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Effects of Climate-Related Adaptation and Mitigation Measures on Nordic Cultural Heritage

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Abstract: This article is based on the project undertaken by NIKU for, and financed by, the Nordic Council of Ministers in 2021, with supplementary literature and the expertise of the authors added to the report findings. The main aim of the project was to find out how climate-related adaptation and mitigation measures impact the Nordic cultural heritage. In this article we present examples of the different adaptation and mitigation measures that impact the cultural heritage. This article has a Nordic focus, which is transferable to other countries. The methodology involves an analysis of qualitative data collected in 2021 through text review, interviews, and workshops. The results can be divided into three relevant themes where there are major challenges: interdisciplinary work, need for more knowledge and use of culture-nature based solutions, and new energy supply systems. We conclude with recommendations on what we believe should be prioritized in the continued work of reducing the risk of damage to cultural heritage in the future. The recommendations cover local and international conditions, they cross sectors and political guidelines, and they reflect the need for newly developed knowledge, interdisciplinarity, and the need for a change of attitude—a paradigm shift in planning procedures.

Keywords: cultural heritage; adaptation measures; mitigation; climate change; archaeology; buildings; landscapes; interdisciplinarity; culture-nature based solutions; green transition

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1. Introduction

Climate change is one of the most significant threats to humans and their living environment, including cultural heritage, around the world. The global average temperature is rising, and according to results from recent research, climate change is already affecting weather and climate systems in all regions of the globe, which will have enormous additional consequences for ecosystems around the world [1–3]. The Earth's climate has always varied, and there have always been physical causes behind these variations. But a clear acceleration of processes, including increase in air and sea temperatures, extreme weather events, sea level rise, and loss of inland ice and glacier mass, shows that the climate is changing faster over the last 30–40 years, a fact that natural causes alone cannot explain. The latest report from the International Panel on Climate Change [1] also clearly states that the present pace of change is so high that anthropogenic influence is the only reasonable explanation. Some researchers trace this development back even further [4,5], but in this paper we are trying to look forward and look at possible solutions, or at least at adaptive measures.

As anthropogenic influences might be the problem, it is also the solution. At the international level, climate change and the impact and threats it poses have mobilized countries to implement a mitigation policy in the form of a wide range of guidelines, regulations and laws used to reduce emissions [1,6,7]. Lastly, these issues were discussed on the UN Climate Change Conference in November 2021 [8]. According to the commitments in the Paris Agreement [2] and in the Glasgow Climate Pact [8], it is imperative for all

countries to reduce greenhouse gas emissions by 50–55% (from the 1990 level) to reach the climate goal by 2030. There is a common international focus on technical solutions and implementing sustainable systems for reaching these goals. All the Nordic countries are implementing mitigation actions to reduce the effects of climate change and reduce greenhouse gas emissions.

The adverse effects on cultural heritage are already being felt [9–15]. The 20th ICOMOS General Assembly voted to declare a climatic and ecological emergency and calls for urgent collective action from all relevant actors to safeguard cultural and natural heritage from climate change. So, in the eagerness to solve the climate change problems and reducing greenhouse gas emissions, many are not yet aware of the impact these measures have on our cultural heritage. Little is written on this topic yet. The Nordic Council of Ministers wanted to find out if and how climate-related adaptation and mitigation measures impact the Nordic cultural heritage, and the Norwegian Institute for Cultural Heritage Research was engaged to gather and systematize relevant information to improve our collective knowledge concerning these issues [16]. In short, we call the project *Climate adaptation and heritage.*

The Climate adaptation and heritage project approached the question of how cultural heritage may be affected by different climate mitigation actions, and it includes direct, indirect, and visual impacts of heritage sites and landscapes. Adaptation measures reducing the impacts of already occurring events are also implemented, both in the Nordic countries and on a global scale, and the effect of these have also been investigated. Our investigations cover climate change mitigation and climate adaptive measures in Sweden, Denmark, Iceland, and Norway. The work is based on gathering information from Nordic expertise.

The main aim of the project was to find out how climate-related adaptation and mitigation measures impact the Nordic cultural heritage, direct, indirect, and visual. In this article, we present examples of the different adaptation and mitigation measures that impact the cultural heritage, both positive and negative. We would like to stress that though this paper is mainly concerned with adaptation to possible damage to heritage sites and landscapes caused by modern climate mitigation measures, we are also aware that there is considerable knowledge and information to be extracted from past societies (see further in Section 3.4.4). As the article is based on the project undertaken by NIKU for, and financed by, the Nordic Council of Ministers in 2021, it has a Nordic focus, which indeed is transferable to other countries. In addition, the different topics from the project are discussed and analyzed further, and later studies are included.

As already described, the combination of climate adaptation and mitigation measures with focus on the impact of cultural heritage is not widely researched. Relevant research papers and articles are therefore scarce. However, national and regional work and project reports are indeed relevant and are partly presented here. By talking to experts in the fields of natural sciences and cultural heritage research and management, we have reviewed today's status and thoughts for the future. The article presents how cultural heritage already is and may in future be affected by climate mitigation or climate adaptive actions. Good and less successful examples of implemented actions are included. We discuss how to minimize the risks of damage to cultural heritage when implementing different measures. These recommendations include local, regional, national, and international settings, they go across sectors and political guidelines, and they reflect the need to develop knowledge, interdisciplinary cooperation, and attitude changes. This is also stressed in a White Paper just printed by the EU JPI Climate and JPI Cultural Heritage and Global Change [17].

We hope this article will add an interesting, important, and highly needed insight into the research of the interdisciplinary field that crosses climate adaptation and cultural heritage. As far as the Nordic countries have come with implementing adaptation and mitigation measures, it is a humbling statement to say that the time is overdue to focus on this cross-disciplinary field of research.

The term cultural heritage includes archaeological heritage, buildings, cultural environments, cultural landscapes, and intangible heritage. The term climate-related mitigation measures include all measures taken by society to minimize the carbon gas emissions, i.e., the green transition. In addition, the term adaptation includes measures taken to minimize damage to cultural heritage directly by climate changes, such as increase in temperature and precipitation in the Nordic countries. In this article we use interdisciplinary understanding as presented in Derry et al. [18]: "The ability to integrate knowledge from two or more disciplines to create products, solve problems, or produce explanations".

2. Methodology

The methodology chosen for the project involves an analysis of qualitative data collected in 2021 through text review, interviews, and workshops (Figure 1). It first builds on the data collected from the current literature and official documents about the topics that are most relevant or urgent regarding the impact of climate change mitigation measures on Nordic cultural heritage. The topics were further developed based on a series of interviews with Nordic experts and researchers from diverse backgrounds and networks in Nordic countries. The primary framework of the project is thus based on these interdisciplinary inputs to ensure a broad coverage of the subject in each country, i.e., archaeology, landscape, building, climate adaptation, climate scenarios, energy supply, etc. The strategy moves forward by bringing together experts and researchers in workshops to discuss the primary results and supplement them with practice-based examples. Additional information on topics that were not addressed in interviews and workshops was obtained by conducting supplementary interviews with complementary expertise. The results are published in a thoroughly structured report financed by the Nordic Council of Ministers [16].

Focus on already known existing problems caused by climate change mitigation measures for cultural heritage represented a natural starting point. A non-exhaustive list of problematic mitigation measures for Nordic cultural heritage was compiled by the project research team based on the available literature, articles, official reports, and documents to map direct, indirect, or visual threats. Gradually, the focus evolved towards constructive solutions to the problems, and on practice-based examples that have proven to be effective and positive for the preservation of cultural heritage. The solutions that were uncovered dealt with topics such as bilateral adaptation, resilience, implemented constructive examples, interdisciplinarity, and knowledge exchange.

Regarding qualitative data, NIKU (represented by the research team) adheres to the applicable ethical guidelines from the National Research Ethics Committee for the Social Sciences and Humanities (NESH), which include privacy protection and research ethics. Current legislation on privacy (cf. Norwegian Personal Data Act, *Personopplysningsloven*) and GDPR requirements have also been followed. The individuals who participated in the interviews and workshops were informed about their rights, and the events were conducted without audio recordings to minimize the collection of personal information and to ensure the integrity of the interviewees.

2.1. Interviews

19 interviews were conducted in June 2021 with a representative sample of 26 experts and researchers (*informants*) in cultural heritage management and research from leading research centers, from central government and public administration at regional and national levels in four Nordic countries: Sweden, Norway, Denmark, and Iceland. Each interview was conducted by two members of the research team with complementary professional backgrounds (16 individual interviews and three group interviews with 2–5 informants) and lasted approximately one hour. Detailed notes were taken manually during interviews (conducted without audio recordings), and the results were later examined and presented in tabular forms, where all topics were referred to and the relevance for cultural heritage explained.

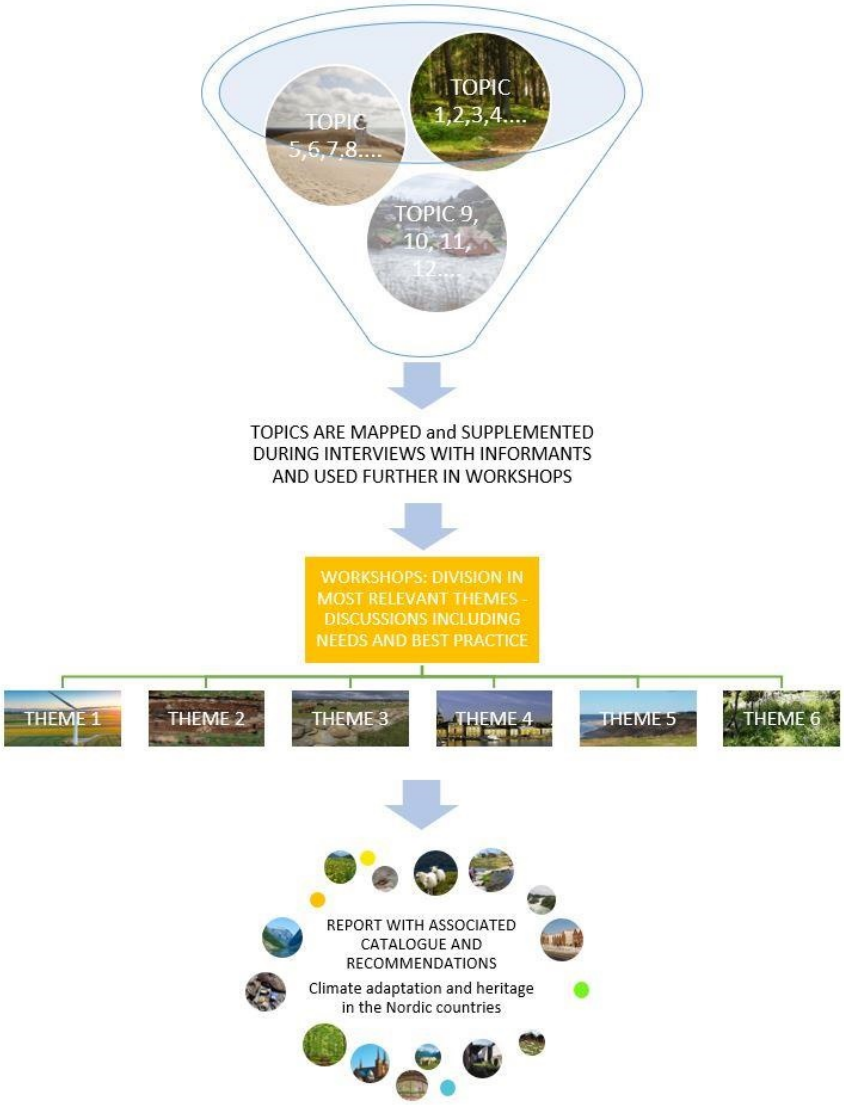

Figure 1. This is a visual description of the method used in report. Idea and graphics: Simon, NIKU.

The aim with the interviews was threefold: (1) put together a comprehensive picture of the situation, (2) identify the adaptation and mitigation measures that are perceived to be a threat to cultural heritage from different professional perspectives, and (3) provide good examples to meet both environmental objectives and cultural heritage needs. The research questions were designed around the issues of the main research question and followed an easily replicable structure with open-ended questions [19]. These were organized into four topics: (1) experience of each informant, (2) present situation, (3) future prognosis and expectations, (4) laws and management systems. Each informant or group of informants was asked to reflect upon implemented local, regional, and national mitigation, and/or adaptation measures in his/her own country, and whether and how these measures ensure or affect the proper preservation and management of cultural heritage. A note on the semi-structural interviews showing topics discussed is included as Supplementary Material. Topics such as closer cooperation between authorities, harmonization of methods and management documents, knowledge collection, and the creation of interdisciplinary networks were also addressed. In addition, relevant management documents in each country were mapped (see Table 1). Overall, the discussions formed the basis for defining the most relevant topics in each country.

Table 1. Relevant national and international governing documents.

Country	Type of Document
Norway	National white paper Kulturmiljømeldingen St.Meld. 16. (2019–2020)
Norway	The Directorate for Cultural Heritage climate strategy, Riksantikvarens klimastrategi 2021
Norway	The Planning and Building Act
Norway	National Standard NS9451: 2009
Norway	The state's planning guidelines for coordinated housing, area and transport planning
Norway	The National Heritage Board's thematic report on cultural monuments and cultural environments. National framework for onshore wind power
Norway	State planning guidelines for climate and energy planning and climate adaptation
Iceland	Climate Action Plan—Umhverfisraduneytid Adgerdaaaetlun, 2020
Iceland	Cultural Heritage Act—Lög um menningarminjar, nr. 80/ 2012
Iceland	Planning Act—Skipulagslög, 123/2010
Iceland	Building Regulations—Byggingarreglugerð, Stjtíð. B, nr. 441/1998
Iceland	Building Act—Byggingarlög, 5416/1978
Sweden	Climate Act (2017:720)
Sweden	Ordinance (2018:1428) on authorities' climate adaptation work, Ministry of the Environment—Förordning (2018:1428) om myndigheters klimatanpassningsarbete
Sweden	National strategy for climate adaptation, 2018, Ministry of the Environment—Nationell strategi för klimatanpassning
Sweden	The Cultural Environment Act—Kulturmiljölagen (1988:950)
Sweden	The Environmental Code—Miljöbalken (1988:808)
Sweden	Planning and Building Act—Plan-och bygglagen (2010:900)
Sweden	Ordinance on flood risks—Förordning (2009:956) om översvämningsrisker
Denmark	Museum Law—Museumsloven
Denmark	A green and sustainable world
Denmark	Climate change projects
Denmark	The Planning Act, for municipal urban planning
Denmark	Building Act
Denmark	Building Protection Act
Europe	Water Framework Directive
Europe	Flood Directive 2007/60/ EC 23.10.2007
International	European Convention for the Protection of the Archaeological Heritage (1992) (Malta Convention)
International	UN Global Goals for Sustainable Development (2015).

2.2. Workshops

Six thematic workshops were held in September 2021, with 17 informants. The topics that were identified as most relevant to the four Nordic countries during interviews constitute the basis for the workshop structure. The timeframe per workshop was 1–2 h. Several informants attended more than one workshop. Each workshop was conducted by three to five members of the research team who assumed different roles (i.e., leader, secretary, interpreter, observer) to be able to capture the essence of the discussions and

highlight topics, examples, and other comments and suggestions from the informants. The workshops represented more extensive thematic discussions than the interviews. Their aim was threefold: (1) interdisciplinary and transboundary discussion about the impact of various climate change mitigation and adaptation measures on cultural heritage, (2) focus on providing examples of mitigation measures that protect cultural heritage, and (3) identify knowledge gaps.

Two workshops were international and gathered informants from the four Nordic countries. They addressed interdisciplinary issues about the following topics:

1. Archaeology, cities, and landscapes.
2. Buildings, cities, and landscapes.

Four workshops were national and gathered the informants of each country. They focused on the specific national challenges related to interdisciplinary approaches on management issues for the following Nordic countries:

3. Denmark.
4. Norway.
5. Sweden.
6. Iceland.

During the first two workshops (cf. numbers 1 and 2), several subject areas were discussed among the four Nordic countries that took on the issues related most specifically to archaeology ('underground' cultural heritage) and buildings ('above ground' cultural heritage) and their immediate relation to cities and landscapes. During the other four workshops (cf. numbers 3–6), challenges and good adaptation and mitigation measures were discussed for each country. The six workshops allowed us to identify good examples of climate change adaptation strategies and mitigation measures that do not adversely affect cultural heritage, and to pinpoint the current shortcomings. Additionally, they showed an urgent need for further research and development of interdisciplinary methods and management systems.

2.3. Complementary Interviews

Nine complementary interviews were conducted in November 2021, with 11 new informants from the four Nordic countries. After the interpretation and analysis of the first round of interviews and workshops, the research team identified a need for additional information within several subject areas, i.e., nature management and environmental issues. These interviews were conducted in the same way as the interviews described in Section 2.1. Interviews.

2.4. Written Sources

Broader knowledge was acquired through the literature studies relevant to the topic related to measures that affect cultural heritage sites and landscapes. The literature that was chosen for the research largely focused on the Nordic countries' governing documents, as well as research and reports available to the wider public (i.e., research papers, official reports, white papers, documents in public administration and official websites). Table 1 shows a non-comprehensive list of the most important governing documents for the Nordic countries. The information from the literature review was compared to results from the interviews and workshops to give an overall picture of each topic. Since the thematic areas are naturally interdisciplinary and international, the informants were also encouraged to send the research team all documents that they deemed relevant, in order to provide a complete picture of the challenges, shortcomings and successful adaptation measures within the four Nordic countries.

3. Results

Through interviews and workshops, experience was cross-evaluated and systematized. The results are presented in the five following topics (Sections 3.1–3.5) that confront the

Nordic countries' main challenges for preserving and making cultural heritage resilient in times of adapting society to a greener world. These topics include solutions that were outlined by the informants to cope with different climate mitigation and adaptation measures that directly, indirectly, and visually affect the Nordic cultural heritage.

The informants stated a growing need for improving the coordination and collaboration between governance and management bodies, whatever topic, mode of mitigation or heritage type is chosen. Their recommendations include a more holistic and more integrated approach and understanding of complex issues across sectors, disciplines, and professions. Equally important is a need for interdisciplinary approaches that follow both horizontal and vertical lines of cooperation and areas of responsibility. This topic is further deliberated in the Discussion section.

Since this is a cross-dimensional topic that until now has not been the subject of intensive research, the existing available literature most often presents disjunctive fractions of much more complex and multifaceted challenges. Simultaneously, the rapid development of the media and social networks through many available channels and platforms over the last 5–10 years, as well as new forms of journalism and new media formats and markets, have greatly influenced society's views and opinions on politics and political decisions. This is also visible in the climate debate, and it challenges society's trust in research and management. Through distortion of general knowledge due to incorrect or incomplete information on popular networks, misconceptions about climate change and misunderstandings about mitigation and adaptation actions are spread among the population. According to our informants, aside from interdisciplinarity, dissemination of correct and reliable information and knowledge transfer are powerful tools and must come from dependable sources. Our personal experiences confirm this. We also believe that it is more important in this context to focus on the measured and experienced effects that climate change and climate change adaptation and mitigation have on heritage sites and landscapes rather than the reasons for these changes. Changes occur and need to be remedied now. Too often the discussion gets sidetracked by the root causes of the changes. It is not that we do not agree that the root causes of climate change must be treated as well, but we see an urgency in the remedies that cannot wait until the other aspects are solved. Cultural heritage risk assessment is essential in the task of prioritizing which sites to adapt or investigate and document before they are lost.

3.1. Energy Efficiency

There are examples of projects where calculations of the cost-benefit of upgrading older buildings to meet current requirements for energy efficient buildings have been performed. Several calculations show that gentle upgrading is energy efficient, safeguards heritage values, and it can help avoid construction damage to the built heritage [20]. Research projects are also being carried out to investigate how to upgrade older buildings to almost zero energy levels [21], and the solution in these projects has been to work in interdisciplinary project groups to safeguard heritage principles. The research and development program, "Spara och bevara" (Save and preserve), focuses on raising knowledge about energy efficiency in culturally and historically valuable buildings [22]. The research program is initiated by the Swedish Energy Agency and aims to develop and disseminate knowledge and technological solutions that contribute to energy efficiency without destroying the historical values of the buildings.

Presenting successful results on how to upgrade without combating buildings' heritage values are indeed relevant to meet the requirements for reducing greenhouse gas emissions. This work is multifaceted, but the focus is often on replacement of building parts (e.g., windows), new types of materials (e.g., insulation and increased density in building structures), as described in 3.1.2. There is also a need to check damage development related to energy efficiency and temperature reductions in buildings. This has been particularly relevant in the autumn and winter of 2021/2022, with high electricity prices in the Nordic region, where indoor temperatures in older buildings have been kept lower to save electric-

ity cost. In the diocese of Växjö in Sweden, for example, the development of damage in churches has recently been seen to increase due to lowering of indoor temperatures.

3.1.1. Technical Installations

In some places in Scandinavia, solar panels have been installed on the roofs of culturally and historically valuable buildings, which can have a negative visual impact, see Figures 2 and 3. Solar cells on private buildings in Denmark have often not been part of a comprehensive analysis of needs, impact and aesthetics, and there is little skepticism associated with their use on roofs. This means that solar cells are installed where other solutions might have been better for preservation and for energy supply. In close collaboration with architects and other professional expertise, the negative visual consequences of solar panels, as exemplified in Figures 2 and 3, can be reduced, as exemplified in Figure 4. Even if there are new developments in solar panels and possibilities for integrations, this is yet to be used on heritage buildings.

Figure 2. Solar panels on roof of historic building, Lund, Sweden. Photo: Haugen, NIKU.

Figure 3. Solar panels on old outhouse, Vega, Norway. Photo: Vandrup Martens, NIKU.

Figure 4. Solar panels on modernistic building in Drammen, Norway. Photo: Vandrup Martens, NIKU.

Heat pumps are energy efficient but can be visually disturbing on older buildings if you choose a solution with an outdoor unit, see Figure 5. There are also variations in how much change and how many major interventions are required in the building structure. It is a challenge, but it is also possible to develop good solutions for heritage buildings with minimal intervention. It requires, however, a close collaboration with expertise within energy technologies, building constructions, municipal administration, and cultural heritage managers.

Expansion of hydroelectric power is largely linked to Icelandic, Norwegian, and, to some extent, northern Swedish conditions. Iceland, Norway, and northern Sweden have well-developed hydroelectric power systems that Denmark and southern Sweden do not have. There are challenges related to the expansion of the existing building stock to increase the capacity for green energy. The challenge is partly to rebuild or build out the existing building stock that includes culturally valuable buildings, and to add new structures, as well as possible new hydroelectric power stations in new areas. In addition, there will be a need for new and renewed power transmission systems and wiring. Today's hydroelectric power plants are an important part of our Nordic cultural heritage and industrial history, and it is therefore relevant to work closely with involved participants to take cultural heritage aspects into account in the event of major changes. Archaeological heritage sites and landscapes are impacted by the dams connected to the hydroelectric power plants. These often cover archaeological sites and landscapes, and by lowering the

water table inundated sites may be exposed to further degradation [23,24]. Establishing new hydroelectric power plants will almost certainly come into conflict with listed sites.

Figure 5. Modernistic building in Arendal, Norway, with outdoor unit from air-to-air heat pump attached to the facade. Photo: Kjølsen Jernæs, NIKU.

3.1.2. Upgrading and Restoration of Heritage Buildings

It is a challenge to choose the right materials and methods in older buildings in connection with measures to reduce greenhouse gas emissions and adapt and secure the buildings against slow degradation and extreme weather events. This applies to general upgrades, preventive measures, and restoration after damage. A change of attitude is required, because new materials have been introduced that are incompatible with original building elements. This is seen as a challenge, partly due to strong market forces that influence homeowners' choices, and partly due to the need for knowledge dissemination. There is a great lack of knowledge about sustainable upgrading of older, but "ordinary", buildings worthy of preservation. There is a need for close collaboration between architects, engineers, craftsmen, and consultants in the field of cultural heritage, to be able to use more traditional materials and methods to a greater extent when upgrading, and in damage analyses after extreme events.

The use of traditional materials as a climate change measure can be a good solution. Traditional craftsmen can have an interesting ecological approach and are important carriers of knowledge. Figure 6 shows Danish traditional materials for house building, and a need to focus on traditional, frequent maintenance as an important measure for achieving energy savings and safeguarding cultural heritage values has been emphasized. Maintenance

will save the need for major repairs from damage that can develop over time. The biggest shortcoming in connection with the restoration of buildings is a lack of knowledge and experience and a shortage of experienced craftsmen. It is important to bring in the right expertise at the right place and time in the processes. Local knowledge is as highly valued as data generated through professional projects, and the acquisition of knowledge should be able to include both. To a large extent, the threat to buildings and cities lies in the fact that cultural heritage expertise enters both the planning and the restoration processes too late and therefore can only contribute to a lesser extent, both for archaeology, buildings and cities. The proposed measures are, therefore, a Nordic knowledge bank, a collection of examples and a Nordic network of professionals. The focus should be on assessing the use of traditional materials and implementing environmentally friendly quality materials. This may relate to the existing Traditional Knowledge World Bank (TKWB) [25]. A robust system for seeking knowledge is developed, in addition to the question of how to join and contribute. When it comes to the topics of climate adaptation and caretaking of the Nordic heritage, it is natural to be inspired by the TKBW system regarding how to gather knowledge and make it available.

Figure 6. Example of the use of traditional materials from Aarhus, Denmark. Photo: Muldbjerg, Unsplash.

Menon Economics and NGI recently completed a preliminary project and report that deals with developing and highlight the socio-economic value of preventing climate change [26]. The preliminary project is limited to assessing measures to reduce the consequences of landslides and floods in Stryn municipality, Norway, and extreme precipitation in the town of Fredrikstad, Norway. The result shows that investments in important climate adaptation measures provide high profitability. Society can save up to six times the invested amount by choosing the most profitable measures. The main findings show that socio-economic analysis is a suitable tool for identifying socio-economically profitable strategies and specific solution choices. The most profitable measures may require cooperation and interdisciplinary collaboration between different service areas in the municipality. Furthermore, citizens' willingness to pay to reduce the probability of incidents, and thereby reduce the feeling of insecurity, can be decisive as to whether the measures are profitable or not. The preliminary project and report also show that climate adaptation measures can provide increased recreational values and improved biodiversity.

3.2. New Energy Supply Systems

There are different views and priorities for the development of a sustainable and environmentally friendly energy supply in the four Nordic countries, especially between southern and northern Scandinavia. For example, Scania (the southern part of present-day Sweden) and Denmark focus on wind energy (80% of total production) and solar energy, while most of the electricity produced in Norway comes from hydroelectric power (91% of total electricity production; as of now, Norway is Europe's biggest producer of hydropower). In Sweden, hydroelectric power accounts for 45% (northern Sweden) and the wind share of total electricity production is on the rise (today, approx. 21%, compared to 3% in 2010). Iceland benefits from geothermal energy and hydropower since the 1970s, that amounts to 99% of the country's electricity production [27]. Therefore, Iceland does not have the same urgent need for new renewable energy systems as the rest of the Nordic regions, although the government is looking at options for adding wind turbines to their primary energy supply.

Solar parks are a valuable part of the future energy supply, and they are in increasing use in southern Scandinavia as well as in the rest of Europe; see Figure 7. Sites for solar parks are likely to be greenfield sites, often positioned on south-facing slopes (to maximize solar exposure), which coincidentally are also potential sites for past settlements and old cultural landscapes [28,29]. Archaeological heritage, cultural landscapes, and cultural environments can be directly disturbed or permanently damaged by the establishment of solar parks, especially if the location of the associated infrastructure (pipelines, road networks, etc.) and the construction methods do not include a detailed assessment of impacts on the cultural heritage of the site. The implementation of practical measures would avoid or minimize any adverse effects. Some sites require more management than others and necessitate integrated and site-specific actions, surveys, and assessments, which may lead to mutually beneficial solutions [28,30]. In the case of metropoles and cities, solar parks located outside building environments and large agglomerations can be seen as a solution, as they can produce green energy for large parts of the population and still be in a concentrated area. The installation of solar parks can also relieve buildings of unsightly solar panels mounted on roofs, although new technological generations of integrated photovoltaic construction elements provide alternative solutions (e.g., building-integrated photovoltaics, BIPV, and building-applied photovoltaics, BAPV). Solar parks can also be seen as a way of safeguarding archaeological heritage and for in situ preservation, where the archaeological remains are protected under the panels. That would specifically be the case for areas that would otherwise be used in agriculture. Modern ploughs go much deeper into the deposits and the subsoil than the solar panel legs need to. However, if the archaeological remains at a solar panel site are all very close to the surface, the site risks destruction rather than preservation and should thus be investigated prior to installation.

There are major national differences in how wind power is perceived as an impacting factor on cultural heritage. There is also a certain difference related to where the windmills are situated in the different parts of Scandinavia, and thus, they have different prerequisites for affecting cultural heritage. In Denmark and in southern Sweden, there are often larger wind-power plants in areas that are already dominated by infrastructure, or in strongly human-influenced landscapes such as cultivated land. There is also a long tradition of single windmills at farms, which is generally perceived as positive and contributes to local power production, where long transmission lines to consumers are avoided. Similarly, only a few individual cases are also found in Norway.

Figure 7. Solar cell park in Gråsten, Jutland, Denmark. Photo: New Øresund/Wikimedia Commons/CC BY 2.0.

The visual and social effects of wind power plants and their impact on cultural landscapes and cultural environments is an ongoing discussion in Europe [31–33]. For many years, Norway has been no exception [34–37]. The National Heritage Board has written a report on cultural monuments and cultural environments as a national framework for onshore wind power [38], and this has been further developed to an up-to-date knowledge overview on the effect of wind power [39]. Here, it is considered that all types of measures such as wind turbines, supply routes, cables, transformers, service buildings, and other necessary elements affect cultural monuments and cultural environments directly and indirectly [38,39]. In addition to the obvious impacts, there are changes in the microclimate, water flow, etc., that can change the conservation conditions underground. There is not much difference in the impact of similar infrastructure in connection with hydroelectric power plants, but the discourse is completely different. The discourse concerning wind power plants in Norway seems largely to be disconnected from the actual effects and instead focusing on a general feeling that large-scale windmills are damaging the landscapes, both as a living environment and as a means of production, and as one of the bases of tourism. This discourse also triggers a general concern for natural environments still unmodified by human activity and a strong public opposition to wind projects in Norway [40]. In Denmark and southern Sweden, windmills have been part of the landscape since medieval times, obviously transforming in shape and size over time. There, the current debate is largely focusing on how large land-based wind turbines are acceptable in the landscape, and whether it is preferable to have single windmills rather than larger wind farms (see Figures 8 and 9). One often sees the wind turbines near existing infrastructure, which differ from the many planned wind turbine parks in Norway. In northern Norway and northern Sweden, there is a growing concern that wind turbines, particularly in larger wind farms, may have adverse effects on immaterial heritage, specifically on reindeer grazing. A recent court case was won by reindeer herders, resulting in a possible need to dismantle a newly erected windfarm placed in a central reindeer grazing area. This type of conflict is highly undesirable and might have been avoided with improved dialogue between all parties before the windfarm was built.

Figure 8. Single wind turbine at a farm in Sweden. Photo: Vandrup Martens, NIKU.

Figure 9. Large windfarm in cultivated land in Denmark. Photo: Vandrup Martens, NIKU.

A challenge for built environments in connection with further development of windmills is that it can have a visual negative impact. In addition, there are concerns regarding construction, operation and maintenance that require power transmission systems and pipelines through or near built environments, as do all forms of power. To achieve minimal negative impact on cultural environments, offshore wind turbines are seen as a solution (Figure 10).

Figure 10. Offshore windfarm photographed from Jutland, Denmark. Photo: News Øresund, Wessman/Wikimedia Commons/CC BY 2.0.

In Norway and northern Sweden, there is a pronounced potential for upgrading hydroelectric power to increase the need for green energy [41]. Increased precipitation means that several of the hydroelectric power plants are undersized. In addition, there is a wish to increase production, and therefore, further develop several of the dams. Upgrading and expansion is a theme with many facets, both for the facilities such as climate considerations and safety, and for cultural heritage and cultural environments that are affected by the facilities. A good solution for safeguarding cultural heritage when rebuilding or expanding existing facilities is to enable a more frequent and closer collaboration between the cultural environment authorities and the Norwegian Water Resources and Energy Directorate (NVE) and similar authorities in the other countries, e.g., by heritage authorities cooperating with energy providers on evaluating vulnerable heritage sites affected by power production, cf. [42,43]. An example of this is the 2000 report from the World Commission on Dams [44]. The heritage management authorities should be included early in such processes to find the best possible solutions and avoid added negative impact on heritage sites and landscapes (see, e.g., Zaina and Tapete 2022 [45]). It is again important to emphasize both the physical and the visual effects of the transmission lines that transfer electricity from the hydropower plants to the consumers. A large number of small hydroelectric power plants has been established in Norway over the past decade [46]. They were established with decreased regulatory rules as an attempt to increase local power production. However, this has resulted in reduced protection of both cultural and natural heritage and is something to consider in future power plant establishments.

Regardless of the choice of energy source, the power station itself is not the only change in the landscape. Wiring and other infrastructure associated with power production have a major impact on cultural heritage, see Figure 11. Energy from water, wind, and sun must be transported from the production site to the consumers. It is therefore not only the direct intervention that is made in the establishment of new energy sources, but the associated pipeline network and/or transmission lines, which can directly, indirectly, and visually affect cultural heritage. This is a factor that is important to consider when planning new climate adaptation and mitigation measures. So are the possibilities of shorter power transmission distances to new development sites. A local power source may significantly

reduce the need for power transport infrastructure. The challenges underline the need for early involvement of all the right expertise at the planning stage.

Figure 11. Dominant power lines at house in Denmark. Photo: Vandrup Martens.

3.3. Renewed and Upgraded Transport Systems

Electrification of transport systems is generally seen as a good way to reduce greenhouse gas emissions, air pollution, and even sound pollution. Development of new infrastructure for power supply and railway lines, subway lines, light rail lines, or electrification of water transport (large ferries and smaller boats), entails large construction areas in connection with development in new areas. Regarding railway upgrading, new, or reinforced, power line networks are established. Ground conditions, water runoff, and drainage will impact archaeological heritage. A special challenge arises when transport routes are planned in areas where no mapping of cultural heritage has previously been done. A lack of information on the possible impact on cultural heritage will, in these cases, not mean that there is no negative impact. However, there will be an absence of known impact, a case where there is clearly an increased reason for including heritage expertise.

Another type of a renewable transport system is the electrification of car parks in the Nordic countries. The number of electric cars that are requested from the Nordic governments, require large amounts of charging stations located systematically to gain a sensible, geographically widespread network. No other country in the world has more electrical cars than Norway, compared to the number of inhabitants [47]. As of April 2022, Norway has 19,705 public charging stations, whilst Sweden has 14,168 public stations [48]. There is no similar overview for Denmark and Iceland, but other overviews reveal that they have far less [49]. By looking at Denmark's leading charging companies (EON and

Clever), there are approximately 4500 public charging stations today, and there is a plan for expanding the public charging net in the coming years.

The charging stations may come into conflict with cultural monuments and cultural environments and have a negative effect on lines of sight and experiences; see Figure 12 for example. In the transition to electric vehicles in the Nordic countries it will be important to include cultural heritage input regarding the location of charging stations, especially because there is a requirement from electric car owners demanding charging stations near cultural monuments, so that they have something to spend time on while charging the car [50]. In Norway, there is a geographical distribution of charging stations, although most of them are in the southern parts of the country [51]. This means that in the northern parts of the country it is more difficult to get access to a public charging station, and instead users become dependent on being able to charge at home. An increase in charging capacity in both Sweden and Denmark, and eventually Iceland, is expected. Therefore, there is a need to look at best practice in Norway as a pioneering country, with the aim of avoiding conflicts in areas with cultural heritage.

Figure 12. Charging stations in a row right in front of preserved built heritage at Bygland Bygdetun, Norway. Photo: Leira, for Visit Sørlandet.

It is not only the worldwide electrification of car parks, which indeed is especially relevant for Norway (where eight of the ten purchases of the most sold new cars in 2021 were fully electric) [52], but that of trams, busses, and ferries as well, that shows the shift from fossil fuel to electrification. This does not particularly affect the cultural heritage in any negative way, as the ports for ferries and tram and bus stations are already built. However, when there is a need for an additional power supply, the challenges are the same as for railway lines. Conflicts may also arise in small coastal harbors with preserved built heritage, where a ferry charging station may have great visual impact [53].

3.4. Nature and Culture-Based Adaptation and Solutions

Nature-based solutions (NBS) is a concept that seeks to integrate nature's own solutions into climate mitigation and adaptation measures. NBS includes ecosystem-based adaptation, ecosystem-based disaster risk reduction, and green, as well as blue-green infras-

tructure [54,55]. Culture-based solutions (CBS) is a topic addressed in UNESCO's report "Changing minds, not the climate: culture-based solutions to local climate adaptation" [56]. The organization believes that it is necessary to draw on local knowledge and experience in addition to scientific and technical knowledge to solve the climate crisis. Both NBS and CBS are included in specific measures that were discussed by our informants.

3.4.1. Water Management

Rain beds in cities are a good example of how climate adaptation measures also safeguard cultural heritage and cultural environments. Bjørnstjerne Bjørnsons gate in Drammen, Norway, is the country's first road construction where local surface water management in the form of rain beds is the only system for managing surface water. The system has many benefits, such as biodiversity and well-being, and it works well for cultural heritage, with natural drainage at the bottom (Figure 13). With this method, the precipitation is filtered, and the need for excavation of pipes which can have a negative effect on archaeological remains is minimized.

Figure 13. Rainwater beds along a busy street in Drammen, Norway. Photo: Vandrup Martens, NIKU.

Other examples of surface water management are the use of permeable materials and surfaces to replace asphalt or concrete covers, particularly in urban contexts. We have come across an aesthetically pleasing and efficient example in France (Figure 14), where permeable materials and sedum were used as cover at a supermarket parking place, infiltrating water to subsoil deposits.

Figure 14. Permeable pavement at a parking lot in central France. Photo: Vandrup Martens, NIKU.

Drainage and dehydration are the biggest threats to heritage preservation at Bryggen in Bergen in Norway, and local infiltration will be an advantage for archaeological in situ preservation. Here is a good example of both a rain bed and a larger infiltration system for precipitation following the globally well tested Dutch model of water infiltration systems (Figure 15) [57,58]. Various measures have been taken both above and below ground to reduce the loss of groundwater from the World Heritage Site, by sealing the sheet pile wall around the neighboring site to the north and using several surfaces in and around the World Heritage Site to infiltrate collected rainwater into the ground [59]. The purpose was to raise the groundwater level, which is of great importance for the continued preservation of archaeological deposits and to prevent the historic wooden buildings included in the World Heritage Site from being exposed to subsidence and subsequent damage.

3.4.2. Forest Management

Many government and non-governmental organizations in Europe directly engage in afforestation programs to create forests and increase carbon capture. For some Nordic countries, afforestation (either natural or intentional) can be an environmental problem that entails a direct risk for the preservation of archaeological remains, cultural heritage buildings, monuments, and landscapes, as well as the maintenance of biological diversity, if not managed sustainably. Many cultural landscapes and ecosystems are disappearing in overgrowth, and archaeological remains are damaged beyond repair, because of poor or lacking management, the introduction of non-indigenous species, and a lack of knowledge [60]. Afforestation also reduces the likelihood of identifying and locating ruins and archaeological sites that have not yet been investigated.

Figure 15. Rainwater bed and infiltration bed at Bryggen in Bergen, Norway. Photo: Dunlop, NIKU.

Measures to reduce the effect of natural afforestation, such as clearing of forests, cutting of scrub, and grazing, can provide good results in terms of protection of cultural heritage landscapes and the re-creation of natural and cultural values and qualities. It is a continuous work and cannot be a one-off measure. However, one must also be aware of risks to heritage sites and landscapes in this regard. Logging on unfrozen ground may cause severe and permanent damage to archaeological remains, and construction of irrigation ditches can permanently change water flows and destroy archaeological deposits. These types of damage are often seen in connection with deforestation. A lack of functioning regulation for follow-up actions, a faulty management plan, or an interruption of regular maintenance of the cultural heritage landscape after forest clearing may cause irreparable damage to archaeological heritage and built cultural heritage. The informants state that it is necessary to coordinate national and local governments and professional bodies who manage landscapes and natural resources, and to integrate cultural heritage in the forest management plans.

3.4.3. Nature and Landscape Management

A general challenge for cultural environments and cultural landscapes involved in nature management processes is that natural resources and nature maintenance are prioritized over the preservation of cultural heritage. As an example, semi-natural habitats, post-Reformation buildings and intangible cultural heritage in protected landscapes such as national parks, are not enforced as directly in the park's chart as natural assets and values, and thus, they are not always given the necessary focus enabling them to be preserved. Although archaeological heritage sites are in principle better protected by the law, archaeological traces in protected areas can be exposed to wear and tear due to mass tourism or to destruction due to lack of knowledge. Cooperation, knowledge, and a holistic approach, as well as dissemination, will contribute to the reduction in this type of conflict of interest and to better protecting cultural heritage in nature management.

Restoring natural water flow and saturating peatland through a process commonly referred to as "rewetting" is a process used in climate change mitigation to reduce carbon emissions and restore ecosystems characteristic of the pre-drained landscape [61–63]; for instance, Iceland has initiated several rewetting projects, and the Norwegian Ministry

of Climate and Environment made the same recommendations [64]. Regarding cultural heritage, rewetting can be a way to secure vulnerable organic archaeological traces and preserve the cultural landscape and biodiversity. However, as some of our informants pointed out, cultural heritage in peatland landscapes is not always adequately considered. Illerup Ådal in Denmark, the oldest and largest site from the Early Iron Age where weapons were sacrificed [65], is an example where only limited monitoring has been carried out and no rewetting has been implemented on the unexcavated areas (most of the valley), as would ideally be desired from the point of view of cultural heritage. Instead, intensive drainage has been carried out in order to cultivate wet areas. Here, archaeological interests stand in opposition to agricultural interests, and there will be a abdication of responsibilities, from private actors to municipal, regional, and state. This type of unresolved area of responsibility threatens the preservation of important archaeological sites and cultural landscapes, and it may apply to further drainage of existing agricultural lands as well, due to more precipitation and greater need for drainage to ensure local food production.

Countries in Scandinavia receive support for the maintenance of cultural landscapes, but Southern European countries provide alternative methods of management that foster the protection of environments and species [66]. In Switzerland, France, Italy, and Spain, support has been provided in Alpine areas for the maintenance of cultural landscapes and traditional farming practices in the form of local initiatives, financial support, certification systems, compensations, etc., i.e., renumerated shepherds and sheepdogs who follow grazing animals on traditional routes and protect them from predators [67–69]. In Switzerland, this aid is not implemented as agricultural support, but specifically as a support for the maintenance of the cultural landscape [70]. This practice is seen as essential to ensure grazing of areas that have traditionally been kept open as pastures or meadows through human activity. It is a way of preserving both intangible and tangible cultural heritage, at the same time as it helps protect valuable cultural landscapes and wildlife. In turn, it has a significant bearing on the socioeconomic development of rural regions (e.g., employment, agrotourism, recreation, etc.). These solutions can indeed be seen as crossing nature-based and culture-based solutions.

3.4.4. Culture-Based Solutions

Pluralistic knowledge (knowledge pluralism) is of great value when it comes to climate adaptation and mitigation, UNESCO believes. The Netherlands is cited as an example where culture-based solutions (CBS) are used in climate adaptation work. Dealing with water problems is not new in the Netherlands; there are centuries of experience and knowledge to fall back on. UNESCO has written another report focusing specifically on CBS that have been implemented in the Netherlands: "Culture and heritage for climate adaptation. Four examples from the Kingdom of the Netherlands" [71]. The report discusses and gives examples of how cultural heritage can be used actively in connection with climate adaptation. UNESCO emphasizes the importance of CBS and believes that cultural heritage should not only be seen as a victim of climate change, but also as part of the solution. We try to focus on adaptation to possible damage to heritage sites and landscapes caused by climate change mitigation, and we would like to emphasize that historic solutions in heritage itself may contribute to the adaptation and future solutions (see e.g., SACC [72]).

Knowledge of historic use of nature and climate adaptation of buildings and building environments could contribute to future solutions for climate adaptation. When looking at the impact of climate adaptation measures on cultural heritage, there is a clear potential in gaining knowledge about how humans have historically managed cultural monuments and cultural environments. The importance of traditional crafts for fighting climate change has also been stressed in the ICOMOS IFLA 2017 convention [73]. Knowledge of past solutions can provide supplementary knowledge to today's choice of good solutions. It is obviously useful to consider culture-based solutions, in parallel with nature-based solutions, when discussing climate adaptation and in general when looking at good examples, see Figure 16.

Our informants mentioned culture-nature based solutions as the next step to best integrate cultural and natural perspectives in climate change mitigation and adaptation measures.

Figure 16. At Huseby bruk in Sweden, historical maps have been used in the restoration and re-creation of wetlands, as a measure to deal with water problems. Photo: L.G.foto/Wikimedia Commons/CC BY-SA 4.0.

3.5. Adaptation to Extreme Hazards

In a changing climate with increasingly frequent extreme weather events in the Nordic region, there is a need to secure heritage, both buildings and archaeology, to prevent damage. This is done in two ways that complement each other; preparedness and plans for mitigation, adaptation, and salvaging, and active changes to secure cultural heritage before an incident strikes.

Preparedness work is especially important at local levels, and includes the planning sector at the municipal level, the local fire brigade, and the owners and managers of the properties. However, this is seen as challenging because of the crossing of responsibility levels; an area plan for securing a heritage environment might include several owners. The incentive is not clear enough for spending money and resources on these issues, even though it is much more cost-effective to invest in preventive risk management planning before disaster has struck (and reduces the loss of cultural historical values as well), than to spend large amounts in post-disaster recovery and rehabilitation, [74–76]. Again, a paradigm shift seems required to ensure the prioritization of safeguarding heritage and disaster prevention.

At the municipal level, climate protection and adaptation measures to meet climate change can therefore be to secure individual buildings or archaeological sites from damage by, for example, sea level rise, coastal erosion, floods, surface water, droughts, and fires. Relevant measures to secure heritage sites can be to build flood defences, make rain beds near buildings (infiltrating water to preserve both wooden building foundations and archaeological deposits), lifting or moving buildings, increase safety in built environments that have previously been exposed to fire, and create filtration systems for surface water to prevent damming. There are also examples of securing listed buildings that are disassembled for temporary or permanent storage, to prevent damage from coastal erosion.

One of the challenges associated with securing buildings and sites to minimize damage from extreme events, is the safeguarding of the cultural-historical value of both built and

archaeological heritage. By carrying out major changes in the environment one will also change the inherent values, and this should be considered when designing and implementing plans. Few of the completed projects have included an impact assessment in which any changes in the values are considered.

4. Discussion

When looking at the findings, we should ask the questions: "How can we adapt to a changing climate and further develop and make the green transition without jeopardizing heritage values? How can we implement this work to make the necessary changes?" Since the existing literature does not approach this subject, we cannot discuss our findings by referring to earlier studies and projects. The discussion will therefore be based on the results from workshops and interviews to look forward and suggest future research directions and implementation. Due to the comprehensive nature of the topics included in the results, not all topics can be further discussed. Therefore, we have chosen the three most relevant areas of interest, where we can approach future needs: interdisciplinary work, culture-nature based solutions, and new energy supply systems.

4.1. Interdiciplinary Work

In March 2022, The Office of the Auditor General of Norway [Riksrevisjonen] launched a report on investigation of the management of climate-related adaptation of buildings and infrastructure [77]. Some of their main findings and topics for criticism correlate with our findings; the lack of interdisciplinary systematized work to reach well-founded solutions for adaptation of buildings and infrastructure. This was a topic that was apparent in all completed discussions and interviews, for all the involved countries. We all see the impact of our own actions, but not the impact of humanity's actions, which makes a great difference when it comes to climate change adaptations and the green transition.

Our findings show in general how complex the approach to climate change mitigation and adaptation is. Both the challenges and the solutions bridge many fields of expertise, which in general need interdisciplinary collaboration. In short, the results show that the planning and execution of mitigation and/or adaptation measures lack the inclusion of management of cultural heritage at an early stage, and in many cases that inclusion is lacking completely. Previous undertaken work often lacks the focus and the understanding of the long-term impact on heritage of the given measures. When the impact is unknown, how can one take this into account when there is urgency in getting adaptation measures implemented? Politicians are now talking about reducing 'red tape', i.e., the bureaucratic rules that control development, to allow for faster implementation of adaptation and mitigation of climate change. This can result in potential danger unless a paradigm shift is implemented that includes heritage specialists in the planning processes from the outset.

The sectorization of management and a multi-level governance system are seen as a general challenge when discussing cultural heritage in relation to mitigation measures which are designed, among other goals, to fight climate change, avoid disasters caused by natural hazards, and facilitate the green transition. The need for interdisciplinary thinking is essential and beneficial from a wide range of perspectives [78–80] but seems to be easier said than done.

The Nordic countries have different divisions of responsibility at different levels. For example, in Norway, operational mechanisms are established at a more local and municipal level than in Sweden, which rather, takes actions at county level. However, it would be unreasonable to assume that local government agencies possess the necessary resources to get deep insight and knowledge about complex, interdisciplinary debates on the impact of climate change mitigation and adaptation measures on Nordic cultural heritage. Partnership between national, regional, and local government agencies is essential to properly ensure knowledge sharing and a holistic management. Nevertheless, it is important that understanding, knowledge, and participation, including training, are also anchored locally to enforce site-specific adaptation and mitigation measures that are adapted to the local

cultural heritage and environment; additionally, analyses and monitoring should also be conducted on a local scale, providing tailor-made solutions.

The conversations with the informants highlighted an urgent need for an earlier and wider inclusion of cultural heritage issues in the processes dealing with climate adaptation and mitigation measures in other sectors. Their impact on cultural heritage can be variable. As we lack the proper distance and integrated knowledge about this relatively recent problem, some measures can easily trigger a type of "domino effect" with delayed implications and unpredictable consequences for Nordic cultural heritage. A solution for mapping the long-term effects on heritage could be an interdisciplinary approach.

It is easy to state a need for interdisciplinary work, to avoid silo-thinking and the ensuing negative impact on our heritage. It is widely known that interdisciplinary work is especially needed when complex, real-world problems cannot be understood or solved with the tools and perspectives of only one discipline [18], but how should this be done?

This complexity requires a paradigm shift, a change of attitude on the part of designers and executors, where the focus is on system-based methodology for interdisciplinary and complex processes and opens for cultural heritage assessments to implement good measures. The interdisciplinary approach is needed at planning stages, preparedness, damage limitation, and salvaging. There is a crucial need for a mapping of possible systems of collaborations in municipal management; a sort of "border crossing public management", not just for cultural heritage, but for finding solutions for climate-related adaption in general. Relevant systems for multidisciplinary processual collaboration can be giga mapping, systems thinking, and boundary work. We also see the need for a systematic approach on how to integrate relevant research in the daily work for municipalities and management. Translational research might pinpoint the needs here. The goal would be to include cultural heritage assessments in connection with climate adaptation measures at local, regional, and national levels.

The workshops and interviews viewed the need for national, Nordic, and international co-operation on guidelines and legislation. To be able to meet these needs, we would suggest that the Nordic countries could facilitate a Nordic knowledge bank. The knowledge bank should focus on hands-on, practical measures to spread the knowledge and best-practice of adaptation measures and solutions for the green transition that do not compromise with cultural heritage. This could be a Nordic network of professionals. The focus should be on assessing the use of traditional materials and implementing environmentally friendly quality materials. The network should facilitate and help local management in including heritage at an early stage for local and regional matters, and the work carried out there should have transfer value to other countries.

4.2. Culture-Nature Based Solutions

Our Nordic heritage would benefit from culture- and nature-based solutions, where the long-term effect of both mitigation and adaptation is mapped and analyzed. Nature-based solutions can be done in many ways, and heritage may benefit in various ways and scopes. Rewetting of areas to restore natural water flow and saturating peatland is supported through EU standards. In parallel, intensive drainage is carried out to cultivate wet areas to ensure food production, and in these conflicting issues, archaeological sites and cultural landscapes can be affected. A dialogue between sectors is necessary, where ecosystem services, agriculture sectors, climate experts, and cultural heritage research and management jointly choose which areas to focus on and which solutions to adopt. It ensures the implementation of efficient rewetting process, as well as both the preservation of cultural heritage and the maintenance of agricultural landscapes. Other ways of managing landscapes are reforestation and clearcutting of forests.

To secure archaeological sites and cultural landscapes, as well as buildings and built environments, from extreme natural hazards in the best possible way, it will be necessary to study and evaluate historical safeguarding solutions against local climate conditions and assess the extent to which these solutions can contribute knowledge that is also relevant

in relation to today's safeguarding needs. So-called culture-based solutions (CBS) look at historical approaches and retrieve present historical knowledge about climate adaptation, to assess which methods previously worked [72].

When looking at today's management, there are unintended side effects that need to be included in the analysis of landscape management and the analysis should involve historic approaches in areas valued as cultural landscapes.

Greenhouse gas calculations and life cycle analyses are becoming more and more relevant tools in restoration processes of buildings, which several previously mentioned projects address. There are, nevertheless, needs for further development of more customized calculations on savings on greenhouse gas emissions and saved energy in relation to material use when upgrading older buildings. The same goes for emission calculations on new buildings that require demolition of old buildings. Here, storage of carbon in the materials in the calculations should be included. Different qualities of materials should also be considered in the analyses. Traditional craftsmen can have an interesting ecological approach and are important knowledge carriers in these matters. This is indeed a beneficial way of looking at different culture-based solutions; where material quality secures the long-term effect of the upgrading, keeping alive the traditional ways of choosing the right solutions supporting energy efficiency. The challenges of using high quality materials are of course closely related to market prices; but could we facilitate a new wave of using cost-benefit analyses when choosing material for our old buildings? Could we in some way challenge today's timber market, by rewarding those who steered away from the cheapest materials and chose the solutions minimizing the carbon footprint and being healthy both for buildings and people?

The national system in each country must be rigged for alternative thinking in supporting owners and managers so it becomes easy for them to choose cultural- and nature-based solutions when maintaining heritage sites and making areas of cultural heritage and landscapes resilient.

4.3. New Energy Supply Systems

The constant warning from IPCC is alarming in many ways, but when looking at the speed of change, the need to change our lifestyles to limit the greenhouse gas emissions is particularly urgent. Because it is so difficult to make "everyone" undergo vast changes, and giving up benefits, there is a galloping need for making electricity greener and renewable. We need to hurry in a slow way, making room for border-crossing risk analysis and the impact of our heritage. In this case, the "red tape", the bureaucracy, is a friend of cultural heritage, allowing at least the possibility of this being included in the planning processes. Regarding wind power, it would be beneficial for Norway and the northern part of Sweden to follow the development in the southern part of the Nordic countries by placing the power station with all its gear and infrastructural needs where there is already existing infrastructure. Some people and companies are always making large profits on green solutions, and they have all the right justifications for placement where the income is high. This goes for the charging stations for electric cars as well; to make good decisions on where to place charging stations, include heritage expertise, so other countries can consider good examples, and not only learn from other countries' mistakes.

After 24 February 2022 and the war in Europe, the question of nuclear power was revived. Countries that did not consider this as a relevant issue before, now suddenly do (as in Norway). Some countries have advocated that nuclear power should be considered green energy (e.g., Sweden and France), whereas others argue the opposite (e.g., Germany and Denmark). When considered from a future heritage perspective, nuclear power cannot be considered green energy. The power production itself is not the most problematical, though it does require a non-renewable resource as fuel, and a nuclear power plant covers a much larger, though more compressed area than a windfarm. The real problem is long-term nuclear waste management. Any material that requires safekeeping for 10,000 years before it no longer poses a health threat to plant or animal life must be seen as a pollutant.

10,000 years ago, the ice was retreating from the Nordic countries after the last Ice Age, and human beings were arriving and settling in the Stone Age hunter-gatherer societies. Human history has changed so much and so fast even in the past 1000 years, and not a single societal system has so far survived millennia. It is impossible for people in the present to guarantee the necessary future safeguarding of nuclear waste. Further focus on more controlled and predictable power production from wind, water and sun is therefore the better way to a green transition and a reduction in greenhouse gas emissions, as well as a better way to protect natural and cultural heritage.

This is a call to heritage experts to join the debate on how we can provide useful information when adapting to a climate that is more extreme and participate in discussing the green future for the Nordic countries. The heritage experts can participate in many ways, using knowledge concerning the long story lines back in time, to come up with solutions that won't harm our heritage either in the short term or the long term. The development of new technologies is moving fast, and so are changes to the climate. Therefore, solutions to these dilemmas concerning adaptation and mitigation in relation to protection of heritage are needed now.

5. Conclusions

The Nordic countries implement mitigating and adaptive actions to reduce the effects of climate change and reduce greenhouse gas emissions. This article has approached the question of how cultural heritage may be affected by different climate mitigation and adaptation actions, and it includes direct, indirect, and visual impacts of heritage sites and landscapes. In this article, we have discussed how we can further develop and ensure the green transition without jeopardizing heritage values, and how we can implement this work to make the needed changes. We have chosen to discuss in depth the three most relevant areas of interest to see where we can best address future needs: interdisciplinary work, culture-nature based solutions, and new energy supply systems. As the topic is both complex and not previously discussed in articles, the recommendations for work that needs to be incorporated now are concluded here as a summary of the discussion. The long-term perspectives of the suggestions are not yet known, nor the adaptation measures to be implemented in the future. Therefore, we need to base our knowledge on theoretic and historic approaches.

We conclude with recommendations on what we believe should be prioritized in the continued work of reducing the risk of damage to cultural heritage in the future. The recommendations cover local and international conditions, they cross sectors and political guidelines, and they reflect the need for newly developed knowledge, interdisciplinarity and the need for a change of attitude, a paradigm shift in planning processes. At the intersection of climate, measures, management and cultural heritage, there are some complex challenges, but they can be solved.

We recommend early involvement of the heritage sector in all processes concerning contingency plans and impact assessments, and, thus, method development for systematic processual work. Additionally, there is a special need for developing detailed map-based cross-analyses for risks of extreme events such as flooding or landslides and their impact on cultural heritage. Use of historic climate adaptation, where the adaptive actions carried out by people facing similar challenges earlier are analyzed, will also contribute to well-founded holistic evaluations of future needs and solutions.

We recommend the establishment of a Nordic knowledge bank. The knowledge bank could be a Nordic network of professionals in cultural heritage research and management. There should be examples of hands-on, practical measures to spread the knowledge and best-practice of mitigation and adaptation measures that are not in conflict with cultural heritage. The network should focus on assessing the use of traditional methods and materials and implementing environmentally friendly quality materials and facilitate and help local management in including heritage at an early stage for local and regional matters.

We recommend close cooperation between national authorities responsible for plans on increased power production, power transmission systems, and cultural heritage management in the Nordic countries. There is also a need for developing future scenarios related to how an extended investment in renewable energy in the Nordic countries, coupled to a close connection to the European power market, will impact Nordic cultural heritage, directly, indirectly, and visually.

Lastly, we would like to point out that impacts on cultural heritage by climate mitigation or adaptation actions may be difficult to distinguish from impacts from climate change itself, when we talk about the need for knowledge, accountability, and practical execution. Thus, our advice will also have relevance concerning heritage preservation in general. As the impacts of climate mitigation or adaptation actions on cultural heritage has so far not been prioritized, we recommend that this subject should be actively included in existing work on cultural heritage and climate change impacts. A good place to start would be to establish the knowledge bank that can start raising awareness of these matters in general.

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References

1. IPCC. Summary for Policymakers. In *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*; Masson-Delmotte, V., Zhai, P., Pirani, A., Connors, S.L., Péan, C., Berger, S., Caud, N., Chen, Y., Goldfarb, L., Gomis, M.I., et al., Eds.; Cambridge University Press: Cambridge, UK, 2021; *in press*. Available online: https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_Full_Report.pdf (accessed on 7 March 2022).
2. Climate Research Unit. Available online: https://crudata.uea.ac.uk/cru/ (accessed on 8 July 2022).
3. Førland, E.J.; Benestad, R.; Hanssen-Bauer, I.; Haugen, J.E.; Skaugen, T.E. Temperature and Precipitation Development at Svalbard 1900–2100. *Adv. Meteorol.* **2011**, *2011*, 893790. [CrossRef]
4. Steffen, W.; Lambin, E. Earth system functioning in the Anthropocene: Human impacts on the global environment. In *Interactions between Global Change and Human Health*; Working Group, Pontificiae Academiae Scientiarum scripta varia: Vatican City, Italy, 2004; Volume 106, pp. 112–144, ISBN 978-88-7761-085-0.
5. Steffen, W.; Broadgate, W.; Deutsch, L.; Gaffney, O.; Ludwig, C. The trajectory of the Anthropocene: The great acceleration. *Anthr. Rev.* **2015**, *2*, 1–18. [CrossRef]
6. United Nations. Paris Agreement. 2015. Available online: https://unfccc.int/sites/default/files/english_paris_agreement.pdf (accessed on 8 March 2022).
7. Europa Nostra. European Cultural Heritage Green Paper 2021. 2021. Available online: https://issuu.com/europanostra/docs/20210322-european_cultural_heritage_green_paper_fu (accessed on 5 December 2021).
8. COP26. UN Climate Change Conference UK 2021. 2021. Available online: https://ukcop26.org/ (accessed on 5 December 2021).
9. Aktas, Y.D. (Ed.) Assessing the Impact of Climate Change on Urban Cultural Heritage. 2021. Available online: https://doi.org/10.3390/books978-3-0365-1831-2 (accessed on 20 June 2022).

10. Harmsen, H.; Hollesen, J.; Madsen, C.K.; Albrechtsen, B.; Myrup, M.; Matthiesen, H. A Ticking Clock? Preservation and Management of Greenland's Archaeological Heritage in the Twenty-First Century. *Conserv. Manag. Archaeol. Sites* **2018**, *20*, 175–198. [CrossRef]
11. Hollesen, J.; Callanan, M.; Dawson, T.; Fenger-Nielsen, R.; Friesen, T.M.; Jensen, A.M.; Markham, A.; Martens, V.V.; Pitulko, V.V.; Rockman, M. Climate change and the deteriorating archaeological and environmental archives of the Arctic. *Antiquity* **2018**, *92*, 573–586. [CrossRef]
12. Hollesen, J.; Matthiesen, H. The Influence of Soil Moisture, Temperature and Oxygen on the Oxic Decay of Organic Archaeological Deposits. *Archaeometry* **2015**, *57*, 362–377. [CrossRef]
13. Martens, V.V. *Mitigating Climate Change Effects on Cultural Heritage Sites?* University of Cambridge: Cambridge, UK, 2017; Volume 32.2, pp. 123–140.
14. Nicu, I.C.; Stalsberg, K.; Rubensdotter, L.; Martens, V.V.; Flyen, A.-C. Coastal Erosion Affecting Cultural He-ritage in Svalbard. A Case Study in Hiorthhamn (Adventfjorden)—An Abandoned Mining Settlement. *Sustainability* **2020**, *12*, 2306. [CrossRef]
15. Sesana, E.; Gagnon, A.S.; Ciantelli, C.; Cassar, J.; Hughes, J.J. Climate change impacts on cultural heritage: A literature review. *Wiley Interdiscip. Rev. Clim. Chang.* **2021**, *12*, e710. [CrossRef]
16. TemaNord; Haugen, A.; Kjølsen Jernæs, N.; Granberg, M.; Simon Nielsen, V.K.; Martens, V.V. Klimatilpasningstiltak og Kulturarv. Muligheter og Oppmerksomhetpunkter ved Studier av Klimatilpasningstiltak og Konsekvenser for Kulturmiljøer og Kulturminner. [Climate-Related Adaptation and Mitigation Measures and Their Effects on Nordic Cultural Heritage]. TemaNord 2022:505. Nordisk Ministerråd. 2022. Available online: https://pub.norden.org/temanord2022-505 (accessed on 8 March 2022).
17. JPI Cultural Heritage & JPI Climate 2022. White Paper. Cultural Heritage and Climate Change: New Challenges and Perspectives for Research. 2022. Available online: https://www.heritageresearch-hub.eu/app/uploads/2022/03/White-Paper-March-2022-def-14-mars.pdf (accessed on 14 March 2022).
18. Derry, S.J.; Schunn, C.D.; Gernsbacher, M.A. (Eds.) *Interdisciplinary Collaboration: An Emerging Cognitive Science*; Psychology Press: New York, NY, USA, 2014; p. xiii.
19. Stake, R.E. *The Art of Case Study Research*; Sage Publications: Thousand Oaks, CA, USA; London, UK; New Delhi, India, 1995; ISBN 0-8039.5766-1.
20. Fuglseth, M.; Sandberg-Kristoffersen, B.; Yttersian, V.L.; Storøy, A.; Saunders, J.; Lesaca, G. Klimagassutslipp fra Oppgradering av Eldre Bygg. 24 Case-Studier fra Innlandet. [Greenhouse Gas Emissions from Upgrading Older Buildings]. (Asplan Viak Rapport). 2021. Available online: https://innlandetfylke.no/_f/p1/i2d695903-7c90-4eb3-b233-57482b391673/klimagassanalyse_bygg_innlandet_190221.pdf (accessed on 15 March 2022).
21. SINTEF 2021. Opptre, Energioppdatering av Småhus i Tre Til Nesten Nullenerginivå. [Energy Updating of Small Wooden Houses]. SINTEF Forskningsprosjekt 2018–2021. Available online: https://opptre.no/ (accessed on 23 November 2021).
22. Spara Och Bevara 2021. Spara Och Bevara. [Save and Preserve]. Energimyndighetens Forskningsprogram för Energieffektivisering i Kulturhistoriskt Värdefulla Byggnader. Energimyndigheten. Uppsala Universitet. Available online: http://www.sparaochbevara.se/ (accessed on 17 December 2021).
23. Martens, V.V.; Skogstrand, L. *Erosjon og miljøovervåkning. [Erosion and environmental monitoring]. Arkeologiske undersøkelser i vassdrag. Faglig program for Midt- og Nord-Norge*; Riksantikvaren: Oslo, Norway, 2020; pp. 195–197, ISBN 978-82-7574052-4.
24. Mjærum, A.; Friis, E.K.; Vandrup Martens, V.; Skogstrand, L. *Erosjon i vannkraftmagasinene—et frislipp av naturkreftene. [Erosion in hydropower dams]. Arkeologiske undersøkelser i vassdrag. Faglig program for Midt- og Nord-Norge*; Riksantikvaren: Oslo, Norway, 2020; pp. 194–195.
25. Traditional Knowledge World Bank. Available online: http://www.tkwb.org/w/index.php/Main_Page (accessed on 3 August 2022).
26. Menon Economics, NGI. Rapport Forprosjekt om den Samfunnsøkonomiske Verdien av å Forebygge Mot Fysisk Risiko Som er Utløst av Klimaendringene. [Socio-Economic Value of Preventive Measures]. Menon-Publikasjon nr. 48/2022. 2022. Available online: https://www.menon.no/wp-content/uploads/2022-48-Forprosjekt-forebygging-fysisk-klimarisiko.pdf (accessed on 26 June 2022).
27. Brittlebank, W. Iceland's Pathway to Sustainability. Climate Action. Iceland's Pathway to Sustainability—Climate Action. 2016. Available online: https://www.climateaction.org/climate-leader-papers/icelands_pathway_to_sustainability (accessed on 29 June 2022).
28. Bolger, T. Shining a Spotlight on Archaeology and Solar Farms. Rubicon Heritage. 2020. Available online: https://www.rubiconheritage.com/blog/shining-a-spotlight-on-archaeology-and-solar-farms (accessed on 1 April 2022).
29. Amante, A. Sicily Bans Solar Park as Archaeologists Fight Environmentalists. Reuters. 2021. Available online: https://www.reuters.com/business/environment/sicily-bans-solar-park-archaeologists-fight-environmentalists-2021-10-14/ (accessed on 3 March 2022).
30. Jones, P.; Comfort, D.; Hillier, D. Spotlight on solar farms. *J. Public Aff.* **2013**, *15*, 14–21. [CrossRef]
31. Bouglé, F. *Éoliennes: La face noire de la transition écologique [Wind Turbines: The Dark Side of Ecological Transition]*; Éditions du Rocher: Paris, France, 2019.
32. Cahart, P. *Alerte—La Peste Éolienne [Alert—Aeolian Plague]*; Hugo Doc: Paris, France, 2021.

33. Borch, K.; Clausen, N.E.; Ellis, G. Environmental and Social Impacts of Wind Energy. DTU International Energy Report, Chapter 12. 2014, pp. 86–90. Available online: https://backend.orbit.dtu.dk/ws/portalfiles/portal/102458530/DTU_INTL_ENERGY_REP_2014_WIND_86_90.pdf (accessed on 6 April 2022).
34. Lindblom, I.; Jerpåsen, G. Visuell Innvirkning på Kulturminner og Kulturmiljø—Vindkraftanlegg og Kraftledninger (NVE Veileder 3). [Visual Impact on Cultural Heritage Sites and Landscapes]. Norges Vassdrags- og Energidirektorat. 2009. Available online: https://publikasjoner.nve.no/veileder/2008/veileder2008_03.pdf (accessed on 5 May 2022).
35. Moe, E. Structural Change, Vested Interests, and Scandinavian Energy Policy-Making: Why Wind Power Struggles in Norway and not in Denmark. *Open Renew. Energy J.* **2012**, *5*, 19–31. Available online: https://benthamopen.com/contents/pdf/TOREJ/TOREJ-5-19.pdf (accessed on 7 March 2022). [CrossRef]
36. Dahl, E.L.; May, R.; Hoel, P.L.; Bevanger, K.; Pedersen, H.C.; Røskaft, E.; Stokke, B.G. White-Tailed Eagles (Haliaeetus albicilla) at the Smøla Wind-Power Plant, Central Norway, Lack Behavioral Flight Responses to Wind Turbines. *Wildl. Soc. Bull.-Wind. Energy Wildl. Conserv.* **2013**, *37*, 66–74. Available online: https://doi.org/10.1002/wsb.258 (accessed on 17 March 2022). [CrossRef]
37. Steen, M.; Hansen, G.H. Barriers to Path Creation: The Case of Offshore Wind Power in Norway. *Econ. Geogr.* **2018**, *94*, 188–210. Available online: https://doi.org/10.1080/00130095.2017.1416953 (accessed on 15 April 2022). [CrossRef]
38. Riksantikvaren. Temarapport om Kulturminner og Kulturmiljøer. Nasjonal Ramme for Vindkraft på Land (RA Temarapport) [Thematic Report on Cultural Heritage and Cultural Environments. National Framework for Onshore Wind Power]. 2019, p. 10. Available online: https://webfileservice.nve.no/API/PublishedFiles/Download/201903419/2731452 (accessed on 10 October 2021).
39. NVE 2022. Kunnskapsgrunnlag om Virkninger av Vindkraft på Land, Kulturminner og Kulturmiljøer [State og the Art Knowledge Base on the Effects of Wind Power on Land, Cultural Heritage and Cultural Environments]. 2022. Available online: https://www.nve.no/energi/energisystem/vindkraft/kunnskapsgrunnlag-om-virkninger-av-vindkraft-paa-land/kulturminner-og-kulturmiljoeer/ (accessed on 11 April 2022).
40. Omholt, M.B. Public Opposition to Wind Power Projects in Norway. Master's Thesis, University of Stavanger, Stavanger, Norway, 2020.
41. Henriksen, M.E.; Østenby, A.M.; Skau, S. Hva er Egentlig Potensialet for Opprusting og Utvidelse av Norske Vannkraftverk? (NVE Faktaark 6/2020) [The Potential for Upgrading and Expansion of Norwegian Hydropower Plants]. Norges Vassdrags- og Energidirektorat. 2020. Available online: https://publikasjoner.nve.no/faktaark/2020/faktaark2020_06.pdf (accessed on 9 April 2022).
42. Indrelid, S. *Arkeologiske undersøkelser i vassdrag. [Archaelogical Investigations in Waterways]*; Faglig program for Sør-Norge; Riksantikvaren: Oslo, Norway, 2009.
43. Skogstrand, L. *Arkeologiske undersøkelser i vassdrag. [Archaelogical Investigations in Waterways]*; Faglig program for Midt- og Nord-Norge; Riksantikvaren: Oslo, Norway, 2020.
44. Brandt, S.; Hassan, F. (Eds.) *Dams and Cultural Heritage Management*; World Commission on Dams: Cape Town, South Africa, 2000.
45. Zaina, F.; Tapete, D. Satellite-Based Methodology for Purposes of Rescue Archaeology of Cultural Heritage Threatened by Dam Construction. *Remote Sens.* **2022**, *14*, 1009. [CrossRef]
46. NRK; Thunold, A. Klimaløftet som Kverner Fisk. [The Green Transition that Kills Fish]. Available online: https://www.nrk.no/klima/xl/vannkraft-som-skal-redde-klima_-dreper-al-og-annen-fisk-1.15483354 (accessed on 28 June 2022).
47. Samferdselsdepartementet. Norge er Elektrisk [Norway is Electric]. 2021. Available online: https://www.regjeringen.no/no/tema/transport-og-kommunikasjon/veg_og_vegtrafikk/faktaartikler-vei-og-ts/norge-er-elektrisk/id2677481/ (accessed on 20 March 2022).
48. Nobil. Statistics Presented by Enova and Norsk Elbilforening. 2022. Available online: https://info.nobil.no/statistikk (accessed on 10 April 2022).
49. Norsk elbilforening. Map of Available Charging Stations in Scandinavia. 2022. Available online: https://elbil.no/lade/ladestasjoner/ (accessed on 1 April 2022).
50. Aftenposten. Aftenpostens Meninger. 2021. Available online: https://www.aftenposten.no/meninger/debatt/i/Popmzp/en-boenn-til-dem-som-skal-tenke-paa-utplassering-av-flere-elbil-ladere (accessed on 26 October 2021).
51. Norconsult. Optimal Plassering av Areal for Ladeinfrastruktur Langs Nye Veiers Veistrekinger. [Optimal Placing of Charging Infrastructure]. Oppdragsnr.: 5202835. Dokumentnr.: RAP-NV-001. Versjon 4. 2020. Available online: https://www.nyeveier.no/media/1blasend/ladeinfrastruktur-norconsult-for-nye-veier.pdf (accessed on 15 March 2022).
52. NRK. Rekordår i Salg av Nye Biler: Tesla er Norges Mest Solgte Bil. [Record Year in Sales of New Cars: Tesla Is Norway's Best-Selling Car]. 2022. Available online: https://www.nrk.no/norge/rekordar-i-salg-av-nye-biler_-tesla-er-norges-mest-solgte-bil-1.15793772#:~{}:text=Tallene%20som%20ble%20presentert%20var,527.000%20nye%20eierskifter%20i%202021 (accessed on 3 January 2022).
53. NRK. Her Har Elfergen Ligget i Flere Måneder—Lokalpolitikerne Mener Ladetårnet er for Stygt. [The Electric Ferry Line Not in Use]. 2021. Available online: https://www.nrk.no/nordland/torghatten-far-ikke-bygge-ladestasjon-for-elferge-i-somna_-_-for-stygg_-mener-lokalpolitikerne-1.15313025 (accessed on 4 March 2022).
54. Cohen-Shacham, E.; Andrade, A.; Dalton, J.; Dudley, N.; Jones, M.; Kumar, C.; Maginnis, S.; Maynard, S.; Nelson, C.; Renaud, F.G.; et al. Core Principles for Successfully Implementing and Upscaling Nature-Based Solutions. *Environ. Sci. Policy* **2019**, *98*, 20–29. Available online: https://doi.org/10.1016/j.envsci.2019.04.014 (accessed on 1 February 2022). [CrossRef]

55. Ruangpan, L.; Vojinovic, Z.; Di Sabatino, S.; Leo, L.S.; Capobianco, V.; Oen, A.M.P.; McClain, M.E.; Lopez-Gunn, E. Nature-based solutions for hydro-meteorological risk reduction: A state-of-the-art review of the research area. *Nat. Hazards Earth Syst. Sci.* **2019**, *20*, 243–270. [CrossRef]
56. UNESCO Nederlandse Commissie. Changing Minds, Not the Climate: Culture-Based Solutions to Local Climate Adaptation. UNESCO. 2021. Available online: https://www.unesco.nl/sites/default/files/inline-files/Changing%20_minds_ENG.pdf (accessed on 15 March 2022).
57. Boogaard, F.; Lucke, T. Long-Term Infiltration Performance Evaluation of Dutch Permeable Pavements Using the Full-Scale Infiltration Method. *Water* **2019**, *11*, 320. [CrossRef]
58. Boogaard, F. Spatial and Time Variable Long Term Infiltration Rates of Green Infrastructure under Extreme Climate Conditions, Drought and Highly Intensive Rainfall. *Water* **2022**, *14*, 840. [CrossRef]
59. Rytter, J.; Schonhowd, I. (Eds.) Monitoring, Mitigation, Management. The 69 Groundwater Project—Safeguarding the World Heritage Site of Bryggen in Bergen. Oslo, Riksantikvaren. 2015. Available online: https://ra.brage.unit.no/ra-xmlui/handle/11250/300104 (accessed on 11 December 2021).
60. Sollund, M.-L.B.; Holm-Olsen, I.M. Monitoring Cultural Heritage in a Long-Term Project: The Norwegian Sequential Monitoring Programme. *Conserv. Manag. Archaeol. Sites* **2013**, *15*, 137–151. [CrossRef]
61. Günther, A.; Barthelmes, A.; Huth, V.; Joosten, H.; Jurasinski, G.; Koebsch, F.; Couwenberg, J. Prompt rewetting of drained peatlands reduces climate warming despite methane emissions. *Nat. Commun.* **2020**, *11*, 1644. Available online: https://doi.org/10.1038/s41467-020-15499-z (accessed on 16 April 2022). [CrossRef] [PubMed]
62. Kitson, E.; Bell, N.G.A. The Response of Microbial Communities to Peatland Drainage and Rewetting. A Review. *Front. Microbiol.* **2020**, *11*, 582812. Available online: https://doi.org/10.3389/fmicb.2020.582812 (accessed on 3 February 2022). [CrossRef] [PubMed]
63. Renou-Wilson, F.; Moser, G.; Fallon, D.; Farrell, C.; Müller, C.; Wilson, D. Rewetting degraded peatlands for climate and biodiversity benefits: Results from two raised bogs. *Ecol. Eng.* **2019**, *127*, 547–560. [CrossRef]
64. Ministry of Climate and Environment. Derfor er Myr og Våtmark Viktige [That Is Why Peatland and Wetlands Are Important]. Regjering—Klima- og Miljødepartementet. 2021. Available online: https://www.regjeringen.no/no/tema/klima-og-miljo/naturmangfold/innsiktsartikler-naturmangfold/vatmark/id2339659/ (accessed on 15 February 2022).
65. Ilkjær, J. *Illerup Ådal—Archaeology as a Magic Mirror*; Moesgard Museum: Aarhus, Denmark, 2002; ISBN 9788787334372.
66. Council of Europe. Convention on the Conservation of European Wildlife and Natural Habitats (ETS No. 104). 1979. Available online: https://www.coe.int/en/web/conventions/full-list?module=treaty-detail&treatynum=104 (accessed on 15 February 2022).
67. Kieffer, A.; Vogel, O. Ménager le Loup et L'agneau, une Cohabitation à L'italienne [Spare the Wolf and the Lamb, an Italian Cohabitation]. Grand Reportage. Available online: https://www.franceculture.fr/emissions/grand-reportage/menager-le-loup-et-lagneau-une-cohabitation-a-litalienne (accessed on 2 April 2022).
68. Tzelpoglou, T. Quand les Bergers Sont Aidés, le Loup est Accepté [When the Shepherds Get Help, the Wolf is Accepted]. Reporterre—le Quotidien de L'écologie. 2021. Available online: https://reporterre.net/Quand-les-bergers-sont-aides-le-loup-est-accepte (accessed on 27 September 2021).
69. Rossberg, M.A.E. Wolves are Saving Shepherds. European Wildlife Society. 2019. Available online: https://wilderness-society.org/wolves-are-saving-shepherds/ (accessed on 8 April 2022).
70. Steinfeld, H.; Mooney, H.A.; Schneider, F.; Neville, L.E. *Livestock in a Changing Landscape. Volume 1: Drivers, Consequences and Responses*; Island Press: Washington, DC, USA, 2013; ISBN 13 978-1597266710.
71. UNESCO Nederlandse Commissie. Culture and Heritage for Climate Adaptation. Four Examples from the Kingdom of the Netherlands. UNESCO. 2021. Available online: https://www.unesco.nl/sites/default/files/inline-files/Best_practice_klimaatadaptatie_ENG.pdf (accessed on 15 March 2022).
72. SACC. Social Archaeology & Climate Change, Kiel SACC Summit 6 September 2021. 2021. Available online: https://tinyurl.com/saccsummit (accessed on 9 March 2022).
73. ICOMOS-IFLA. *Principles Concerning Rural Landscape as Heritage*; ICOMOS: Paris, France, 2017. Available online: https://www.icomos.org/images/DOCUMENTS/Charters/GA2017_6-3-1_RuralLandscapesPrinciples_EN_adopted-15122017.pdf (accessed on 2 May 2022).
74. João Revez, M.; Coghi, P.; Rodrigues, J.D.; Vaz Pinto, I. Analysing the Cost-Effectiveness of Heritage Conservation Interventions: A Methodological Proposal within Project STORM. *Int. J. Archit. Herit.* **2019**, *15*, 985–999. [CrossRef]
75. Shreve, C.M.; Kelman, I. Does mitigation save? Reviewing cost-benefit analyses of disaster risk reduction. *Int. J. Disaster Risk Reduct.* **2014**, *10*, 213–235. [CrossRef]
76. UNESCO-WHC; ICCROM; ICOMOS; IUCN. *Managing Disaster Risks for World Heritage*; UNESCO: Paris, France, 2010; p. 8. Available online: http://whc.unesco.org/uploads/activities/documents/activity-630-1.pdf (accessed on 24 April 2022).
77. Riksrevisjonen. Riksrevisjonens Undersøkelse av Myndighetenes Arbeid Med å Tilpasse Infrastruktur og Bebyggelse til et klima i endring. [The Office of the Auditor General's Investigation of the Authorities' Work in Adapting Infrastructure and Buildings to a Changing Climate]. Document 3:6 (2021–2022). 2022. Available online: https://www.riksrevisjonen.no/globalassets/rapporter/no-2021-2022/dokument-3-6-2021-2022-undersokelse-av-myndighetenes-arbeid-med-klimatilpasning-av-bebyggelse-og-infrastruktur.pdf (accessed on 8 March 2022).

78. Sandkjær-Hanssen, G. Planlegging for Risikosamfunnet: Hvordan Fungerer Flomsonekart Med Klimapåslag Som Kunnskapsoversettelse? [Planning for the Risk Society]. In Kart og Plan (1), Oslo: Fagbokforlaget. 2018. Available online: http://kartogplan.no/Artikler/KP1-2018/Planlegging%20for%20risikosamfunnet.pdf (accessed on 10 February 2022).
79. Rusdal, T.; Aall, C. Kartlegging av erfaringer fra arbeidet med klimatilpasning i små og mellomstore kommuner. [Mapping of Climate Adaptation Experiences]. Vestlandsforskingsrapport nr. 4/2019. Report 2019. Available online: https://www.vestforsk.no/nn/publication/kartlegging-av-erfaringer-fra-arbeidet-med-klimatilpasning-i-sma-og-mellomstore (accessed on 15 March 2022).
80. Klemetsen, M.E.; Dahl, M.S. 'Hvor Godt er Norske Kommuner Rustet for Klimaendringer? Spørreundersøkelse om Klimatilpasning Våren 2020'. [How Well are Norwegian Municipalissties Prepared for Climate Change?]. 2020. Available online: https://pub.cicero.oslo.no/cicero-xmlui/bitstream/handle/11250/2686544/Rapport%202020%2005%20web4.pdf?sequence=10&isAllowed=y (accessed on 5 March 2022).