Realizing the Potential of UNESCO World Heritage Sites in the Derwent Valley to Advance the 2030 Agenda.

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Declaration

I, Manfred Kyenkyehene Osei, hereby declare that the dissertation, “REALISING THE POTENTIAL OF UNESCO WORLD HERITAGE SITES IN THE DERWENT VALLEY TO ADVANCE THE 2030 AGENDA”, consists entirely of my own work produced from thorough research undertaken under the supervision and that no part of it has been published or presented for another degree elsewhere, except for the permissible references from other sources, which has been fully cited and acknowledged.

Date: 28/09/2023

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Dedication

This work is dedicated to my late sister, Georgina Osei Boadiwaa whom I lost on 18th April 2022. She would have been proud of the brother I am becoming in achieving an academic dream and making this project a reality.

Abstract

The increasing notion that climate change is threatening the conservation of UNESCO World Heritage Sites is unquestionably affirmed by research in today's science. This has become a growing global concern, with increasing catastrophic risks, making it difficult for society to cope and adapt.

In 2005, a number of organizations and individuals with an interest in the impact of climate change on WHS brought the matter to the World Heritage Committee's attention. Since then, their authenticity and capacity to support local economic and social development are posed by the effects of climate change. To explore the intricate relationship between humans and the environment, this research has captivated the cultural significance of the Derwent Valley Mills World Heritage Sites, recognizing them as irreplaceable treasures that bear witness to humanity's history and natural assets. Hence, the urgent need to address possible external factors in the conservation of these global properties and realize the potential of these UNESCO-inscribed sites within the context of community development.

Future predictions for climate change in the twenty-first century have an escalating growing impacts on heritage policies and conservation practices, mainly because of the discernible effects of changes that have already been noticed. The heritage sector in the UK exhibits a lower level of concern about the impact of climate change on heritage sites which slows down efforts to effectively create longer-term mitigation, adaptation and management strategies that take into account possible alterations to the factors and mechanisms of degradation at historic sites. This has posed doubts on the capacities of stakeholders to understand the climate impacts on their outstanding universal value to keep them well informed of their continuous preservation.

Using Braun & Clarke's (2006) 6-step framework thematic analysis, the qualitative research revealed financial resources, coordination of regulatory bodies, and unawareness of local initiatives as the primary barriers hindering the sites conservation efforts. The research concluded that education and campaign awareness can bridge the gap and link sustainable development, cultural heritage, and community participation in the Derwent Valley communities. This research will provide recommendations for further studies on this topic and enhance the capacity of cultural heritage and environmental change to be investigated and further updated in subsequent academic reports.

Keywords: sustainable development; cultural heritage; climate change; community development; stakeholder

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I would also thank the Belper Community Energy volunteers and Derbyshire Dales Community Energy group for inviting me to their meetings to understand local community development. .

Finally, a big appreciation to my family, friends and colleague students whose assistance came from motivations, prayers, and morale supports. This work could not have been possible without you.

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List of Abbreviations

Abbreviation	Title
BCE	Belper Community Energy
CO2	Carbon dioxide
DVMWHS	Derwent Valley Mills World Heritage Sites
EU14	European Union 14
GHG	Greenhouse Gas
GISS	Goddard Institute for Space Studies
HEP	Hydro Electric Power
ICOM	International Council of Museums
ICOMOS	International Council on Monuments and Sites
IPCC	Intergovernmental Panel on Climate Change
NASA	National Aeronautics and Space Administration
NUA	New Urban Agenda
SDGs	Sustainable Development Goals
UK	United Kingdom
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organization
USGCRP	United States Global Change Research Program
WHC	World Heritage Committee
WHS	World Heritage Sites
WMO	World Meteorological Organisation

1. Introduction

Cultural heritage has an important and long outstanding legacy from the past that gives local communities a profound feeling of traced ancestral roots, and aesthetic pleasure of human well-being. (Phillips, 2015). They can be defined as a collection of tangible and intangible assets including historical and archeological designed buildings, which depict significant artistic, social, and spiritual ties for a particular community (M. Cassar, 2009). Because of its exposure to the environment, there are humanly induced influences on its usage or indirect effects from extreme weather conditions. Not only does degradation impact the outdoor collections but according to Nik et al. (2015), climate change is a challenge for building interiors as well since uncontrolled structures, like many old buildings, are subject to direct impacts from external atmospheric factors conditions. Deterioration of preserved artifacts may erode in physical appearance and lose the value of their beauty (Bertolin, 2019). The causes of these environmental changes result from the degradation of the physical, chemical, and biological reaction materials being used in their production. Climate change-induced effects such as rising sea levels, increased extreme weather events, storm surges, loss of biodiversity, cost of living crisis, inequality, and shifting ecosystems can pose direct threats to cultural heritage; affecting the economic stability and livelihoods of nearby communities. Global scientists have supported with data-driven research stating, the extent of climate change risks has intensified in the past decade making it the biggest and most urgent threat facing current and future humanity endeavors (IPCC 2021a; 2021a). The alarming rate of climatic consequences has escalated after the official publication of the Intergovernmental Panel on Climate Change's (IPCC) "Special Report on Global Warming of 1.5°C" (2018), hinting at the urgent need for global action if the planet is to achieve the 2015 Paris agreement and reduce global warming to 1.5°. The publication had caused public fear-mongering referring to future scenarios as climate catastrophe which has been debatable by the scientific community as a misleading concept (Mauelshagen et al., 2011). In contrast, this has been an effective communication deployed to use these occurrences to highlight the growing susceptibility to natural disasters amidst the gradual degradation of our global ecosystem, which serves as the fundamental support system for life on Earth (Wallace, 2012).

The UNESCO World Heritage Committee recognized the threat of climate change as a pressing issue in 2005, and ought to necessitate alertness to detect early warnings and signals in order to limit severe impacts on heritage site conservation (UNESCO World Heritage Center, 2007). This resulted in the publication of a policy paper in the subsequent year (UNESCO World Heritage Center, 2008) to serve as a catalyst for a growing body of interconnected research.

1.1. Research Focus

The research focused on the Derwent Valley's Cultural World Heritage Sites, and the stakeholder engagement to address the challenges they face. Carrying out a project on heritage and climate change through the lens of the SDGs allows the research to focus on the outcomes of cultural heritage restoration strategies, and inform future management of at-risk heritage properties in other localities and the UK in general.

1.2. Research Aims and Objectives

In the past, the site of industrial heritage has frequently been closely intertwined with physiography and the natural resources that supplied the energy for factory-based textile and other industries; beginning the inception of the 'Industrial Revolution' (Naylor, 2008). Within the Derwent Valley and beyond the historical remnants of the World Heritage Site, the area has encountered developmental challenges in present times linked to the contamination from past metal mining (Bradley and Cox 1990, pp. 441-454). This was evidently recognized as geomorphological investigations conducted in other regions of the UK have revealed that during the most recent documented era of notable climatic shifts (the Little Ice Age, around 1450-1850 AD), there was a resurgence of similarly tainted sediments due to alterations in flood frequency (Howard et al., 2015). In view of this, the Derwent Valley is responding to global temperature changes and the formation of a new sustainable management plan for the WHS (UNESCO UK, 2022). With regard to this, the study aims to bring multiple stakeholders together at Cromford Mills and other UNESCO World Heritage Sites in the Derwent Valley to address the three main pillars of the interrelated Sustainable Development Challenges. Exploring cultural heritage and climate change through the lens of the Sustainable Development Goals (SDGs) as a framework, the study was to:

1. Investigate the ways stakeholders can collaborate with local communities at national and international levels to identify the social, environmental, economic, and cultural impacts of the challenges they face.
2. utilize this information to guide the ongoing formulation of the local management strategy for the DVMWHS and enhance understanding of the potential impacts of future climate change on the cultural assets.

In pursuit of these aims, the following objectives were delineated and focused upon the surveyed areas to establish a guiding framework. The research underwent the listed methodologies in arriving at the data sets:

a) Evaluation of the information concerning the hydropower generation and industrialization revolution during the 18th and 19th centuries, and the metal-mining history of the DVMWHS from reviews of available published resources.
b) Comparison of existing data [e.g., National Aeronautics and Space Administration (NASA), Copernicus Climate Change Services (C3s), United Nations, UK Met Office, Natural England, Historic England] to assess the documentation of past, current and future climatic trends within the UK, Europe, and the world.
c) Assessment of information into the DVMWHS's evolving management framework and identification of overarching concepts that apply to various aspects of the historic environment, particularly industrial landscapes.
d) Input of information from the New Urban Agenda (2016) that establishes international treaties and multiple stakeholders, particularly considering the management of heritage landscapes enacted under the UN Housing and Sustainable Urban Development (Habitat III).

2. Literature Review

Climatic changes leading to excessive shifts in the environment, including but not limited to, flooding, sea level rise, and landslides with corresponding heavy rains or drought, can exert significant influence on cultural heritage (Sesana et al., 2021).

2.1. Causes and Effects of Climate change

Climate change topics have turned into global discussions in recent years. The scientific research embodied behind climate change defines it as the emission of greenhouse gases into the atmosphere which affects the lives of the environment in an observed period of time (IPCC, 2018 p.558). The causes are attributed directly or indirectly to anthropogenic activities, and naturally occurring hazards as a result of external forcing such as volcanic eruptions, and variations in solar cycles. (IPCC, 2018 p.558). Solar energy is absorbed by the Earth's surface, which subsequently emits heat into the atmosphere. As the heat escapes into space, certain greenhouse gases intercept and absorb a portion of it. These greenhouse gases then re-radiate the absorbed heat, redirecting it towards the Earth's surface, other greenhouse gas molecules, or into space (NASA, 2010). As greenhouse gas levels increases in the atmosphere, a greater amount of heat becomes trapped, resulting in progressive warming of the Earth's climate (National Geographic, 2021). The current global warming trend can be attributed to the following factors: (1) combustion of fossil fuels for energy generation (2) alterations in land use and deforestation, leading to a reduction in the available tree population for carbon dioxide absorption (3) agricultural practices, which contribute to the release of greenhouse gases through energy consumption, livestock emissions, and fertilizer application on land, and (4) industrial activities involving cement, chemicals, and metals production, resulting in the emission of greenhouse gases into the atmosphere. Anthropogenic activities still remain the greatest threat to the environment. Natural factors such as volcanic emissions increase 5 percent per year on greenhouse gas effect, but despite this increment, they still do not comprehend with the large amount of fossil fuels emitted from industrial processes (Zagir, 2020). The NASA Goddard Institute for Space Studies (n.d) provides more details in the analysis of climate change, indicating the earth’s average global temperature has increased about 2 degrees Fahrenheit in the last two decades. Temperature impact ranges from changing rainfall patterns resulting from longer drought periods and excessive flooding to severe heat waves (Kaddo, 2016). The aftermath event may see a decrease in agricultural products in some parts of the world due to prolonged growing seasons, food insecurity, and biodiversity loss (Zagir, 2020). Emissions of greenhouse gases have increased the risk of new extreme events by 5 times over the 50-year period creating challenges to human health and safety, and opportunities for populations to boost economic growth (WMO, 2021; USGCRP, 2018). In addition, climate

change widens existing inequalities and social justices, threatening fundamental human rights of many developing countries and vulnerable individuals (Skillington, 2012). Heat-trapping greenhouse gases such as carbon dioxide, methane and nitrous oxide are rising record levels of global temperature indicating the years between 2015-2022 as the warmest periods in the last eight years (WMO, 2023); alongside Thompson et al. (2023) statistically proving the record-breaking heatwave in most vulnerable parts of the earth in 2023.

The rapid growth of human population has contributed to consumerist demands and increase in individual and country carbon footprints. For instance, in the UK, the annual per capita Carbon dioxide emissions is approximately 7.1 tonnes, while in India, this figure remains below 2 tonnes per individual per year. The UK is the second-highest emitter of GHGs and CO2 compared to the European Union's 14 countries (ONS, 2022). In 2020, the collective residential GHG emissions within the EU14 and UK regions amounted to approximately 3,109 million tonnes of carbon dioxide equivalent (Mt CO2e) (ONS,2022). This marked a decline emission of 9% when compared to the preceding year, representing the most significant year-on-year reduction observed since 1990 (ONS,2022). The principal contributing factor to this significant decrease is attributed to the far-reaching impacts of the COVID-19 pandemic, along with the subsequent implementation of restrictive measures and nationwide lockdowns (ONS,2022). The data below indicates surface temperatures averaged over the entire globe for the year (1880 – 2022). After experiencing a brief decline in 2020 due to the COVID-19 pandemic, anthropogenic greenhouse gas emissions have resumed to higher levels (NASA 2023).

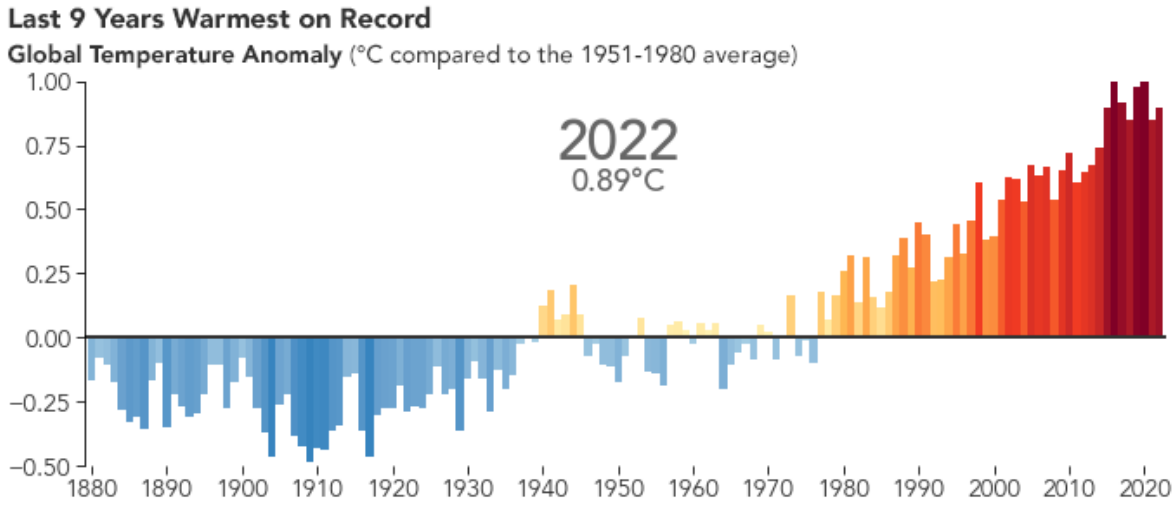

Fig.1. Global Temperature of greenhouse gases by natural variability and aerosols between 1880 to 2022 (NASA, 2023)

Using simulations of the carbon cycle in the atmosphere, the IPCC (2001) report projected atmospheric carbon dioxide concentrations are anticipated to span from 490 to 1260 ppm by the year 2100. These levels represent a considerable increase, ranging from 75% to 350%, compared to the estimated pre-industrial concentration of 280 ppm in 1750. Notably, by late 2007, carbon dioxide concentrations had already reached approximately 382 ppm, signifying a 36% rise above the pre-industrial limit, with a continuing annual increase of 2% to 3% (IPCC, 2001, ch. 3).

In aquatic ecosystems, accumulated and increased levels of CO2 have caused thermal expansion in oceans accounting for sea level rise, reduced dissolved oxygen, and acidification (Brierley and Kingsford, 2009). Acidification has degraded the exterior bones and shells of marine ecosystems threatening global coral reefs (WWF, 2023). This affects their habitat, especially for species that rely solely on mollusks and crustaceans for food (World Bank, 2022). For example, the world's largest Great Barrier coral reef in Australia was inscribed by UNESCO on the basis of its outstanding universal value and home to diverse ecological communities (UNESCO, 2023). Heating temperatures change ocean currents and mediate land temperatures that regulate rainfall patterns, droughts, and floods. Oceans act as carbon sinks, accumulating 25 % of annual CO2 emissions and trapping about of 93% heat caused by increasing greenhouse gases (Heinze et al., 2015; Russell, 2023)

Without revised Nationally Determined Contributions, the UN (2021) estimates that 50% of the world's population will be vulnerable to flooding, storms, and tsunamis by 2030. The UN Global Assessment Report (2022), indicated the extensive disasters that have occurred in the last 20 years and further predicted disaster events to reach 560 annually by 2030. Throughout 2020, climate and weather changes were a major driving force for 9.8 million migrants vulnerable to climate hazards and displacing up to 216 million people across six world regions by 2050 (WMO, 2021; World Bank, 2021).

2.2. Global Climate and UK Climate

Projections of global temperature increases for the period 2090-2099 extend a range of 1.1°C to 6.4°C, contingent upon the specific emissions scenarios employed in the models. Among these scenarios, a probable range of 2°C to 4.5°C is considered likely, as suggested by Meehl et al. (2007). The IPCC has summarized some of the most evident changes vividly observed from the repercussions of this warming process, each of which has intricate feedback systems. However, despite the scenario theory, there is a high likelihood that the rates of increase will surpass observations from the late 20^{th} century (1.8 ± 0.5 mm yr-1) (Parkin, 2014). According to the IPCC, there are multiple deviations between the projections for the global mean and the projections for

the European climate. In comparison to the scenarios modeled, these include temperature rises in Europe that are higher than the corresponding global mean values (Christensen et al., 2007). As projected at the global level, there is no doubt that the UK climate is changing across its seasonal variation with uncertainties such as rising sea levels, heatwaves, tropical cyclones, storms, droughts, and floods are bound to happen at faster frequencies as the carbon cycle shifts (Randall et al., 2007). Over the last decade (2012 to 2021), there has been an average temperature increase of 1.0°C when compared to the baseline period of 1961 to 1990 (Kendon et al., 2021). Overall, all of the ten hottest periods in the UK have been observed since 2003 (GOV.UK, 2023). In 2022, the UK experienced its highest recorded temperatures, with an unprecedented year-round average temperature surpassing 10°C for the first time in history breaking the Central England temperature series of 1659 (Met Office, 2022). The "State of the UK Climate Report" by the Met Office for the year 2022 revealed that, with the exception of December, each month experienced higher temperatures compared to the 1991-2020 average. Moreover, research indicates that extreme temperatures in the UK are undergoing a more rapid rate of change than the overall average. This accelerated warming trend has resulted in the declaration of frequent drought conditions in various regions of the UK due to the occurrence of heatwaves. The highlighted report reviewed that, 2022 was a year of meteorological extremes, peaking the knock-off effects of UK weather sets. UK experienced a 6% reduction in rainfall as compared to 1960 – 2020 with a marginal rise in heavy rainfall lately. The UK Met Office indicates the record-breaking 40°C temperatures of 2022 will be seen as a cool year by the end of this century as the coming years climate is predicted to be warmer with increasing changing effects over time. Again, July broke the current warmest month as projections showed in recent weeks in other parts of Europe that is approaching far greater levels of heating (Copernicus, 2023). This year's UK summer has witnessed a distinct meteorological pattern characterized by increased windiness and cooler temperatures. This shift can be attributed to the positioning of the jet stream, which has moved slightly farther south compared to previous years (Finnis, 2023). As a result, the heat that typically affects the UK has remained below Europe, while the region has experienced more prevalent rainfall (Science Media Center, 2023). A static low-pressure system over the UK resulted in extensive flooding, while downstream regions, such as the Mediterranean and Eastern Europe, experienced contrasting weather conditions, with a high-pressure system induced with heatwaves and drought (www.westweather.co.uk, 2007-2022). The jet stream can be defined as wind and pressure changes as a result of the movement of strong winds from west to east directions that defines a country’s weather systems across the Atlantic (UK Met office, n.d). This explains why the UK experienced the utmost heatwave last year due to the jet stream

located further north. The UK is situated in a temperate zone that is projected to experience high precipitation. Smith et al. (2010) highlighted a rise in algal biofilms on stone structures of heritage assets due to increased precipitation, resulting in extended periods of surface wetness for the materials.

The UK's weather and climate is monitored by the Met Office, and the National Atmospheric Emissions Inventory which provides map of UK emissions. In support of climate data, the GHG Inventory at the Department of Business, Energy, and Industrial Strategy is also charge in of providing key statistics (Met Office, n.d)

2.3. Climate Change and Cultural Heritage

The escalating pace of climate change represents the most significant and pressing threat to cultural heritage and its conservation worldwide (Markham, 2022). A persistent challenge that involves the assessment of baseline conditions and the assessment of historical data, current information, and future projections. (Le Treut et al., 2007). Climate change is widely recognized as a threat to both natural and historic environments. For instance, changes in the intensity of storm surges will disturb ranges of historical sites, from coastal properties to venerable trees (English Heritage, 2002]. Increased anthropogenic impact on the environment has gained attention from scholars (Sabbioni et al., 2006; Brimblecombe et al., 2006b; Brimblecombe and Grossi, 2009), particularly as environmental degdardation continues to endure and affect heritage landscapes over an extended period. In respect to this, Cassar (2005) aimed to address the aforementioned question, and support his publication, 'Engineering Historic Futures: Stakeholders Dissemination and Scientific Research Report' (Cassar and Hawkings, 2007), and advancing English Heritage's work on preserving cultural heritage, as evidenced in their report "Climate Change and the Historic Environment" (English Heritage, 2006 [updated 2008/2012]).

The World Heritage Convention's (2019 para.4) core conservational mandate acknowledges cultural and natural heritage as unique and rare assets, not only for country pride but of humanity as a whole". The loss of these invaluable assets, whether due to negligence or damage, signifies a depletion of the shared cultural heritage of all the world's populations. (UNESCO, 2021b, p.11). Hence, the urgency to address the role of cultural heritage frameworks and climate resilience within the current and future projection trends of environmental changes (Markham, 2022). The UNESCO World Heritage Convention 1972 (Article 2) recognizes natural features (both physical and biological), and geological formations should be considered in terms of the natural beauty of heritage sites. Climate change affects these features widely with changes to environmental temperatures (Nik et al., 2015). Many heritage sites and monuments have withstood and endured

serious climate changes in the past and potentially experienced resilience in the capacity to combat impending climate change (Philips, 2014). Despite their historical significance, many heritage properties face potential risks due to climate change, which may result in damage, abandonment, or unsuitable actions that could lead to the destruction of heritage or greatly diminish its value, uniqueness, or importance (Graham and Spennemann, 2006). Moreover, the historic environment has the capacity to harbor indicators of past climate change and serve as a repository of knowledge concerning human adaptation to past climate-change occurrences (English Heritage, 2008). In a video presentation featured in the World Monuments Watch, Ahmed (2022) articulated the deep concern of local residents regarding the rapidly deteriorating climate conditions that pose a significant threat to a heritage site they hold in high regard and deeply cherish. Sea level rise and storm surges threatens many world monuments and have been a major challenge for UK sites including Hurst Castle which has encountered excessive erosion and caused some parts of its wall to collapse (World Monument Watch, 2022). In view of this, the English Heritage seeks to investigate climate catastrophes in order to maintain resilient solutions for future management of other vulnerable coastal assets and nearby world heritage site communities. However, site managers emphasize that projections indicate a sea level rise of up to 5 feet (1.5 meters) within the next century is bound to happen, rendering change and potential loss unavoidable (World Monument Watch, 2022).

There is an evidential study that the Derwent Valley mills could lose their World Heritage recognition because of growing vulnerability to the risks linked with climate change, as well as detrimental repercussions that are affecting the environment, economic and social-cultural welfare of the community (“The Valley That Changed The World”, n.d.). Following the 2021 heavy flooding along the Derwent Valley, many people attributed the problem to the depletion of trees and the absence of natural floodplains (Massey, 2022). According to the Met Office's (2009) forecast, winter rainfall series will be more intense, which suggests a higher risk of flash floods in the future. Due to increased flow rates caused by extremely heavy rainfall, the mills and other heritage properties are particularly vulnerable to flooding due to their proximity to the River Derwent in the landscape (Cigna et al., 2016). In the UK, numerous features of historical significance are acknowledged and safeguarded through planning designations and protections typically associated to historic buildings and prominent monuments. Particularly in the northern and western regions of Britain, these features have often been linked to sectors such as textiles, chemicals, and mining, resulting in the contamination of rivers with heavy metals and other toxins (Hudson-Edwards et al., 2008). Over the past centuries, the weirs have been relatively unaltered, however, due to the expansion of hydropower and ensuring water quality in accordance with the

Water Framework Directive of the European Union, these structures are facing growing pressures to be changed or removed entirely (Howard et al., 2017). The paper by Howard et al., (2015) investigated experiential findings from documented events of historical climate change and flooding as well as assessed the potential impacts of future climate change. Additionally, the research considered the influence of contamination from previous mining activities, which is believed to increase potential UK climate change effects. Given the challenge posed by climate change to the historic environment and its management, it is pertinent to assess the gravity of climate change impacts on cultural world heritage sites (Historic England, 2017).

2.4. Management Plan for World Heritage Sites

The UK Climate Change Act (2008) outlines the country's GHG emissions target, "to ensure that the net UK carbon account for the year 2050 is at least 80% lower than the 1990 baseline" (p. 1). (Climate Change Committee, 2008. c. 27). Averchenkova et al., (2020) recognize the passage of the Climate Change 2008 (c 27) Act as a leading example of climate change frameworks that embeds various organizations tools towards structured governance and support. Fankhauser et al. (2021, p. 21 - 25) admitted that in order to ensure global goals such as those established by the 2015 Paris Agreement are met, additional actions will be needed to advance the directions. In the last 10 years, there has been an increase in public awareness of the need for effective, and scientifically based methods to monitor and conserve cultural and natural heritage (Valagussa et al., (2020), but many climate change models adopted by the European Commission to monitor the progress of heritage assets remain low in some governments (Taramelli et al., 2020). The UK in this regard is among countries that do not have an existing strategy for their heritage governance, unlike Northern Ireland which has developed guiding principles on the management of its WHS (Historic Environment Scotland 2016; Historic England 2015). This has limited the comprehensive solutions to reviving heritage prestige in the country, and not specifically addressing climate issues on WHS. With findings from the past and current assessment of IPCC reports, heritage conservationists have developed awareness of the current and anticipated climate-related effects on cultural heritage. These concerns have now taken a central role in the responsibility of safeguarding heritage properties. Consequently, there is a growing emphasis on proactive measures aimed at conserving cultural heritage, (Historic Scotland, 2012). At the local level in the Derwent Valley, the Derbyshire County Council and support from Historic England manage the UK World Heritage Sites. The regulatory bodies collaborate closely with the Derwent Valley stakeholders and have a five-year strategic management plan research framework that focuses on managing the cultural heritage of the DWMWHS, which is updated after the research timeline. The current WHS site management plan was published in 2019 and extends the valley's

strategic vision from 2020 to 2025 (DVMWHS, 2019). The DVMWHS Research Framework Network (2023) objective is to establish the industrial advancements that support the Valley's designation as a World Heritage Site within a broader historical context. In 2006, the World Heritage Committee mandated that all management plans for World Heritage Sites should evaluate the potential impact of climate change and establish suitable mitigation measures tailored to the specific needs of each WHS (WHC, 2006). At the time of writing (18th June, 2023), there are 33 World Heritage Sites in the UK, with additional sites advancing towards the attainment of World Heritage Site inscription (WHUK, 2023). The Department for Culture, Media and Sport (2023) revealed, seven sites are on the verge of being granted for UNESCO World Heritage recognition. Each of these sites plays a crucial role in narrating the collective story of humanity and our planet. (WHUK, 2023). As part of the core functions of the UNESCO Convention, state parties should update their management plans in accordance with UNESCO's strategy that acknowledges climate change factors (UNESCO 2007, 2008; Philips 2014). This action has already been put in place by the English Heritage for the revision policies for Stonehenge and Avebury WHS (English Heritage, in press). Member states are tackling climate issues to conserve culture and traditions at local, regional and national levels (UNESCO, 2022). As supported by Gupta et al., (2007), the formulation of mitigation strategies considers generational limits to effectively address the challenges posed by climatic factors. The extent of climate acceleration was revealed by UNESCO (2022) which currently poses a threat to one in three natural sites and one in six cultural heritage sites. Schleussner et al. (2016, p. 828 & 830) assert that climate change's effects on meteorological temperatures, global economies, crop productivity, and the environment are much more severe at 2°C warming than they are at 1.5°C, however, Taalas and Msuya (2018, p. 5) acknowledge that scientific knowledge and evidence concerning these impacts remain insufficient and unclear. Humanity has already caused extensive damage to the natural world. As highlighted by Steiner (2007, para. 2), addressing the long-term impacts of climate change requires urgent action from all nations and if not addressed now, it may take centuries to tackle instead of decades - emphasizing "time" as the keyword. Tache et al., (2018, abstract) recognize long-term cultural heritage protection as a fundamental requirement for sustainable development and keeping community or ethnic integrity, and the transfer of knowledge from older generations to future generations. Benefits for the protection of heritage include sociocultural opportunities such as the promotion of community culture, acknowledgment and enhancing the education of diverse evolution of cultural heritage (Smith et al., 2011c). Economically, protecting cultural resources can play a significant role in promoting tourism growth. The Department for Culture, Media and Sport (2017) household survey showed,

“94.2% of adults in England agreed or strongly agreed with the statement", it is important to me that heritage buildings or places are well looked after". Sofaer et al., (2021) added, that visitors express the significance of heritage sites in relation to various dimensions of well-being and family reunion and strongly value the social connections, especially after the COVID-19 Pandemic.

2.5. Cultural Heritage and the 2030 Agenda for Sustainable Development

As it stands, limited research has been conducted concerning the indicators that can effectively establish the connection between cultural heritage preservation and sustainable development (Nocca 2017, abstract). The theory of sustainable development originates from the 1970s when concerns about the potential collapse of natural systems gained recognition over the past 50 years that traditional development focused solely on economic development (Harris 2000, pp. 21). Realizing economic development is becoming less satisfactory, greater focus has been directed toward environmental and social concerns (Thierry et al., 2023). There are many possible routes that can be followed to accomplish sustainable development, but each country's trajectory differs due to the unique characteristics of their national economies and political structures (IMF, 2008). From the perspective of urban settling, nearly half of the global population will reside in urban areas by the end of the century, characterizing the 21st century as a global mass urbanization period. Global population has increased from 108 million in 1920 to 8 billion in the recently published State of World Population Report 2023 (Durand 1967; UNFPA, 2023). Wang et al., (2020) recognize that several social and political structures are related to environmental and economic determinants. The World Commission on Environment and Development in the “Our Common Future” report (1987, p. 41) defines sustainable development as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs, and involves a progressive transformation of economy and society”. Sustainable development is based on three fundamental principles - environmental, economic, and social which intertwine and dependent on each other (Keser, 2023). The ecological relationship depends on the protection of natural resources, and in contrast, impedes heritage and natural resources as well as violates equal rights and opportunities (Borowy 2013, pp. 102-185).

The 2030 Sustainable Development Agenda places a minimal focus on cultural heritage. The necessity to create cities and human settlements is specifically addressed only once (out of the 169 targets) in goal 11, relating to making cities and communities, “inclusive, safe, resilient and sustainable”, through “inclusive and sustainable urbanization, planning and management” (Target 11.3) and more “efforts to protect and safeguard the world’s cultural and natural heritage” (Target 11.4) (United Nations, 2015). Nonetheless, the reference is weakly considered and does not

specifically address cultural heritage but rather lists it among natural heritage. In addition, this particular target solely addresses cultural heritage protection and preservation without making any mention of its valuing or restoration (Nocca 2017, p. 3). The United Nations New Urban Agenda (2016) acknowledges cultural heritage as a crucial component of sustainable urban development and throws more spotlight on its importance in human settlements. Highlighted in the next paragraphs are some indicators from the New Urban Agenda (2016) (Habitat III) and ways of strengthening the sustainable development of cities and cultural diversity in ways of contributing to poverty reduction, well-being, innovation, tourism investment, local business and economic recovery. In parenthesis, the New Urban Agenda (2016) (Habitat III) states:

> "culture should be taken into account in the promotion and implementation of new sustainable consumption and production patterns that contribute to the responsible use of resources and address the adverse impact of climate change" (indicator 10). (NUA, 2016 p. 16)
>
> NUA vision is to "Leave no one behind, by ending poverty in all its forms and dimensions, including the eradication of extreme poverty, by ensuring equal rights and opportunities, socioeconomic and cultural diversity, and integration in the urban space, by enhancing liveability, education, food security and nutrition, health and well-being, including by ending the epidemics of AIDS, tuberculosis and malaria, by promoting safety and eliminating discrimination and all forms of violence, by ensuring public participation" [(Indicator 14 (a)]. (NUA, 2016 p. 19)
>
> NUA further highlights the role in the restoration of civic engagement and community involvement, "to the sustainable leveraging of natural and cultural heritage (both tangible and intangible), in cities and human settlements, as appropriate, through integrated urban and territorial policies and adequate investments at the national, subnational and local levels, to safeguard and promote cultural infrastructures and sites, museums, indigenous cultures and languages, as well as traditional knowledge and the arts". (Indicator 38) (NUA, 2016 p. 25)
>
> Supporting local economies and building resilient environments to improve the standard of living through technological advancement and provision of "quality, decent and productive jobs, including through the promotion of cultural and creative industries, sustainable tourism, performing arts and heritage conservation activities". (indicators 45 and 60) (NUA, 2016 pp. 26 - 30)

> Culture is mentioned as, “a priority component of urban plans and strategies in the adoption of planning instruments, including master plans, zoning guidelines, building codes, coastal management policies and strategic development policies that safeguard a diverse range of tangible and intangible cultural heritage”. (indicator 124). (NUA, 2016 p. 44)

In the last ten years, integrating cultural and socio-economical systems has evolved and become the main focus of heritage protection and not the “monument” in particular (Girard, 2015). The concept of the Historic Urban Landscape acknowledges the landscape as a dynamic "living heritage," which reflects societal transformations and enhances local welfare (UNESCO, 2011). This signifies the growing interconnections between conservation and development which can be seen as a mutually beneficial relationship (ICOM, 2019; Greffe, 2009). Every cultural landscape has a cultural element that reflects distinct local community characteristics that serve as a driving factor in improving people’s lifestyles. The effects on the local economy can be demonstrated through the utilization of performance metrics, which serve as essential instruments for attracting the financial investments required for urban revitalization (Garcia, 2004).

2.6. Reintroduction of hydropower at the Derwent Valley

During the period 1714 to 1830, pioneer capitalists and innovators like Richard Arkwright and Jedediah Strutt diverted water flow into generating power to establish and operate the world’s first mass-producing textile thread factories, resulting in significant community and economic transformations (DVMWHS, 2019). Textile industries and communities continued to manage competing demands on the rivers, such as water abstraction to support the newly constructed canals, the preservation of fisheries for sustenance and recreational purposes and regulating challenges posed by droughts and floods (Jackson, 2023). This management strategy led to long-term sustainable businesses, exemplified by certain DVMWHS, which have continuously utilized the potential of the River Derwent for over three centuries (Jackson, 2023). Historic disputes existed in the eighteenth century between mills industrialists and local communities who relied on the Derwent River for food. However, an agreement was made to resolve the longstanding disputes to further demonstrate that Hydro Electric Power can operate without conflicting river ecology at the DVMWHS areas (Jackson, 2021). Water still remains an essential source of power throughout the 19th century and basic life demand by the ecosystem; regarded as a sustainable and clean means of mitigating climate challenges by provision of HEP. The DVMWHS had sustainably operated its business during the pre-industrial revolution and even before the global climate’s alarming consequences, incorporating environmentally safe working ethics in their

production. The current project at Cromford Mills will refurbish and use the original 1776 size of a 6m water wheel, and install a 15kW hydro-turbine to generate electricity for the mill facilities and the wider communities (https://www.cromfordmills.org.uk, n.d). This will enable the site to switch its current use of fossil fuels to renewable energy, envisioning the Cromford Mills to become a sustainable heritage site. The hydropower project aligns with the community energy transformation agenda and cultural restoration to mark the birthright of the DVMWHS and heritage pride of a large industrial revolution, and also provide income for the community's historic projects. Cromford Mills aims to decarbonize its site emissions by the use of renewable energy which seeks to save about 14 tonnes of CO2 emissions annually (UoN, n.d) and offset electricity bills by £17,600 yearly (NCC, 2023) and reduce energy usage by 55,000 kW per year. The integration of dependable and cost-effective electricity systems plays a pivotal role in driving today's economies. Since 2020, greenhouse emissions have increased, with carbon dioxide estimated by the IPCC (2007c) to increase by 40 to 100% by 2030 if prevailing energy and development policies remain unchanged. This emphasizes the significance of creating efficient long-term climate mitigation solutions. In order to achieve the goals of such long-term mitigation, appropriate adaptation methods to ensure the safeguarding of culturally significant sites and properties are essential (Cassar, 2010). In large-scale geographical regions, natural disasters and temperature change occurrences, such as storms, droughts, and floods, can concurrently impact several supply units and network systems, thereby impacting significant portions of the distribution energy mix (Campbell, 2012). Storms and extreme weather events pose the greatest threat to power distribution networks (Campbell, 2012). For instance, the 2001/22 and 2013-2016 Brazilian drought, as well as the drought season in California from 2011-2017 influenced the accessibility of affordable hydroelectricity, resulting in increased use of comparatively more expensive thermal power plants (Hunt et al., 2018). This factor incurred excess costs in the electricity prices budgeted to be approximately US$41 million, (£45 million GBP2018), US$19.1 billion (£15.8 billion GBP2018) (Prado, 2016), and US$2 billion8 (£1.7 billion GBP2018), correspondingly (Gleick, 2015) and also have a vast effect on the national economy. Safeguarding energy security amidst an era of climate change and global pandemics demands complex calculations and proper decision-making to prevent energy shortages in the future (Geng et al., 2022). Underdeveloped communities that receive the least share of public infrastructures and resources, are triggered by thes economic crises. The current and future supply of electricity in many countries will be heavily dependent on stable water supplies for the efficient operation of hydroelectric power plants (Byers et al., 2015). Climate change is anticipated to influence electricity generation in two primary aspects: the free flow of water resources essential for hydropower generation and the

consumption of cooling water in thermoelectric power production (van Vliet et al., 2013). Additionally, Van Vliet et al., (2013) further discussed the effects of mid-northern latitude (50–60 °N) countries like the UK's capacity to operate hydropower and thermoelectricity. Showing the UK is likely to experience only minor changes in its gross hydropower potential in response to the climate crisis in the future. In a comparative analysis of the entire Europe (except Scandinavia), the gross hydropower capacity is projected to decline during 2031-2060 when compared to the reference period of 1971-2000 (Kovats et al., 2014). This projected decrease corresponds with the findings of Lehner et al. (2005), who predicted a broader decrease of 6-12% in gross hydropower capacity impacted by climate change within a timeframe of 2070. In past centuries, even though England benefited from water power, its energy infrastructure was predominantly built upon the utilization of coal reserves. Jackson (2021) argued that despite existing underused infrastructure, hydroelectric power is not currently being regarded as a new source of renewable energy by the central government in the Energy white paper 'Powering our Net Zero Future' (December 2020). Due to this, future HEP projects within the Derwent Valley regions have stagnated in recent years. The establishment of weirs and their related infrastructure not only furnished the necessary power to operate the machinery within the mills but also supplied energy for ancillary processes to feed the workers and used by the mills in the production and printing of paper (Howard et al., 2017).

3. The Study Area and Project Scope

Guided by the principles of the Sustainable Development Goals, the project covers an exploration of the DWMWHS and climatic challenges faced by these historic sites. Initial surveys were conducted at Cromford and Belper communities. As described in the DVMWHS Management Plan (2019, p. 17), the site spans a distance of approximately 24 kilometers, extending from Matlock Bath in the north to Derby City Centre in the south across the lower Derwent Valley in Derbyshire in the East Midlands of England. The geographical coordinates for the location are Latitude 53°01'13''N and Longitude 01°29'59''W. The boundary core zone has an area of 12.29 km² and a Buffer Zone of 43.63 km² (Cigna et al., 2016) to protect the areas under the green belt and maintain the Outstanding Universal Value of the site. The requirement for a limited reassessment of the site perimeter has been recognized to better understand the original map from 2001 and make minor modifications where buildings have been excluded or added near the boundary (DVMWHS, 2019).

Despite being an early facility during the Industrial Revolution, a unique aspect of the World Heritage Site is the preservation of large blocks of rural terrain away from the industrial settlements and villages that emerged around the mill sites (Howard et al., 2015). Apart from the historical landscape, the WHS also protects a diverse array of wildlife and plants whose significance has led to the classification of many Local Nature Reserves and Sites of Special Scientific Interest (SSSI) and maintaining a rich ecosystem within the Derwent Valley (Howard et al., 2015). The area consists of undulating forests, wide greenery space, and reservoirs that house three large dams on the River Derwent (www.visitpeakdistrict.com, n.d.). The historic complexes comprise a large-scale textile production in a rural landscape with many cotton mill facilities (i.e. Strutt's North Mills, Mason Mills, Cromford Mills, Darley Abbey Mills, and Derby Silk Mill; Fig 2) (Cigna et al., 2016). The boundaries consist of the mill facilities for the workers, river weirs and infrastructures (including canals and railways) for transportation. The Valley is well known for its economic and social extension, especially in key areas such as Belper, Cromford, Darley Abbey and Milford.

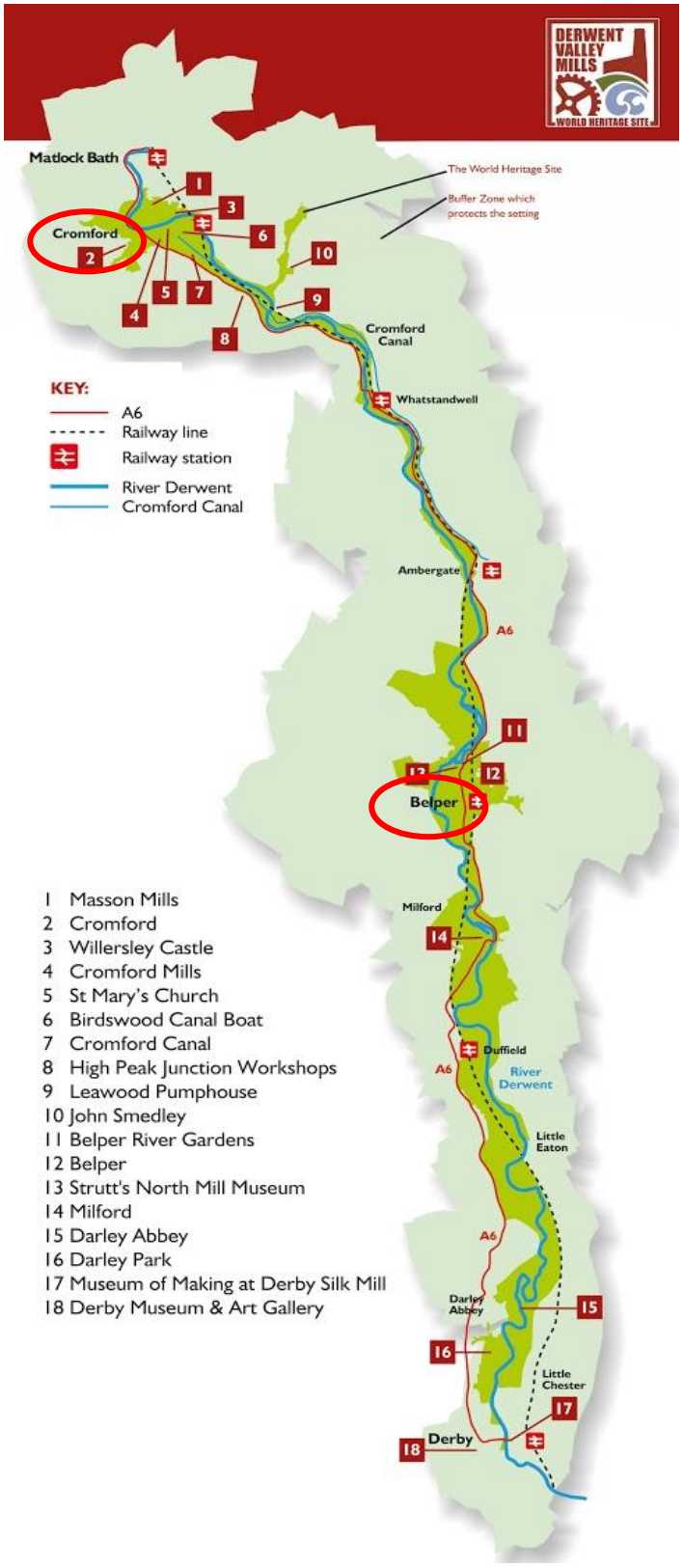

Fig 2: Location of the study area (red circles) showing core and buffer Zone boundaries. (DVMWHS map, 2019)

3.1. Research Methodology

3.2. Focus of Research

The project has drawn upon a variety of published and unpublished academic literature sources and datasets which have been put in the context of the wider built environment and archaeological heritage assessment of natural, cultural, and socio-economic dimensions. The pressing issue of climate change was critically evaluated in all literature headings when exploring the three pillars of the Sustainable Development agenda which formed the central idea of the research. The research focused on the UNESCO World Heritage Site in the Derwent Valley (Masson Mill: Matlock Bath; Cromford Mill: Cromford; Strutt North Mill: Belper; Silk Mill: Derby; Milford Mill: Darley Abbey) with initial survey work at Cromford village and Belper.

3.3. Ethical considerations and limits

Before starting the field data collection, the research was embedded within the University of Nottingham's Code of Research Conduct and Ethics with the approval of the School of Geography's risk assessment procedures for all research methodologies on 11th May 2023. (See:https://uniofnottm.sharepoint.com/sites/ResearchEthicsandIntegrity/SitePages/Code-of-conduct.aspx), please see Appendix 1 for full documentation. The project is considered to protect the rights of research participants, maintain data confidentiality, and use transparent means of collecting and sharing data. (Statistics Authority, 2022). The research involved the participation of people and groups of different ages, ethnicities, and social backgrounds which needed coordination and arrangement of a gatekeeper for participants to be enlisted.

3.4. Survey Methodology

In order to investigate and understand the literature discussed, a methodology for the qualitative data collected was based on two parts: (1) an Online questionnaire using Google Forms and (2) a Focus Group discussion via Microsoft Teams.

Experts like (Bryman 2006; Creswell and Plano Clark, 2011; Tashakkori and Teddlie, 2010) recognize 'mixed methodology' as utilizing qualitative and quantitative research at the same time within a project, however, Moran-Ellis et al. (2006) argued that it is a limited explanation and should consider researches that adopt two different qualitative methods as well (Cronin et al., 2008).

(1) Firstly, a semi-structured online questionnaire composed of 21 questions was collated from visitors during fieldwork at Cromford Mills WHS. Each question aimed at adopting the relevant pillars of the UN SDGs (2015) as a framework to guide the data structure. Participants accessed

the online questions by scanning one sheet containing a QR code. This method of QR code scanning aligns with the environmentally friendly practices designed by the researcher to minimize excessive use of paper, therefore, reducing resource consumption and waste generation. This strategy fits within the researcher's principles of resource conservation and reducing ecological footprint. Questions allowed participants to share demographic information which was strictly adhered to in accordance with the university's ethics code of conduct. Demographic information was collected as it was assessed by other follow-up questions to make future projections of heritage site visitation in comparison to different age groups and generations. The last question included a section to provide additional comments to allow respondents to express their thoughts, feelings, and opinions in their own words. Questionnaires were opened for response collection from 12th July to 12th August 2023. A copy of the questionnaire is provided in Appendix 2 for reference.

(2) The second part of the data survey utilized a focus group interview which was conducted with two different separate groups.
(a) the Belper Community Energy (BCE) Group on 2nd August 2023 answered five open-response questions varying from the general knowledge of the group on global climate change to community engagement and development of heritage site preservation in the Derwent areas. For clarity purposes:

> The focus of the interview was to gather information on how climate change is affecting the UNESCO Derwent Valley World Heritage Sites using the SDGs framework. By examining the specific vulnerabilities of these sites, the project aims to provide data-driven insights that can inform local authorities and key stakeholders of a collaborative action to address and effectively manage these sites.

Questions followed a semi-structured format and allowed all participants to discuss the subject matter for approximately 1 hour in a collective conversational manner. Before the arranged focus group discussion, the researcher had attended three meetings of the Derbyshire Dales Community Energy group meetings and Belper Community Energy Group meetings. Criteria for Focus Group participant selection were based on the member's familiarity with the study areas as local residents and sharing common experiences serving as community volunteers. To understand the work of the BCE:

Belper Community Energy (BCE) is a community organization of local based volunteers who are deeply committed to addressing the climate crisis by actively promoting solar panel initiatives on rooftops within the local community.

Interview complexities were minimal as further details about the project were attached in the participant information form alongside the research questions to elaborate clearer responses ahead of the actual meeting.

(b) The second focus group discussion was conducted on 8th August 2023. A 30-minute online meeting with the DVMWHS management to explore questions relating to governance, structure, and operations of the DVMWHS, and the regulatory bodies contributing to the site's management plan. The expertise of the DVMWHS management team played a pivotal role in recognizing the value of including this group as research participants and adding to the wealth of knowledge already shared by the BCE. Because the nature of the research assesses the management of the DVMWHS, this regulatory body was identified as one of the important stakeholders to address this issue. A copy of the focus group question is provided in Appendix 3 for reference.

The mixed qualitative interview design was adopted to maximize the survey response rates and produce more complete evidence. By employing an interdisciplinary approach, the study uncovered the vulnerabilities of the sites faced by various climate-related stressors, and informed the development of adaptive strategies that safeguard the unique values and integrity of the historic properties present in the Valley.

4. Survey Results

Out of the total 50 respondents initially targeted in the project design, 32 responses were collected during sampling, resulting in a response rate of 64%. Detailed information on the responses to individual questions can be found in Appendix 2. The outcomes of each question's results are displayed using illustrations generated by Microsoft Google Forms. These qualitative results form part of the life cycle of the project data collection stage with other additional comments reviewed and presented in the research.

4.1. Limitations of the Research

Methodological limitations depended on historical data and timeframe analysis that might not fully capture the complex and dynamic interactions between climate change and heritage sites. Complex systems involving both natural and cultural components can be challenging to model accurately. Out of the 17 SDGs, Goal 13 (Climate Change) was the relevant goal selected to interconnect the three pillars of sustainable development in the discourse which may affect the outcome of the study.

Prior to the designing stage and data collection, a few research limitations were predicted and considered. The selection of specific sites or aspects to focus may inadvertently distort the findings. The study put the Derwent Valley area into perspective but fully focused on Cromford Mill and Belper communities. Cromford Mills received the spotlight in this research because of the cultural heritage revitalization activities that are currently happening at the site such as the hydropower project, the reopening of the visitor's center, and stakeholder investment funding to complete these projects. The biggest shortcoming identified was time (Focus group meetings) and internet connection to complete online questionnaires at Cromford Mills. The disregard for face-to-face interviews was due to the time factor convening participants in same room as de Leeuw (2008) asserted, fewer face-to-face interviews can be conducted within a specific timeframe compared to other methods, such as internet or telephone surveys. In addition, Fontana and Frey (2005) recognized electronic data gathering as a platform for completing self-administered semi-structured questionnaires. These setbacks constrain the extent of conclusions that can be drawn from the study; however, they also lay the foundation for future research in the field. The research encompasses topics that involve the sensitivity of climate change concerns and the historical/ancestral connections linked with potential participation barriers for certain visitors in completing the online survey.

4.2. Research Results

The employed methodology and results for investigating the intersection of cultural heritage and climate change within the framework of the Sustainable Development Goals (SDGs) will be elaborated upon using insights from each individual question. After appropriate review, the final outcomes are presented in this report as outlined below.

4.3. Questionnaire Results

4.3.1. Unnumbered Section: Consent Form

The aim of this question is to identify the respondents' agreement to participate, aligning with the approval received from the University of Nottingham and the School of Geography's research ethics committee.

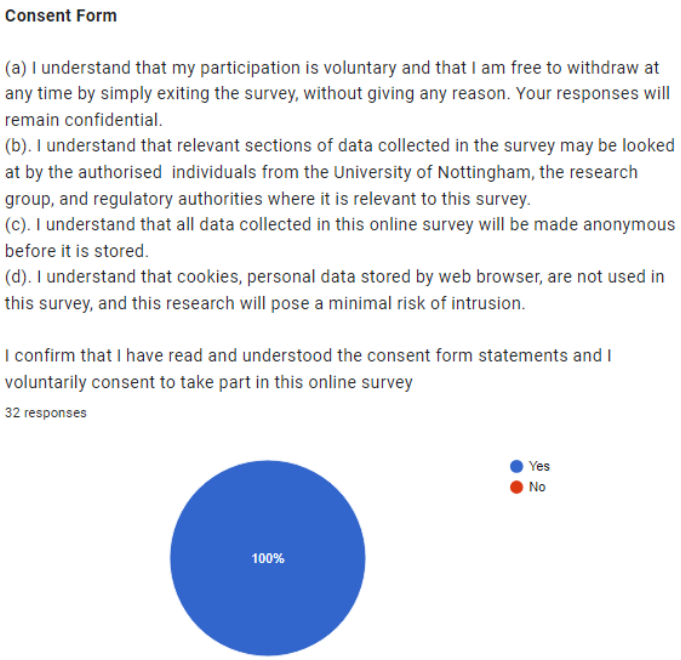

Figure 3: Result of Consent Section. (Google forms, 2023)

All 32 respondents provided an affirmative response, indicating that their consent had been obtained before engaging in the completion of the online questionnaire.

4.3.2. Section 1: General Information

4.3.2.1. Question 1: Gender

In line with the advancement of the socioeconomic factor of sustainable development, the inclusion of gender-based questions aims to support the pursuit of gender equality objectives. These questions help identify disparities and areas where gender-related inequalities may exist.

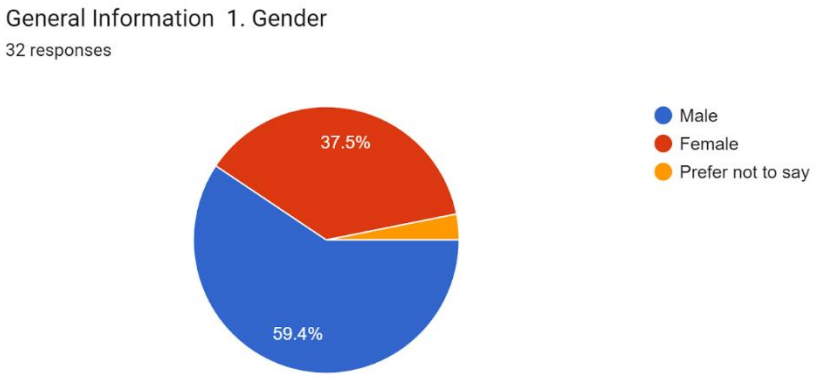

Figure 4: Result of Question 1. (Google forms, 2023)

Out of the 32 participants who responded to the question, 12 identified as females, representing 37.5% of the sample. 19 respondents identified as males, constituting 59.4% of the sample. Additionally, one person chose the option 'prefer not to say,' indicating their reluctance to disclose their gender identity.

This information is significant in understanding the gender representation within the respondent group, which can be important for considering the inclusivity of the study and for analyzing potential differences in responses based on gender. It also assists in assessing diversity and equity of the social factor in sustainable development.

4.3.2.2. Question 2: Age

This question was included to explore the interconnection of age groups with cultural norms and societal factors, influencing perspectives, behaviors, and experiences. This question correlates to question 17 to give context to the generational perception of visiting heritage sites.

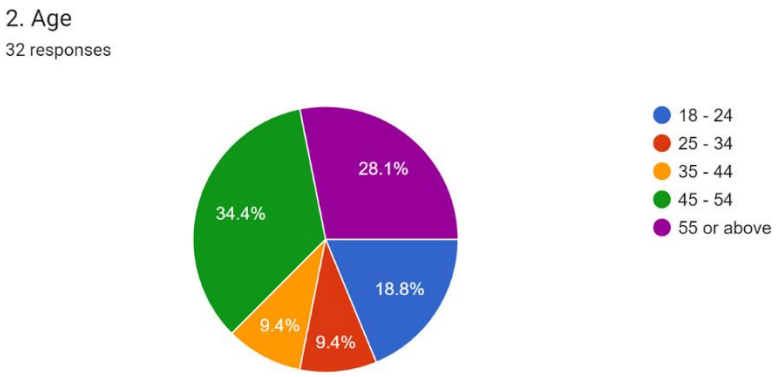

Figure 5: Result of Question 2. (Google forms, 2023)

The highest outcome recorded was age group 45-54 followed by 55 or above. This indicates the older generation is more likely to visit heritage sites as compared to the youth. This can be used to establish timeframe analysis to observe changes or trends that occur within different age groups and provide strong recommendations about youth activism in this research.

4.3.2.3. Question 3: Town of Residence

This question provides insights into visitation numbers which can help site activities to boost the local economy of the Derwent Valley communities. A comparison between local and foreign visitors can be drawn to discuss heritage and the economy which can guide in the formulation of effective management plans for sustainable tourism.

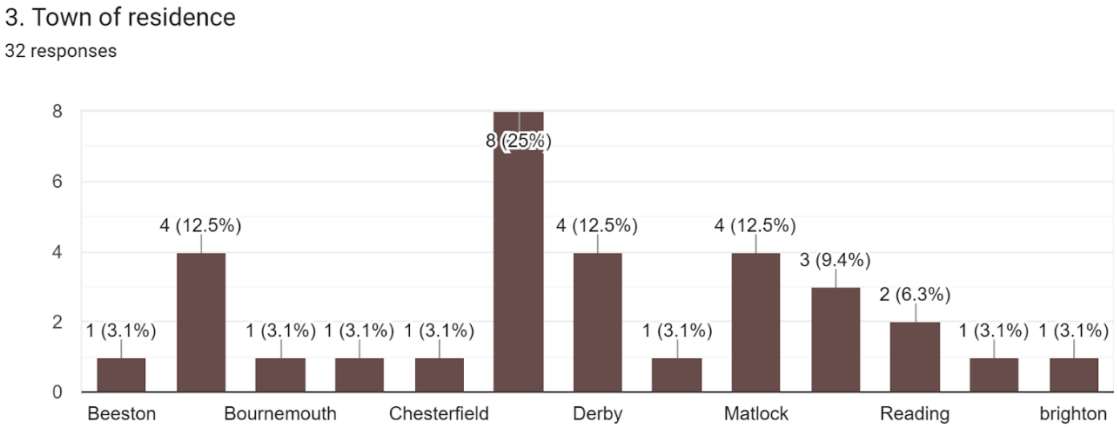

Figure 6: Result of Question 3. (Google forms, 2023)

To provide clarity on the missing names of towns of residence as shown in Figure 6, the following list is presented (from left to right):

Beeston, Belper, Bournemouth, Brighton, Chesterfield, Cromford, Derby, Long Eaton, Matlock, Nottingham, Reading, Sheffield. The distribution shows that Cromford has the highest representation at 25%, suggesting locals have connected back to the reviving site activities currently happening at Cromford Mill. Belper, Matlock, and Derby also exhibit significant proportions at 12.5% each. Nottingham and Reading are represented at 9.4% and 6.3% respectively. Visitors from Chesterfield, Long Eaton, and Sheffield recorded 3.1% indicating the lowest turnout during sampling.

4.3.2.4. Question 4: Educational Background

This question is intended to identify the different educational levels and how people understand the issue of climate change. This question links to the next climate awareness (Q.5) questions and concludes with question 20 (education campaign). These three questions were assessed together to incorporate education as an important resource to advocate for climate action.

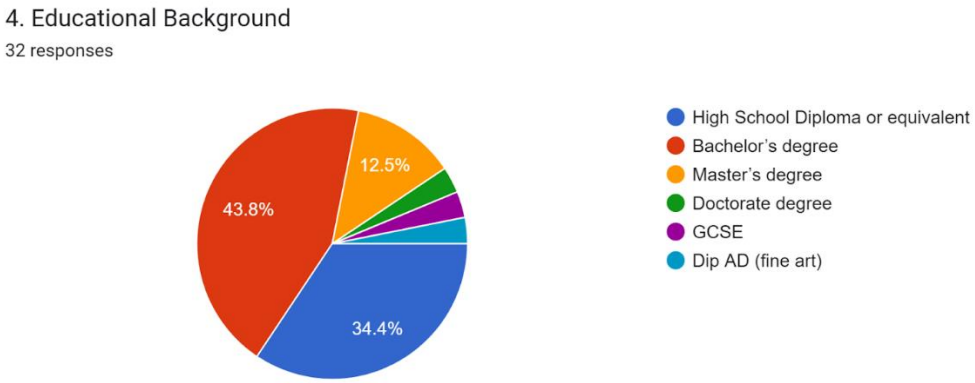

Figure 7: Result of Question 4. (Google forms, 2023)

Results from respondents with bachelor's degrees showed 43.8 %, indicating a relatively well-educated sample. This illustration is important as it suggests that the respondents possess a certain level of critical thinking and analytical skills that might influence their responses. Participants with higher educational qualifications, such as master's degrees (12.5%) and doctorate degrees (3.1%) saw a low percentage. High school diploma or equivalent (34.4%) showed how different levels of education understand and engage with heritage sites. GCSE (3.1%) and Diploma AD in fine arts (3.1%) represented the lowest sample. For instance, those with a background in fine arts might offer unique insights into the aesthetic and cultural value of

the sites and not focus much more on climate change. Higher education levels are associated with greater environmental awareness or engagement in sustainable practices.

4.3.3. Section 2: Awareness of Climate Change and UNESCO World Heritage Sites

4.3.3.1. Question 5: How familiar are you with the concept of climate change?

To understand the potential impact of climate change on the DVMWHS, it becomes imperative to ascertain whether visitors and staff possess an awareness of the concept of climate change, rather than considering it merely as a commonplace subject discussed.

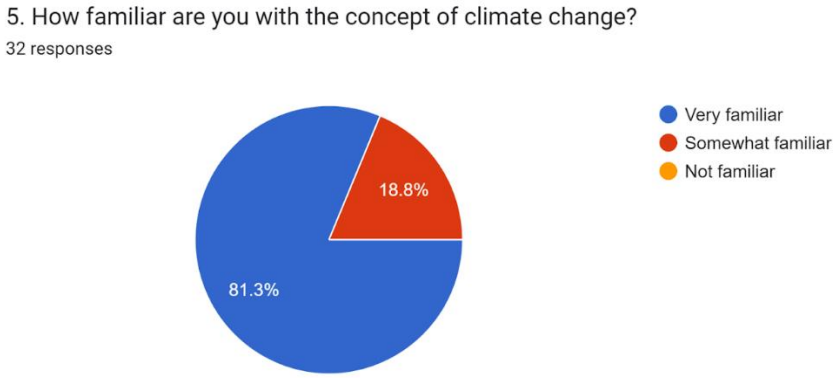

Figure 8: Result of Question 5. (Google forms, 2023)

The results indicated majority of respondents (81.3%) expressed a high degree of familiarity with the topic and 18.8% were somewhat familiar, which suggests a basic awareness among the surveyed individuals. This level of familiarity is crucial for the study's validity, as it establishes a baseline understanding of climate change before investigating its potential effects on the UNESCO WHS in the Derwent Valley.

4.3.3.2. Question 6: Are you aware of the UNESCO World Heritage Sites

This question aims to evaluate participants knowledge regarding the existence of World Heritage Sites, including both their awareness of general heritage sites and specifically those designated as UNESCO-inscribed World Heritage sites.

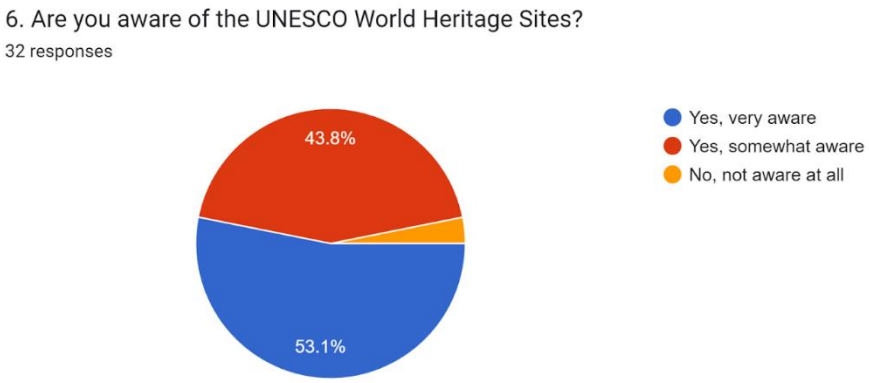

Figure 9: Result of Question 6. (Google forms, 2023)

The results demonstrated a significant number of the respondents (53.1%), reported being very aware of these sites, while 43.8% indicated a somewhat level of awareness. There was a low percentage, (3.1%) known to have no awareness of UNESCO World Heritage Sites. Total results indicated a strong response to knowing the UNESCO WHS, which is important in understanding their engagement with cultural and heritage conservation efforts.

4.3.3.3. Question 7: Have you visited any UNESCO World Heritage Site in the Derwent Valley?

This question seeks to establish participants actual engagement with the World Heritage Sites in the Derwent Valley area.

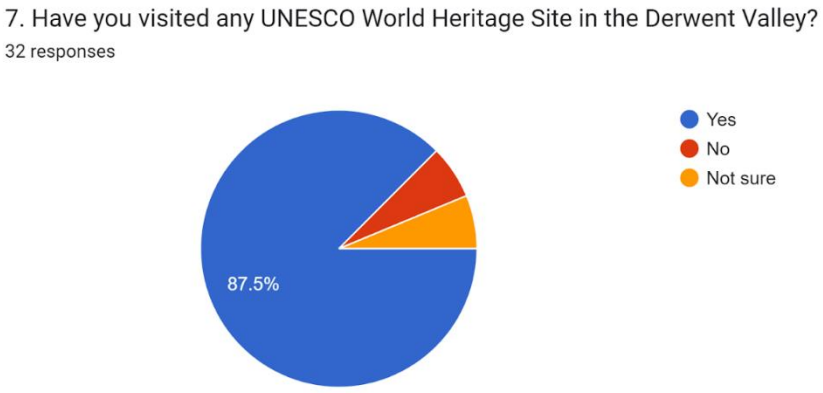

Figure 10: Result of Question 7. (Google forms, 2023)

The results reveal 87.5% of respondents have visited these sites, indicating a relatively high level of interaction and interest. A smaller percentage 6.3%, showed that they have not visited such site, while an equal percentage, 6.3%, expressed uncertainty about their visitation. These responses offer valuable insights into the extent of the respondents' physical connection with the UNESCO World Heritage Sites in the Derwent Valley, providing context to their perspectives and opinions on heritage sites significance, potential, and role in advancing sustainable development goals.

4.3.3.4. Question 8: If you have visited the UNESCO World Heritage Sites in the Derwent Valley, please indicate the purpose of your visit (select all that apply).

The aim of this question is to identify the motivations behind respondents visit to the DVMWHS.

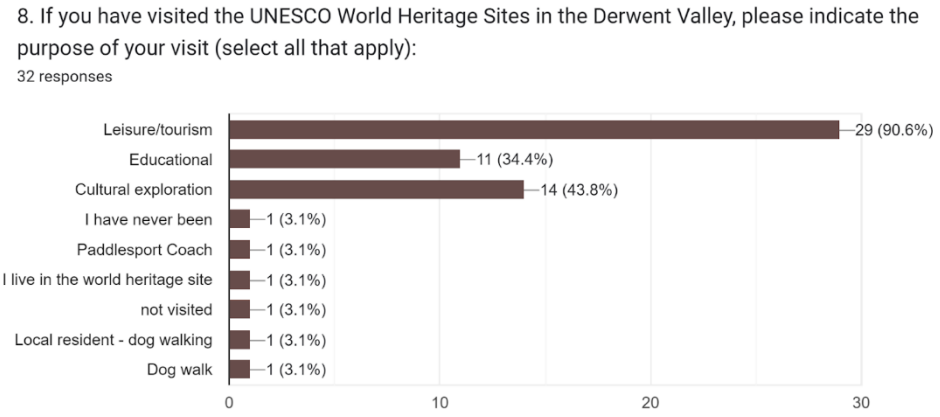

Figure 11: Result of Question 8. (Google forms, 2023)

The highest outcome indicated 90.6% of respondents' main purpose for visiting is for leisure and tourism. This suggests that these heritage sites are perceived as attractive destinations for relaxation, sightseeing, and recreational activities, signifying with their role as cultural landmarks. 43.8% answers showed cultural exploration, revealing a desire to learn about the historical and cultural significance of the sites. Furthermore, 34.4% indicated an educational purpose, which recognizes the educational potential of these sites in providing insights into history, culture, and heritage. These diverse motivations offer valuable insights into the multifaceted roles that the UNESCO World Heritage Sites in the Derwent Valley can play in fulfilling recreational, educational, and cultural needs, thereby contributing to the 2030 Agenda's goals of sustainable development.

In 'other' comment section, the following answers were recorded:

1 respondent (3.1%) indicated ‘I have never been’.

1 respondent indicated ‘Paddle sport Coach’

1 respondent indicated ‘I live in the world heritage site’

1 respondent indicated ‘not visited’

1 respondent answered ‘local resident – dog walking

1 respondent answered ‘dog walk.

4.3.4. Section 3: Impact of Climate Change on UNESCO World Heritage Sites

This section seeks to identify participants awareness of the effects of climate change at the DVMWHS. It also explores whether respondents acknowledge the influence of climate change on the integrity, appearance, and overall experience of the UNESCO World Heritage Sites in the Derwent Valley. This information is valuable for the research to gather insights into the general understanding of climate change impacts and connections to these cultural and natural assets.

4.3.4.1. Question 9: Climate change has caused visible changes in the natural landscapes of UNESCO World Heritage Sites.

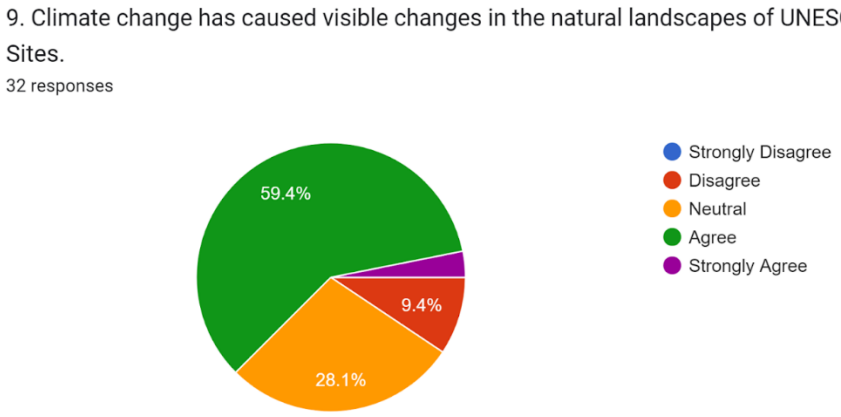

Figure 12: Result of Question 9. (Google forms, 2023)

The varying responses indicated that a majority of participants (62.5%) either agreed or strongly agreed that climate change has resulted in observable changes in the natural landscapes of these sites. This suggests participant’s knowledge of the impact of climate change on the appearance of the UNESCO WHS in the Derwent Valley. On the other hand, a combined total of 9.4% disagreed with the statement. These responses provide value to public awareness of the evident transformations occurring due to climate change and the implications for long-term preservation.

4.3.4.2. Question 10: Climate change has led to increased risk of erosion, flooding, or other natural disasters in UNESCO World Heritage Sites.

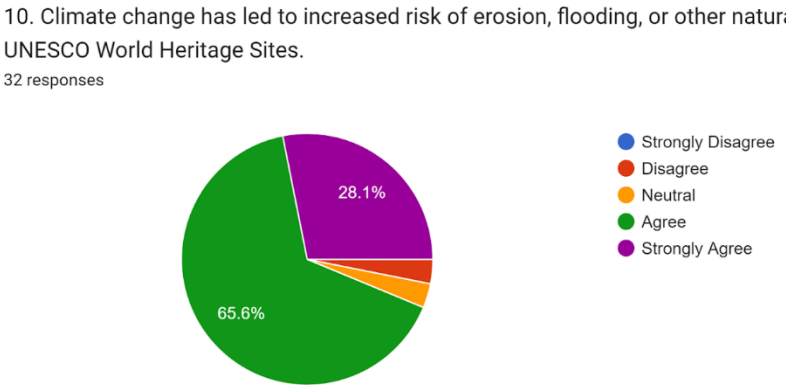

Figure 13: Result of Question 10. (Google forms, 2023)

This question became clear that a higher response (93.8%) either agreed or strongly agreed that climate change has increased the susceptibility of these sites to erosion, flooding, or other forms of natural disasters. This indicates a peaked awareness among the respondents about the potential adverse impacts of climate change on the physical integrity and resilience of the UNESCO WHS in the Derwent Valley. A combined total of 6.2% expressed disagreement or neutrality regarding this statement.

4.3.4.3. Question 11: Climate change has negatively affected the biodiversity and ecosystems of UNESCO World Heritage Sites.

This question aims to explore respondents' perceptions regarding the ecological impacts of climate change on these heritage sites

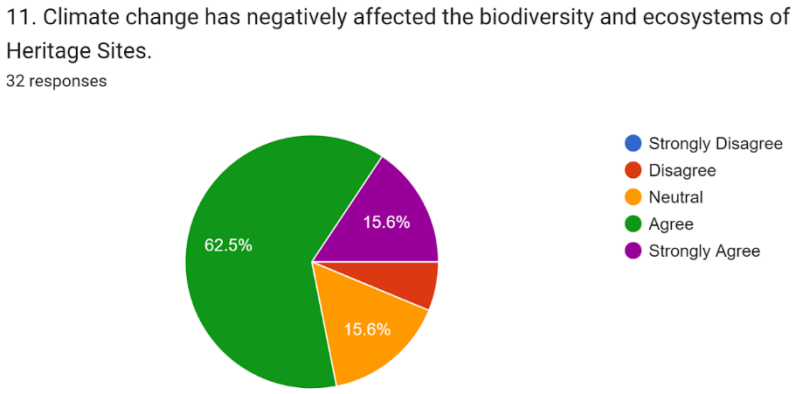

Figure 14: Result of Question 11. (Google forms, 2023)

Responses showed that a majority of participants (78.1%) either agreed or strongly agreed that climate change has caused detrimental effects on the biodiversity and ecosystems of these sites. This avails the recognition of the interconnectedness between climate change and threats to these sites. 21.9% expressed disagreement or neutrality regarding the statement with no information recorded for ‘strongly disagree’ responses.

4.3.4.4. Question 12: Climate change has led to the loss of cultural heritage and historical structures in UNESCO World Heritage Sites.

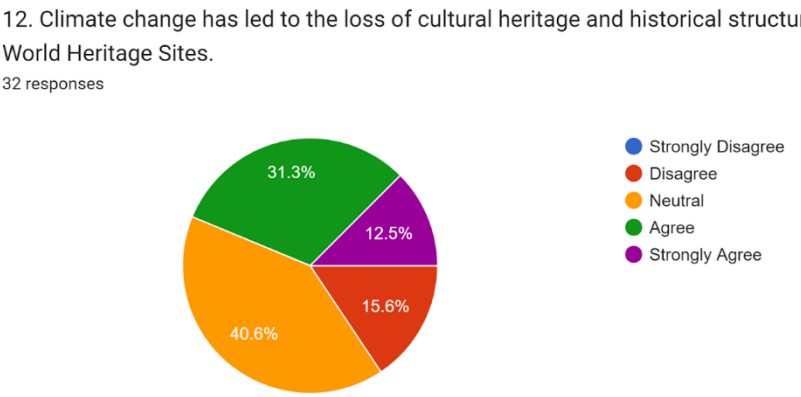

Figure 15: Result of Question 12. (Google forms, 2023)

Results indicated 43.8% of respondents (agreement percentage comprising both "agree" and "strongly agree") expressed agreement that climate change has resulted in the loss of cultural heritage and historical structures in these sites. 40.6% remained uncertain about the statement.

15.6% of participants disagreed with the question asked. These diverse responses will help provide a better recommendation.

4.3.4.5. Question 13: Climate change has impacted the cost of living crisis of the local communities living near UNESCO World Heritage Sites

The aim of this question is to identify participants views on whether they believe climate change is contributing to the cost of living crisis faced by local communities near the UNESCO World Heritage Sites in the Derwent Valley. This question acknowledges the extended socioeconomic implications that climate change can have beyond its direct environmental impacts. The results can contribute to discussions in the capacity for strong management strategies that address both environmental changes and socioeconomic challenges within the context of UNESCO World Heritage Sites.

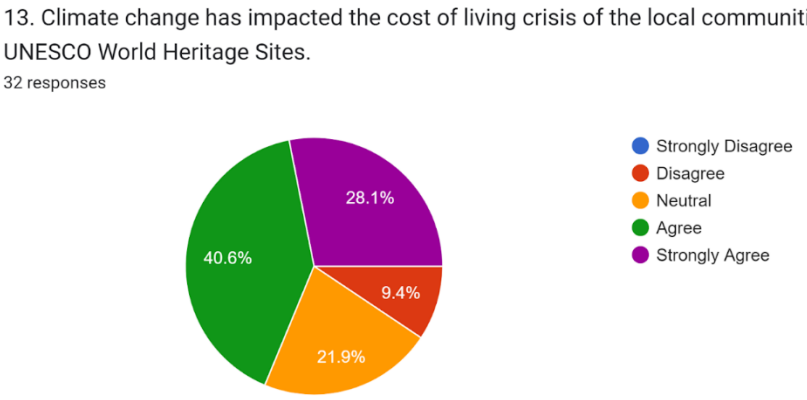

Figure 16: Result of Question 13. (Google forms, 2023)

A collected response of 68.8% agreed and strongly agreed with the socioeconomic aspect of the research question. This indicates that a significant majority of participants believe there is a connection between climate change and the cost of living challenges faced by these communities. 9.4% of answers expressed disagreement to the statement with 21.9% of participants remaining uncertain about the question. These results will benefit the socioeconomic factors of the research and evaluate how sustainable tourism can be achieved.

4.3.4.6. Question 14: Are you aware of any local or community-led efforts to address climate change impacts on UNESCO World Heritage sites?

The purpose of this question is to examine participants knowledge and awareness regarding any initiatives or actions taken by local or community groups to address climate change in the Derwent

Valley UNESCO World Heritage sites. Acknowledging the involvement of local stakeholders in climate action is crucial for addressing environmental concerns and preserving heritage assets.

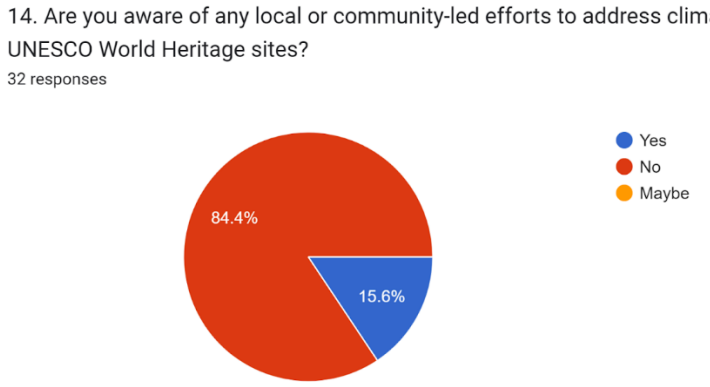

Figure 17: Result of Question 14. (Google forms, 2023)

The findings of this question – where 15.6% of respondents indicated "yes" and 84.4% indicated "no" – reveal a relatively low number of participants are aware of any local or community-led initiatives. This implies that there could be limited awareness among the public regarding ongoing community-driven initiatives to address climate change at the UNESCO World Heritage sites in the Derwent Valley. The results emphasized the necessity for increased awareness and communication of local activities and initiatives, as well as the need to promote community involvement in climate change mitigation and adaptation strategies. These findings can guide policymakers, researchers, and community leaders in their efforts to increase public participation and collaboration in protecting heritage sites amidst climate change challenges.

4.3.4.7. Question 15: How important do you think it is for local communities to be actively involved in the sustainable development and management of the Derwent Valley UNESCO World Heritage Sites?

This question follows up on Question 14 and delves deeper into local community engagement regarding the preservation of heritage sites.

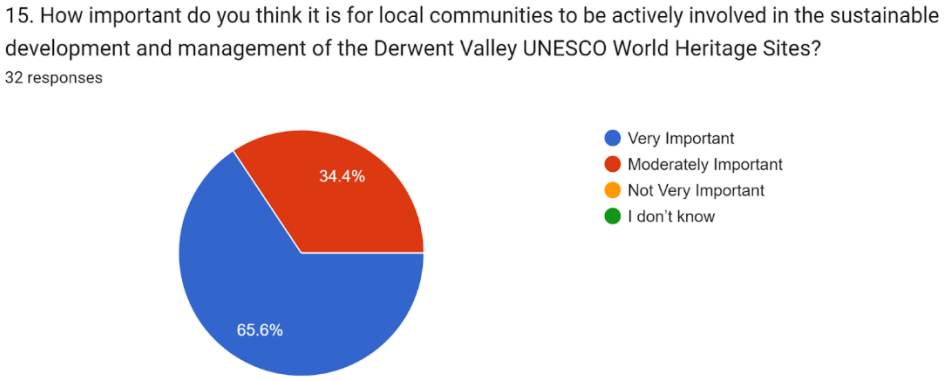

Figure 18: Result of Question 15. (Google forms, 2023)

The responses indicated majority of participants (65.6%) considered it "very important" for local communities to be actively involved in this management practice. Furthermore, a significant percentage (34.4%) also expressed opinions as 'moderately important'. There were no responses collected for "not very important" or "I don't know" which further suggests that the participants agree on the significance of local community involvement in improving the sustainable development and management of the Derwent Valley UNESCO World Heritage Sites.

4.3.4.8. Question 16: What do you think of installing solar panels on heritage buildings? (Select all that apply):

The purpose of this question is to understand participants attitudes toward sustainable lifestyle, specifically the adoption of renewable energy sources like solar panels**.** Responses indicated whether participants view solar panels as a viable means to achieve sustainability of heritage sites, with respect to the project's focus on advancing the 2030 Agenda. Question 16 aims to explore the economic, cultural and environmental advantages of how renewable energies contribute to addressing climate change in today's society.

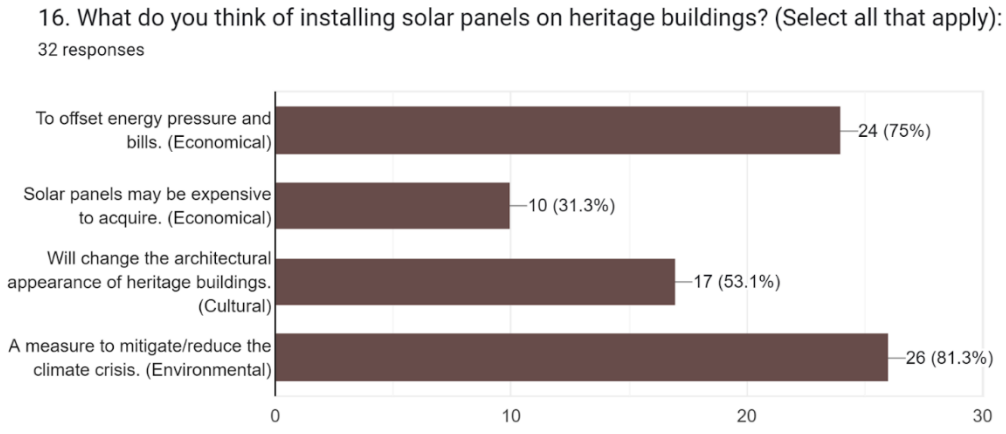

Figure 19: Result of Question 16. (Google forms, 2023)

Out of the 32 responses received, majority (75%) identified the potential benefit of installing solar panels as a strategy to offset energy pressure and reduce utility bills. This response reflects a practical and economical viewpoint, indicating that participants recognize the financial advantages of utilizing solar energy in heritage buildings. A portion of 53.1% indicated that the installation of solar panels could change the architectural appearance of heritage buildings, which will diminish the aesthetic and historical value of the monument. While 75% of respondents considered the economic burden of heritage sites to be reduced if solar is adopted; a representation of 31.3% weighed cost-economical concerns with acquiring solar panels. This response will suggest the transition to invest in sustainable technologies despite high costs. The highest response was received from 81.3% of participants indicating this was a measure to mitigate and address the climate crisis, supporting a strong environmental commitment in this regard.

4.3.4.9. Question 17: Is visiting heritage sites an outmoded leisure spending activity now?

This question aims to gather participants views on the modern significance of visiting heritage sites these days as a leisure activity.

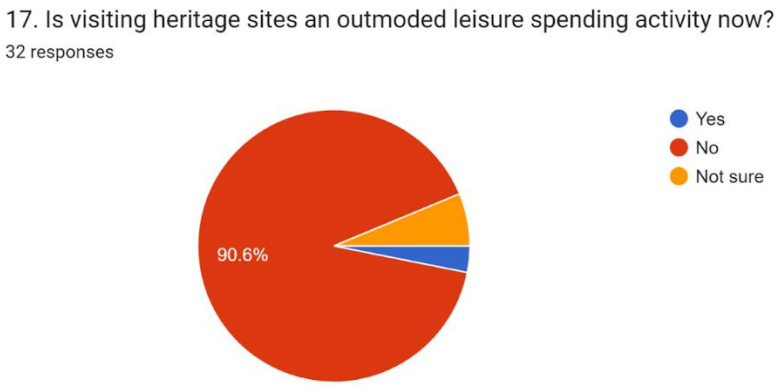

Figure 20: Result of Question 17. (Google forms, 2023)

The vast majority of respondents (90.6%) stated that they do not perceive visiting heritage sites as an outmoded leisure activity. This result suggests a strong belief among participants that heritage sites continue to hold significance and value as leisure destinations. Only 1 participant out of a total 32 responses selected 'no'. Uncertain results showed a few outcomes of 6.3%. The answers to the question highlight how important these sites are unique resources in a locality that supports business investment, tourism, cultural exhibition, education, and sustainable development.

4.3.4.10. Question 18: Have you personally taken any actions to support the conservation of UNESCO World Heritage Sites or to address climate change?

This question seeks to determine participants personal engagement in locally-led conservation efforts to safeguard heritage sites. The collective conservational efforts by participants reported for this question will guide the recommendations and conclusions of this research thereby, creating community awareness to advance the 2030 agenda.

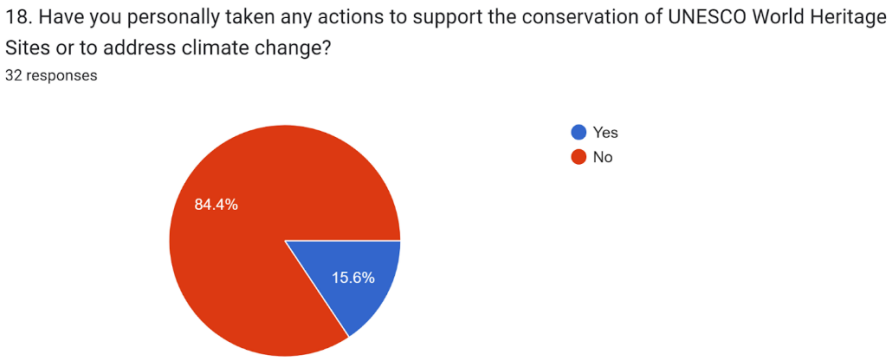

Figure 21: Result of Question 18. (Google forms, 2023)

The following results prevailed during data collection: Many respondents (84.4%) had minimal impacts on personal actions taken to support the conservation of UNESCO World Heritage Sites or to address climate change while 15.6% of participants answered that they have taken actions to support the conservation of heritage sites or address climate change

4.3.4.11. Question 19: if yes, please describe.

This a follow-up question to Question 18. The 5 participants who selected 'yes' provided the following additional comments:

Respondent 1: "Habitat restoration of peat lands/uplands"
Respondent 2: "I support local businesses anytime I come to heritage site by buying their local stuff. I once donated to a charity that was funding a heritage project"
Respondent 3: "Recycling organic matter, use hybrid car, donate to FoE"
Respondent 4: "Before I retired as a teacher, I taught students about climate change from the early noughties. I have been a member of the Green Party since 1990, working to inform people about Climate Change. I was a Green Party borough councillor 2019-2023, and worked with council officers (and councillors from other parties) to attempt to improve the council's actions to mitigate climate change, including moving motions on divestment from fossil fuels,, biodiversity and planning requirements (decarbonisation of homes, active travel, etc,). Personally, I stopped eating meat in 1984, have not flown for over three years, and walk and cycle as much as possible. 2007-2013 I was a founder member of Belper Against Tesco Superstore, which prevented Tesco building a superstore in Belper and thus ruining the town centre. 2022 Founder member and Treasurer of Belper Community Energy"

Respondent 5: “Maintaining a dwelling. Allowing land to revert to wild areas. Planting trees . Encouraging bird and insect life in the garden. Member of the Arkwright society”

Table 1: Additional comment – question 19 (Google forms, 2023)

4.3.4.12. Question 20: Do you think education and awareness campaigns can play a significant role in reducing climate change impacts on UNESCO World Heritage sites?

This question aims to gain insights into participants understanding on the efficacy of campaigns and their capacity to motivate the public towards adopting sustainable practices for the preservation of heritage sites. The results will guide and recommend the formulation of strategies and initiatives associated with education and public engagements to advance sustainable development goals.

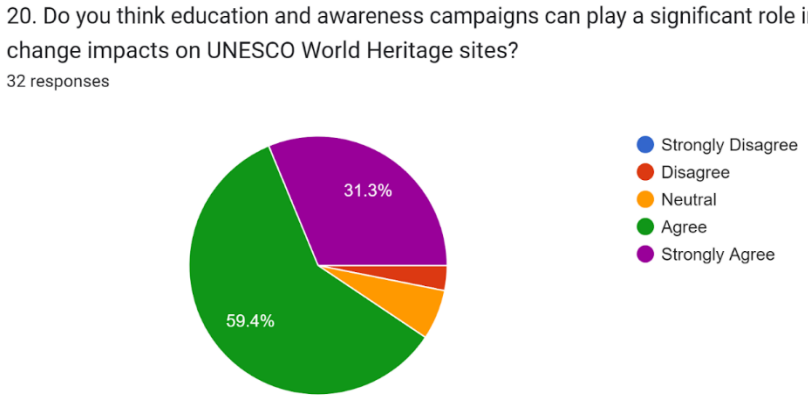

Figure 22: Result of Question 20. (Google forms, 2023)

A combined total of 90.7% of participants (a percentage comprising both “agree” and “strongly agree”) revealed that education and awareness campaigns can significantly contribute to reducing the impacts of climate change on UNESCO World Heritage sites. A minor group of 3.1% disagreed with the above heading and 6.3% of participants remained uncertain with their answers. Presenting the results, the wide gap seen between “agreed” and “disagreed” recognized the fact that participants believe in education as a tool to collaborate global efforts and policy implementation. This is a strong statement attributing the pivotal role education can play in raising public awareness, influencing behavior change, and contributing to the conservation of UNESCO World Heritage sites amidst climatic disturbances.

4.3.4.13. Question 21: Is there anything else you would like to add regarding the impact of climate change on UNESCO World Heritage Sites?

Among the responses, four participants answered "no," and the remaining four responses are outlined as follows:

Respondent 1: “There is too much tokenism at the World Heritage Site - for example, the water power project at Cromford Mill actually produces very little power but this is never made clear - not enough focus on urgent and immediate action. This is made worse incidentally by politicians using this issue as a voting issue. It isn’t, it’s an existential issue becoming more urgent by the week. 2030 is way too late”
Respondent 2: “The impact of climate change on WHS obviously depends on their geographical situation in the world. In Belper, I believe we are seeing the impact mainly through increased frequency of flooding. I believe that actions taken to mitigate climate change, such as solar panels on roof and solar farms, should take precedence over the appearance of old buildings or the countryside which has already been altered by centuries of human interference. There will be no heritage for our grandchildren if we don't take urgent and serious action”
Respondent 3: “Climate change will drastically impact the environment in many ways. There will likely be more flooding causing damage to buildings alongside higher temperatures. An unstable and unpredictable environment which could well result in a drop in visitor numbers.”
Respondent 4: “A lot of people still think climate change is a Hoax. We have long way to go. All the best in your studies and changing peoples mind.”

Table 2: Additional comment – question 21 (Google forms, 2023)

4.4. Research Focus Group Results

In collating and assessing responses from the Belper Community Energy group and two management staff of the DVMWHS, the evaluation deduced from the interview transcripts revealed some common themes as the main points of discussion. The comments provided a comprehensive interaction, contributing to the dissemination of knowledge regarding sustainable development, stakeholder engagement, regeneration Mills projects, existing governance, finance, and management strategies in the Derwent region. These codes cover a range of topics discussed in the interview, highlighting UNESCO's role and the complexity of the heritage site to management, partnerships, historical sustainability, environmental challenges, and the balance between environmental and heritage goals.

4.5. Research Analysis

NVivo 14 software was used to code the interview transcripts while supporting them with a manual synthesis of grouping crosscutting themes. Based on the study aim to explore the intersection of cultural heritage and climate change through the lens of the Sustainable Development Goals as a framework, the research analysis can be understood in Braun & Clarke's (2006) 6-step framework thematic analysis.

Qualitative open coding was used to conceptualize latent themes. Sage (2015, p.147) who cited Glaser and Strauss (1967) described this technique of sorting responses is based on constant comparative method. Codes were assigned to one of the following groups: "Challenges" (if the code name suggests that it is something negative or something that may negatively influence managing the DVMWHS). "Positive factors and positive experiences" (if the code name suggests that it is something in anyway positive and may positively influence managing the DVMWHS), and "other" (for codes that do match any of the initial two groups). In this part of the research, the interviews conducted within the two different groups were merged to identify similarities and disparities across key topics focusing on prevalent themes. To establish clear guidance, the analytic units (codes) and quotes from interviewees are grouped and presented in the following list of nine topics and subtopics as discussed:

Topics	**Subtopic**
Challenges	
1. Environmental Challenges	a. Climate Change Impact on Heritage Sites b. Balancing Environmental and Heritage Goals (solar panels on heritage buildings)
2. Economic Challenges	a. Financial Viability vs. Heritage Preservation b. Financial Challenges for Community Buildings
3. Complexity of Derwent Mills as a Heritage Site	a. Underdevelopment of other heritage sites
4. Historical Context	a. Historical Use of Renewable Energy in Mills b. Heritage Designation and Boundaries c. Management Structure and Planning

Positive Factors and Experiences **(**Potential Impact of Sustainable Development)	
5. Community Engagement and Sustainability	a. Community Energy Groups and Sustainable Development b. Community Engagement in Energy Projects c. Community Energy Initiatives
6. Visitor and Public Engagement	a. Visitor Behavior at Cromford Mill b. Impacts of visitors c. Public Opinion and Solar Panels d. Public Awareness and Education
7. Heritage Sustainability and Innovation	a. Sustainable Energy as Heritage Enhancement b. Heritage Site Viability c. Hydro Power in Heritage Sites e. Role of Heritage in Local Economy
8. Government and International Support	a. UNESCO's Role and Funding b. Government Policy and Support c. Importance of International Collaboration
9. Local Support and Partnerships	a. Local Authority Support b. Impact of Volunteers c. Role of Local Authorities d. Public-Private Partnerships
Other	
10. Comparative Analysis	a. Development between Belper Mills and Cromford Mils

Table 3: Presentation of the analytic units (codes) and quotes from the interview transcript (Anon, 2023)

5. Research Discussion

5.1. Resource Management: Organization Structure

In general, participants answered all questions successfully in the focus group and highlighted “financial challenges” as the dominant hindrance to managing the DVMWHS. Participants addressed the issue of the general public perception pertaining to the financial system of managing the designated sites. Even though these sites possess the status of a UNESCO inscription, it does not automatically come with financial support from them. The allocation of funds for the conservation and management of these sites remains contingent upon the individual decisions made by the different state parties responsible for managing the UNESCO World Heritage status and within each of the individual state parties such as the United Kingdom. This misconception is known to originate from the basic and unsurprising predominance of national interests over international concerns. Ashworth and van der Aa (2006) affirmed the issue of over-dependency in their publication that, while the practice surrounding World Heritage Sites adopts a global perspective, the actual implementation is predominantly managed at the national level. Furthermore, it is noteworthy that World Heritage Sites are nominated by bodies like UNESCO or its affiliates such as ICOMOS, but this process is ultimately overseen by the respective national governments within whose boundaries these sites are located. There has been an exception just once in 1981 when Jerusalem was included as a World Heritage Site, despite Jordan’s nomination (Ashworth and van der Aa, 2006 p.148). In the context of the UK National Commission's awareness of events unfolding at Cromford Mill and the crisis in Belper, it is evident that their knowledge extends to these underdevelopment situations and reflects concern for the challenges at hand. However, their capacity to address these issues effectively appears constrained, primarily due to resource limitations—a major permanent challenge frequently encountered in the management of many World Heritage sites, and utilizing its full potential usage (Eppich and Grinda 2019). The Commission's awareness of these matters is further demonstrated by the fact that the Foreign Office has been alerted of these concerns through multiple communication channels but much attention has not been given yet. Meskell (2013) discussed that coordination on a global level relating to the ineffective functioning of the advisory bodies that oversee world heritage conservation fell behind in achieving common ambitions and causing breakdowns in their operations. This was highly noted when the UNESCO monitoring system realized that climate change is increasingly affecting heritage sites and needed swift international support (UNESCO 2011a p.7). Besides, financial sustainability supports better management practices of both tangible and intangible assets of cultural exploration.

5.2. Environmental Goals Vs Historical Legacy

The research revealed up to the point where it was established that the question "Will environmental benefits outweigh heritage advantages? Which one has to bend for the other?" should not be a conflicting issue but rather, an equal balancing impact to environmental and heritage goals. As quoted in the interview, "…if you look at the top down directives in terms of the United Nations Sustainable Development Goals and the United Nations Educational, Scientific and Cultural Communities idea of transmitting and preserving and conserving our World Heritage sites go hand in hand with, we've got to look after our Climate. We've got to look after our planet so that we can pass these things on for the future" (Anon, 2023). The boundaries should still be respected and accorded without improvising the other as it was in the 18th and 19th centuries. In this context, there is a crucial aspect that involves engaging in meaningful dialogues about the various ways that environmental actions are addressed. It is our responsibility to understand that initiatives aimed at mitigating carbon emissions, protecting biodiversity and the environment may be distinct within other communities facing different environmental pressures. Addressing different environmental needs as initially explained in the literature review for 'Reintroduction of hydropower at the Derwent Valley', establishes the human and natural resources relationship and managing conflicts in the Derwent region in terms of energy and water resources. For instance, the hydropower needed the weirs to be opened to spin the waterwheel and generate electricity but inadvertently, this caused flooding and the destruction of many farm products (Jackson, 2021). The topic of solar panel installation on heritage buildings sparked an argument on various content of sustainability and cultural heritage during the interview. Discussions revealed that both environmental sustainability and cultural heritage have priority. A participant expressed the issue as an undeniable fact that it would be pointless having a world heritage site if the planet deteriorates completely without humans. However, the heritage cannot permit some changes to happen to these protected buildings because they risk losing the world heritage status which is of outstanding universal value to humanity. An argument supported by Lucchi et al., (2020) frames solar energy as an important technology to reduce environmental impacts but the need to integrate them without diminishing the aesthetic appearance of historic structures must also be taken into account. In the online questionnaire (Q.16), 81.3% participants acknowledge the installation of solar panels on heritage buildings as a measure to reduce and address the climate crisis which supports a strong environmental commitment in their belief to tackle climate change. The UK government has a vital role to play in this debate in order to meet the 2050 net zero target, especially with mounting pressures on historic conservationists to accept the integration of solar panels on heritage roofs (Green and Heritage, 2023). Proposal 17 of the 'Planning for the Future'

white paper (2020 p.45) seeks to adapt to the updated framework for historic properties to utilize the right energy efficiency standards to support the country's climate change ambition.

5.3. Sustainable Tourism

In response to the ongoing (as of the time researcher was writing this study: 12/09/2023), hydropower project at Cromford Mills, the reinstallation of the hydro-sourced energy has become a topical issue with relevance to climate change and historical legacy at the Derwent Valley Mills. Additionally, hydro projects trace back to 200 years ago, as evidenced by the Mills initial operation powered by hydro energy – aligning with their carbon neutral plans. After failed transition to fossil fuel as a result of cost of operation (Anon, 2023), the DVMWHS aims to become a harbor for sustainable tourism which will be key in promoting economic viability, technological evolution and environmental sustainability. All of these are related to the current debate on the restoration of hydroelectric power at the site with a projection of increasing tourist visitation as well. Not only does the Derwent region boast of them becoming the first industrial textile revolution, but also, has been known for centuries as a sustainable community bringing people together to work on a larger scale. This practice initiated the farming revolution to grow and produce food to feed families as their population increased over time. The potential of this revolution provided local community with good standard of living including employment, food, health, education and cotton products from farms, etc. Because every product was sourced from the local farms, the economic impacts cycled and sustained within the communities to make it more resilient and improved the livelihoods of local workers. This research has shown that the sustainable community lifestyle has influenced the management of the DVMWHS to reintroduce and incorporate these legacy stories in the educational curriculum for visitors at the heritage learning centers. The Canadian Commission for UNESCO and United Kingdom National Commission for UNESCO (2022) indicated that tourism increases the local economy by creating activities that attract visitors to enjoy their time, stay longer, and spend more money. The online questionnaire, "Is visiting heritage sites an outmoded leisure spending activity now"? is evident in the above response that indicated 90.6% feedback rejecting the motion. The Heritage and the Economy (2020) publication supports this argument of the importance of heritage assets to sustainable development which is dependent on multidimensional economic development and social wellbeing. The paper additionally stated a total GVA of £36.6bn was retrieved from the heritage sector and also generated more than 563,509 employments in 2019 (prior to COVID-19) which boosted the UK employment growth by 13% (CEBR, 2020). The pandemic hugely impacted global tourism and leisure events and deprived socioeconomic activities of most people and businesses (Duro et al., 2021). Furthermore, building social connections and economic growth was highly distorted during

COVID-19 which was evident in visitor's behavior change in response to the usage of heritage sites.

5.4. Local Community Development

Results revealed that Community-led efforts to address climate change impacts at the DVMWHS are on the low and ineffectively manipulated. A vast 84.4% indicated they are not aware of any local or community-led efforts currently happening at the DVMWHS which signifies an underdeveloped approach to bringing local knowledge together in the heritage management practices. Recognizing local stakeholders in community initiatives is important in addressing historic environments because locals feel a sense of belonging and identity values framing their community and take personal responsibilities to become part of the cultural heritage (Smith et al. 2003, p.75–76). This information also supports the demographic information taken from visitors to evaluate their travel locations to the sites, which showed more than half of the visitors were locally based residents. Besides the limited awareness of local engagement in heritage projects, participants demonstrated a 100% positive response to agreeing," It is important for local communities to be actively involved in the sustainable development and management of the DVMWHS. Pikirayi (2016) argued in the 'Community Archaeology and Heritage in Africa' paper that, local communities are prone to focus their attention primarily on areas or sectors that offer tangible benefits in a global landscape characterized by increasing social disparities, limited access to fundamental resources, economic breakdown (including poverty and conflicts) in a society. According to the focus group discussion, it was highlighted that due to the North mill's closure to the public, Belper is seeing a decline in volunteers at its cultural sites instead of an increase, resulting in volunteer's mass dispersal.

5.5. Partnership for the Goals

The role of Stakeholder collaboration and partnerships was a key mention in achieving global goals and bringing cultural heritage into the spotlight. Government, businesses, private, NGOs, community energy groups and local communities need to share similar visions and collaborate on joint agendas in order to build a more resilient planet for the future. In identifying the role of the DVMWHS management, it was established that it acts as a link between UNESCO and the local authorities. The study indicated there is a low level of stakeholder engagement connecting the DVMWHS from International, national and local community decision-making contexts. This has affected the sector to maximize the full potential of youth volunteers, and young talents in reshaping the community and local economy. Heritage and the Economy (2020) supported with evidential data that a culturally enriched environment characterized by a higher density of cultural

activities has the capacity to attract highly skilled individuals. Moreover, Backmann and Nilsson (2018), in their study, argued in a similar context that a per capita increase of one heritage site corresponds to a significant rise in highly educated individuals. Local communities have direct relationships with cultural assets and their engagement can combine indigenous knowledge to deliver a sense of stewardship and local pride in the preservation of the WHS.

5.6. Creating Awareness

Lack of education and campaign awareness for community participation at the DVMWHS was a strong indicator of why many visitors have not personally taken any actions to support the conservation of UNESCO World Heritage Sites or to address climate change. Education and campaign awareness are important in transferring knowledge and science into action to engage in wider community efforts. It can influence positive behavior change in society and equip the community with the necessary skills and capacity to ascertain and prepare for future climatic events (Anderson, 2012). In many parts of European nations, a study prevailed the primary factors influencing the decision of the public to visit heritage sites have been identified to be income, level of education, and occupational status. (Ateca Amestoy, 2019, Falk and Katz-Guerro, 2016). Even though all the participants had formal education and more than half had completed a bachelor's or master's degree, educational campaigns have not been fully utilized as results were presented in the study. Research questions related to educational awareness did not comprehend the general assumption that an educated society means it is aware of current environmental repercussions likewise its direct impact on cultural heritage. This statement is supported by Burchett (2015) when he identified significant deficiencies in the general public's perception and awareness of environmental topics, particularly concerning the human influence on climate change. Many participants have not engaged in conservational efforts of their local heritage sites because of unknown initiatives and awareness. Many responses received from question 20 indicated that, if education is incorporated into cultural initiatives, local residents are willing to engage in such activities. To preserve the legacy of the DVMWHS, initiatives can be implemented to follow the trend of the GREAT Britain campaign to attract visitors globally, invest in local businesses (VisitBritain, 2016) and promote generational industrialization and hydropower innovation in today’s market.

6. Conclusion

Looking at this study, it becomes evident that climate change intertwines with all the sustainable development goals and is dependent on the social, economic and environmental factors affecting humans and the planet. The literature review established the alarming rate at which climate change is occurring and its direct impact on cultural heritage. Thus, calling for global collaboration in order to focus and prioritize the unique features of global heritage sites that have connections to the sustainable development of a community. Since 2018, global climate activists like Greta Thunberg has used a campaign strategy of engagement to create mass attention and demand accountability from governments and big corporate institutions (Heidrich and Nakonieczna-Bartosiewicz, 2021). Strategies have been identified and put in place by UNESCO to revitalize global WHS that are highly susceptible to climate change, however, Otero (2022) suggests visitor numbers and inadequate management and resources are the main challenges to the preservation of World Heritage Sites. Using the Sustainable Development Goals framework to intersect the social lifestyle of people, protection of the environment and the economic development that balances an equitable and fair society, it was established that DVMWHS goes beyond just being a historic building but also, a driving force to boost local economy, reduce inequalities and bond the spirit of nature and people together.

The research results revealed all participants are aware of the concept of climate change and 97% recognize the Derwent Valley as a UNESCO World Heritage Sites which is a significant figure in addressing future climate actions. The varying responses indicated that a majority of participants (62.5%) either agreed or strongly agreed that climate change has changed the physical appearance of the DVMWHS. The most challenging aspect of the research outcomes emerged from funding as the major setback in the management of the DVMWHS. The coordination of stakeholders from international, national, and local levels has not been effective as much as to identify the financial constraints facing these sites and the local economy. At both the national level in the United Kingdom and within the decentralized government structures, there is an absence of comprehensive guidance that specifically targets the assessment and mitigation of climate-related impacts on World Heritage Sites. As expressed in the results, UNESCO does not work directly with the site coordinators even though they are aware of what is happening on the grounds. The delineation of roles and boundaries for international bodies tasked with the management of World Heritage Sites has evolved to provide a more distinct framework. This transition departs from the broad misconception that the mere UNESCO inscription of a property, such as the DVMWHS, inherently entails a mandate over all site-related activities, including the provision of funding for associated projects. Lack of awareness regarding locally led initiatives

was identified to be one of the desisting determinants of public engagement at heritage sites. Not only did the study identify environmental changes as the biggest threat facing the heritage sector, but also, its direct impact is greatly affected upon local communities that solely depend on these natural resources and cultural properties to sustain a living.

The Derwent Valley legacy marked the true significance of industrialization and cultural heritage in understanding community development, sustainable living, and the promotion of traditional identity. Industrialists like Sir Richard Arkwright and William Strutt maintained a long-time legacy to achieve global recognition as a testament to the pioneering era of the hydropower revolution. To realise the potential of these inscribed WHS in the Derwent Valley, the financial challenges that came out as the core concern for strategically managing these global treasures need to be given much attention and addressed at national and international levels. Additionally, governments and cultural heritage regulatory advisory bodies must dedicate financial resources from individual state parties to ensure the preservation of these historic monuments.

7. Research Recommendations

The research findings indicated the absence of a national framework within the United Kingdom addressing the influence of climate change on the management of WHS. In light of this observation, it is advisable for the UK heritage management bodies to consider adopting strategies similar to those implemented by Historic Environment Scotland. These strategies have proven effective in addressing the escalating impacts of global temperature rise on both the tangible and intangible assets of WHS, as well as the communities that solely depend on these heritage resources. The research literature indicated the extent to which climate change is affecting the cultural heritage sector and the implications for the foreseeable future.

In tackling the challenge posed by the insufficiency of resources available to support management activities, it is recommended that centralizing access to financial resources would enhance the visibility and transparency of outgoing monetary streams, however, it is equally imperative that the contributions to fund these projects would be decentralized to source finances from other partners and departments working under the authorities of cultural heritage. Rather than adhering to a top-down financial management framework, the emphasis should be on empowering individual sites to autonomously curate their funding means. This decentralization strategy will minimize the administration burdens from UNESCO and any prolonged waiting periods in financial decision-making process.

To acknowledge a long-term and viable management plan for preserving historical legacy, education and campaign awareness should be integrated within the learning and visitor centers at the sites. These centers should not only tell narratives pertaining to cultural heritage but also, emphasize external determinants such as climate change that hinder its preservation status. By embracing this approach, the visitor learning centers can evolve into an important institutional facility for promoting open-access learning opportunities by educating visitors about the intersection of climate change and sustainable development in cultural heritage conversation. Education plays a pivotal role in imparting new skills to individuals, fostering their understanding of climate change, and nurturing sustainable livelihoods within a community.

Encouragement and support should be extended to facilitate the continuation of Participatory Action Research in various domains, including but not limited to cultural heritage, community development, stakeholder engagement, and adequate financial support derived from national and international collaborations. These endeavors are instrumental in the ongoing identification and rectification of gaps within the management plan of the DVMWHS and the local authority's decision-making. The UK universities are well positioned to become driving stakeholders and undertake projects involving students and researchers from departments specializing in environment, sustainability, and history to collaborate and augment scientific insights that complement local knowledge. These efforts are important in today’s global decision for addressing positive changes in a community. These initiatives have the capacity to unveil and amplify the cultural richness of various communities to promote businesses, tourism and embed economic, social and environmental guidance within their localities.

Opportunities for ideation, creativity, and innovation can be advanced in the process of conserving heritage and community development. The reintroduction of the hydropower scheme at Cromford Mills can serve as a replicable model across multiple sites at the Derwent Valley to utilize the Derwent River in its energy operation and generate electricity power outside the mill's complexes to reach wider households. Leveraging emerging technologies to address global environmental challenges presents an innovative approach that can potentially reshape the conservation efforts and management of the DVMWHS. This scheme has the potential to significantly enhance the accessibility and equitable distribution of knowledge through educational workshops. Moreover, it offers invaluable support to the global community of scientists and practitioners through the introduction of innovative tools, by utilizing community-driven conservation methods that professionals can readily consult in the course of conservation decision-making processes (Otero, 2021). Such an undertaking has the capacity to catalyze a transformative shift in the prevailing

approaches adopted by heritage conservation professionals, thereby contributing to the advancement of global conservation practices.

The call for action to achieve the 2030 agenda for Sustainable Development Goals is a call for global collaborations and partnerships. Governments cannot achieve it alone, and neither can individuals or business organizations. Transformative and transparent systems that recognize the inclusion of both people and the planet should be prioritized urgently in order to leave no one behind in protecting the world's unique heritage and the environment.

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Appendix 1: University of Nottingham's Code of Research Conduct and Ethics with the approval of the School of Geography's risk assessment procedures for all research methodologies on 11th May 2023.

FORM E4015

School of Geography
Research ethics checklist for undergraduate and taught Masters students

This form must be completed for **all** research projects, research assignments or dissertations which are conducted within the School. You must not begin data collection or approach potential research participants until you have completed this form, received ethical clearance, and submitted this form for retention with the appropriate administrative staff. Starting these activities before you receive ethical clearance may be treated as a case of academic misconduct and subject to disciplinary action.

Completing the form includes providing brief details about yourself and the research in Sections 1 and 2 and ticking some boxes in Sections 2 and/or 3, 4, 5, 6. Ticking a shaded box in Sections 2, 3, 4, 5 or 6 requires further action by the researcher. Three things need to be stressed:

- Ticking one or more shaded boxes does **not** mean that you cannot conduct your research as currently anticipated; however, it does mean that further questions will need to be asked and addressed, further discussions will need to take place, and alternatives may need to be considered or additional actions undertaken.
- Ticking one or more shaded boxes means that you must explain the methodological decision relating to that box in Section 7. Your response to section 7 must also include how you will address or mitigate the ethical issues and risks that arise in relation to that box.
- Avoiding the shaded boxes does **not** mean that ethical considerations can subsequently be 'forgotten'; on the contrary, research ethics - for everyone and in every project – should involve an ongoing process of reflection and debate.

The following checklist is a starting point for an ongoing process of reflection about the ethical issues concerning your study.

SECTION 1: THE RESEARCHER(S)

1.1: Name of principal researcher (in CAPITALS): **MANFRED KYENKYEHENE OSEI**

1.2: Status: ☐ Undergraduate student

☐X Postgraduate taught student

1.3: Student ID number: **20493728**

1.4: Degree programme: **MSc Environmental Leadership and Management**

1.5: Module name/number: **GEOG4085**

1.6: Email address: **lgxmo1@nottingham.ac.uk**

1.7: Names of other project members (if applicable):

1.8: Name of supervisor for dissertations; module leader or staff member for other research projects: **RAH**

In relation to General Data Protection Regulation (GDPR)

		Yes	No
1	I confirm that I am aware of the GDPR and the proposed work will be compatible with it (You can find details on GDPR and the university's data protection policy here: https://uniofnottm.sharepoint.com/sites/InformationSecurityandCompliance/SitePages/Data-Protection.aspx)	x	
2	The research to be undertaken is in the public interest	☒	
3	If the project involves participants they will be directed to an appropriate privacy notice (Seehttps://uniofnottm.sharepoint.com/sites/InformationSecurityandCompliance/SitePages/Privacy-Notices(1).aspx)	x	

If the answer to any of the above is 'no' further details should be provided in section 7.

	Yes	No
1.9: I have read the University of Nottingham's *Code of Research Conduct and Research Ethics* and agree to abide by it and any relevant update (available on Moodle Dissertation Preparation module pages) (See: https://uniofnottm.sharepoint.com/sites/ResearchEthicsandIntegrity/SitePages/Code-of-conduct.aspx)	x	

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SECTION 2: THE RESEARCH

2.1: Title of project: Realising the Potential of UNESCO World Heritage Sites in the Derwent Valley to Advance the 2030 Agenda.

Please provide brief details (50-150 words) about your proposed research, as indicated in each section

2.2: Research question(s) or aim(s)

The study aims to bring multiple stakeholders together at Cromford Mills and other UNESCO World Heritage Sites in the Derwent Valley to address the three main pillars of the interrelated Sustainable Development Challenges. Exploring cultural heritage and climate change through the lens of the Sustainable Development Goals (SDGs) as a framework, the study was to:

1. **Investigate the ways stakeholders can collaborate with local communities at national and international levels to identify the social, environmental, economic, and cultural impacts of the challenges they face.**
2. **utilize this information to guide the ongoing formulation of the local management strategy for the DVMWHS and enhance understanding of the potential impacts of future climate change on the cultural assets.**

2.3: Summary of Method(s) of data collection

Qualitative Survey using a semi-structured interview.

Focus Groups Discussion

2.4: Proposed site(s) of data collection

(If online, indicate that the research is virtual and indicate the main online resources/archives that will be used).

Cromford Mill: Cromford Village

2.5: How will access to participants and/or sites be gained?

(Include details of how you will approach any research participants)

	Yes	No
2.6: Will your research take place outside the UK? **(If Yes, please supply further details in Section 7)** For fieldwork-related to travel outside of the UK please ensure appropriate insurance is in place. Review the Overseas Travel Guidance https://www.nottingham.ac.uk/sociology/documents/ethics-documents/overseas-university-travel-guidance.pdf and see the University's Travel Insurance Check List https://uniofnottm.sharepoint.com/sites/TravelStaffandPGR/SitePages/Insurance-Am-I-covered.aspx		x

SECTION 3: RESEARCH INVOLVING USE OF SECONDARY DATASETS OR ARCHIVES RELATING TO PEOPLE

If your research involves use of secondary datasets or archives relating to people all questions in Section 3 **must** be answered. If it does not, please tick the 'not relevant' box and go to Section 4.

NOT RELEVANT	x

Please answer each question by ticking the appropriate box.

	Yes	No
3.1: Is the risk of disclosure of the identity of previously unidentified individuals 'low or non-existent in the use of this secondary dataset or archive?	x	
3.2: Have you complied with the data access requirements (where relevant) of the supplier, including any provisions relating to presumed consent and potential risk of disclosure of sensitive information?	x	

SECTION 4: RESEARCH INVOLVING ACCESS TO FIELD SITES AND ANIMALS

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If your research involves access to field sites and/or animals all questions in Section 4 **must** be answered. If it does not, please tick the 'not relevant' box and go to Section 5.

NOT RELEVANT	x

Please answer each question by ticking the appropriate box.

	Yes	No
4.1: Has access been granted to the site?		
4.2: Does the site have an official protective designation of any kind?		
If yes, have the user guidelines of the body managing the site a) been accessed?		
b) been integrated into the research methodology?		
4.3: Will this research place the site and/or its associated wildlife at any greater physical risks than are experienced during normal site usage?		
4.4: Will this research involve the collection of any materials from the field site? If yes, please check to see whether your research project falls within the remit of the *Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity* https://uniofnottm.sharepoint.com/sites/ResearchEthicsandIntegrity/SitePages/Access-and-Benefits-Sharing.aspx If the research falls within the remit of the Nagoya Protocol, please ensure you complete a University of Nottingham "Due diligence declaration template (receipt of research funding)" form. For further information see the University's Nagoya ABS SharePoint Site		
4.5: Will this research expose the researcher and other people using the site to any significant risk of physical or emotional harm? If yes, please address this issue on the School of Geography Risk Assessment Form (RA409).		
4.6: Will the research involve vertebrate animals (fish, birds, reptiles, amphibians, mammals) or the common octopus (*Octopus vulgaris*) in any capacity? (If this is the case, please consult with the School of Geography's Research Ethics Officer before submitting this form for ethics review).		
If yes, will the research with vertebrates or the common octopus involve handling or interfering with the animal in any way or involve any activity that may cause pain, suffering, distress or lasting harm to the animal?		

SECTION 5: RESEARCH WITHIN OR INVOLVING THE NHS OR SOCIAL CARE

If you are undertaking research within or involving the NHS or social care all questions in Section 5 **must** be answered. If not, please tick the 'not relevant' box and go to Section 6. ***Please note the Prison Service does not allow undergraduate research in their institutions.***

Further guidance on research and ethics related to the NHS can be found at http://www.hra-decisiontools.org.uk/research/ and http://www.hra-decision-tools.org.uk/Ethics/

NOT RELEVANT	x

Please answer each question by ticking the appropriate box.

	Yes	No
5.1: Does this research involve the recruitment of patients, or the use of their records through the NHS, or involve NHS sites or other property?		
5.2: Does this research involve participants aged 16 or over who are unable to give informed consent? (e.g. people with learning disabilities: see Mental Capacity Act 2005)?		
If you have answered **Yes** to either of the above questions (5.1 or 5.2), ethical approval **must** be sought from the relevant NHS research ethics committee (see National Research Ethics Service (NRES) http://www.nres.npsa.nhs.uk). Evidence of approval from such a committee **must** be lodged with the School Office prior to the commencement of data collection. Please indicate that you agree to this.		
5.3: Does this research involve the recruitment of users or staff, or the use of their records or other data through social service authorities (children and adult services), or involve social service sites or other property?		
If you have answered **Yes** to the above question (5.3), then you must check whether or not the relevant social service authority has its own ethical scrutiny procedures. If appropriate, evidence of approval from such an authority **must** be lodged with the School Office prior to the commencement of data collection. Please indicate that you agree to this.		

Where external ethical approval has been obtained from a NHS committee or social service authority completion of the remainder of this form is optional.

SECTION 6: RESEARCH ON PEOPLE

If your research involves the participation of people all questions in Section 6 **must** be answered (unless you have already obtained external ethical approval from a NHS committee or social service authority). If it does not, please tick the 'not relevant' box and go to Section 7.

NOT RELEVANT	

Please answer each question by ticking the appropriate box.

A. General issues

	Yes	No
6.1: Will this research involve any participants who are known to be vulnerable due to:		Unknown
Being aged under 18?		
Residing in institutional care (permanently or temporarily)?		
Having a learning disability?		
Having a mental health condition?		
Having physical or sensory impairments?		
Previous life experiences (e.g. victims of abuse)?		
Other (please specify)...		
6.2: Will this research require the cooperation of a gatekeeper for initial access to the groups or individuals to be recruited? (typically a **gatekeeper** is an intermediary between a researcher and potential participants, with the authority to deny or grant permission for access to potential research participants)	x	
6.3: Will this research involve discussion of sensitive topics (e.g. sexual activity, drug use, physical or mental health, racism, prejudice, illegal activity)?		x
6.4: Will this research place participants at any greater physical or emotional risk than they experience during their normal lifestyles?	x	
6.5: Will this research involve the administering of any drugs, placebos or other substances (e.g. food substances, vitamins)?		x
6.6: Will this research involve any physically invasive, intrusive or potentially harmful procedures of any kind or the collection of bodily samples?		x
6.7: Will this research expose the researcher to any significant risk of physical or emotional harm?		x
6.8: Will this research involve people taking part in the study without their knowledge and consent at the time?		x
6.9: Will this research lead to the disclosure of the identity of previously unidentified individuals, for example respondents to the internet or through other visual/vocal methods?	x	

(Examples of this include audio recordings from interviews or focus groups, videos from focus groups or online interviews, screen shots from social media posts, online photographs, photographs at research sites, photographs on google maps. Please note that this does not apply to images or videos that are in the public domain and are being used in their intended context e.g. photographs of politicians)		
6.10: Will this research involve access to personal information about identifiable individuals without their knowledge or consent?		x
6.11: Does the research involve recruiting members of the public as researchers? (in such a case members of the public help collect the research data. If you are undertaking participatory methods, you should check whether this applies to your project with your supervisor)		x
6.12: Will tissue samples (including blood) be obtained from participants?		x
6.13: Will the study involve prolonged or repetitive testing?		x

B. Before starting data collection

	Yes	No
6.14: For those intending to work with children and/or vulnerable adults a) I have read the University's *Guidance on arrangements for Protection of Children and Vulnerable Adults* (2009) http://www.nottingham.ac.uk/registrar/documents/child-vulnerable-adult-protection-policy-april-2009-1.pdf	x	
b) I am prepared to allow a Disclosure and Barring Service (DBS) check to be made on me by organizations facilitating my research.	x	
6.15: My full identity will be revealed to all research participants.	x	
6.16: All participants will be given accurate information about the nature of the research and the purposes to which the data will be put. (An example of a Participant Information Sheet is available for you to amend and use.)	x	
6.17: All participants will freely consent to take part, and, where appropriate, this will be confirmed by use of a consent form. (An example of a Consent Form is available for you to amend and use.)	x	
6.18: All participants will freely consent to take part, but due to the complex nature of the research a formal consent form is either not feasible or undesirable. Alternative means of recording consent are proposed and will be detailed in section 7.		x
6.19: A signed copy of the consent form or (where appropriate) an alternative record of evidence of consent will be held by the researcher.	x	
6.20: It will be made clear that declining to participate will have no negative consequences for the individual.	x	
6.21: All participants will be free to withdraw from the study at any time, including withdrawing data following its collection.	x	
6.22: Participants will be asked for permission for quotations (from data) to be used in research outputs where this is intended.	x	
6.23: I will inform participants how long the data collected from them will be kept.	x	

6.24: Incentives (other than basic expenses) will be offered to potential participants as an inducement to participate in the research. (Here any incentives include cash payments and non-cash items such as vouchers and book tokens.)		x
6.25: For research conducted within, or concerning, organisations (e.g. universities, schools, hospitals, care homes, etc) I will gain authorisation in advance from an appropriate committee or individual. (This is in addition to any research ethics procedures required by those organisations, particularly health and social care agencies – see Section 5.)	x	

C. During the process of data collection

	Yes	No
6.26: I will provide participants with my University contact details, and those of my supervisor, so that they may get in touch about any aspect of the research if they wish to do so.	x	
6.27: Prospective participants will be informed that data collected will be treated in the strictest confidence and will only be reported in anonymised form, but I will be forced to consider disclosure of certain information where there are strong grounds for believing that not doing so will result in the continuation of terrorist activities, money laundering, acts of treason or abuse of minors or vulnerable adults. You can find more information on your responsibilities in relation to illegal activities in the University's research integrity policy (see https://uniofnottm.sharepoint.com/sites/ResearchEthicsandIntegrity/Shared%20Documents/Forms/AllItems.aspx?id=%2Fsites%2FResearchEthicsandIntegrity%2FShared%20Documents%2FResearch%20involving%20Illegal%20Activities%20%2D%20Research%20Integrity%20Byte%20%20v1%2E1%2002Oct2020%2Epdf&parent=%2Fsites%2FResearchEthicsandIntegrity%2FShared%20Documents) I will seek advice from the School of Geography's Research Ethics Officer if any information shared with me raises concerns about present or future illegal activities.	x	
6.28: Prospective participants will be informed that data collected will be treated in the strictest confidence and will only be reported in anonymised form, but I will be forced to consider disclosure of certain information where there are strong grounds for believing that not doing so will result in harm, abuse, or neglect to research participants or others. ("Safeguarding" in research is defined as "preventing and addressing any sexual exploitation, abuse, or harassment of research participants, communities and research staff, plus any broader forms of violence, exploitation and abuse ... such as bullying psychological abuse and physical violence". (UKCDR, February 2020). I will seek advice from the School of Geography's Research Ethics Officer if any information shared with me raises concerns about harm, abuse or neglect to research participants or others.	x	
6.29: All participants will be free to withdraw from the study at any time, including withdrawing data following its collection.	x	

6.30: Data collection will take place only in public and/or professional spaces (e.g. in a work setting). If fieldwork takes place in the respondent's home complete the Risk Assessment Form (RA409) and contact the Safety Officer, John Corr with queries.	x	
6.31: .	x	
6.32: Participants will be treated with dignity and respect at all times.	x	

D. After collection of data

	Yes	No
6.33: Where anonymity has been agreed with the participant, data will be anonymised as soon as possible after collection.	x	
6.34: All data collected will be stored in accordance with the requirements of the GDPR Act 2018.	x	
6.35: Data will only be used for the purposes outlined within the participant information sheet and the agreed terms of consent.	x	
6.36: Details which could identify individual participants will not be disclosed to anyone other than the researcher, their supervisor and (if necessary) the Research Ethics Panel and external examiners without participants' explicit consent.	x	
6.37: I will inform my supervisor and/or the School's Research Ethics Officer and (if necessary) statutory services of any incidents of actual or suspected harm of children or vulnerable adults which are disclosed to me during the course of data collection.	x	

E. After completion of research

	Yes	No
6.38: Participants will be given the opportunity to know about the overall research findings.	x	
6.39: All hard copies of data collection tools and data which enable the identification of individual participants will be destroyed.	x	

SECTION 7: ETHICAL APPROVAL

If you ticked any of the shaded boxes in sections 1 - 6 of this form, then you must complete SECTION 7 (below).

In all cases you must discuss all ethical issues arising, record the outcome and have this form countersigned by a member of staff (see below).

FURTHER INFORMATION & JUSTIFICATION OF METHODOLOGY

One box should be completed for **each** shaded box ticked in sections 1 - 6 of this form.

Ethical issue: 6.2

Rationale for chosen methodology and/or how ethical issue is to be addressed: not as issue as they are volunteering to give information.

Supervisor's/staff member's response (including whether ethical issue has been satisfactorily addressed):

Satisfactory

Ethical issue: 6.4

Rationale for chosen methodology and/or how ethical issue is to be addressed: participants are free to drop out of anytime. Environmental and historical topics especially issues on climate change could trigger an emotional response. Emotional support resources should be provided if the need arises.

Supervisor's/staff member's response (including whether ethical issue has been satisfactorily addressed):

Satisfactory

Ethical issue:6.9

Rationale for chosen methodology and/or how ethical issue is to be addressed: make it clear on the original participation forms that their data will be collected but can be discarded and destroyed at any point upon request. Ensure they know they can drop out freely at any time without compromising the researcher's activity.

supervisor's/staff member's response (including whether ethical issue has been satisfactorily addressed):

Satisfactory

Ethical issue: identify 6.2 6.4 6.9

Rationale for chosen methodology and/or how ethical issue is to be addressed:

Supervisor's/staff member's response (including whether ethical issue has been satisfactorily addressed):

Please continue on separate sheets if required

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Student's declaration of ethical research

Please sign and date below **and** get the checklist countersigned by a member of staff (see below).

If you ticked any of the shaded boxes *in Sections 1 - 6 of this form*, you should have completed Section 7 after discussion of the ethical issues with a member of staff.

Students must submit the authorised checklist along with their assessed work to Turnitin on Moodle.

Dissertation students **must** include the checklist, previously signed and authorised by their supervisor, as an appendix when they submit their dissertation proposal. Please keep one copy of this form for your personal records.

By signing this form you agree that if there is a possibility your data may be published you are responsible for appropriately storing your data for up to 7 years following publication. If you do not intend to publish your data you agree to appropriately destroy all data relating to the dissertation once you have received your final marks and feedback.

By signing this form you are agreeing to work within the protocol which you have outlined and to abide by the University of Nottingham's Code of Research Conduct and Research Ethics. If you make changes to your research protocol (such as changes to methods of data collection, the proposed sites of data collection, the means by which participants are accessed) which in turn would change your answers to any of the above questions then you **must** complete a new form and submit a copy to your supervisor/tutor. Once approved this should be lodged with the School Office.

Signed …….. Date: 6th May, 2023

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Appendix 2: Online Research Questionnaire

Section 1 of 4

Realising The Potential Of UNESCO World Heritage Sites In The Derwent Valley To Advance The 2030 Agenda

The purpose of this questionnaire is to gather information on how climate change is affecting UNESCO World Heritage Sites and aims to provide a data-driven insights that can inform local site coordinators and stakeholders of the urgent need for adaptation and mitigation measures. Furthermore, this research seeks to identify strategies that can promote local entrepreneurship and foster community empowerment through community energy groups and partnerships with major stakeholders for transitioning sustainable energy in nearby heritage towns. Your responses will contribute to understanding the challenges faced by these sites and aid in the development of strategies to safeguarding these global heritage sites for future generations. Please answer the following questions to the best of your knowledge. Thank you.

General Information *

1. Gender

- Male
- Female
- Prefer not to say
- Other...

2. Age *

- 18 - 24
- 25 - 34
- 35 - 44
- 45 - 54

3. Town of residence *

Short answer text

4. Educational Background *

- High School Diploma or equivalent
- Bachelor's degree
- Master's degree
- Doctorate degree
- Other...

Section 2: Awareness of Climate Change and UNESCO World Heritage Sites

Description (optional)

5. How familiar are you with the concept of climate change? *

- Very familiar
- Somewhat familiar
- Not familiar

6. Are you aware of the UNESCO World Heritage Sites? *

- Yes, very aware
- Yes, somewhat aware
- No, not aware at all

7. Have you visited any UNESCO World Heritage Site in the Derwent Valley? *

- Yes
- No
- Not sure

8. If you have visited the UNESCO World Heritage Sites in the Derwent Valley, please indicate the purpose of your visit (select all that apply): *

- [ ] Leisure/tourism
- [ ] Educational
- [ ] Cultural exploration
- [ ] Other...

9. Climate change has caused visible changes in the natural landscapes of UNESCO World Heritage Sites. *

- Strongly Disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

10. Climate change has led to increased risk of erosion, flooding, or other natural disasters in UNESCO World Heritage Sites. *

- Strongly Disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

11. Climate change has negatively affected the biodiversity and ecosystems of UNESCO World Heritage Sites. *

- Strongly Disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

12. Climate change has led to the loss of cultural heritage and historical structures in UNESCO World Heritage Sites. *

- Strongly Disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

13. Climate change has impacted the cost of living crisis of the local communities living near UNESCO World Heritage Sites. *

- ○ Strongly Disagree
- ○ Disagree
- ○ Neutral
- ○ Agree
- ○ Strongly Agree

14. Are you aware of any local or community-led efforts to address climate change impacts on UNESCO World Heritage sites? *

- ○ Yes
- ○ No
- ○ Maybe

15. How important do you think it is for local communities to be actively involved in the sustainable development and management of the Derwent Valley UNESCO World Heritage Sites? *

- ○ Very Important
- ○ Moderately Important
- ○ Not Very Important
- ○ I don't know

16. What do you think of installing solar panels on heritage buildings? (Select all that apply): *

- ☐ To offset energy pressure and bills. (Economical)
- ☐ Solar panels may be expensive to acquire. (Economical)
- ☐ Will change the architectural appearance of heritage buildings. (Cultural)
- ☐ A measure to mitigate/reduce the climate crisis. (Environmental)

17. Is visiting heritage sites an outmoded leisure spending activity now? *

- Yes
- No
- Not sure

18. Have you personally taken any actions to support the conservation of UNESCO World Heritage Sites or to address climate change? *

- Yes
- No

19. If yes, please describe.

Long answer text

20. Do you think education and awareness campaigns can play a significant role in reducing climate change impacts on UNESCO World Heritage sites?

- Strongly Disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

After section 3 Continue to next section

Section 4 of 4

Section 4: Additional Comments

Description (optional)

- Agree
- Strongly Agree

After section 3 Continue to next section

Section 4 of 4

Section 4: Additional Comments

Description (optional)

21. Is there anything else you would like to add regarding the impact of climate change on UNESCO World Heritage Sites?

Long answer text

Appendix 3: Focus Group Research Question

FOCUS GROUP QUESTIONS

(1) How have communities/visitors behaviors changed in response to the usage of heritage sites? **(10 minutes)**
(2) Has the county council improved sustainable developments in the Derwent areas to increase volunteers in these sites? (Staff absence). **(10 minutes)**
(3) What is UNESCO (UK national) doing about the sustainable development of heritage sites and communities down the valley? **(10 minutes)**
(4) Will environmental benefits outweigh heritage advantages? Which one has to bend for the other? **(10 minutes)**
(5) What are the main challenges or barriers faced by the Derwent Valley UNESCO World Heritage Sites in advancing the 2030 Agenda? **(10 minutes)**

Any additional comments? **(10 minutes)**

Appendix 4: QR Code Scan used at Cromford Mills

Hello, please help me protect the Derwent Valley Mills World Heritage Sites. If you want to do so, kindly scan the QR Code below and it will direct you to my project online questionnaires. It will take you about 10-15 mins to complete. Thank you