Future-proofing the past

We speak to **Dr Johanna Leissner** about her current work on the Climate for Culture initiative, which is aimed at safeguarding our cultural heritage against the effects of climate change

What inspired the creation of the Climate for Culture initiative, and what are the main objectives of the project?

The inspiration for the project was borne out of our concern about the effects of climate change on our cultural heritage. Existing knowledge on the subject is limited, so we wanted to investigate the possibility of combining climate modelling and building simulation, which has never been done before. Our objectives and the main innovation are to use simulation and modelling tools to better predict the influence of the changing outdoor climate on the microclimate in historic buildings until 2100, and to assess the damage potential of these future microclimates on art collections in various climate zones. These data will serve for the economic assessment of the cost of protecting cultural heritage, and for the development of energy efficient and sustainable mitigation and adaptation measures to best preserve the collections

How have previous studies such as Noah's Ark, informed the formation and ongoing research of Climate for Culture?

The findings of the Noah's Ark project were the starting point for our research. However, we use data from climate modelling on a regional scale with a resolution of 10 times 10 km over the whole of Europe. These models are based on two scenarios (A1B and the latest scenario for the IPCC Assessment Report 5) to obtain information on the climatic effects on indoor conditions in historic buildings

Could you provide some examples of cultural heritage and European symbols that are threatened by the effects of climate change? How is climate change affecting these?

The threat of climate change on cultural heritage is manifest – for example, the corrosion and degradation of all the materials from which art and cultural objects are made

will increase with increasing temperatures. The reaction rate follows the well known Arrhenius equation, meaning that the reaction rate for many common chemical reactions at room temperature will double for every 10 °C rise in temperature, which implies a threat of damage to objects all over the world. Cultural heritage sites in coastal locations such as Venice or Alexandria will also be threatened by rising sea levels, with the increased potential of flooding and storms leading to physical damage of delicate structures and outside surfaces.

Can you discuss how data is being gathered to demonstrate damage to cultural heritage, and how you will use this information to inform your models?

Currently we are setting up a European-wide data bank consisting of more than 180 historic buildings, covering the different climate zones over Europe and Egypt. We are collecting data concerning the historic outdoor climate at the site, indoor microclimate recordings about the properties of the buildings concerned (what kind of construction materials were used, lightweight or heavyweight construction etc.) and observed damages related to climate change. The data will feed into simulation models for historic buildings.

How will you ensure that these models provide a more reliable damage assessment when compared with their current counterparts?

We are the first team to use high resolution climate models in a combination of building simulation models. Of course there will be room for improvement later on, but for the moment we are just trying to obtain damage assessment data through the models we are developing.

What are the projected effects if these cultural sites are lost from Europe? Would their loss extend beyond an economic impact?

The effects of climate change are manifold and operate on different timescales – in one sense it is a gradual, creeping process, and on the other hand can act very suddenly, for example if a heavy storm destroys the roof of a historic house. Some of the most attractive features of Europe's rich cultural diversity, which make it so unique in the world, could be lost. The impact would be both economic and cultural; it's not just a matter of attracting fewer tourists but also losing our cultural memory and identity as a society, leaving fewer opportunities for future generations to learn about the achievements of their forebears.

Is the protection of cultural heritage accounted for in the IPCC reports?

The protection of cultural heritage from climate change is not yet included in the IPCC reports. We would like to suggest including cultural heritage in the reports since it is a non-renewable resource of utmost significance to mankind. Once it is lost, it is lost forever. We do not have the right to hand over to future generations a world depleted of our cultural testimonies.

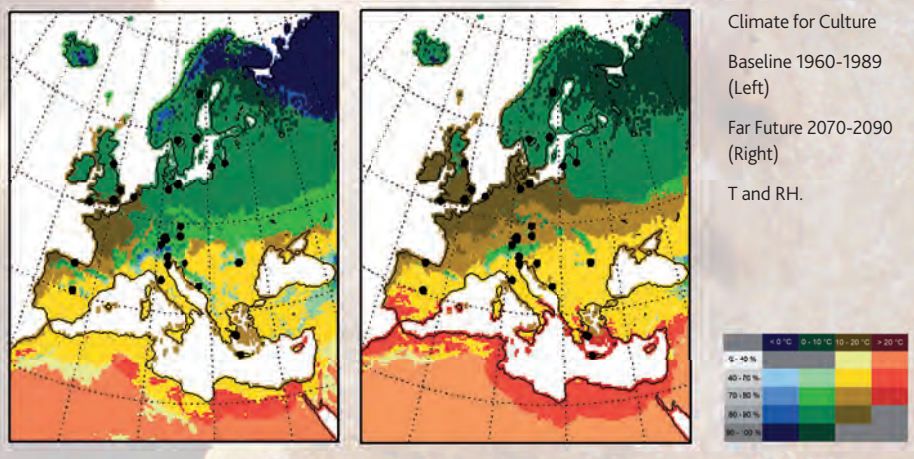
Protecting our history, whatever the climate

Climate for Culture is a major new European initiative, which seeks to improve the preservation of our cultural heritage by predicting the effects of changing outdoor climate on the indoor microclimates of historic buildings

CLIMATE CHANGE IS one of the critical global challenges of our time. Scientific consensus is now clear that human-induced global climate change is occurring, and will continue to affect the global climate for at least the next one or two hundred years. Since the pre-industrial era, atmospheric concentrations of greenhouse gases have increased due to human activities including significantly changing land use and land cover and the widespread combustion of fossil fuels. For the range of emissions scenarios foreseen by the IPCC, it is predicted that the Earth's mean surface temperature will warm by 1.4°C to 5.8°C by the end of the 21st Century, with land areas warming more than the oceans, and high latitudes warming more than the tropics. Precipitation is predicted to increase in high-latitude and equatorial areas while decreasing in the subtropics, with an increase in heavy precipitation events. Cities would also see their temperatures rise beyond the 2°C difference already observed between urban areas and the surrounding countryside.

These changes in temperature, rainfall, soil conditions, groundwater and sea levels will contribute to a range of direct and indirect effects on the natural and material environment. According to UNESCO's World Climate Report, we are already seeing the initial effects of climate change; glaciers are melting away, rivers are heating up, and plant and animal species are moving beyond the ranges of their known habitats.

Environmental changes will have important implications for the preservation of our cultural heritage including historic buildings and the art within them. Serious planning will be necessary to safeguard Europe's many sites of significant historical relevance. The position taken by the Climate for Culture project is that action must be taken now, and not left to future generations; our cultural heritage is a vital window to the past, the key to our collective memory, and should be recognised as a non-renewable resource to which sustainability principles must be applied. More reliable assessments will lead to better prediction models, which in turn will enable efficient sustainable adaptation and mitigation strategies to be developed to preserve these invaluable cultural assets for the long-term future.



Climate for Culture

Baseline 1960-1989 (Left)

Far Future 2070-2090 (Right)

T and RH.

The project builds on the work of the landmark study Noah's Ark, which aimed to predict the effects of climate change on Europe's culturally important buildings over the next century. The care of buildings and cultural heritage in general must take into account the climatic factors affecting buildings over long periods, accounting for specific conditions including freeze-thaw cycles, erosion from wind-driven rain or sand, diurnal humidity cycles, solar radiation, gas and particle concentration, rainfall acidity levels, and water table and sea levels.

The sensitivity of cultural heritage sites to climate change effects is such that they could become important indicators of climate change itself.

UNDERSTANDING SITE SPECIFIC THREATS

Climate for Culture is a large-scale joint collaboration, which brings together 30 partners from 16 nations in Europe and North Africa to connect climate change evolution scenarios with whole building simulation models for the first time. Hygrothermal assessment is the analysis of heat, vapour and moisture transfer through multilayered building elements over time. The development of innovative hygrothermal simulation software, in conjunction with high resolution climate modelling on regional scale and multiple in situ investigations at cultural heritage sites throughout Europe, will enable more systematic and reliable damage and risk assessments to be developed for specific sites.

Over a five year period, the effects of climate change on selected European and North African UNESCO World Heritage Sites will be studied, including Schönbrunn Castle in Vienna, the pyramids at Saqqara in Egypt, and the city of Venice, applying the new software simulation techniques to provide customised early prevention strategies. For example, the thousands of tourists who visit the Bavarian royal castles of Ludwig II bring with them an overabundance of moisture, leading to mould – a symptom of the site's hygrothermal pathology which will be exacerbated by global warming. Using the powerful new software platform, researchers investigating the influence of climate change on these structures will be able to model this process to develop new mitigation strategies, incorporating the findings of previous EU projects on sustainability and energy efficiency.

In order to ensure an effective and efficient use of resources, Climate for Culture will be reassessing existing mitigation strategies with a special focus on energy and resource efficiency, and on their potential for transfer to different regions of Europe and the Mediterranean. In the near future these new strategies will be applied to a wide variety of immovable and movable

CASTLE OF LINDERHOF OF THE BAVARIAN KING LUDWIG II

cultural assets, such as museums, churches, castles, libraries, and archives, which operate under changing environmental conditions in different climatic zones.

The project aims to develop a simplified classification system for historic buildings as part of its new risk assessment methodology for preventive conservation, which will utilise a retrospective investigation of climate-induced damage processes and the preservation of works of art over past centuries to improve future risk assessments.

DISSEMINATING FINDINGS FOR INFORMED POLICY

A Political Dissemination Board will be established consisting of members of the European Parliament, National Ministries and other representatives, to ensure that the results from this project are brought to the attention of policy and decision makers. The Climate for Culture project recognises the need to raise awareness among the political establishment of the relative costs of action versus inaction in the protection of cultural heritage, and so the economic impacts and physical risks will be clearly identified. Easily readable outdoor and indoor climate risk maps will be produced using completely new data from high resolution climate modelling, as a useful measurement and maintenance planning tool to aid decision makers in Europe's different climate zones.

An important cornerstone of the project will be the case study database, intended to facilitate the direct transfer of knowledge between the major European institutions taking part. This will also be fostered by the creation of exchange programmes for younger researchers.

To date, this genuinely multidisciplinary team has proven that it is possible to combine high resolution climate modelling with buildings simulation software, obtaining results which can predict microclimates inside historic buildings until 2099. Chemists, material scientists, physicists, meteorologists, ocean physicists, wall paintings conservators, paintings conservators, engineers, IT specialists, economists, art historians and biologists from all over the continent have worked together to address the project's complex goals.

The final achievement of the Climate for Culture project will be an economic impact report on cultural heritage in the times of climate change, similar in nature to the 2006 STERN report which cast the implications of global warming in terms of monetary cost. In-depth assessment of the most recent methodological developments in cost-benefit analysis will inform this document, which will be able to base its economic valuation techniques on the gains made by the project in the areas of climate change modelling, whole building simulation and damage/risk assessments. Along with the other products of Climate for Culture, these results will form the basis of a significant and truly European contribution to future IPCC reports.

The regional climate model REMO developed at MPIMET. Jacob D (2001) A note to the simulation of the annual and inter-annual variability of the water budget over the Baltic Sea drainage basin. Meteorol Atmos Phys 77:61–73.

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CLIMATE FOR CULTURE

DAMAGE RISK ASSESSMENT, ECONOMIC IMPACT AND MITIGATION STRATEGIES FOR SUSTAINABLE PRESERVATION OF CULTURAL HERITAGE IN THE TIMES OF CLIMATE CHANGE

OBJECTIVES

Development and application of methodologies, technologies, models and tools for damage assessment, monitoring and adaptation to climate change impacts (excluding extreme events).

PARTNERS

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