes in the face of potentially conflicting environmental change (i.e., forest re-growth for Røros) may be an exemplar to guide other properties.

Such situations can provide educational opportunities to the local community and visitors regarding heritage conservation in a changing environment and from climate change. The public event, co-hosted with the national craft professionals workshop, provided a demonstration of the strong affinity and co-benefit that can arise through such collaborative ventures.

6.3 Revisiting the CVI process for Røros

As a result of the CVI process, Norway now has an improved basis for reporting to UNESCO on the status of climate vulnerability for three WH properties (Vega Archipelago, Bryggen and Røros) 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. Other CVI applications in the Nordic/Baltic region, Europe and beyond have established its value in supporting heritage management.

The results from the CVI workshop for Røros 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.

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. To allow comparison of trends and results, it is proposed that future CVI workshops apply the same methodology, beginning with a systematic review of the 2024 workshop information.

ACKNOWLEDGEMENTS

The townscape of Røros shows variations in bulding techniques, roofing and colors

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- The presenters for the public meeting and the representatives of the Røros community who participated.

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Hyttstuggu in winter, the smelter administration building

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APPENDICES

Weigh scale on Malmplassen in Røros, used to measure the horse sledges filled with ore

Appendix 1 – Statement of Outstanding Universal Value, Røros Mining Town and the Circumference World Heritage property

Brief synthesis
Røros Mining Town and the Circumference consist of three sites within the Circumference, i.e. the area of privileges awarded by the Danish-Norwegian King to Røros Copper Works in 1646.

The town and the cultural landscapes cover a large continuous area which includes the landscape surrounding the mining town, the urban agricultural areas, and the most important mining landscapes where agricultural practices and copper work operations were carried out.

Femundshytta is a largely relict landscape which includes the industrial cultural landscape with the remains of a smelter, water management systems, and the community that grew up around them. The Winter Transport Route is made up of a sequence of lakes, rivers, and creeks in an almost untouched landscape. It was used from November to May.

Røros Mining Town, established in 1646, is unique. It is built entirely of wood, and interlinked with a cultural landscape that shows in an outstanding and almost complete manner how mining operations, transportation, and the way of life had to be adapted to the requirements of the natural environment – the mountain plains, the cold climate, the remote location without roads and with marginal growth conditions for forests and agriculture. On this basis a unique culture developed that has partly disappeared, but an outstanding testimony of the existence of which has been preserved.

Criterion (iii): From the time copper ore was found in the mountains at Røros in 1644 until the copper works went bankrupt in 1977, with German mining technology as a starting point, employing German, Danish, Swedish immigrants, and Norwegian nationals,, a unique culture developed to extract the valuable copper in a remote and sparsely inhabited area. Today there is no mining in the area, but Røros Mining Town and the traces of mining, smelters, transport, and water management systems bear unique witness to the adaptation of technology to the requirements of the natural environment and the remoteness of the situation.

Criterion (iv): Røros townscape and its related industrial and rural landscapes, with their interlinked industrial activity and domestic and agricultural accommodation within an urban environment, illustrate in an outstanding manner how people adapted to the extreme circumstances in which they had to live and how they used the available indigenous resources to provide shelter, produce food for their sustenance, and contribute to the national wealth of the country. Technologically, their buildings and installations evolved through the use of available indigenous materials to functionally satisfy the combined approach of mining and agrarian practices whilst at the same time accommodating the consequences of dealing with extreme climatic conditions.

Criterion (v): Røros Mining Town and the Circumference constitute a totality that is an outstanding example of traditional settlement and land-use. The various activities that have been carried out in the area constitute a coherent and interdependent unit. These activities have shaped a cultural landscape that provides a unique picture of how the mines and the mining town functioned as a complex and at times vulnerable system that verged on the limits of what was possible in an inhospitable environment with a harsh climate.

Integrity and authenticity
The nominated property contains all elements that convey the Outstanding Universal Value of the property and its most relevant features present a high or good level of integrity. The mining landscape is relict in nature, but almost no transformations or encroachment occurred after the closure of the copper works.

The authenticity of the property is expressed in almost all its aspects and features. All the remains bear credible witness to the history and development of the site. This is also reinforced by the rich archive documenting the copper company's history.

Protection and management requirements

The most important legislative instruments that help to protect and manage Røros Mining Town and the Circumference are the Cultural Heritage Act (1978) and the Planning and Building Act (1985).

The management framework for Røros Mining Town and the Circumference is embodied in a Statement of Intent which has been signed by all responsible bodies for the nominated property.

The basis for management relies on the existing Norwegian legal framework, the planning instruments in force, the administrative and private bodies responsible for the property and sources of funding for heritage conservation, agricultural activities in heritage areas, productive and marketing activities based on cultural and natural heritage, and sustainable tourism. The management framework contains an action programme including short- and long-term actions.

Appendix 2 – List of other Significant Property Values (SPVs) that are locally, regionally or nationally significant

Broad grouping of SPVs	Key SPVs	Additional justification (Why is the value significant?)
Values in the Buffer Zone	The transport systems along the Femund and Hådal watercourses, including timber slides in the Langtjønna watercourse	Illustrates the infrastructure that supported copper transport and timber floating, essential to the mining economy.
	The hamlet of Feragsgrenda	Represents traditional settlement patterns and cultural continuity in the buffer zone.
	The Glomma River between the outlets of Aursunden and Orvos, including its passage through valleys from Sundet southwards through Os and Tolga, including Tolga centre	Key natural corridor and historical transport route, shaping settlement and industry.
	The Gammelmannsveien road on the west bank of the Glomma River	Historic road used for trade and communication, linking communities.
	The Gruvåsen area	Important mining landscape with remnants of historical extraction activities.
	The passage of the Rugla and Gaula rivers through valleys, including the Killingdal plant and the Eidet smelter	Sites of smelting and hydropower use, reflecting industrial heritage.
	The Raudhåmmårn ridge	Prominent ridge with visual and cultural significance.
	The Narjordet area	Area of coal production vital to copper smelting, with historical settlements.
	Extensive use for reindeer husbandry by the Sámi people, with approx. 12,000 reindeer using the area as winter pasture	Demonstrates long-standing Sámi land use and cultural landscape.
Heritage Values Outside the World Heritage Context	Settlement and resource use before the establishment of the copper works	Shows pre-industrial human activity and land use traditions.
	Long-standing traditions of agriculture, hunting, fishing, trapping, and reindeer husbandry	Reflects subsistence practices that shaped the cultural landscape.
	Archaeological finds from the Stone Age to the Middle Ages, including hunting grounds, burial sites, and iron mining facilities	Evidence of continuous human presence and technological development.
	Recent cultural monuments related to agriculture, forestry, hunting, trapping, and industry	Illustrates rural livelihoods and industrial evolution.
	Difficulty in distinguishing between cultural monuments related to the copper works and other social activities	Highlights the intertwined nature of industrial and local heritage.

Broad grouping of SPVs	Key SPVs	Additional justification (Why is the value significant?)
Nature Values	Femundsmarka National Park: pristine forest and mountain areas, cultural heritage, canoeing and fishing, reindeer grazing	Preserves wilderness, biodiversity, and cultural heritage.
	Forollhogna National Park: intact wild reindeer biotope, high biodiversity, cultural heritage	Protects vital wild reindeer habitat and traditional land use.
	Skardsfjella and Hyllingsdalen: untouched nature, Glomma river sources, Sámi cultural monuments	Safeguards pristine ecosystems and Sámi heritage.
	Kvitsanden: inland dune system, rare insect species, Quaternary geology, impacted by mining and invasive species	Unique geological site with rare species and mining history.
Southern Sámi Cultural History	Lack of written sources from the Sámi themselves, leading to skewed historical interpretation	Emphasises the need to include oral and material Sámi history.
	Conflicts with the copper works over grazing rights and land access documented in legal sources	Reveals historical tensions over land use and rights.
	Limited interaction between Sámi and Norwegians during early mining history	Indicates cultural separation and marginalisation of Sámi communities.
	Nomadic lifestyle visible in cultural monuments such as turf hut remains, tent rings, milk pits, and stone graves	Physical traces of Sámi nomadic traditions and land use.
	Reindeer husbandry fully developed by the mid-1600s	Marks the establishment of organised Sámi reindeer herding.
	Earlier hunting-based subsistence economy with cultural traces like pitfall traps and hearths	Shows earlier subsistence strategies and their archaeological remains.
	Difficulty in linking prehistoric cultural monuments to specific ethnic groups	Points to interpretive challenges in identifying cultural origins.
Archaeology/prehistoric sites	Finds from the Stone Age to the Middle Ages across the Circumference	Key archaeological features showing subsistence and technology.
	Hunting and trapping systems, burial sites, iron production facilities	Demonstrates long-term human occupation and activity.
	Sámi sacrificial sites and settlement traces	Spiritual and domestic traces of Sámi presence.
	Tools, weapons, and house ruins in mountain areas	Material culture reflecting adaptation to mountain life.

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

Appendix 3 – Outline of the CVI workshop agenda for Røros, August 2024

__Wednesday 21 August 2024__

1. Welcome to the workshop; Introduction to Røros and context setting
2. Overview of workshop aims; explain use of plenary and breakout-group sessions; basic logistics; 'parking lot'; Steering Group intro.
3. Introductions of workshop participants

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

4. Brief overview of the CVI process.

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

5. Ensure all participants are aware of the Statement of OUV for Røros and how the table of key values was derived from the Statement of OUV.
6. Undertake high-level assessment of current condition of key values and the recent trend in those values (i.e., since the date of inscription, 1980).
7. Discuss other Significant Property Values (SPVs) that are not part of the OUV but important locally/regionally/ internationally.

AIM 3: Understand future climate change for Røros.

8. Introduction to climate change issues globally, regionally and locally.
9. Provide overview of climate change projections. Agree upon the climate scenario and timeframe for the assessment (e.g., High-emissions scenario for 2050).

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

10. Show list of climate stressors – check for (i) understanding? (ii) timescales? Demonstrate selection of top three climate stressors impacting each key value (discussed in #5).
11. Using the list of climate stressors provided, small groups to brainstorm what are the top three climate stressors impacting the key values of OUV.
12. Bring outputs from #11 back to plenary and ensure all participants agree on which climate change stressors are impacting the attributes of OUV.

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

13. Introduce process for exposure, including detail of categories, and review modifiers.
14. Participants in breakout groups assess the exposure term (and modifiers) for each of the three key climate stressors.

Wrap-up discussion, review Day 1, preview Day 2.

__Thursday 22 August 2024__

Brief recap of Day 1; overview of Day 2.

15. Bring outputs from #14 back to plenary and discuss any variation in assessments of exposure.
16. 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.
17. Participants in breakout groups assess the sensitivity (and modifiers thus determining potential impact) for the key climate stressors.
18. Bring outputs from #17 back to plenary and plenary and discuss any variation in assessments of sensitivity.
19. Introduction to adaptive capacity (intrinsic and extrinsic) and brainstorming task to identify existing strategies used to mitigate climate-related impacts and potential adaptive capacities.
20. 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.
21. Bring outputs from #20 back to plenary. Prioritise extrinsic adaptive capacity in terms of feasibility. Introduce adaptive capacity assessment.
22. Participants in breakout groups assess the adaptive capacity (thus determining OUV Vulnerability) for the key climate stressors.
23. Bring outputs from #22 back to plenary and discuss any variation in assessments of adaptive capacity.
24. 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.

25. 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.
26. Overview of ESC for Røros.

Wrap up discussion, review Day 2, preview Day 3.
Public event in evening.

<u>Friday 23 August 2024</u>
Brief recap of Day 2 and overview of Day 3.

27. Discussion of business types for analysis and introduction to Economic breakout group.
28. Participants in breakout groups assess the economic dependency and adaptive capacity for Røros.
29. Bring outputs from #28 back to plenary and discuss any variation in assessments of economic dependency and adaptive capacity.
30. Introduction to Social breakout group.
31. Participants in breakout groups assess the social dependency and adaptive capacity for Røros.
32. Bring outputs from #31 back to plenary and discuss any variation in assessments of social dependencies and corresponding adaptive capacities.
33. Introduction to Cultural breakout group.
34. Participants in breakout groups assess the cultural dependency and adaptive capacity for Røros.
35. Bring outputs from #34 back to plenary and discuss any variation in assessments of cultural dependencies (thus determining ESC potential impact) and corresponding adaptive capacities (thus determining Community Vulnerability).

AIM 7: Summary, feedback and next steps.

36. Summarise outcomes from workshop, following final analysis worksheet.
37. Recap on those items that had been ‘parked’ during the workshop.
38. Discussion of next steps.
39. Receive feedback on CVI framework and workshop process.
40. Complete workshop evaluation forms; receive other feedback from participants.
41. Thanks and close workshop.

Appendix 4 – List of participants in the CVI workshop for Røros

* Steering Committee/*Styringsgruppe*

Name/*Navn*	Institution/*Institusjon*
Anne Morvik Robberstad	*Riksantikvaren*/ Directorate for Cultural Heritage
Anne Nyhamar	*Riksantikvaren*/ Directorate for Cultural Heritage
Åse Juveli Berg	Selskapet Miljø og litteratur/ The company Environment and Literature
Elisabeth Wikan Heidtmann	*Røros kommune, Organisasjon og samfunn*/ Agency for Organization and Society, Røros Municipality,
Hans Olav Hygen	*Metrologisk institutt*/Norwegian Meteorological Institute
Ingunn Holøymoen	*Røros kommune, Tekniske områder/* Technical department, Røros Municipality
Jon Day *	CVI developer and James Cook University, Australia
Justė Zavišaitė	WH site manager, Curonian Spit
Kim Andre Nilsen	*Røros, Holtålen og Os kommune, brann og redning/* Fire and Rescue department, Røros, Holtålen and Os Municipality
Kjersti Dalen Stæhli	*Statsforvalteren i Trøndelag, kommunal- og justis-avdelingen/* Municipal and Justice Department, County Governor of Trøndelag
Lars Inge Sevatdal	*Rørosmuseet, driftsavdelingen*/ Technical department, Røros museum
Magnus Borgos *	*Røros kommune, byantikvar*/ Cultural heritage manager, Røros Municipality
Marilė Kosaitė	Ministry of Environment of the Republic of Lithuania
Odd Sletten *	*Verdensarvkoordinator Røros bergstad og Circumferensen*/ WH site coordinator, Røros Mining Town and the Circumference
Ole Søe Eriksen *	*Riksantikvaren*/ Directorate for Cultural Heritage
Per Ove Nordskogen Volden	*Røros, Os og Holtålen kommune, landbrukskontoret*/ Agricultural office, Røros, Holtålen and Os Municipality
Ragnhild Rolfsdatter Trønnes	*Røros, Os og Holtålen kommune, landbrukskontoret*/ Agricultural office, Røros, Holtålen and Os Municipality
Renata Kepežinskienė	Lithuanian National Commission for UNESCO
Runa Finborud	*Rørosmuseet, direktør*/ Director of the Røros Museum
Sandra Lilledal	*Statsforvalteren i Trøndelag, Klima- og miljøavdelingen*/ Climate and Environment Department, County Governor of Trøndelag
Scott Heron *	CVI developer and James Cook University, Australia
Sigita Bugenienė	Ministry of Culture of the Republic of Lithuania
Sigrid Lina Vadstein	*Interkommunal Kulturminneforvalter/* Cultural heritage manager, Røros, Os, Holtålen and Tolga Municipality
Sigurd Svendsen	*Forbonde og Lasskjørerunionen*/ Association of coachmen for horsedrawn sledges in Norway and Sweeden
Silje Holiløkk *	*Trøndelag fylkeskommune, kulturminneseksjonen*/ Cultural Heritage Department, Trøndelag County Council
Tanja Staldvik Wallervand	*Trøndelag fylkeskommune, kommunalseksjonen*/ Municipality Department, Trøndelag County Council
Thea Sørensen	Innlandet fylkeskommune, seksjon for bygg og landskap/ Building and Landscape Department, Innlandet County Council
Tove Martens	*Visit Røros og Østerdalen*/ Visit Røros and Østerdalen
Vegard Berggård *	*Riksantikvaren*/ Directorate for Cultural Heritage

Appendix 5 – 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
IC	Ice change
ICOMOS	International Council on Monuments and Sites
IPCC	Intergovernmental Panel on Climate Change
IPE	Intense precipitation events
IUCN	International Union for Conservation of Nature
OUV	Outstanding Universal Value
SOUV	Statement of Outstanding Universal Value
SPVs	(Other) Significant Property Values
TT	Temperature trend
WH	World Heritage

CVI CLIMATE VULNERABILITY INDEX

Rossen tjïelte
Røros kommune

OS KOMMUNE

Trøndelag fylkeskommune
Trööndelagen fylhkentjïelte

Norwegian Meteorological Institute

RIKSANTIKVAREN

JAMES COOK UNIVERSITY AUSTRALIA

An important issue for Røros is forest re-growth in some areas of the human-modified cultural landscape and how to manage this whilst also maintaining the integrity and authenticity of the World Heritage property.