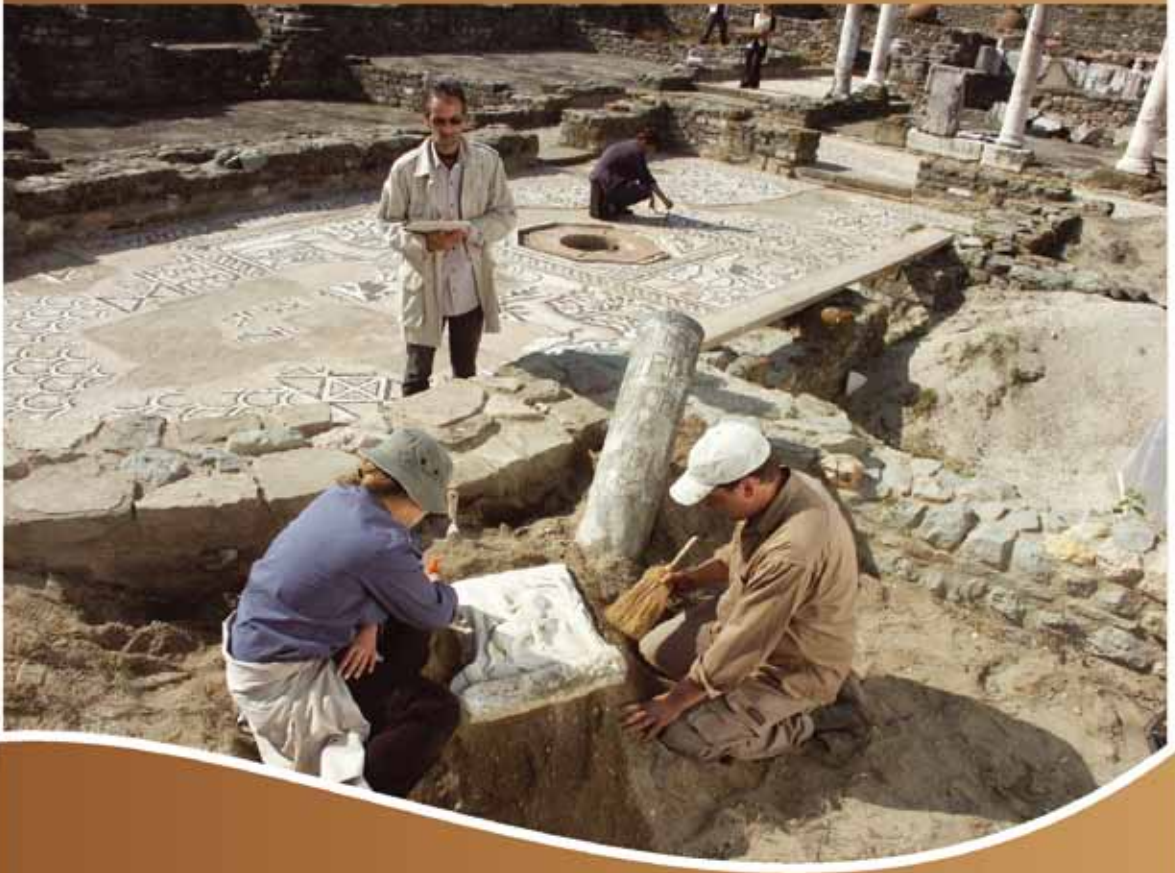




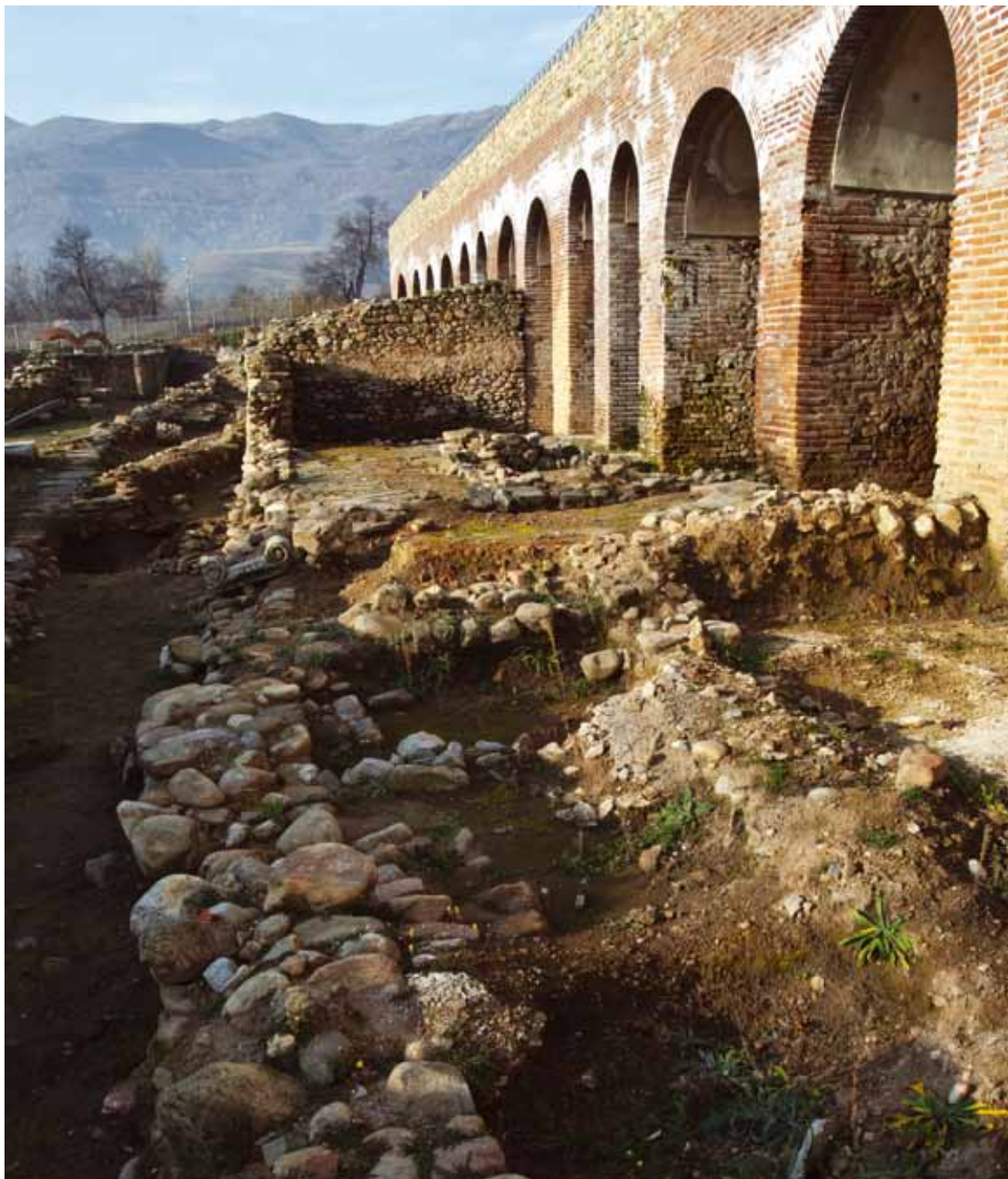
GOVERNMENT OF THE
REPUBLIC OF MACEDONIA
MINISTRY OF ENVIRONMENT
AND PHYSICAL PLANNING

THIRD NATIONAL COMMUNICATION ON CLIMATE CHANGE



PROTECTION OF CULTURAL HERITAGE AND CLIMATE CHANGE

VULNERABILITY ASSESSMENT AND ADAPTATION MEASURES



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PROTECTION OF CULTURAL HERITAGE AND CLIMATE CHANGE

This publication summarizes the key findings of an assessment of the vulnerability of the Republic of Macedonia's cultural heritage to the effects of climate change and possible measures and strategies for adaptation.

This report was prepared by the Institute for Cultural Heritage from Germany, in close cooperation with all relevant national institutions (Ministry of Culture, Cultural Heritage Protection Office, National Institution Conservation Center Skopje, National Institution Stobi and the National Institution for Protection of Monuments of Culture and Ohrid Museum). The preparation of the report was financed and supported jointly by the Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ) and UNDP.

The assessment was made as part of the country's Third National Communication on Climate Change to the United Nations Framework Convention on Climate Change by the Ministry of Environment and Physical Planning with support from the United Nations Development Programme (UNDP) and the Global Environment Facility (GEF).

The full report is available at:
www.klimatskipromeni.mk

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THE IMPORTANCE OF PRESERVING CULTURAL HERITAGE

This Republic of Macedonia has a rich cultural heritage that comprises influences from diverse peoples, cultures and traditions, as well as many monuments from great civilizations, including Ancient Macedonian, Hellenistic, Roman, Byzantine and Ottoman.

The material remains of these cultures - the 'built cultural heritage' - are found throughout the country in Classical amphitheatres and mosaics, Late Antique and Medieval fortresses and churches, icons and frescoes, Ottoman mosques, tekkes and caravanserai.

In addition to these monumental structures, the country's cultural heritage includes many unique 'cultural landscapes'. These are landscapes produced by centuries of interaction between people and nature - by traditional ways of living and working in response to specific local environments. This is a heritage that can still be seen in the effects of different regional methods of farming and forest management, in different local styles of building and in the layout of fields and villages and towns.

The value of these monuments and landscapes - their historical, artistic and spiritual significance - is incalculable. They are a crucial aspect of the nation's complex identity and history. Their aesthetic appeal has proven timeless. The importance of their preservation - for Macedonia and for all world culture - is beyond question.

For the Macedonian economy, too, preservation of the cultural heritage is crucial for the continued development of tourism - a vital and growing source of revenue.

With cultural heritage, the stakes are always high, since these treasures are, unlike other resources, irreplaceable.

NEW CHALLENGES IN PRESERVING CULTURAL HERITAGE

Preserving cultural heritage is a major undertaking for all countries at all times, requiring the mobilization and coordination of many different human and material resources across various sectors.

The country has shown a strong and ever-increasing commitment to this task over the years.

But now there are new complexities involved in the challenge of preservation - the complexities of climate change.

Climate change is especially relevant in preserving the cultural heritage because these monuments and landscapes were all developed at times when different weather conditions prevailed. How they will withstand changes in the climate, especially an increase in extreme weather events such as flooding, has so far been largely unexplored.

"One of the areas that is often overlooked in thinking about climate change is cultural heritage. Climate change poses a very real threat to the precious cultural heritage monuments that define our nation's history and values. As tourist attractions, moreover, these treasures also contribute significantly to economic growth and higher living standards. Cultural heritage faces a special threat. For, unlike natural resources such as forests, cultural heritage monuments cannot simply grow back after a destructive storm or other natural disaster. When they are damaged, whether by extreme weather events such as floods or by human factors, that damage is often irreversible."

Louisa Vinton, UNDP Resident Representative

New questions now need to be asked:

- How will changes in the frequency and intensity of extreme weather events affect the country's cultural monuments and landscapes?
- What approach and methodology should be developed to assess the specific vulnerability of different cultural heritage monuments and landscapes to the impacts of climate change?
- What adaptive measures can be taken to help prevent and mitigate the destructive effects of climate change on the cultural heritage?
- What first steps should be taken in developing a national strategy that takes into account the threats arising from climate change?

These are questions addressed by the authors of a 2013 Report on "**Climate Change and Cultural Heritage**", whose findings and recommendations are summarized in this brochure.

DEVELOPING THE REPORT ON CLIMATE CHANGE AND CULTURAL HERITAGE

One of the first reports in the world to focus on climate change and cultural heritage, and the first ever to be produced in this country, the Report was undertaken as part of the country's Third National Communication on Climate Change.

The Report draws largely on findings from a rapid vulnerability assessment of three important sites of cultural heritage:

- the Aquaduct near Skopje
- the archaeological site of Stobi
- the Plaošnik site in Ohrid

The matrix used to assess vulnerability.

Potential receptors of impacts \ Climate change risks	Long-term temp. increase	Increase in the number of freeze/thaw cycles (temp. fluctuations around 00C)	Heavy rain events	Increased flood events	Changes in humidity
A: Archaeological site:					
Static and integrity of archaeological remains					
Static and integrity of reconstructions					
B: Stone / brick deterioration:					
Stone/brick surface					
Stone/brick integrity					
Mortar					
Surface colour					
Stone / rock carvings					
C: Decorative elements:					
Mosaics					
Stone and wall paintings / frescos					
Ceramics					
C: Surrounding landscape:					
Slopes					
ravines and gullies					
Soils					
Coastal zones					

GENERAL FINDINGS OF THE REPORT

The Report confirmed that further research and preventative actions are vital to preserve the cultural heritage from the negative effects of climate change. Without such research and intervention, cultural monuments are at risk of collapse and entire cultural landscapes may disappear.

While ecosystem elements may have regenerative potential, the impact of climate change on the country's cultural heritage may be irreversible. It is a matter of urgency, therefore, to identify the specific vulnerabilities of each archaeological site, structure and landscape.

The Report found that the costs of developing and implementing an early response to climate change would be significantly lower than the costs of future damage and actions aimed at recovery.

Built structures

The Report identified the following main areas of concern regarding the impact of climate change on built structures.

- The impact of rainfall, flooding and water saturation
- The impact of extreme weather events, including strong winds
- The impact of dramatic temperature changes and increased humidity
- The impacts of pests and diseases
- The impact of changing plant physiology and distribution
- The impact of changes in the chemistry of the water table

Increased rainfall and water penetration into masonry damages the fabric of buildings by increasing the risk of damp, condensation, rot and fungal growth. This damage can both harm the decorative elements of cultural monuments, such as facades and icons, and undermine the very structures of historic buildings.

Historic buildings were constructed of porous materials, drawing water from the ground and evaporating it through the surface. Increased rainfall will thus lead to higher levels of moisture, causing increased mobilization of salt on decorated surfaces through evaporation.

An increase in the frequency of floods, storms and winds will cause significant structural damage and accelerate the natural decay processes of wood and stone work.

Dramatic temperature changes, including an increase in wet/dry/ freeze/thaw cycles will significantly accelerate the deterioration of facades and wall paintings, causing internal damage to brick, stone and ceramics. These changes will also lead to fractures in construction elements.

Soil alteration and changes in hydrological, chemical, and vegetation patterns may lead to the destruction of archaeological artefacts buried in the ground – especially objects that are not resistant to increased humidity.

Changes in ecosystems may lead to biological infestation – resulting in the migration of pests that may introduce new structural threats to timber and other organic building materials.

Cultural landscapes

Rising sea levels and increased storm events may cause the disappearance of entire coastal settlements.

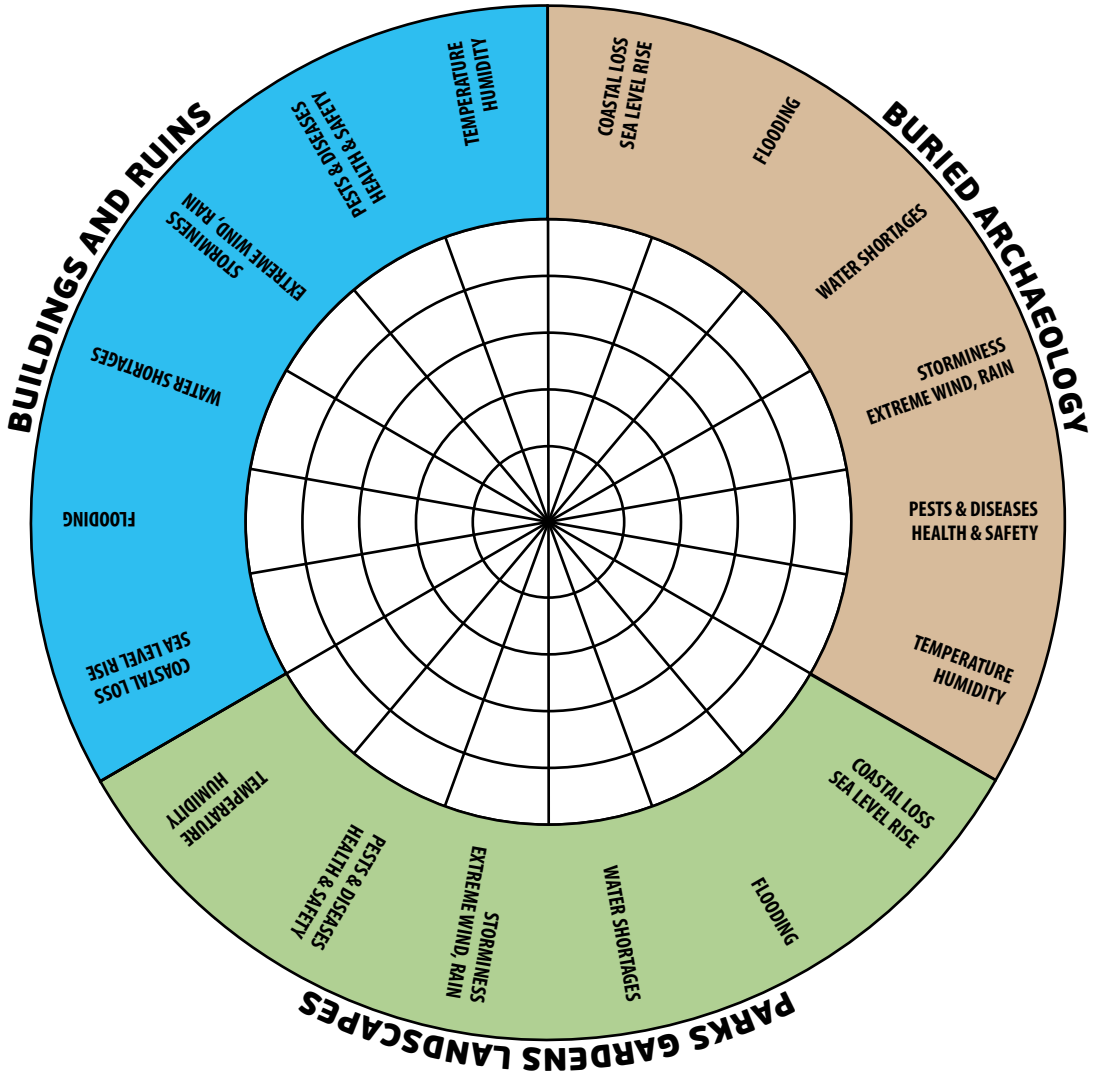
Increased temperatures, droughts and extreme climatic conditions may irreversibly affect cultural landscapes, especially agricultural and pastoral landscapes.

Traditional patterns of land-use and management were often developed and sustained in fragile ecosystems with limited natural resources, making them especially vulnerable to changes in climate. These changes may force communities to abandon such traditional practices and even to abandon these living sites.

Depopulation and the breaking up of communities will cause the loss of invaluable cultural memory and important traditional knowledge about the sustainable use of land in specific environments, particular building techniques, and the erosion of physical structures.

This Report thus highlighted the need to take account of the social impact of climate change on cultural landscapes, including demographic changes, socio-cultural preferences, and the relationship of people with the environment. Thus the Report emphasized the range of variables that need to be considered in assessing the impact of climate change on cultural heritage - the variables of nature, culture and people.

Figure: Key Climate Impacts on Cultural Heritage
 (Source: UCL, Centre for Sustainable Heritage)



MAIN FINDINGS OF THE RAPID VULNERABILITY ASSESSMENT

The report found that changes in climate will either induce significant damage or accelerate ongoing damaging processes in all three sites.

THE SKOPJE AQUADUCT



Appearance and Origins

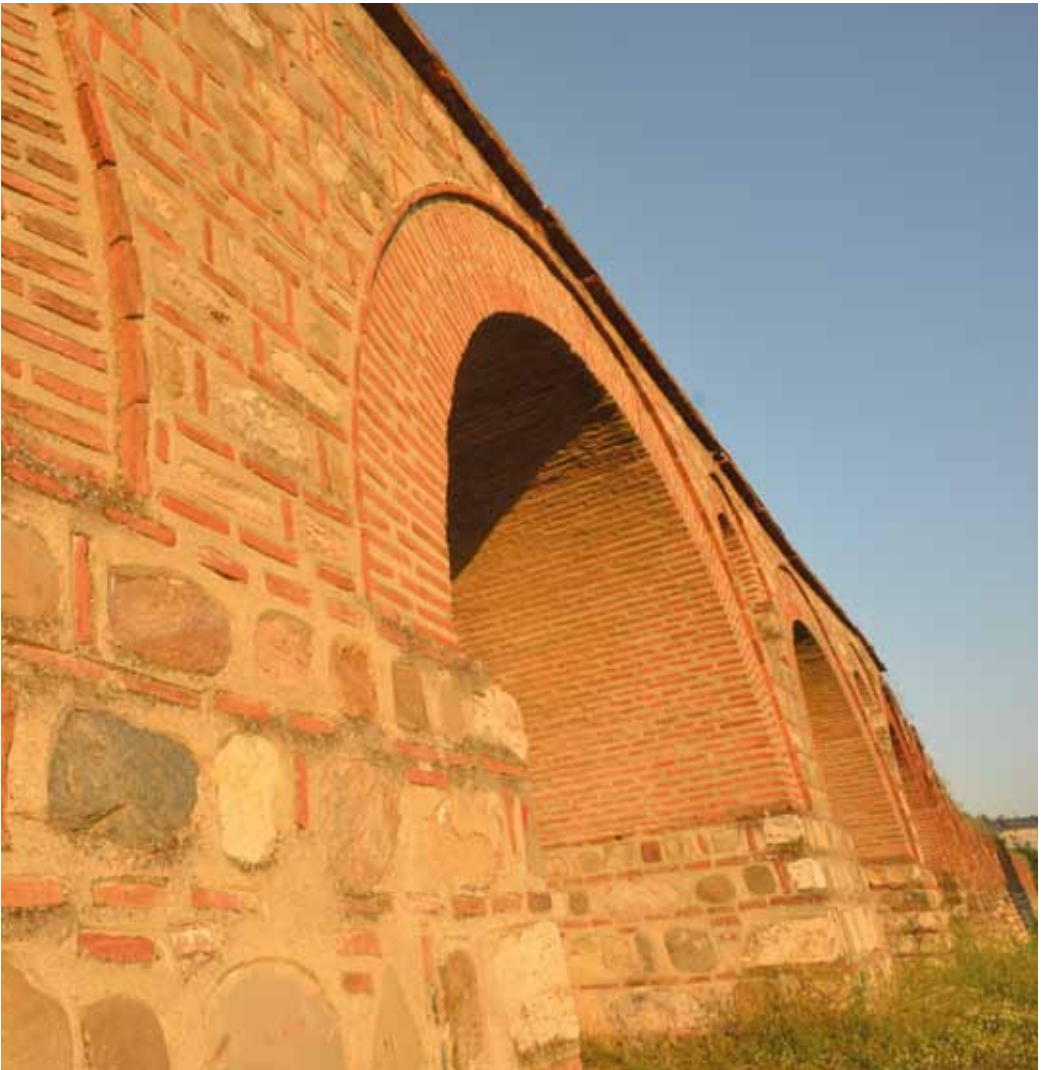
The Aquaduct near Skopje, in the village of Vizbegovo, is one of the largest preserved Aquaducts in the territories of former Yugoslavia, with 55 remaining arches.

The elaborate masonry of the construction, with varying layers of brick and stone, make it a highly attractive landmark, while its disputed historic origins reflect the complexity of Macedonia's history.

The date of origin of the Aquaduct has still not been definitively established. Two main theories have been put forward:

- The southern part of the Aquaduct was built under the Roman Emperor Justinian in the 6th century AD.
- The Aquaduct was built in the 15th century under the Ottoman ruler Mustapha Pasha.

In the absence of conclusive research, the Report allows for both possibilities, accepting that the greater part of the current structure was built (or reconstructed) in the 16th century, with some additional piping added in the 19th century. The Aquaduct is found to have been in use till as recently as 1914. Until that time, the structure was regularly maintained.



Conservation Status

The Skopje Aquaduct is currently in a critical state of conservation. There is conspicuous visible damage to the surface of the structure and some arches have recently collapsed.

The Report identifies the main cause of this damage in the earlier canalization of the River Serava, which altered the ground water saturation of the soil in the southern part of the site. These changes in the level of ground water resulted in uneven soil compression under the pier foundations, causing a number of arches to lean. Further soil movements could cause these structures to collapse.

The canalization of the River Serava also reduced the drainage of rainwater, causing the formation of lakes of water during the rainy season and leading to erosion and an increase in water penetration in the upper levels of structure.

Seasonal changes in soil saturation and water penetration are critical. Natural processes of decay are accelerated by the number of freeze/thaw cycles.

The Report further found that a proposed project to re-naturalize the riverbed, while welcome, needs to take greater consideration of the threats of climate change to avoid further shifts in soil, and should be accompanied by efforts to strengthen the southern foundations of the Aquaduct.

In addition to damage from ground water saturation, rain-induced damage includes surface water retention. Existing cracks and structural damage allow rain to penetrate more deeply, accelerating erosion and threatening disintegration.

A third cause of damage was found in the uncontrolled growth of vegetation on the upper level of the Aquaduct, with tree roots resulting in cracks.

The Anticipated Impact of Climate Change

Climate change will primarily affect the statics of the Aquaduct, threatening its structural integrity.

An increase in the number of days with freeze/thaw cycles, as well as increased heavy rain and flooding, with fluctuations in the water table, together threaten to damage the structure in its entirety. This is because freeze/thaw cycles result in frost shattering, which causes damage to the bricks at the top of the Aquaduct, ultimately leading to the collapse of arches.

Increased rainfall threatens to wash out the grout and lime mortar from the seams of the structure, leading to the deterioration of the bricks.

Heavy rain will increase flooding, resulting in damage to the bases of the arches.

Fluctuating ground water levels will exacerbate the problem of uneven soil compression, destabilizing the structure.

STOBI



Stobi is one of the country's most famous archaeological sites. Located on the main ancient trade route from the River Danube to the Aegean Sea, the first town was founded here in early Roman times where the River Crna joins the River Vardar and the settlement became an important trading centre. The structures that survive today are largely from the Late Hellenistic period, though the site covers all stages in urban development from the early Roman period to the late 6th century.

The town underwent many changes over the centuries, many of which were the results of adaptation to historical changes in climate. Recurrent flooding of the River Crna, for example, is thought to have caused the lower terraces to be abandoned after the 4th century. This flooding resulted in high levels of ground water, which continue to be a problem today.

State of conservation

The field survey undertaken for the Report found that the walls exposed by excavation showed conspicuous damage from the weathering of rocks and the ongoing washout of bonding materials. Frost damage has led to plate-like cracking of the soft sandstone.

Anticipated impact of Climate Change

Prolonged heavy rainfall will result in additional washout of ancient bonding materials.

An increase in precipitation events threatens to erode the transition areas of the excavated sites and the steep escarpments of the surrounding terrain. Such erosion may ultimately cause the structures of the upper layers to collapse or move to deeper levels, further undermining the structural stability of ancient walls

Increased rainfall is expected to lead to Increased flooding of the River Crna.

Temporary flooding of the ground surfaces of the structures at lower levels will result in the soil surfaces being muddied by eroded sediment. This in turn can lead to cracking in subsequent dry periods.

Flooding in the lower terraces will cause ground water changes that can damage the sub-surface structures of the site.

The country's high number of 'icing days' —with some 40–60 freeze/thaw days per year—will continue, with the frequency of freeze/thaw cycles leading to further deterioration of the grey tertiary sandstone that forms the main construction material of the walls of Stobi.

An increase in sand storms with higher wind speeds may damage the ancient mosaics.





Increased fluctuations in the water table will damage the structural integrity near the banks of the River Crna.

Ground water changes will intensify the washout of clay and mortar.

Changes in anoxic and oxygen conditions may cause damage to frescos.

Further rock decay, with the leaching of fine grained particles, will lead to the removal of rock mass

The ancient ceramics exposed by excavation and displayed on site are vulnerable to freeze/thaw cycles.

THE ARCHAEOLOGICAL SITE OF PLAOSŃNIK IN OHRID

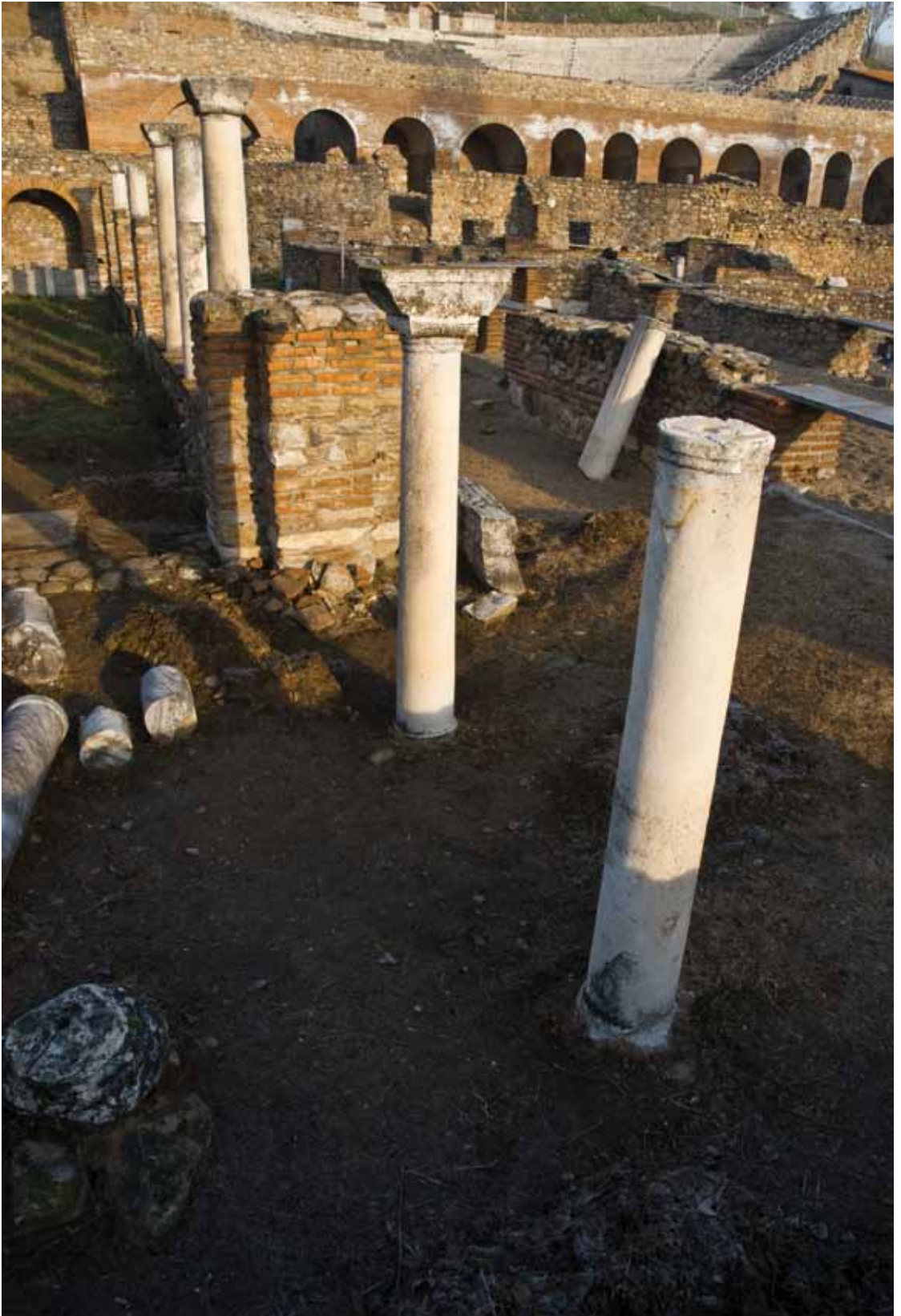


Plaošnik is an archaeological site within the UNESCO-protected city of Ohrid and a religious centre of great significance. The site includes remains from the Late Bronze Age, the Classical and Late Antique periods, as well as early Christian and medieval structures - especially the Monastery of St Clement and the Basilica of St Panteleimon.

The site is of immense historical and religious significance, above all as the location where the first Slavic bishop, St Clement, who arrived in Ohrid in 886, established what may have been the first institution to use the Glagolitic alphabet to translate the Bible into a Slavonic language.

The 9th century Monastery of St Clement was itself built on the remains of an earlier Roman complex with stunning 5th century mosaics. St Clement is buried in the crypt of an earlier Roman basilica whose foundations are visible today beneath the later building.

Under Ottoman rule, the monastery was turned into a mosque. From this period, too, is dated the tomb of Sinan Chelebi, the founder of an Islamic charitable institution, which is situated within the Plaošnik site.



Intense excavation work continues on the site, together with major building projects that include the recently reconstructed Church of St Clement and Panteleimon, and the ongoing construction of a massive new monastic complex St Clement's University, which will cover up to a third of the site in several locations built into or above the excavated Christian remains.

State of conservation

The Report found the site of Plaošnik to be well protected due to conservation measures.

The main damage identified on the site is due to the uncontrolled growth of vegetation in almost all sections of the site. This vegetation affects the stone and clay floors and wall segments underneath the new additions to the site. Removing this vegetation is a matter of urgency.

Other problems identified on the site arise from thaw transition, rainwater runoff and wind erosion.

Rain water runoff was found to be a matter of particular concern, especially because the planned new constructions may reduce drainage on the site.

Anticipated impact of climate change

The preservation layers that have been added to the site are largely adequate to protect the structures from the eroding effects of climate change.

However, water runoff remains a threat with changes in climate, as increased rainwater runoff streams, especially after heavy precipitation, could wash out soil segments underneath the stratigraphy and walls, leading to their eventual collapse and the creation of cavities.

The Report raised concern that the plans for the new buildings may not have taken sufficient account of the effects of climate change, and particularly the need to cater for increased rain water drainage.

CONCLUSIONS AND RECOMMENDATIONS

The findings of the Report confirm and reiterate the urgent need for in-depth systematic studies to be undertaken on the effects of climate change on the country's cultural heritage. No such studies have previously been conducted in Macedonia.

From the results of the rapid vulnerability assessment carried out for the three selected sites, the Report concludes that climate change is likely to accelerate a number of damaging processes in all three case studies.

The Report's initial analyses of the sites show that damage to the cultural heritage never occurs as a result of isolated causes, but arises from a combination of environmental and anthropogenic factors, including changes in land use, urbanization and development. These changes over time have increased the vulnerability of ancient sites to the effects of climate change.

The vulnerability to climate change identified in all three sites confirms that archaeological sites may be the category of cultural heritage most vulnerable to the effects of climate change.

The results of the Report's initial and preliminary assessments of the three sites provided the basis for recommended next steps to be taken. These steps are suggested in the form of five work packages.





The proposed work packages would enable verification of the initial findings, participation of local authorities in the development of further assessment and management strategies, and the design of a full strategic plan of adaptation measures for each site.

The Report identified three major limitations that will need to be addressed in developing adaptation measures:

1. The current lack of research and knowledge about soil conditions, including ground water reservoirs
2. The need for more information about plans for future developments, e.g. the building of the new monastic complex in Plaošnik, and the re-naturalization of the River Serava.
3. The difficulty of predicting the occurrence and impact of extreme weather events.

One of the key achievements of the study undertaken for the Report is the formulation of recommendations for future steps to develop full strategies for adaptation.

The key objective to be included in national strategies is that of increasing the general understanding of the severity of the impact of climate change on the cultural heritage and the need to include cultural heritage as a priority field in the country's National Communications to the UNFCCC.

The Report highlights the importance of active information exchange and cooperation with other countries from the region, for example through UN and EU cooperation or participation in trans-national and cross-regional research project.

The five sample work packages produced by the Report further recommended continuing the studies towards a systematic approach for assessing vulnerability and strategic management planning in the form of general guidelines and toolkits allowing for easy application at site level. The development of such toolkits would enable those responsible for the heritage sites to understand the specific risks and vulnerabilities of each site to climate change and allow them to develop adaptation strategies.

A systematic monitoring framework needs to be developed for Macedonia's cultural heritage. Such a framework would enable the country to document efforts and solutions at a variety of sites, building a richer database for future actions.