Climate, Environment and Food Connections

Interdisciplinary Perspectives on Societal Resilience

International Workshop 19–21 September 2023
Uppsala University

ABSTRACT BOOKLET &
INFORMATION FOR PARTICIPANTS

Organized by:
Marco Hostettler, Erika Weiberg, Martin Finné and
Centre for Integrated Research on Culture and Society (CIRCUS)

UPPSALA UNIVERSITET

Centre for Integrated Research on Culture and Society

UNIVERSITÄT BERN

OESCHGER CENTRE CLIMATE CHANGE RESEARCH

I. INTRODUCTION

The workshop aims at interdisciplinary exchange concerning the drivers of climate and environmental change as well as the societal responses towards these changes across time and space. Through land use and food production human societies have been transforming their environments at least since the transition to agriculture (Southwest Asia/Europe ca. 9000-3500 BC). At the same time food production systems have always been vulnerable to climate and environmental change, which might alter important variables such as the availability of water, the presence of pests or other crucial ecosystem services. Understanding the causes and effects between the different factors of change, however, is far from straightforward and requires interdisciplinary research.

Today, there is an unprecedented amount of data on past climate change, on human cultural evolution and human-environment interactions in different fields. Climate and environmental indicators (so called proxies) preserved in e.g., sediments, ice cores or speleothems help to trace past climate and environmental change. Archaeological data offers understandings of human behaviour and bio-cultural interactions in the deep past. Case studies and forecasts might reveal current and past vulnerabilities, mitigation strategies and adaptations to environmental change. Understanding the drivers of such dynamics and how human societies responded might help build resilient pathways for the future.

The workshop seeks to address questions, such as:

- What can we learn about the past climate from natural archives and what are their limitations?
- How can human impact on the environment be disentangled from other drivers of environmental change?
- How did and do societies react towards climate and environmental change and what helps to build resilience?
- How did and does climate change affect food-systems and what can be learned from past and present examples?

Front image: Solar panels and olive trees on Chalkidiki peninsula (northern Greece) as examples of recent land use change (Photo: Marco Hostettler, University of Bern).

II. SCHEDULE

Tuesday, 19 September

Room: 06-1023 Geijersalen, Engelska Parken

17:00 Welcome
17:10 Paola Vesco
Uppsala University, Department of Peace and Conflict Research & Peace Research Institute Oslo
01 Climate, Conflict, and Vulnerabilities: Insights from the Societies at Risk Project

18:00 John M. Marston
Archaeology Program & Department of Anthropology, Boston University
02 Local Ecological Knowledge and Imperial Demands in Agricultural Practice

Wednesday, 20 September

Room: 22-0031, Engelska Parken

08:30 Registration

09:00 Welcome

09:15 Introduction

09:30 Anna Rutgersson
Uppsala University, Department of Earth Sciences
03 Reconstructing Climate by Numerical Modelling

10:00 Matthew J. Jacobson
Swedish University of Agricultural Sciences, Department of Urban and Rural Development
04 Palaeoclimatic Records in the Aegean and their Uncertainties

10:30 COFFEE BREAK

11:00 Martin Finné
Uppsala University, Department of Archaeology and Ancient History & Department of Human Geography
05 Reconstructing Past Climate Using Cave Speleothems

11:30 Sarah Rowan
University of Bern, Department of Chemistry, Biochemistry and Pharmaceutical Sciences & Oeschger Centre for Climate Change Research
06 Radiocarbon: A Time Machine for Earth's Carbon Cycle and Critical Zone Dynamics

12:00 Discussion (Chair: Karin Holmgren, Swedish University of Agricultural Sciences)

12:30 LUNCH BREAK

14:00 Claudia Teutschbein
Uppsala University, Department of Earth Sciences
07 Disentangling Climate and Human Impacts on Water Resources: Insights from Sweden and the Growing Potential of Data-Driven Techniques

14:30 Vincenza Ferrara
Uppsala University, Department of Archaeology and Ancient History
08 Climate and Environmental Change: Measures, Perceptions or Both? A Case from Rural Sicily (Italy)

15:00 COFFEE BREAK

15:30 Anton Bonnier
Uppsala University, Department of Archaeology and Ancient History
09 Climate Variability and Agricultural Strategies in the Greek Polis: the Case of Attica and the Northeastern Peloponnese

16:00 Lieveke van Vugt[1,2], Erika Gobet[1,2], César Morales-Molino[1,2,3], Kathrin Ganz[1,2], Tryfon Giagkoulis[4], Antonietta Knetge[1], Andy Lotter[1,2], Martin Grosjean[2,5], Hendrik Vogel[2,6], Kostas Kotsakis[4], Albert Hafner[1,7], Willy Tinner[1,2]
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10 **Deciphering Human-Environment Interactions at the Onset of Farming in Europe with a Continuous High-Resolution Palaeoecological Record from Limni Zazari, Northern Greece**

16:30 Discussion (Chair: John M. Marston, Boston University)

19:00 Workshop Dinner (Speakers only)

Thursday, 21 September

Room: 22-0031, Engelska Parken

09:15 **Introduction**

09:30 Wiebren J. Boonstra
Uppsala University, Department of Earth Sciences
11 **Sociologies of Scale. What Is the Relation Between the Scale of Human Societies and Global Environmental Change?**

10:00 Kailin Hatlestad
Uppsala University, Department of Archaeology and Ancient History
12 **Investigating Regional Sensitivity to Climate Events through Spatio-Temporal Analysis of C14 Records**

10:30 COFFEE BREAK

11:00 Stefan Döring[1,2], Jonathan Hall[1], Tobias Hecker[3]
[1] Uppsala University, Department of Peace and Conflict Research, [2] Peace Research Institute Oslo, [3] Bielefeld University, Department of Psychology
13 **Drought Exacerbates the Impact of War Exposure on PTS: Evidence from Surveys Among Refugees**

11:30 Erika Weiberg
Uppsala University, Department of Archaeology and Ancient History
14 **Vulnerable Mycenaeans? Climate Change Vulnerability Assessment of a Bronze Age Society**

12:00 Discussion (Chair: Anneli Ekblom, Uppsala University)

12:30 LUNCH BREAK

14:00 Martin K. Skoglund
Swedish University of Agricultural Sciences, Department of Urban and Rural Development
15 **Agrometeorological Relationships in Early Modern Scandinavia**

14:30 Niklaus E. Bartlome
University of Bern, Institute of History & Oeschger Centre for Climate Change Research
16 **Wine, Vacherin and Volcanoes: Impacts of the 17th Century Large Volcanic Eruptions**

15:00 Marco Hostettler
University of Bern, Institute of Archaeological Sciences & Oeschger Centre for Climate Change Research
17 **Exploring Prehistoric Land Use and Climate Adaptations in the Southern Balkans**

15:30 COFFEE BREAK

16:00 Final Discussion (Chair: The organizers)

III. ABSTRACTS

September 19 ‖ KEYNOTE LECTURES

01 The Impacts of Armed Conflict on Societal Vulnerability

Paola Vesco, Department of Peace and Conflict Research, Uppsala University, Sweden/Peace Research Institute Oslo, Norway

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The detrimental impacts of wars on societies are well documented across research domains, from public health to micro-economics: Armed conflicts kill and injure people, deteriorate human development, destroy infrastructure and capital, reduce access to water and food, halt or impair economic growth, induce migration and displacement, spread uncertainty and fear, and may encourage authoritarian drifts. In turn, the adverse societal effects of armed conflicts can shape communities' vulnerability to other types of disasters, such as those induced by climatic changes and natural hazards, the spread of epidemics, or threats to social cohesion and trust, thus making communities less able to recover from shocks. Understanding the interplay between climate-related hazards, conflict exposure, and societal vulnerability is therefore paramount to inform effective actions to manage and adapt to risks, and increase societal resilience against climate-related and human induced shocks. Yet, the association between exposure to armed conflict and societal vulnerabilities is still poorly understood. The lecture provides an overview of the existing knowledge on the effect of armed conflict on vulnerability, collecting evidence from ongoing work. I will present the results of three main research efforts: a systematic literature review of over 50 studies on the effect of armed conflict on societal vulnerability to hazards; an empirical study of the political determinants of vulnerability to flood, and a machine learning approach to assess the compound effect of natural disasters and armed conflict on country-level vulnerability. The lecture pays particular attention to indirect effects of armed conflict and feedback loops, shedding light on the potential mechanisms and drivers through which violence may increase societal vulnerability to climate related hazards, and how increased vulnerability may in turn amplify threats to political stability and human development. The lecture concludes by highlighting some future research avenues, with a special focus on the complex interactions between climate shocks, armed conflicts and societal vulnerability, and how and under what conditions armed conflict exacerbates vulnerability to climate hazards.

02 Local Ecological Knowledge and Imperial Demands in Agricultural Practice

John M. Marston, Archaeology Program & Department of Anthropology, Boston University

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Agriculture mediates human interactions with environments and provides the primary avenue through which human societies adapt to environmental change, primarily at the local level through lived experience and inheritance of ecological knowledge. Such adaptations are constrained, however, by both economic pressures and histories of environmental change, which render certain agricultural strategies desirable and others unproductive. Here I illustrate one narrative of long-term agricultural and environmental change over the course of successive imperial periods, the Hittite through Roman empires, at the site of Gordion in central Anatolia. The application of two distinct theoretical perspectives, niche construction and resilience thinking, to a rich body of environmental archaeological data helps us trace long-term entanglements between people and

landscapes. I explore how these theoretical perspectives conflict, as well as complement one another, in reconstructing environmental change in the past. I conclude with the implications of such studies for a broader understanding of global environmental change in the Anthropocene.

September 20 ǁ Session 1

03 Reconstructing Climate by Numerical Modelling

Anna Rutgersson, Department of Earth Sciences, Uppsala University

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Numerical models for climate research have been developed from stand-alone atmosphere or ocean models describing the development of the atmosphere or ocean over time as a response to the radiative forcing. The use of Earth system models (ESMs) that interactively couple atmospheric, marine and terrestrial energy, water and biogeochemical dynamics is becoming increasingly common practice in global climate assessments (e.g., IPCC 2013). Through international coordinated protocols for climate simulations common frameworks have been set up to generate ensemble of model simulation with a range of models, processes, time periods and numerical resolution to improve models, understand the climate variability and better understand climate responses. For simulation of future climates scenarios of radiative forcing are being used. For the past climate models can be used combined with observations (in-situ or remote sensing) to develop reanalysis products of reconstructed climates. For longer time-scales paleoclimate simulations are being developed, for those radiative forcing needs to be estimated from geological records (GHG levels and insolation) as well as key processes (like extent of continental ice sheets and sea-level). Development of climate is strongly linked with the terrestrial biosphere and food-production creating an interlinked climate-environment system. Paleoclimate simulations also need geological data for defining initial state a model validation. One example of a climate model used for reconstruction is the EC-Earth, sing a horizontal resolution of ~125 km it is part of the Paleoclimate Model Intercomparison Project (PMIP), contributing to phase 6 of the Coupled Model Intercomparison Project (CMIP6). Paleoclimate modelling is robust out-of-sample test bed of the climate models used to project future climate changes.

04 Palaeoclimatic Records in the Aegean and their Uncertainties

Matthew J. Jacobson, Department of Urban and Rural Development, Swedish University of Agricultural Sciences

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The Aegean has a long and diverse history of human occupation that has left rich archeological and paleo-environmental remains. Analysis of these remains has enabled a detailed understanding of previous societal, agricultural, and environmental change. Fortunately, the Aegean is also one of the most extensively studied regions in the field of paleoclimatology, which makes it a very promising testbed for human-environment-climate interactions at different time scales and in different environmental settings. Most commonly, geochemical and isotopic analyses of palaeoclimate archives – cave speleothems, lake sediments, and marine sediments – in the Aegean are utilized to produce records of various aspects of the hydro-climate: lake water balance, effective moisture, and precipitation. Even when quality-controlling records based on

several criteria, the amount of hydro-climate records in the wider Aegean region has more than doubled in the last 5 years – going from 15 to 31.

In this talk, I will present the results of a collaboration between researchers at SLU, Uppsala University and Leibniz University Hannover (Germany): a synthesis and analysis of Aegean hydro-climate records. For this, we have collated all available Holocene palaeoclimate data from the Aegean region into standardized centurial and decadal (where they are appropriately high resolution) bins, thus enabling direct comparison through statistical and spatial analyses. A complex picture emerges of heterogeneous climatic conditions that vary through space and across time, which contributes to our understanding of Holocene climate evolution over decadal and centurial timescales.

Whilst enabling this type of study, having numerous diverse palaeoclimate records also presents significant challenges. Each archive type, and individual record, comes with its own interpretation, characteristics, and uncertainties. The Aegean synthesis will thus also be utilized in this talk to introduce the different archive types and their limitations. Issues such as resolution, dating uncertainty, lag, spatial coverage and non-climatic influences are often masked in the paleoclimate literature or hard to identify without specialist knowledge, but these are vital to consider in studies of human-environment-climate interactions.

05 Reconstructing Past Climate Using Cave Speleothems

Martin Finné, Department of Archaeology and Ancient History & Department of Human Geography, Uppsala University

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Paleoclimatologists use a range of different proxies recorded and preserved in natural archives to reconstruct climate conditions beyond the period of systematic meteorological observations. Speleothems from karstic caves form slowly over centuries and millennia and can be used as a natural archive containing several types of climate proxies. In recent decades paleoclimate data from speleothems from different environments and covering time spans have been produced from around the world, illustrating the versatility and robustness of the method. In this talk I will give a brief overview of how speleothems can be used to reconstruct the climate of the past using case studies from the Mediterranean.

In the Mediterranean paleoclimate information from speleothems have been instrumental for the understanding of climate and climate change during the Holocene. Speleothems can be dated with great precision and proxies held within them are often less influenced by human activity than for instance proxies from lake and wetland sediments. However, like all natural archives and proxies, speleothems have their unique set of limitations and uncertainties that need to be accounted for when reconstructing the climate of the past. A brief view on the possibilities and limitations with the method will conclude the talk.

06 Radiocarbon: A Time Machine for Earth's Carbon Cycle and Critical Zone Dynamics

Sarah Rowan, Department of Chemistry, Biochemistry and Pharmaceutical Sciences & Oeschger Centre for Climate Change Research, University of Bern

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Radiocarbon is an important radionuclide used to investigate processes in the global carbon cycle. The technique is based on the radioactive decay of the ^{14}C isotope. Naturally produced ^{14}C is absorbed into the terrestrial biosphere through photosynthesis and respiration, and into the oceans through equilibration with the atmosphere. With a half-life of ~ 5700 years, the decay of ^{14}C serves as a clock through which up to ~ 55,000 year old material can be dated. For paleoclimate applications, ^{14}C dating can be applied to several natural archives including sediments, ice cores, tree rings, and speleothems. Aside from the conventional dating methods, ^{14}C can also be used to attribute sources of carbon and evolution of carbon in different systems for example, the contribution of CO_2 to the atmosphere from natural versus industrials sources, and the source apportionment of atmospheric aerosols from natural biomass burning versus anthropogenic pollution.

Of particular interest is how radiocarbon can be used to study the carbon cycle of the Earth's critical zone, the thin skin of the Earth's crust which encompasses interactions between the biosphere, pedosphere, hydrosphere, and lithosphere. As almost all terrestrial life is sustained from the resources found in the critical zone, a sound understanding of how different climate conditions have impacted it in the past is crucial for predicting how these interactions will evolve under future climate scenarios. Carbonate rocks make up ~ 15% of the ice-free terrestrial geology, making caves ideal environments to study processes as they act as a connection between water, soil, and rock. An environmental monitoring campaign of a cave in north Switzerland is ongoing, aiming to trace fluxes, attribute sources, and to assess the spatial-temporal variations of critical zone carbon in a modern setting. Here, the stable isotope $\delta^{13}C$ is used to assess the contribution of biological respiration in the system. Additionally, ^{14}C is used to quantify the time that the carbon has been cycling in the environment. In a paleo perspective, advances in accelerator mass spectrometry have allowed the ^{14}C quantification of extremely small samples, which has enabled the exploration of the ^{14}C of the organic carbon fraction of speleothems, typically comprising 0.01-0.3% of the total carbon. The isotopic characterization of this carbon fraction may give information about the paleoecology of the local region and has the potential to be an exciting new proxy for broader paleoenvironmental changes when included in a multiproxy analysis. The ability to create robust proxies for past environmental change in the critical zone is essential when evaluating adaptation and mitigation strategies for future ecology, biodiversity, and agriculture.

September 20 II Session 2

07 Disentangling Climate and Human Impacts on Water Resources: Insights from Sweden and the Growing Potential of Data-Driven Techniques

Claudia Teutschbein, Department of Earth Sciences, Uppsala University

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Increasing anthropogenic influence on the environment, particularly noticeable since the mid-20th century, has affected even the most remote water resources. Understanding the driving forces behind observed shifts is crucial for well-informed water resource management and planning. To this end, we examined and quantified the combined effects of climate and human activities on streamflow alterations in Sweden through a classic 2-step approach, performed over a variety of regions across Sweden: Firstly, we identified trends and abrupt shifts in annual streamflow. Then we utilized a climatically-driven rainfall-runoff model to attribute the causes of the observed alterations. We found that anthropogenic factors did contribute to shifts in streamflow. However, their impact was generally overshadowed by the more prominent influence of climate change.

Looking ahead, a natural progression involves the extension of this methodology and its insights to a more intricate water-energy-food-ecosystem (WEFE) nexus. With the surge in available data within the WEFE framework, the prospect of harnessing novel data-driven techniques to identify nexus models (system identification) and facilitate system control (e.g., human interference and policy implementation) has become an attractive option. As a potential avenue for future exploration of human and climate impacts on the WEFE nexus, we showcase that data-driven approaches, reliant on statistical analyses and Machine Learning, hold remarkable potential for applicability in modeling the WEFE nexus, including system identification, system control, and state estimation.

08 Climate and Environmental Change: Measures, Perceptions or Both? A Case from Rural Sicily (Italy)

Vincenza Ferrara, Department of Archaeology and Ancient History, Uppsala University

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In this contribution, I present the work done within the ERC project "LICCI. Local Indicators of Climate Change Impacts: the contribution of local knowledge to climate change research" (https://licci.eu/). By looking at climate and environmental changes as perceived by locals in a remote fluvial system of inner Sicily (Italy), I compare local observations with temperature and rainfall data collected by the nearest meteorological stations and a longer-term reconstruction of the climatic, environmental and societal past of this part of the island, covering the entire Holocene. With this work, my co-author and I highlight the importance to take into account different spatial and temporal scales when approaching the climate discourse, cultural constructs derived from socio-cultural and historical events, and place-based local perceptions.

Ferrara, V., Lindberg, J. (*accepted*) Chapter 4.1. Climate and environmental change perceptions. A case from rural Sicily (Italy). In Reyes-Garcia V. et al. (eds.) (*forthcoming*) Handbook of Climate Change and Local Social-Ecological Systems. London, Routledge.

09 Climate Variability and Agricultural Strategies in the Greek Polis: the Case of Attica and the Northeastern Peloponnese

Anton Bonnier, Department of Archaeology and Ancient History, Uppsala University

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The ancient Greek *polis* was constituted both by its urban core and surrounding territory, commonly referred to as the *chora*. The *chora* provided the fundamental resources for the economic life of the *polis* in the first millennium BCE and were in most instances the principal place for food production sustaining the community. Greek agriculture consisted primarily of dry farming utilising natural precipitation and stored moisture in the soils. Interannual variability in precipitation was recurrent and seems to have been accounted for through risk management strategies in the form of surplus storage and in particular trade. Climate change, providing longer trajectories of shifts in temperature and/or precipitation patterns as opposed to interannual variability, may however have resulted in different forms of insecurities, and prompted more profound socio-economic dynamics. The current presentation will focus on evidence for land-use patterns, cultivation strategies and supply systems in Attica and the northeastern Peloponnese, together with recent palaeoclimatic proxy records from the southern Greek mainland. Both these areas constitute some of the naturally driest parts of the Greek mainland yet saw the expansion of a range of politically and economically significant *poleis*. It will be argued that agricultural land use expansion was to a certain extent pushed by above-average humid conditions around 500 BCE and onwards, but which also created agricultural vulnerabilities in the face of an increasingly dry climate that is suggested by the proxy data towards the end of the first millennium BCE.

10 Deciphering Human-Environment Interactions at the Onset of Farming in Europe with a Continuous High-Resolution Palaeoecological Record from Limni Zazari, Northern Greece

Lieveke van Vugt[1,2], Erika Gobet[1,2], César Morales-Molino[1,2,3], Kathrin Ganz[1,2], Tryfon Giagkoulis[4], Antonietta Knetge[1], Andy Lotter[1,2], Martin Grosjean[2,5], Hendrik Vogel[2,6], Kostas Kotsakis[4], Albert Hafner[2,7], Willy Tinner[1,2]

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More than 8500 years ago, agriculture was first introduced to Northern Greece from Western Asia, starting the European Neolithisation process. The establishment of early farming societies with

their crops and livestock changed the natural biomes and environments of Europe forever. New land use practices had a notable impact on vegetation and fire regimes. However, these first farmers were highly dependent on their natural environment and had to adapt their practices to changes in climate and vegetation. The interplay between Neolithisation, vegetation and climate is complex and still not well understood. Continuous, high-resolution multi-proxy time series of past vegetation dynamics and fire histories are needed to understand the long-term relationships between the first Neolithic European farmers and their environment.

We analysed sediments from Limni Zazari, a small lake in Northern Greece, to study the interactions between climate, land use, fire and vegetation. We present a new continuous high-resolution vegetation, environment and fire history record spanning the Late Mesolithic and the Neolithic (ca. 10,000-5,000 cal BP), reconstructed by using pollen, spores, microscopic charcoal, XRF and Hyperspectral Imaging (HSI) scanning.

During the Mesolithic, mixed deciduous oak woodlands interspersed with open grassland communities covered the surroundings of Limni Zazari. Around 8,500 cal BP, a significant decline in forests occurred, together with an increase of steppe vegetation, that lasted for about 400 years. The synchronous increase in anthropogenic indicators suggests the start of agriculture in the area during this period. Early Holocene climate instability possibly facilitated the start of Neolithic farming in Northern Greece. Subsequently, after the establishment of several Neolithic settlements nearby at ~7,500 cal BP, forests experienced regular disturbances. Even though forests were resilient and recovered quickly from these disturbances, vegetation composition slowly changed.

Our study describes the interactions between vegetation, climate and the first European farming communities, with an emphasis on primeval forest response dynamics. A better understanding of the processes and mechanisms of past societal and ecosystem adaptation to climate change and disturbance may provide useful insights for a future under global change conditions.

September 21 II Session 3

11 Sociologies of Scale. What is the Relation Between the Scale of Human Societies and Global Environmental Change?

Wiebren J. Boonstra, Department of Earth Sciences, Uppsala University, Sweden

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With the growing awareness of climate change and the loss of biodiversity comes a perspective and terminology about global human society as a driving force of planetary change. A new name – the Anthropocene – now demarcates the growing power of humanity in the history of Earth. Many recent and popular studies of the origin and development of the Anthropocene pay attention to the growth of the scale of human societies. An underlying and central idea in these books is that a correspondence exists between the scale of human societies, a concentration of wealth and power in the hands of elites, technological innovation, and environmental degradation. This assumption forms the basis of a popular and evolutionist sociology of scale that has nevertheless received critique for being deterministic and simplistic. In this presentation I will interrogate the relations between scale, power, and humans' dependence on natural environments. I will use in particular the work of sociologist Johan Goudsblom who explicitly theorizes scale (what he calls "the expanding anthroposphere") to capture the growing size and power of global human society.

What can Goudsblom's work contribute to the current debate on the effects of the extensive and intensive growth of human societies on global environmental change? To address this question, I will first discuss sociologies of scale in relation to the debate about limits to growth. And, second, assess the potential contribution of the work of Goudsblom, and other process sociologists, to the debate about contemporary environmental problems related to climate change and loss of biodiversity.

12 Investigating Regional Sensitivity to Climate Events through Spatio-temporal Analysis of C14 Records

Kailin Hatlestad, Department of Archaeology and Ancient History, Uppsala University, Sweden

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This study aims to comprehensively analyze and contrast regional reactions to two notable climatic occurrences of the Holocene epoch, the 8.2 ka and 4.2ka events. Encompassing pre-event, event, and post-event phases, the research aims to gain insights into human responses to environmental hazards. By correlating 14c records with prominent climatic incidents within two distinct Northwestern European watersheds, the study seeks to explore regional sensitivities and vulnerabilities to such climatic events. To achieve this, this study will query 14c records for the Rhine-Meuse and Oder Delta regions from the XRONOS open repository (Hinz & Roe, 2022). Whenever possible, these records will be augmented with additional localized data sources, allowing for a more comprehensive assessment. The paper will examine the effectiveness and reliability of recent statistical methodologies for discerning trigger events, or temporal correlations between climatic shifts and archaeological patterns, and those attempting to measure resilience formally (Heitz et al., 2021; Kim et al., 2021; Riris & de Souza, 2021). Additionally, the investigation will compare these high-level climatic events against more regional records of temperature change sourced from the Temperature 12k database in attempt to account for the spatiotemporal heterogeneity of these past climate changes (Kaufman et al., 2020). During this analysis, the study will also examine methodological and theoretical challenges intrinsic to the analytical techniques frequently employed in synthetic paleo-data studies (Degroot et al., 2021). This critical assessment will contribute to a more robust interpretation of the findings and their broader implications. Overall, the study seeks to enrich our comprehension of regional responses to climatic events and their associated implications for resilience and adaptation strategies, while also addressing the complexities involved in linking archaeological and palaeoenvironmental analyses.

13 Drought Exacerbates the Impact of War Exposure on PTS: Evidence from Surveys Among Refugees

Stefan Döring, Department of Peace and Conflict Research, Uppsala University, Sweden

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A growing literature considers the role of mental health for populations affected by environmental scarcity. Such research tends to focus on sudden-onset disasters with much less focus on slow-onset events such as drought. Furthermore, very few studies consider how mental health is affected by both war and environmental disasters although it is well documented that climate-change frequently affects conflict regions. Here, we examine drought conditions and post-

traumatic stress through surveys among refugees from Syria and Iraq. This setup allows to separately account for both exposure to drought and war. In line with previous research, we show greater war exposure is associated with greater posttraumatic stress, but this relationship is qualified by exposure to war vis-a-vis drought. This suggests that environmental scarcity such as drought undermine psychological resilience in the aftermath of traumatic war experiences. In other words, people that are affected both by war and drought are particularly vulnerable, potentially at higher risk of developing mental health problems. These results enhance our understanding of climate-conflict links as well the role of environmental stressors for the well-being of people affected by war.

14 Vulnerable Mycenaeans? Climate Change Vulnerability Assessment of a Bronze Age Society

Erika Weiberg, Department of Archaeology and Ancient History, Uppsala University

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The breakdown of the seemingly thriving Mycenaean palatial societies on the Greek mainland around 1200 BCE has received enormous attention, not least because similar processes played out in other areas in the Eastern Mediterranean at roughly the same time. A combination of internal and external drivers has been suggested as contributing to the outcome, including a focus on the possible negative effects of climate change. However, any effects of climate change, negative or positive, depend on the societal as well as environmental settings in the study area. The question is how we can reliably assess the climate vulnerability of ancient societies.

This paper will deliberate on the potential to draw on modern vulnerability assessment schemes – with the concept of vulnerability seen as the sum of exposure, sensitivity and adaptive capacity – to better understand climate change vulnerability in the past. Instead of asking what the present can learn from the past, we propose that contemporary methods can not only enhance our understanding of the past but also provide a common language for cross-cultural as well as past-present research collaborations. The challenges are obvious in that the type, quality and detail of data differ between contexts, with variable potential for quantification and hence of comparability. We need therefore to develop metrics for social-ecological vulnerability that can cut across such regionally specific conditions.

Through a case study of the Mycenaean period, we assess the co-evolution of climate, environmental and societal change across a period of five hundred years. Such an assessment necessitates a discussion of the overall scale of human activity and resourcefulness, socio-political control functions and societal cohesion, along with the patterns and content of land use. These are factors that contributed to the vulnerability load of these societies, affecting their inherent sensitivity and adaptive capacity and making them more or less able and willing to adapt to and to utilise changing environmental conditions stemming from climate change.

September 21 II Session 4

15 Agrometeorological Relationships in Early Modern Scandinavia

Martin K. Skoglund, Department of Urban and Rural Development, Swedish University of Agricultural Sciences

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Harvest shortfalls during the early modern period were often brought about by weather or climatic shocks. Just as there are weather and climatic patterns, there are patterns of agrometeorological dependencies. Understanding these dependencies is crucial to arguments relating to risk-mitigation and resilience strategies. In central agricultural areas with well adapted agricultural systems, agrometeorological dependency is spread out across multiple meteorological factors, where the degree of dependence on any single indicator is low, making identification of agrometeorological relationships more difficult. In marginal agricultural areas, relationships between harvests and single climate indicators are in general stronger and more readily identifiable.

Southern Scandinavia hosts several central agricultural areas. During the early modern period, the most apparent agrometeorological risk in these areas was that of summer drought. Spring crops like barley and oats were particularly sensitive to this risk, similar to in other areas of northwestern Europe, like England. Autumn-rye, even though often argued to be more resilient to early summer drought, also appears to have been susceptible to this risk. Cultivation of more temperature-sensitive wheat varieties did not become widespread until the late 19th century. In this context, harvests tended to be larger in wetter and cooler summers, and smaller during drier and warmer summers. In fact, in most central agricultural areas, cereal production appears to have been favoured by relatively cool and wet conditions after germination and in the crop development stages before the final ripening stage. In contrast, in central and northern Scandinavia, as well as in many other marginal agricultural areas across northern Europe, harvests clearly benefitted by warmer growing season conditions.

This changed over time, at least in southern Scandinavia. In the late 19th century, an increasing reliance on new autumn-crops, including autumn-wheat but also new varieties of autumn-rye, shifted the main agrometeorological dependency to spring temperatures, and summer droughts became less of a threat. The case of Scandinavia clearly illustrates the need to consider the level of aggregation carefully when studying relationships between agriculture and climate, as climatic signals in harvests can show opposite signs within the same larger region, obfuscating the aggregated climatic signal. It also illustrates the need to carefully consider the agricultural context, especially the type of crop varieties cultivated.

16 Wine, Vacherin and Volcanoes: Impacts of the 17th Century Large Volcanic Eruptions

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It is today undisputed that the volcanic eruption of Tambora in 1815 caused a year without summer in Central and Western Europe, which led to crop failures, inflation, disease, and famine.

However, little attention has been paid to the teleconnections of the great volcanic eruptions in the 17th century on agriculture and society in early modern Switzerland.

Using different regional examples, the present study attempts to examine the climatological and socio-economic effects of those eruptions and the coping strategies that were developed as a result. For instance, for several centuries, the Hôpital des Bourgeois de Fribourg meticulously recorded every year all their harvests of crop, wine and dairy products - such as the famous Vacherin cheese - and the number of cattle slaughtered. These primary or secondary climate proxies can be examined for potential climatological effects.

Similarly, the Heilig-Geist-Spital in St. Gallen also recorded their harvests in wine and crop. With a comparative approach, potential teleconnections can be investigated for both western and eastern Switzerland. This makes it easier to determine whether the impacts were local/regional or more far-reaching.

The Hôpital des Bourgeois de Fribourg, as a public institution, is strongly linked to the state of Fribourg itself. In addition to accounting books, the state archive possesses an extended corpus of sources related to the history of this institution. Essential archive material, such as the Ratsmanuale (protocols) and the Mandatenbücher (regulations), allows us to draw conclusions about the socio-economic impact of the climate crises of the 17th century and the responses of the state and this important social and economic institution. These findings can then be compared with modern climate reconstruction data from the ModE-RA project – presented in a newly developed tool called ClimeApp – to better assess the interrelation between the two. In other words, we will better identify whether and how volcanoes affected climate, environment, and food connections of early-modern Swiss viticulture and Fribourg's Vacherin production, using a highly interdisciplinary approach.

17 Exploring Prehistoric Land Use and Climate Adaptations in the Southern Balkans

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The Southern Balkans include today's territories of North Macedonia, Albania and Greece and are one of the geographically most diverse regions of Europe. The rugged landscape, created by tectonic activity and limestone weathering, spreads from high altitude plains and lake systems to the Aegean Sea with its Mediterranean climate.

Around 7000–8000 years ago farming practises reached the Aegean Coast and subsequently spread into the European mainland in the millennia to follow. The Southern Balkans are on the cross-roads where farming and the involved societies underwent the adaptations needed for the further spread into the continent.

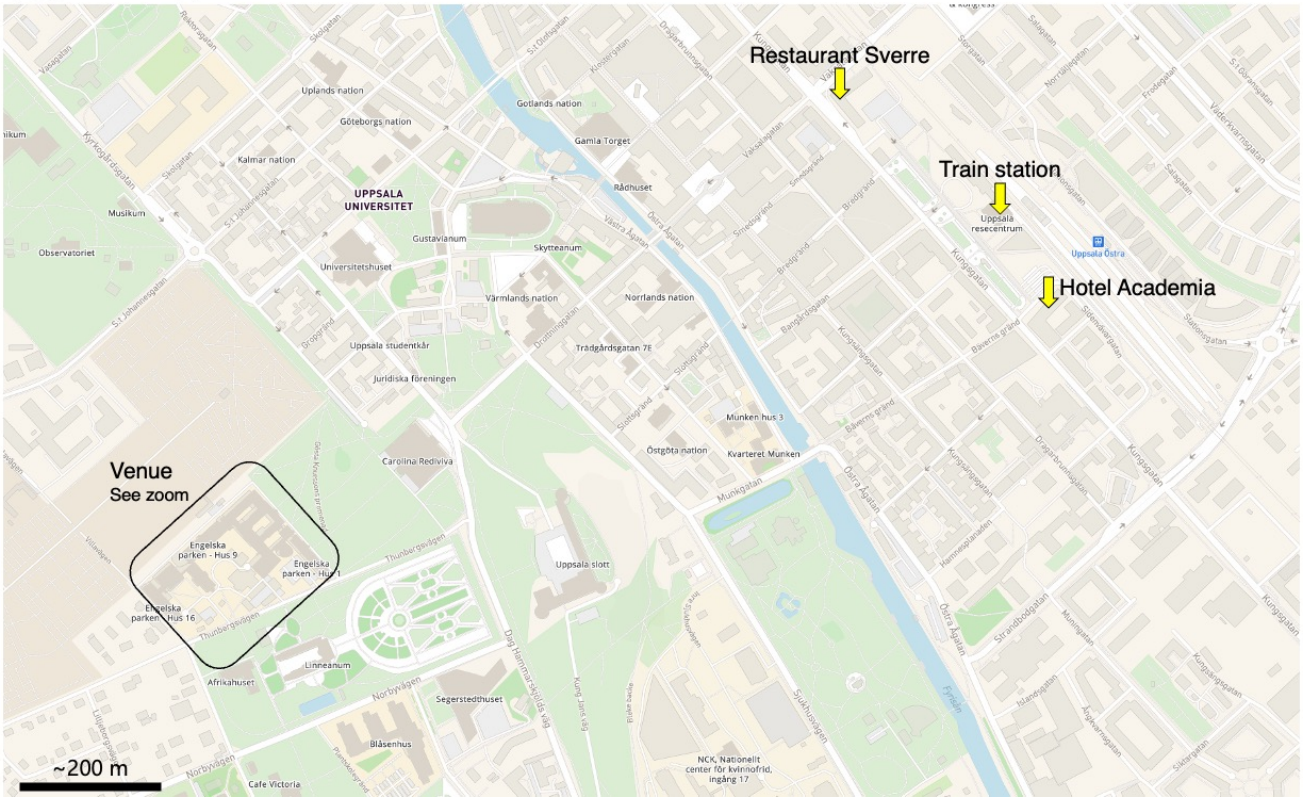
Radiocarbon data show that after an initial phase, Neolithic sites can be found in a range of diverse environmental zones on different elevations, where climatic conditions differ from each other. Radiocarbon dates from archaeological settlements suggest prevalence of human activities in the Balkans for at least two millennia until ca. 4000 BC, when the evidence for human activities sharply decreases. The phase coincides with maxima in forestation at least in parts of the region and with the transition from the Holocene optimum to the cooler phase with lower summer

insolation. Only after 3500 BC there is stronger evidence for growing human presence connected to the Onset of the Early Bronze Age. During this time several backlashes in human activities can be observed which have been discussed to be connected to climate events, such as the 8.2 ka BP event at the onset of the Neolithic on the European mainland or the 4.2 ka event at the end of the Early Bronze Age. The aim is to shed light on how the temporally distinct food systems might have been affected by these climatic impacts and how the involved societies reacted. By exploring common traits and differences in the respective subsistence economies and land use systems of the Neolithic and Bronze Age societies, the talk will give insights on their probable resilience strategies or vulnerabilities facing climatic variability.

IV. LOCATION MAPS

Image: Workshop venue, Engelska parken, Uppsala University seen from the north-east (Photo: Mikael Wallerstedt, Uppsala University).

Uppsala map



Venue map