SESSION 11

Social resilience to climate changes with perspectives on the past 5000 years

Wednesday March 13th until Friday March 15th, Lecture hall

Session organizers: L. Yang, M. Weinelt, J. Seguin, I. Unkel, J. Kneisel, A. Ribeiro

WED

15:30

POSTER SESSION Analysis of the Evolution of Extreme Drought Events Based on Complex Networks - Take Dingwu Qihuang as an example
Xianshuai Zhai (Faculty of Geographical Science, Beijing Normal University, China)

POSTER SESSION The Africa Story: Social Resilience to Climate Changes with Perspectives in the past 5000 years
Queen Linda Chinozvina (University of Zimbabwe)

POSTER SESSION Disentangling climate and human factors in the settlement of the Maori in the North Island of New Zealand: A multi-proxy approach
Ronald Lloren (Department of Earth Sciences, ETH Zürich)

POSTER SESSION Historical Environmental Extreme Events in China: Magic, Mysteries, and Challenges
Hongming He (Faculty of Geosciences, South China Normal University)

POSTER SESSION Holocene sediment transfer and monsoon variability with human settlement in the Godavari River of Peninsular India: Inferences from Mineral Magnetism
Y. R. Kulkarni (Department of Civil Engineering, Gharda Institute of Technology, Khed- 415708, India)

POSTER SESSION Transmission pathways of China's historical climate change impacts based on a food security framework
Jia He (Faculty of Geographical Science, Beijing Normal University)

POSTER SESSION Modeling the social resilience of mountain communities to climate change extreme events: A case of Northern areas of Pakistan
Muhammad Abid (Centre for Climate Research and Development, COMSATS University, Islamabad, Pakistan)

THU

08:30 Megadrought, Collapse and Resilience at 4.2 ka BP across West Asia
Keynote lecture: Harvey Weiss (School of Forestry & Environmental Studies, Yale University)

09:00 The Roman Empire: on the brink of collapse?
Paul Erdkamp (Vrije Universiteit Brussel)

09:20 Boom and bust cycles in Neolithic Europe: climate sensitivity or social dynamics?
Kai Wirtz (Helmholtz-Zentrum Geesthacht, Germany)

09:40 The Toledo Mountains, a resilient landscape and a landscape for resilience. Hazards and strategies in a mid-mountain complex in central Spain
Reyes Luelmo-Lautenschläger (CSIC-UAM)

10:30 Social resilience to climate changes in the Lake Ladoga basin during the past 5000 years
Tatyana Sapeko (Institute of Limnology RAS, St.Petersburg, Russia)

10:50 Cold and dry winters 4200 years ago in the Northern Hemisphere and their impact on human societies
Aurel Persoiu (Institute of Speleology, Romanian Academy, Cluj Napoca, 400006, Romania)

11:10 Paleo-climatic impacts and socio-cultural system resilience along the historical Silk Road
Liang Emlyn Yang (GSHDL, Kiel University)

11:30 The Utopia of the mountain: resilience and collapse of a social-environmental system
Alessio Cinti (MIUR - Italian Ministry of Education)

11:50 Discussion

13:30 Impact of climate change and resilience of human societies in Eurasian continent during the last millennium
Keynote lecture: David Dian Zhang (School of Geographical Sciences, Guangzhou University, Guangzhou, Guangdong Province, China)
14:00 NEO-ARABIA: Analysis of sustainability and reorganisation of Arabian coastal Neolithic socio-ecological systems during the Mid-Holocene period (6.2-2.8 ka BC)
Jean-Francois Berger (UMR 5600 CNRS, University of Lyon, France)

14:20 Response of cultural evolution to climate change during late prehistoric and historical periods in the Hexi Corridor, northwest China
Liu Yang (College of Earth & Environmental Sciences, Lanzhou University)

14:40 Bell Beakers and the 4.2ka event: when worlds collide?
Jos Kleijne (Institute for Prehistoric and Protohistoric Archaeology, Kiel University)

15:30 How was the ancient trans-Eurasia culture exchange affected by climate change?
Guanghui Dong (College of Earth & Environmental Sciences, Lanzhou University)

15:50 How to ‘downsize’ a complex society: experiments with agent-based models to assess the resilience of Indus Civilisation settlements to past climate change
Andreas Angourakis (University of Cambridge)

16:10 Rethinking the 8.2 cal BP event: Resilience and Collapse in the Konya Plain in Central Anatolia
Peter Bielli (Department of Anthropology, University of Buffalo)

16:30 Long-term socio-ecological change in Cambodia Part 2: the exacerbating influence of control structures and material inflexibility on social resilience
Tegan Hall (University of Sydney)

16:50 Discussion

FRI 08:30: Temperature changes and difference of hydro-climatic pattern between centennial cold and warm periods in China for the past 2000 years
Keynote lecture: Jingyun Zheng (Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences)

09:00 Resilience and Landscape Transformation during the Bronze and Iron Age in a Mountain Steppe (Tsaghkahovit Plain, Armenia)
Amy Cromartie (Cornell University; ISEM, Université de Montpellier)

09:20 Climate change and the grain price anomaly around the turn of the 19th century in North China Plain
Yanjun Wen (Faculty of Geographical Science, Beijing Normal University, Beijing 100875, China)

09:40 Is landscape intensity resilient? A comparative view from South Asia
Adam Green (University of Cambridge)

10:30 Impacts of recurring extreme climatic events on societies and landscapes in Provence and Southern French Alps during the past 800 years
Nicolas Maughan (Aix-Marseille University)

10:50 Temperature changes during the past millennium along the Ancient Silk Road and Social events
Zhixin Hao (Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences)

11:10 Aridization and social resilience in Argentinean Andean prehistory
Malena Pirola (Instituto de Arqueología, FFyL-UBA / CONICET)

11:30 Ancestral Puebloan maize farmers in Utah distribution and growing season length using a statistically downscaled climate model, 850-1450 CE
Marcus Thomson (International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria)

11:50 Discussion

13:30 Political Participation and Social Resilience to Climate-Related Disasters
Keynote lecture: Peter Peregrine (Lawrence University, Appleton, Wisconsin USA)
14:00 Integrating collapse theories to understand robust designs for social-ecological systems governance
Cathy Rubinos (Universidad Del Pacifico, Lima Peru and Center for Behavior, Institutions and Environment, ASU)

14:20 How Europe and the Qing Dynasty Endured the Little Ice Age: Social Resilience, Norms, and Adaptable Governance
Susann Handke (Erasmus School of Law, Rotterdam)

14:40 The role of swidden agriculture in contributing to long-term socio-ecological resilience in north-east Cambodia
Rebecca Hamilton (School of Culture, History and Language, The Australian National University)

11 ABSTRACTS

Social resilience to climate changes with perspectives on the past 5000 years
Keynote speakers: H. Weiss (School of Forestry & Environmental Studies, Yale University, USA), P. Peregrine (Lawrence University, USA), J. Zheng (Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, China), D. Zhang (School of Geographical Sciences, Guangzhou University, China)
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During recent decades, many studies have highlighted periods when significant climatic changes coincided with social upheavals or transformations. However, fewer studies have discussed periods of social stability or prosperity when faced with climate risks. The concept of social resilience has gradually become an important topic in scientific communities (e.g. Climatology, Geography, Socio-ecology, Geo-archaeology, Sustainability). It refers to the capability of human social systems to cope with stress, maintain function, and evolve sustainably when faced with climate variability. In fact, increasing studies are suggesting that societies continued to settle and develop in hazard-prone areas and periods.

In comparison with the session on social transformations (Grimm, et al., Session 2), this session focuses more on the social resilience or resistance to climate impacts during pre-historic, historical, and contemporary periods, at local to global scales, and from theoretical, empirical, and quantitative modelling perspectives. Specifically, the session will discuss the following questions:

• What are typical cases of social resilience to climate changes in past societies?
• What are the key factors and features for a social system to be resilient in the face of climate variation?
• How was resilience performed in key societal sectors, e.g. agriculture, nomadism, livelihood, urbanization, or population development?
• How can social resilience to climate changes be quantified, evaluated, modeled, or simulated?
• What kind of changes and evolution of social resilience to climate changes could be observed?
• What are the scope, thresholds, and tipping points of social resilience to climate changes?
• What can we learn from the experience and lessons of the past resilient and/or “un-resilient” cases? Are these lessons up-scalable to explanatory theories?
• What could be the pathways, measures, strategies, and priorities for building social resilience in present social and climatic conditions?
The topic of this session is interdisciplinary and can be of broad interest to geologists, historians, archaeologists, geographers, paleo-environmentalists, paleo-climatologists, and cultural-sociologists. The session is expected to advance our understanding of the interaction between cases of socio-cultural resilience and climate change in time and space, and to utilize this knowledge in supporting current sustainable development at the local, regional, and global levels. The topic of social resilience in this session may further relate to sessions of complex social networks (Nakoinz, et al., Session 6) or marine connections in the Mediterranean regions (Rutter, et al., Session 7), as network connects are an essential feature of social systems.

**POSTER SESSION: Analysis of the Evolution of Extreme Drought Events Based on Complex Networks - Take Dingwu Qihuang as an example**

*Xianshuai Zhai (Faculty of Geographical Science, Beijing Normal University, China)*

*Co-author: Su Yun*

Dingwu Qihuang as a famous drought in the historical period of China, explored its specific evolutionary process in the human-environment couple system providing empirical evidence for understanding the impact of climate change and major disasters and the adaptation mechanism. Based on the historical literature data, this paper uses complex networks to reconstruct the evolution process of Dingwu Qihuang from 1876 to 1879, identifying key evolution events and core evolutionary paths, and analyzing each of them in detail according to the elements of “disaster origin→disaster process→response. To analyze in detail the transmission process of disaster impact in the human-environment couple system. (1) The complexity of the disaster event evolution reached its peak in 1877, and the network has no scale characteristics in 1876-1879, indicating that there are key nodes affecting network evolution grain failure and high food prices. Therefore, when the extreme climate impact is transmitted in the human-environment couple system, the production system and the economic system are the transfer stations that control the impact transmission, while the economic system and the political system adjust and feedback the transmission of the disaster impact to prevent further transmission. (2) With the development of drought, the role of extreme climate in the evolution process of disasters is gradually reduced. The level of delivery is also reduced by the complexity, the number of systems passing through is reduced, but the system level at the beginning of delivery is higher when the extreme climate impacts in the human-environment couple system. (3) According to community analysis, different disaster events can be transmitted to different levels of the human-environment couple system in beginning of drought. But with the development of drought, the phenomenon is not obvious.

**POSTER SESSION: The Africa Story: Social Resilience to Climate Changes with Perspectives in the past 5000 years**

*Queen Linda Chinozvina (University of Zimbabwe)*

*Co-author: Prof. Innocent Chirisa (University of Zimbabwe)*

This paper analyses the relationship between social resilience and climate change by tracing the trends from prehistoric, historic and contemporary. It made use of document analysis and desktop analysis to decipher data on the history of social resilience and climate changes in old cities up to the current cities globally, regionally and at a local level. Social resilience is here defined as the capability of a human social system to cope with stresses, maintain its function and evolve into a more sustainable society with respect to climate stresses. There has been much debate on adaptation to climate change where studies have focused on how human species may adapt, have adapted, or are adapting to climate changes looking at how the society can respond to such. The missing link in the existing scholarship has been of the traces on trends in climate changes thus prehistoric, historic and current. There has not been much link between social resilience and climate change rather the solutions to climate change for long have remained scientific. The effects of climate change can be traced from as early as the 19th Century where people lived in caves and their lifestyle was more nomadic hence referred to as the paleo-climatic period. With time due to changes in climate people began to settle leading to the formation of societies and communities. Caves became their homes and keeping of livestock and crop cultivation (agricultural activities) defined their economic and social structure. In Egypt, for example, the Nile River would attract people due to the availability of water and this gave shape to a settlement. However, during flooding they would come up with some alternatives such as the use of the canal system. With time, most of the African cities were colonised and this had an impact on their lifestyle. There were some changes in the way they lived and their place of habitation. In Southern Africa, most countries were characterised by a primitive way of life and as soon as they were colonised some people migrated to other areas for safety and protection against the invaders. The colonial system led to the period of historic era where cities were now being formed adopting for example the British way of life. During this period, there was less focus on climate. However, as cities grew and developments in the cities began to grow some of the activities have contributed to the changes in climate change. Contemporary societies are modernised and the activities are controlled and influenced by technology. Due to this technology, they are adapting to changes hence withstanding the shocks and stresses faced. As such, strengthening of adaptation mechanisms might enhance a reduction in social vulnerability by encouraging people or the community to work together in dealing with the threat of climate change hence social resilience.
POSTER SESSION: Disentangling climate and human factors in the settlement of the Maori in the North Island of New Zealand: A multi-proxy approach

Ronald Lloren (Department of Earth Sciences, ETH Zürich), Co-author: Paul Augustinus, School of Environment, University of Auckland, Private Bag 92019, Auckland 1142, New Zealand; Nathalie Dubois, Department of Surface Waters Research and Management, Eawag, Überlandstrasse 133, CH-8600 Dübendorf

Based on archaeological evidence, Maori landed on New Zealand around 700-800 cal BP. However, the question of why and what caused Maori migration is still a question: whether this is in search of new resources brought about by human exploitation or is it a factor of climate induced, or could it be a nexus of human-climate-environment. Here, we present downcore leaf wax carbon and hydrogen isotopic record coupled with XRF data (Ti) and geophysical data (Magnetic Susceptibility) in Lake Pupuke, in the North Island of New Zealand spanning 1718 cal yr BP. By using these footprints, these will help us to further define factors that triggered the arrival of early Polynesians in the North Island of New Zealand as well as possible implications of concurrent climatic changes.

POSTER SESSION: Historical Environmental Extreme Events in China: Magic, Mysteries, and Challenges

Hongming He (Faculty of Geosciences, South China Normal University), Co-authors: Hongfei Zhao (Institute of Soil and Water Conservation, Northwest Agriculture and Forestry University); Jie Fei (Institute of Historical Geography, Fudan University)

Extreme events occur in natural, technical and societal environments, and often entail loss of life. However, our knowledge of extreme events is often rather fragmentary with limited records. Indeed, we do not really understand what causes extreme events, how they develop, and when and where they occur. In addition, we are rarely able to cope with their consequences, due to lack of anticipation and preparedness. This presentation focuses on extreme events from history in China, including selected examples from volcanism, earthquakes, meteorite impacts and floods and droughts. Although, events related to these processes occur on different timescales, any of these processes can be the trigger for dramatic consequences. We also look into the background of any scientific debates about the extreme events. Approaches to proposing and forecasting extremes events over history in China are discussed. We hope to bring multi-discipline together from a variety of fields of expertise in perspective of general background in mathematics and physics.

POSTER SESSION: Holocene sediment transfer and monsoon variability with human settlement in the Godavari River of Peninsular India: Inferences from Mineral Magnetism

Y. R. Kulkarni (Department of Civil Engineering, Gharda Institute of Technology, Khed-415708, India), Co-authors: S. J. sangode1, D.C. Meshram2, K. Nageshwar Rao2 and Yoshiki Saito2

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3 Estuary Research Center, Shimane University, Japan

The Middle to Late Holocene monsoonal variations largely impacted the fluvial regimes and the early human settlements in the Indian subcontinent. We studied the mineral magnetic properties of floodplain sediments from the Godavari drainage basin and AMS 14C dated core sediments from the Godavari delta. Our results showed that the characteristic ferrimagnetic mineralogy of the Deccan basalt dominated the floodplain sediments all along the Godavari River and the Middle to Late Holocene sediments in the delta. A general increasing trend in ferrimagnetic mineralogy is observed from Middle to Late Holocene sediments with the events of abrupt increase in Deccan source during ~4.9 and ~3.2 cal ka BP which coincides with the expansion of Jorwe culture of Maharashtra. The increased influx from the Deccan source near 3.2 cal ka BP suggests intensified erosion in the Western part of the basin as a result of decreased vegetation cover. We suggest that this phenomenon greatly influenced the adaptation and cultural practices of the Jorwe culture during the Middle Chalcolithic period in this region.

POSTER SESSION: Transmission pathways of China’s historical climate change impacts based on a food security framework

Jia He (Faculty of Geographical Science, Beijing Normal University), PhD student Co-Authors: Yun Su, Xiaqi Fang, Jingchao Teng

There are still many uncertainties about how climate change affects the development of human society. The impact of climate change is likely to be weakened or amplified by the response and adaptation of the reciprocal feedback process after entering the socio-economical subsystem. The study of the climate change impact processes is the basis for understanding the mechanisms of climate change impacts. Furthermore, long-term research of climate change impacts can provide historical similarity and experience for current or future adaptation of climate change. Ancient China was traditionally an agricultural country. Its food production safety; food supply safety and food consumption safety reflect the impacts of climate change being transferred from a production subsystem, to a population subsystem to an economic subsystem.
Based on a conceptual framework of food security, we selected 10-year resolution sequences of grain harvest grades, famine indices, and economic levels in China over the past 2000 years (206 BC-1911 AD) to quantify and recognize the main transmission pathways of climate change impacts during cold and warm units of climate change. Our results were as follows: (1) According to the transmission relationship climate change → grain harvests → famines → economic levels, there are 16 main transmission pathways, including 10 pathways starting from cold units and 6 pathways starting from warm units. (2) The main pathway is dominated by natural factors and socio-economic factors, with each factor set accounting for approximately 50%. However, the probability of the main pathways with socio-economic influence leading toward negative developments was 60% for cold units, and the probability of the main pathways with socio-economic influence leading towards positive developments was 66.7% for warm units. According to the main pathway led by natural factors, of all transmission pathways in cold units (100%), 14.7% of the depressed economy may be more directly related to climate change. However, 32.3% of the prosperous economy may have a more direct relationship with climate change in warm units (100%). (3) Famine is the most important link in the climate change influence on transmission chains regulated by socio-economic factors. Famine reflects both poor harvests due to the natural production subsystem and a lack of grain allocation by the socio-economic subsystem or the government’s ability to eliminate famine. Thus, there may be another pathway of transmission, such as, climate change → agricultural yield/grain production → economic prosperity → famine relief (social vulnerability).

POSTER SESSION: Modeling the social resilience of mountain communities to climate change extreme events: A case of Northern areas of Pakistan

Muhammad Abid (Centre for Climate Research and Development, COMSATS University, Islamabad, Pakistan)

Climate change is a reality and affecting the human societies in multiple ways by interacting with socioeconomic and natural systems. In order to enhance the resilience of human societies to climate change and related extreme events, a full understanding of factors that contribute to the vulnerability and resilience of society to multiple climatic impacts is required. This study is designed to fill the important research gaps in understanding the resilience of mountain communities in Pakistan through modeling their resilience using multiple indicators from social as well natural systems. This study first developed a hypothetical model of social resilience where social resilience is measured considering social, economic, historical, environmental and institutional factors. Further, the interactions between individuals, community and institutional are also considered as an important determinant of social resilience in this framework. For each of the major indicator, a set of sub-indicators is developed and included in the model. For instance, the key indicators of social dimension of the social resilience include social capital, social beliefs, social equity, structure and social actions. Similarly, the cultural factors include cultural values and norms. The economic indicators include the patterns of economic opportunities, employment history and economic dependence and resource distribution and utilization. Historical factors include information on the frequency and intensity of current and past extreme events and their nature. The institutional factors include the indicators related to access to infrastructure, water and sanitation, credit, market and policies. The hypothetical model of social resilience is tested using a community level data collected from Northern areas (Gilgit-Baltistan province) of Pakistan that is employed into a structural equation modeling (SEM). SEM illustrates the causal-relationship of factors and its contribution to social resilience through a path diagram. The study finding confirms the hypothesis of the importance of the different natural, social, environmental, cultural and institutional factors in determining the social resilience of the mountain communities. The study findings show that social capital and social beliefs and social structures play important role in building societal resilience. It is also observed that people living in joint family system and are well-connected to their social networks have more indigenous knowledge of historical changes in climate and natural systems and hence are more resilient. Moreover, we found that historical information on past extreme events is essential in shaping local perceptions and resilience as such knowledge is seen to be used by the communities to the improved formulation of resource management strategies. In other words, we could say that the present nature and complexity of socio-ecological systems is heavily contingent on the past and could be understood more by going back to decades and centuries. Similarly, institutional factors particularly access to infrastructure facilities, credit and information are also crucial in determining social resilience. The findings of this study will not only fill a significant research gap in structuring and measuring the social resilience of mountain communities but also identify gaps in current social systems that needs to be filled to improve their social resilience to ongoing and future climatic changes.

Megadrought, Collapse and Resilience at 4.2 ka BP across West Asia

Keynote lecture: Harvey Weiss (School of Forestry & Environmental Studies, Yale University)

Decadal to century-scale megadroughts are a recently discovered but now well-documented feature of the Holocene. A major and much-discussed example is the abrupt global megadrought and cooling at ca. 4.2-3.9 ka BP (ca. 2200-1900 BC). Data for this megadrought are derived from analyses of lake and marine sediments, glacial and
and organizationally different, cereal-agriculture-based societies collapsed synchronously and coincident with the megadrought. The archaeological record for these societal collapses includes (1) intensive regional settlement surveys (2) high-resolution radiocarbon dating for abrupt abandonments in dry-farming domains across the scales of settlement, from villages to cities, and (3) epigraphic and radiocarbon data for the collapses of the region-wide, expanding Mesopotamian Akkadian Empire and the Nile-based Egyptian Old Kingdom. In these rain-fed agriculture regions, the adaptive societal response linked with abandonment was resilient habitat-tracking to riparian, paludal and karstic refugia along the banks of the Euphrates River and the karst-spring fed Orontes River. The abrupt desiccation also forced pastoralist tribal groups, Amorites, to seek refugia along and down the Euphrates River. This infiltration of southern Mesopotamian urban kingdoms prompted their dynasts to construct the “Repeller of the Amorites” wall recorded in contemporary records. The wall proved porous, however, and within a few generations the former pastoralists’ descendants became the Amorite rulers of Babylon. Indeed, the megadrought at 4.2-3.9 ka BP, serendipitously the best-documented period in cuneiform sources for southern Mesopotamia, was previously understood to represent inherently maximizing irrigation-based agriculture and hypertrophic city growth, but its anomalous character, a function of demographic and subsistence forces unleashed by the 4.2 ka BP megadrought, now encourages environmental historicization.

The Roman Empire: on the brink of collapse?
Paul Erdkamp (Vrije Universiteit Brussel)

During the past decade, several studies have related the rise of the Roman Empire – in terms of economic prosperity, population, political stability and military power – to the Roman Climatic Optimum, and its subsequent decline to the so-called Late Antique Little Ice Age. Adverse climate change is generally thought to have disrupted the food supply, leading in turn to misery and increased mortality, and to social and political unrest. However, a thorough analysis of the causal links between climate change and agricultural productivity on the one hand, and agricultural productivity and the food supply on the other, is often missing. Two elements of the ‘climate change scenario’ of the fall of the Roman Empire will be discussed. First, the use of the metaphor of a ‘tipping point’: the Roman Empire is argued to have been on the brink of sustainability in terms of population and resources. The ‘tipping point’ metaphor allows to argue that relatively minor societal shifts due to climate change had major historical consequences without being accused of environmental determinism and mono-causality. It will be argued, however, that there is no good reason to assume that the Roman Empire had reached the ceiling of sustainability. Moreover, the impact of changes in temperature and precipitation are much more diverse and complex than more or less intuitively assumed in some of the recent studies. Cereals and pulses were the staple foods of the Roman world and the fluctuations in temperature remained well within the range of growing conditions of the main crops. The intuitive link between adverse climate change and famine is generally based on instances of extreme weather and on the experiences of peoples who lived on the margins of the biological requirements of arable crops, such as the extreme north or semi-arid regions. If we want to test the hypotheses regarding the demographic, economic and political consequences of climate change in less clear-cut cases, we should go beyond intuitive conjectures and analyze the consequences of climate change for agriculture more thoroughly. This brings us to the second element: the concept of ‘carrying capacity’. It is often claimed that warm periods increased the carrying capacity of the land and thus allowed populations to grow and prosper, while cold periods exactly did the opposite. The balance between land and population brings us back to Malthusian pressure, with the added element that climate change means that not only population is a varying factor, but that also the carrying capacity of the land varies independently of human action. However, the argument is based on the wrong assumption that population levels are determined by an environmentally determined carrying capacity of the land. In reality, agricultural production is not only determined by such ecological factors as soil, yields and weather, but also by such societal factors as the structure of landholding, the extent of (under)employment, of specialization and of market integration. In other words, it is an oversimplification to argue that climate change lowered the carrying capacity of the Roman world, causing a breakdown of the political institutions and economic structures of the Roman state.

Boom and bust cycles in Neolithic Europe: climate sensitivity or social dynamics?
Kai Wirtz (Helmholtz-Zentrum Geesthacht, Germany)
With the arrival of agropastoralism across western Eurasia, local population densities rapidly increased. This boom in population density can be understood as the result of social and technological transformations supporting higher reproduction rates. Maximum population densities and boom durations, however, differed between European regions, as revealed by our reanalysis of the integrated EUROEVOL data set. Also, the population declines (‘bust’) following each local boom lasted from a few decades to many centuries, a pattern that again differed greatly between regions. Some regions even exhibit multiple boom and bust cycles. We investigated the correlation of the different bust timings and intensities for the period 8,000-3,500 a BP with a large paleoclimate variability data set: we found a poor correlation of long-term trends in population dynamics with climate anomalies and a moderate coincidence between bust periods with climatic events. Using a mechanistic numerical model of socio-technological dynamics we estimated the relative importance of environmental perturbation and endogenous societal transformation in shaping regional population cycles. Model results suggest that robustness of a region against endogenous and exogenous collapse factors mostly depended on its socio-technological history.

The Toledo Mountains, a resilient landscape and a landscape for resilience. Hazards and strategies in a mid-mountain complex in central Spain
Reyes Luelmo-Lautenschlaeger (CSIC-UAM)
Co-Authors: Sebastián Pérez-Díaz, José Antonio López-Sáez, Olivier Blarquez César Morales- Molino

The Toledo Mountains is a mid-elevation range that separates the Tagus and Guadiana basins in the central part of the Iberian Peninsula. The location of these mountains allows the development of a typical Mediterranean vegetation with some Atlantic influence. Consequently, typical broadleaved evergreen Mediterranean vegetation currently dominates the regional landscape, but with the remarkable presence of more mesophilous species refuged in sheltered and more humid microsites such as gorges (e.g. Prunus lusitanica, Taxus baccata) and mires/bogs (e.g. Betula pendula subsp. fontqueri, Erica tetralix, Myrica gale). Palaeoecological data from this area suggests that this territory has been even more diverse in the past (e.g. Corylus woods seem to have disappeared and Betula populations significantly retreated in recent times), what resulted essential for the long-term development of local human communities. First, these mid-elevation ranges offered a number of diverse and valuable natural resources like wood, charcoal, honey or wax. Furthermore, the Toledo Mountains played a major role as hunting reserve allowing the local settlers to survive harsh climatic oscillations or economic and political instability. Finally, clearance of the natural thick Mediterranean vegetation using fire created pasturelands for livestock support, also permitting the establishment of crops when population grew up and more fertile resources were used up. Here we illustrate using a set of palaeoecological records from the Toledo Mountains the long-lasting and tight connections between the vegetation landscape and the local human communities in midwestern areas of southern Europe. Despite having remained barely investigated so far, midmountains represent unique scenarios to explore the close interactions between vegetation dynamics and human activities during millennia in such particular environments. One should not overlook that the above-mentioned long history of human-environment interactions has led to the design of complex cultural landscapes that host a high biodiversity in the Toledo Mountains. A deep understanding of these aspects along with a more detailed knowledge about the impact of disturbances on the natural ecosystems and their responses (including resilience, population declines, and even local extinctions) will definitely contribute to guide present and future attempts to conserve and restore the natural vegetation cover.

Social resilience to climate changes in the Lake Ladoga basin during the past 5000 years
Tatyana Sapelko (Institute of Limnology RAS, St.Petersburg, Russia)
Co-author: Dmitry Gerasimov Peter the Great Museum of Antropology and Ethnography RAS, St.Petersburg, Russia

Lake Ladoga is the largest freshwater reservoir in Europe. People lived on its shores from the beginning of the Holocene period. During the entire Holocene period the outlines of the Ladoga shores experienced serious changes. Changes of the lake in size and level, as well as ecology were traced basing on numerous paleolimnological studies. Development of landscapes throughout the Holocene also depended on formation of paleobasins on its territory. Thus, in the Atlantic period, the territory of the north-western Ladoga area was under the waters of a deep cold-water ancient Ladoga Lake. Our research covers the study of small lakes in the Lake Ladoga basin area and the study of archaeological sites on the north-western and southern Ladoga shores. Our research covers the study of small lakes in the Lake Ladoga basin area and the study of archaeological sites on the north-western and southern Ladoga shores. As our studies show, the beginning of the settlement of the coastal areas of the lakes is fixed by the pollen spectra of small lakes and archaeological sites. The pollen records of small lakes sites we used to reconstruct of the climatic conditions changes under which previous cultures flourished or declined, providing an ecological context to help interpret social change. There are two catastrophic events can be traced in the Late Holocene Ladoga history. First is a breakthrough of the Saimaa Lake to the Ladoga circ. 3900 cal. BC. It caused rather dramatic rise of the water level and inundation of the ancient people settlements of the Ladoga shore. In the Lake Saimaa
Cold and dry winters 4200 years ago in the Northern Hemisphere and their impact on human societies

Aurel Persoiu1,2
Co-authors: Monica Ionita3, Harvey Weiss4

The 4.2 ka BP climate event was a ca. two–three hundred year period of synchronous abrupt megadrought, cold temperatures and windiness manifest globally. Coincident societal collapses and habitat tracking, particularly in regions where archaeological data are both extensive and high–resolution, have attracted the attention of many paleoclimatologists and archaeologists since the event’s first observation. Causal explanations for the 4.2 ka BP event are based on the amalgamation of seasonal and annual records of climate variability manifest across global regions dominated by different climatic regimes. The present study investigates the spatial manifestation of the 4.2 ka BP event during the boreal winter season in Eurasia, where climate variability is a function of the spatio-temporal dynamics of the westerly winds. We present a multi-proxy reconstruction of winter climate conditions in Europe, west Asia and northern Africa between 4.3 and 3.8 ka BP. Our results show that, while winter temperatures were cold throughout the region, precipitation amounts had a heterogeneous distribution, with regionally significant low values in W Asia, SE and N Europe and local high values in the Carpathian Mountains, and E and NE Europe. Further, strong northerly winds were dominating in the Middle East, and E and NE Europe. Analyzing the relationships between these climatic conditions, we hypothesize that in the extra-tropical Northern Hemisphere, the 4.2 ka BP event was caused by the strengthening and expansion of the Siberian High, which effectively blocked the moisture-carrying westerlies from reaching W Asia, and enhanced outbreaks of cold and dry winds in that region. We further discuss the societal impact of these events across transect from eastern Europe through western, southern and eastern Asia and examine how these impacts translated into societal collapses and/or habitat tracking.

Paleo-climatic impacts and socio-cultural system resilience along the historical Silk Road

Liang Emlyn Yang (GSHDL, Kiel University)
Co-authors: Hans-Rudolf Bork, Xiuqi Fang, Steffen Mischke, Mara Weinelt, Josef Wiesehäfer

This study introduces, by literature reviews, the issue of the links and processes behind climate change, environmental change, and socio-culture change in a historical perspective in the ancient Silk Road region. Analyses of the changes and development of the socio-environment system in this significant area enhance our understanding on the regular patterns of coupled natural and social evolution, and is thus of important theoretical and practical significance. We argue that the cross-cutting theme has been to reach beyond simple explanations of environmental or human determinism, but social resilience under environmental impacts. Preliminary results indicate that local communities was able to reinforce their resilience through simple but effective initiatives, such as investing infrastructures, sharing responsibilities, diversifying livelihoods, networking recoveries. The findings further highlight the importance of understanding how human society maintains living under environment stresses in a long historical period. We conclude both that climate conditions significantly influence human socio-cultural systems and that the social-culture systems are certainly resilient to climate impacts. The study also summarizes the scope of the recent book “Socio-Environmental Dynamics along the Historical Silk Road” by illustrating the specific topics, research areas, focused time periods and the inner relationships of its 22 chapters.

The Utopia of the mountain: resilience and collapse of a social-environmental system

Alessio Cinti (MIUR - Italian Ministry of Education)

The relationship between human communities and the environment consists of a dynamic balance in which different factors contribute. The climate and its oscillations over time are one of these variables; however, it is evident that, although it plays an important role, it is not the first cause that triggers a social-environmental system. If on a global scale this statement proves difficult to demonstrate, instead on a local scale,
it finds a definite confirmation: every climatic oscillation left on the field those who won and those who lost; in the lst ones, the factors that determined their resilience were already intrinsic to the social-environmental system that underlay them. External influences, however, can cause the system to collapse and the climate worsening can only be an aggravating factor of an already compromised situation. This paper analyzes the evolution of the relationship between Man and Environment of a community of the Central Apennines (Massa Trabaria, between Marche, Tuscany and Emilia Romagna - Italy), between late Antiquity and the Renaissance. This social-environmental system that managed to find an equilibrium when the previous one breaks down (late Antiquity), succumbs to a Utopia imposed from the outside (Renaissance) that definitively changes its characters and leads it to an irreversible crisis. While Utopia remained as it is, its effects on this mountain community still were tangible, together with the worsening of the climatological conditions that have helped to make it fail. In the end, Utopia remains on paper and moves to the written page, becoming a critique of that power that has tried, in vain, to make it a reality.

Impact of climate change and resilience of human societies in Eurasian continent during the last millennium

Keynote lecture: David Dian Zhang (School of Geographical Sciences, Guangzhou University, Guangzhou, Guangdong Province, China)
Co-author: Qing Pei (Department of Social Sciences, The Education University of Hong Kong, Lo Ping Road 10, Tai Po, Hong Kong)

Climate change has created great impacts in agrarian societies across Eurasian continent in historical times due to the consequential change in land carrying capacity. When humans facing the changes, they have three general options: cultural adaptation, migration and resource redistribution. Nevertheless, the quantitative assessments of these options has rarely been systematically investigated at large scales. By numerical analyses of the variations in climate, population size, war number, economy, migration and agricultural production at macroscales, we show that the latter two options often are the choices of the Old World societies, which often led to social disturbances and ecological disasters in ancient China and European Middle Ages and Early Modern Era, although some improvement of agricultural techniques and peaceful redistribution of resources had partially mitigated the impact at local and short time scales. However, industrialization, use of fossil fuel and changes in societal organizations in Europe, has greatly mitigated the impact of the change in 19th century and lifted humans to another homeostatic plateau of civilization.

NEO-ARABIA: Analysis of sustainability and reorganisation of Arabian coastal Neolithic socio-ecological systems during the Mid-Holocene period (6.2-2.8 ka BC)

Jean-Francois Berger (UMR 5600 CNRS, University of Lyon, France)

NeoArabia is an interdisciplinary and multi-scalar project, dealing with the very long term of the Arabian Neolithic (6200-2800 BC) by a latitudinal transect of ~1000 km, documented by the French Archaeological Missions of the Ministry of Foreign Affairs from Ra’s al-Khaimah, in the Northern United Arab Emirates (UAE, 25.5°N-55.6°E) to the Dhofar region, in the South of the Sultanate of Oman (16°N-53,45°E). Focused on environments/landscapes reconstructions and the mobility of coastal human communities, it intends to test the societal resilience at scales from the site to the region, using socio-environmental scenarios. In this region, highly productive marine environments, favoured by coastal upwelling, compensate in part for relatively limited inland resources. This led to intense exploitation of marine and lagoon-deltaic resources from the Neolithic onwards. We propose to develop an integrative approach incorporating evidence from Neolithic occupation sites and their immediately surrounding environment (lagoons, mangroves, estuaries), to wider regional contexts (deltas activity, marine SST and upwelling activity, monsoonal air masses). Neolithic Eastern Arabia offers an exclusive exploratory research opportunity on the role of resiliency. This is due to the abundance of stratified archaeological data (preserved in shell middens), excellent preservation of intra-site palaeo-economic data, rich coastal environmental archives (under current sebkhas), the combination of highly accurate data on upwelling changes in the Arabian Sea (cores available) and climate/environmental records preserved in speleothems and lake archives. Since the end of the 1990’s, collapse and abandonment due to prolonged periods of climate stress, dominate the scientific (popular) literature for Prehistoric societies. Climatologists working with the theoretical resilience model argue that reorganization is an important component of long-term adaptive cycles, a topic that is not sufficiently studied in both social science and ecology. Resource stress can be created or intensified by both climatic change and human impacts on the environment, for example by reducing the availability of some resources. A comprehensive examination of these interconnected processes, exploring links between types, durations, and magnitudes of resource stress and human responses, is necessary to understand how resource stress contributes to human decisions regarding settlement and landscape use. Based on the resilience model, we intend to explore the process of reorganisation of the eastern Arabian Neolithic communities in terms of geographic location strategies, economic and technological adaptations, evolution of social structures, and behaviour aimed at
avoiding or reducing impacts. We want to understand which technological innovations (fishing techniques, advances in ocean navigation) or socio-ecological/ economical choices (spatial and social reorganisation, food specialisation or diversification, changes in seasonal mobility...) prevailed and why. One of the main uncertainties in the field of Neolithic archaeology deals with our knowledge of the continuity-discontinuity of settlements and the temporal status of occupation (seasonal or not). Some sites with wide trench or multiple soundings (UAQ2, RWY-1) are therefore questioned in this sense to control the site formation processes. Interpretations and theories regarding the origin of these causes are often overlooked when explaining the development of socio-cultural and economic divergence. This has often led to deterministic over-interpreta-
tion. Neoarabia will address these assumptions and provide direct and robust arguments to assess the question of environmental determinism. This project which functions since 20 months is still in a phase of multi-data acquisition and the presentation will be focused on the methodological, conceptual aspects and to the first concrete results, discussed in a way of socio-ecological interactions at different spatio-temporal scales.

Response of social evolution to climate change during late prehistoric and historical periods in the Hexi Corridor, northwest China

Liu Yang (College of Earth & Environmental Sciences, Lanzhou University)
Co-authors: Zhilin Shi, Shanjia Zhang, Guanghui Dong

Culture evolution in relation to climate change in ancient times has been widely concerned and discussed in recent decades, while the trajectory for the changing human-land relationship throughout prehistoric and historical periods and mechanism behind it has not been clearly elucidated. In this work, we review the results of radiocarbon dating, archaeobotanical and zooarchaeological studies from Neolithic and Bronze sites, and summarize the information of population, wars and disasters recorded in historical documents in the Hexi Corridor of northwest China, and compare them with high-resolution paleoclimate records, to study how social system response to climate change in different periods in ancient times in the area. Our results suggest climate change had contributed to the frequent transformation of human subsistence strategies, and then influenced culture evolution during late Neolithic and Bronze periods (~ 2800-100 BCE) in the Hexi Corridor, which was also affected by trans-Eurasia culture exchange that emerged post ~2000 BCE. During historical period (121 BCE-1911 CE), however, social development in the Hexi Corridor was primarily affected by changing geopolitical patterns instead of local climate change, indicating human-environment interaction was much complicated in that period than prehistoric era. Climate change might have affected the rise and fall of powerful regimes in historical north China, which was likely an indirect factor for social evolution in the Hexi Corridor in historical period.

Bell Beakers and the 4.2ka event: when worlds collide?
Jos Kleijne (Institute for Prehistoric and Protohistoric Archaeology, Kiel University)

Around 4200 BP, changes in temperature, humidity and precipitation affected the Eurasian ‘low- and mid-latitude’ climate and ecosystem (Walker et al. in press). This drastic climatic change, the ‘4.2ka event’, is nowadays even chosen as the global start of the Late Holocene or Meghalayan period (Cohen et al. 2018, Walker et al. in press). Coincidingly, societies such as the Akkadian Empire and the Egyptian Old Kingdom experienced droughts, failed harvests and famine, decreasing population sizes and a general collapse of settlements (e.g. Weiss 2015; Stanley et al. 2003). However, it is unclear whether this climatic change also took place in mid-latitude Western and Central Europe, and if it had any effect on societies here. In the middle of the 3rd millennium BC, the cultural phenomenon of the Bell Beaker appeared in Western and Central Europe. This widespread phenomenon, characterised by its specific burial ritual of single inhumation graves and distinctive thin-walled S-shaped pottery vessels, lasts until the first centuries of the 2nd millennium BC. Past studies into the relationship between climate and society in Western and Central Europe have focused primarily on site specific and regional evidence (see papers in Meller et al. 2015). Outcomes have been inconclusive, reflecting the complex relationship between climate and society. By reviewing cultural and social transformations between various regions, and correlating the available vegetation and climate reconstructions, the impact of the 4.2ka event on Western and Central Europe is targeted. So, do we see any social and cultural changes around 2200 BC, taking place during the Bell Beaker phenomenon in Western and Central Europe? And if so, can we correlate these changes with the climatic event around 4200 BP or provide models for a causal relationship?

How was the ancient trans-Eurasia culture exchange affected by climate change?
Guanghui Dong (College of Earth & Environmental Sciences, Lanzhou University)
Co-author: Liu Yang

Culture exchange along the ancient Silk Road played an important role in shaping political and economic landscape in the Eurasia in the past 2000 years, while the earliest trans-Eurasia culture exchange emerged during the fifth Millennium in Eurasian Steppes. The spatiotemporal variation of culture exchange across the Eurasia and its relation to climate change has not been well understood. We reconstruct...
mid-late Holocene climate change in central and east Silk Road, and discuss its impact on the development of trans-Eurasia culture exchange in late prehistoric and historical times. Our results suggest climate change was an important driving force for some key events of transcontinental culture exchange in the old world, which was responsible for the shift of major passageway in prehistoric Eurasia, and the abandonment of Dunhuang area by government of Ming Dynasty (1368-1644 AD), which is suggested as a significant event for triggering the end of the ancient Silk Road.

How to ‘downsize’ a complex society: experiments with agent-based models to assess the resilience of Indus Civilisation settlements to past climate change

Andreas Angourakis (University of Cambridge)


The development and decline of the urban phase of the Indus Civilisation (c. 2500-1900 BC) provide an ideal opportunity to investigate social resilience and transformation in relation to a variable climate. The Indus Civilisation extended over most of the Indus Basin, which includes a mix of diverse environments. Indus farmers made use of a wide range of food production strategies. The resulting social diversity was conditioned, among other factors, by partially overlapping winter and summer rainfall systems. It is clear that there were changes to these two weather systems between 4.3 and 4.1 ka BP, but the impact of these processes appears to have been varied, and patterns of urban decline, change and transformation were also not uniform. We present an agent-based modelling (ABM) simulation addressing the potential diversity of agricultural strategies adopted by Indus settlements in different socioecological scenarios in Haryana, NW India. This work is part of the multi-disciplinary TwoRains project and brings together research on material culture, settlement distribution, food production and consumption, vegetation and paleoenvironmental conditions. The preliminary model aims to assess the implications of different food production strategies for the sustainability of urban population and the resilience of such strategies in the face of changes in the intensity and variability of winter and summer rainfall.

Rethinking the 8.2 cal BP event: Resilience and Collapse in the Konya Plain in Central Anatolia

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Because of the site’s long uninterrupted sequence from ca. 7100 to 5500 BC, Çatalhöyük and its environment are a good case study to scrutinize the multifaceted evidence and short- and long-term impact of and adaptations to the 8.2. event. This paper will discuss the most recent debates in the context of the site of Çatalhöyük in general, and the latest results of the research on its West Mound in particular. It shows that the beginnings of Çatalhöyük West at ca. 6100 BC overlapped seamlessly with the end of the older East Mound, and that the adaptations to environmental changes associated with the 8.2 event are characterized by resilience including a gradual spatial transformation of the settlement within the confines of the East Mound around 8.2, followed by a relocation to the West Mound and a final abandonment of the settlement 5500 BC – including the other settlements on the Konya Plain. With its distinctive pattern of traits resembling the classic levels of the East Mound, traits first attested on the later levels of the East Mound and newly developed features, the data from Çatalhöyük West represent both resilience and collapse surrounding the 8.2 event in Central Anatolia.

Long-term socio-ecological change in Cambodia Part 2: the exacerbating influence of control structures and material inflexibility on social resilience

Tegan Hall (University of Sydney)

Co-authors: Rebecca Hamilton, Dan Penny, Josephine Gillespie

For communities across the Southeast Asian mainland during the past millennium, episodes of societal fluorescence, decline and mobility have been linked to climate changes (Lieberman and Buckley, 2012) and regional economic patterns to a lesser extent (Reid, 1988, Hall, 1985). Through this time, various iterations of Khmer society persisted across the landscape, including the extensive kingdom that dominated much of the mainland between the 9th and 15th centuries C.E. The 15th century waning of political power in Angkor, this kingdom’s capital, and its gradual depopulation along with several cities within its territory, is a particular episode of mobility and rupture that ostensibly presents as a case of weakened social resilience in the face of heightened climate variability (Buckley et al., 2010, Hua et al., 2017, Yamoah et al., 2017). However, two aspects of this narrative are worthy of further investigation. First, placed in the context of long-term climate records and socio-ecological dynamics (R. Hamilton, this workshop) the climate variability of the 14th and 15th centuries should not have been catastrophic for mainland communities. Second, recent palaeoenvironmental and archaeological research indicates that the attenuation of land use within Angkor (Penny et al., in review) and at two (at least) secondary centres elsewhere in the kingdom (Penny et al., 2014, Hall et al., in press) was complex and protracted and had begun a century or more before the climate crises of the proceeding centuries, while other centres

Temperature changes and difference of hydro-climatic pattern between centennial cold and warm periods in China for the past 2000 years

Keynote lecture: Jingyun Zheng (Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences)

Co-authors: Zhixin Hao1,2, Xuezhen Zhang1,2, Quansheng Ge1

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This study presents an up-to-date overview on temperature and hydro-climate reconstructions in China for the past 2000 years. Multi-proxy synthesized reconstructions show that temperature variation in China has exhibited significant 50–70-yr, 100–120-yr, and 200–250-yr cycles. Results show that the amplitudes of decadal and centennial temperature variations were 1.3°C and 0.7°C, respectively, with the latter significantly correlated with long-term changes in solar radiation, especially cold periods, which were corresponding to sunspot minima approximately. The most rapid warming in China during the past 2000 years occurred at AD 1870–2000, may primarily be attributed to global warming induced by the anthropogenic increase of in greenhouse gas concentrations. However, the warmth in the 20th century may not be unprecedented for the last 2000 years, as data shown that mean of temperature in the periods AD 981–1100 and AD 1201–1270 were comparable to that in the 20th century. The ensemble mean of dryness/wetness spatial patterns in eastern China across all centennial warm periods illustrated a tripole pattern: dry in south of 250N, wet from 250–300N, and dry to the north of 300N. However, for all centennial cold periods, this spatial pattern also exhibited a meridional distribution. Moreover, the simulation revealed that the increase in precipitation over the monsoonal regions of China (especially for the region between 250N and 300N) within the 20th century warming period may be attributed to the Inter-decadal Pacific Oscillation (IPO) and the Atlantic Multi-decadal Oscillation (AMO) primarily. In addition, the general characteristics of impacts of climate change (especially for the warm/cold fluctuation at centennial scale) on the human dimensions in Chinese history were also reviewed.

Resilience and Landscape Transformation during the Bronze and Iron Age in a Mountain Steppe (Tsagkhakivot Plain, Armenia)

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The steppe region of the Mountainous Caucasus has been home to human communities practicing agriculture and pastoralism for almost 6000 years. In the area around Mount Aragats, the highest mountain peak in the country of Armenia, inhabitation of the surrounding Tsagkhakivot plain during the Bronze and Iron Age has pointed to periods of settlement and abandonment of this high-mountain region coinciding with periods of cultural transformation of these human communities. The contribution of climate and anthropogenic change, however, in shaping the plant and human landscape to date have not been fully studied. In this paper, we will present the results from our first phase of paleoecological research from the lake site of Shenkani, which
is part of an intensive lake coring program led by a French / American / Armenian team. We combine these data with 20 years of archaeological exploration of the region by American / Armenian archaeological project named Project ArAGATS. We will present the results of a multi-proxy approach combining pollen, non-pollen polymorphs, charcoal and geochemical analysis from this core along with archaeo-

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Climate change and the grain price anomaly around the turn of the 19th century in North China Plain

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Co-authors: Xiufang Fang, Yang Liu, Yikai Li

Impact of climate change on social development in historical period has been important hot spot during recent decades. As the interaction between climate change and the response of human society, economic subsystem with enough resilience can help to prevent climate risks from evolving into a population crisis. From the view of food security in historical China, grain price could be regarded as a indicator of the resilience of economic subsystem for buffering the balance between grain supply and food consumption to cope with the impacts including climate extremes. Based on the wheat price of Baoding Prefecture since 1736, linkages between climate change and grain price anomaly in North China Plain around the turn of the 19th century was explored in this paper. The main findings are as below: (1) The mean grain price and fluctuation range significantly increased after 1781, while the variation and periodicity of the de-trend grain price greatly enhanced. Then a shocking grain price spike emerged from 1810 to 1820. (2) The grain price anomaly had an evident correspondence with climate transition to colder and drier with greater variability. The negative correlation between precipitation and grain price was remarkably heightened from 1780 to 1810, indicating more sensitivity of grain price to precipitation. (3) The impact of extreme droughts was the direct cause of the grain price spike in North China Plain. In addition to the bad harvest for colder climate and continuous severe droughts, the decreased social resilience also played an important role for the

shocking grain price spike, such as less capacity for grain redistribution and relief aid. Key words: Climate change, Grain price anomaly, North China Plain, Resilience of economic subsystem

Is landscape intensity resilient? A comparative view from South Asia

Adam Green (University of Cambridge)


South Asia’s varied and dynamic environments have been home to diverse agricultural societies for over five millennia, but there is considerable variation in how long particular societies appear to have lasted. These differences can provide insights into what makes societies sustainable for long periods of time, and what makes them resilient to change. This paper will present data from northwest India collected by the Land, Water and Settlement, TwoRains, and TIGR2ESS projects, which have identified the location of hundreds of settlements dating to the entire span of human occupation in the region. Many of these settlements belong to the Indus Civilization (c.2600-1900 BC), home to South Asia’s first complex society. It will also introduce data from south India’s archaeological record, which will serve as a comparative example of social change under very different environmental conditions. The concept of ‘landscape intensity,’ which considers number, size, and distance between settlements, will be introduced as a means of comparing signature archaeological landscapes from different periods. Societies appear to adopt varying degrees of landscape intensity under different climate conditions – some build cities, some build settlements in new locations, some build tanks, some construct irrigation networks. The objective of the paper will be to address the general question: Is landscape intensity resilient? As a result, it will be possible identify forms of collective action, coordinated endeavors among households, communities and settlements, that were resilient for long periods of time and those which appear to have been prone to shocks and disruptions.

Impacts of recurring extreme climatic events on societies and landscapes in Provence and Southern French Alps during the past 800 years

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Co-author: Mr. Georges Pichard, Aix-Marseille University

Both urban and rural Mediterranean societies have always coped with specific climatic constraints (i.e. summer hot waves, persistent droughts, violent and flashy floods) causing agricultural, economical but also health disasters; these events are key factors of the dynamics of coupled human and ecological systems throughout history in this
part of the world. In the case of the Provence area and the Southern French Alps, if various aspects of the environmental and climate history during the Little Ice Age have already been explored, especially from the 18th to mid-19th century, consequences due to unusual recurring extreme climatic events on the long run since the early 13th century have been neglected notwithstanding available specific regional historical archives in Southeastern France. Therefore, a long-term analysis of the impact of these strong climate fluctuations, both on urban and rural societies, but also on landscapes, in a comparative perspective between two adjacent areas, with distinct topographies, soils and natural resources, thus appears original and interesting. First, after describing the hydro-climatic context in Southeastern France during the LIA (using the newly created HISTRHONE database, http://histrhone.cerege.fr/), we will present major social, economic and sanitary outcomes as well as ecological crises (e.g. important soil erosion or severe frostcaused mortality of trees) due to these extreme climatic events which impacted this area together with their effects on urban and rural dynamics. Then, we will see if it’s possible to highlight significant differences about the socio-environmental consequences of these events between lowland/coastal areas and mountainous regions of the Southern Alps.

Temperature changes during the past millennium along the Ancient Silk Road and Soical events
Zhixin Hao (Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences)
Co-author: Jingyun Zheng

Based on the recently published multiproxies temperature reconstruction series (longer than 1000 years) along the Ancient Silk Road, combined with the dry and wet condition variation reconstructions, the general characteristics of temperature changes were analyzed and the regional differences of dry and wet condition variations were compared for the Medieval Climate Anomaly (MCA, AD950-AD1250) and Little Ice Age (LIA, AD1450-AD1850). The main conclusions are: the centennial temperature variations during the past 2000 years experienced warm epochs in the 1st-3rd century, the latter part of the 7th century to the early of the 11th century, the mid-12th century to mid-13th century, and since the 20th century; and cold epochs during the 4th century to the early 7th century, the middle of the 11th century to the early 12th century, and the end of the 13th century to the mid-19th century. The phases of warm and cold condition and fluctuation at decadal-centennial temporal scales differed among the various regions. The wet and dry condition variations during the MCA and LIA also exhibited regional differences, which was larger during the MCA than the LIA on the Guanzhong Plain and in the Hexi Corridor of China, and the climate was dry during the MCA and wet during the LIA in the arid region of Central Asia. The climate was drier during the MCA than the LIA in the south of Scandinavia and the middle and northern parts of Europe, and in the central part of this region the variation was large during the LIA. In contrast, Finland, northern Scandinavia, and Russia had wetter climate during the MCA. The Mongol invasion of Europe and the vanished ancient City of Loulan could have possible linkage with the Abrupt climate change.

Aridization and social resilience in Argentinean Andean prehistory
Malena Pirolo (Instituto de Arqueología, FFyL-UBA / CONICET)
Co-author: Dr. Marcelo R Morales (Laboratorio de Diatomeas Continentales, DBBE, FCEN, UBA / CONICET), Dr. Hugo D Yacobaccio (Instituto de Arqueología, FFyL-UBA / CONICET)

The disruptive effects of droughts on human societies have been widely studied, both in current settings and among past societies. For example, intense and recurrent short-term droughts associated to the Medieval Climate Anomaly (MCA) have been considered one of the main causes behind the collapse of the Mayan and Tiwanaku centralized polities between 900 and 1300 AD. At a larger scale, more gradual but long-reaching aridization associated to the mid-Holocene Climate Optimum has been used to explain the abandonment of large areas of the Tropical and Sub-tropical Andes highlands in South America. To fully understand environment-society interactions it is necessary to explore, not only the full range of variability involved in environmental processes - graduality, periodicity, duration, and intensity, but also the baseline patterns of human organization, which ultimately determine the strategic responses available to human groups to mitigate –or even take advantage of- the impacts of environmental change and ensure societal reproduction. In this paper we compare two environmental change scenarios involving aridization in the Andes highlands of NW Argentina (Puna): the mid-Holocene arid period and the Medieval Climate Anomaly. We review the previous research that strongly suggests that mid-Holocene widespread and long-lasting aridity prompted the reorganization of mobility, settlement and subsistence patterns in this region, as well as a change in human-animal interactions that ultimately derived in the local domestication of camelds, giving birth to a transhumant pastoralist way of life that is still active today. In turn, we analyse the paleoenvironmental evidence that suggests the installation of an aridization process associated to the Medieval Climate Anomaly and we review the available dates to test the proposed link between aridization and the development of large agricultural sites with water management facilities in the northern sector of the Argentinean Puna. At the same time, camelid pastoralism continued to be a predominant subsistence strategy in this area of the Argentinean Puna, complemented with hunting of wild camels, which suggests that herds could have been used as a way of food storage as part of a
comprehensive risk management strategy. Here we compile and analyse the available evidence of faunal composition and mortality age patterns in archaeological sites with ACM-compatible chronologies, in order to evaluate the response of pastoralist groups to ensure herd sustainability in the face of short-term drought. While many research efforts have focused on the negative impacts of droughts on human societies, we consider the two processes cited here as good examples of social resilience, driven mainly by flexibility of social, technological, and mobility organization, but also made possible by the characteristics of environmental change itself. These two instances of increased aridity in the Argentinean Andes highlands prompted social change that led to substantial increases in social complexity, intensification of resources, technological development and modifications of short and long distance social networks to ensure social reproduction. However, certain responses to increased aridity may, in time, reduce societal flexibility and weaken the capacity of social groups to react effectively to prolonged drought. A reduction of mobility and tethering to water control features could be such a case.

Ancestral Puebloan maize farmers in Utah distribution and growing season length using a statistically downscaled climate model, 850-1450 CE

Marcus Thomson (International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria)
Co-author: Glen M. MacDonald

The rise and decline of complex, maize-farming Ancestral Puebloan (AP) cultures in the American Southwest coincides with the warm, climatically consistent Medieval Climate Anomaly (ca. 850-1350 CE) and transition to the cool, hydrologically variable Little Ice Age (ca. 1350-1850 CE). The impact of temperature stress on the growth of AP maize crops remains an open question. We statistically downscaled a climate model (CESM LME) to map changes to cumulative growing degree days for maize (cGDD, 30/10°C) over Utah between 850 and 1449 CE. We compared downscaled CESM-derived cGDD changes over Utah to local AP (“Fremont”) archaeological site occupations from radiocarbon-dated artifacts mapped as spatially discrete, chronologically summed probability distributions (SPDs). We then analyzed correspondences between Fremont SPDs and cGDD between 850 and 1449 CE. In general, we found (1) high Fremont occupation intensity coincident with high, low-variability cGDD, and low occupation intensity coincident with, or following, periods of volatile cGDD; (2) intensified occupation of high-elevation Colorado Plateau sites during the MCA, followed by a retreat to lower elevation sites driven by a proxy-identified drop in mean annual temperatures; and (3) these occupation changes occurred in spite of the greater temperatures and variability in cGDD at low-elevation sites. We speculate that the interannual variability of growing seasons, and the risk of staple crop failures, was a crucial determinant of Fremont subsistence strategy decision making, site occupation, and migration.

Political Participation and Social Resilience to Climate-Related Disasters

Keynote lecture: Peter Peregrine (Lawrence University, Appleton, Wisconsin USA)

Scholars of disaster response and management hypothesize that societies providing greater local participation in decision-making and which have more community coordination and governance organizations are more resilient to climate-related disasters. This paper tests this hypothesis using a cross-cultural research design and a sample of archaeologically-known societies that have experienced catastrophic climate-related disasters. The paper finds that societies allowing greater political participation appear to provide greater resilience to catastrophic climate-related disasters, generally supporting the predominant hypothesis guiding contemporary disaster response and management.

Integrating Collapse Theories to Understand Robust Designs for Social Ecological Systems Governance

Cathy Rubinos (Universidad Del Pacifico, Lima Peru and Center for Behavior, Institutions and Environment, ASU)
Co-author: John M. Anderies (School of Human Evolution and Social Change, School of Sustainability and Center for Behavior, Institutions and Environment, Arizona State University (ASU))

The world is facing new environmental challenges that may trigger the collapse of some social-ecological systems (SES). It has been forecasted that more extreme weather events may be much more common in the decades to come due to climate change. Although we have an idea of what climatic events to expect in each region, we know less about how SES can cope with these challenges. We study The Peruvian Piura Basin, which has been exposed to harsh environmental events associated with the El Niño Southern Oscillation for centuries. The Piura basin was even home of an ancient civilization named Moche, which collapsed due to a combination of factors, but strong El Niño events was one of them. To analyze the robustness of The Piura Basin to flood events, we used as guidance the robustness framework and different hypothesis from prominent collapse theories, and carry out a longitudinal study from collected secondary and primary data. We found that the Piura basin is very fragile based on almost all of the predictions of collapse theories (specially with respect to selfish elites, centralized governance, systems interconnection, anticipation capacity and sensitive dependence on resources), but the biggest strength is its growing stock of social capital.
In small steps, user associations have been collectively working towards solutions for water conservation and public-infrastructure maintenance. There is a long way to go yet to be entirely robust, but with the right policies to encourage the strengthening of these associations, the Piura basin could become more robust to future El Niño events. This study also provides methodological and theoretical insights that can contribute to theory building for robust SES, which is an urgent endeavor.

How Europe and the Qing Dynasty Endured the Little Ice Age: Social Resilience, Norms, and Adaptable Governance

Susann Handke (Erasmus School of Law, Rotterdam)

The Little Ice Age occurred between the 17th and 19th centuries. The cooling that was felt in many parts of the Northern Hemisphere was caused by several volcanic explosions. The consequences of cooler temperatures particularly affected societies in Europe and China. In the 17th century, large parts of Europe and China experienced long periods of social unrest, societal collapse, and war. In China, the Ming Dynasty was defeated by the Manchus who invaded the Chinese territory from the north and established the Qing Dynasty in 1644. During the following decades, the Qing rulers succeeded in both re-unifying China and pacifying nomadic tribes on the empire’s northern and north-western flanks. In Europe, a new order emerged after the signing of the Treaty of Westphalia in 1648. This treaty formed the basis of the modern system of sovereign states in which states in principle seek to resolve conflicts through negotiations rather than war. This paper examines how societies in Europe and China responded to climatic change in the past and developed social mechanisms that helped to maintain stability. These mechanisms had to overcome the consequences of population decline and socio-economic collapse following wars, epidemics, and famine. The paper particularly studies how European states and the Qing Dynasty managed to endure the aftermath of the cooling period and developed forms “adaptable governance” – i.e., malleable norms and institutions that ensured some degree of social resilience. The paper takes the emergence of international law and, in particular, the modern system of sovereign states in Europe as well as the adaptation of Ming institutions during the Qing Dynasty as case studies of social resilience. It first explores the effects of cooling on societies in western and central Europe and China during the 17th century. Then, it shows how ruling elites and society succeeded in responding to these crises by establishing and maintaining norms and institutions that stabilised the states and regional order. The paper argues that both cases reveal important lessons on climate resilience and the relevance of norms and institutions when dealing with instances of climatic and ecological stress.

The role of swidden agriculture in contributing to long-term socio-ecological resilience in north-east Cambodia

Rebecca Hamilton (School of Culture, History and Language, The Australian National University)

Co-authors: T. Hall, D. Penny and J. Gillespie

Analysis of palaeoenvironmental data archived in lake sediments from the dry tropics of Cambodia demonstrates that the past 5,000 years have been punctuated by multiple, protracted droughts. Several of these, particularly those occurring between 4300 and 1540 cal. yrs BP, appear to far exceed in both severity and duration the drought events of the last millennium. This is of consequence given that these more recent, lower magnitude climate perturbations have been attributed to disrupting the large-scale social and economic networks of Angkor in the 14th and 15th centuries, suggesting low resilience of these systems to environmental change. This study highlights the potentially catastrophic impacts that earlier, more severe climatic extremes may have had on socio-ecological systems in Cambodia. However, there are few datasets that are of a sufficient temporal length to test this hypothesis. This study uses a multi-proxy, palaeoenvironmental approach to examine the long-term dynamics of swiddenbased societies in Ratanakiri Province, north-east Cambodia, with a particular focus on environmental response to extreme climate events. The persistence of fire activity across the duration of the record (with the exception of the late 20th century conflict period), suggests the continued presence of swidden practice at the site through time. Low-scale anthropogenic burning for agriculture appears to heighten the beta-diversity of the landscape, contributing to the stability of the surrounding forests in the face of climate extremes. These results suggest long-term, coupled socio-ecological resilience. This has implications for future forestry management in north-east Cambodia, including the important role of long-fallow swidden practices in forestry – a approach that is often inconsistent with current management strategies.
### Session 12: Archaeohydrology – natural water supply and cultural water demand in the past

**Tuesday March 12th, Room 204**  
Session organizers: I. Unkel, T. Kluge, E. Zagana, M. Finné

<table>
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<th>Time</th>
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| 08:30 | Archaeohydrology: A discipline at the interface of archaeology, hydrology, and hydraulic engineering  
Kai Wellbrock (Technische Hochschule Lübeck - University of Applied Sciences)  
Co-author: Matthias Grottker |
| 08:50 | Flood Risk Management in Classical Antiquity. The case of the sanctuary of Amphiaraoas at Oropos  
Anna Androvitsanea (Technical University of Berlin) |
| 09:10 | Archaeology between the Danube and the Timiş rivers: multi-proxy investigations of the Pančevački Rit alluvial plain near Belgrade, Serbia  
Dragana Filipovic (Institute for Pre- and Protohistory, Kiel University; Institute for Balkan Studies, Serbia) |
| 09:30 | Discussion |
| 10:30 | Monsoon, climatic anomalies and society in late medieval India: introduction to the MANDU Project  
Anne Casile (Research fellow, IRD (French National Research Institute for Sustainable Development), PALOC) |
| 10:50 | The remain of supply water systems in soltaniyeh plain, Zanjan, Iran  
Mahsa Feizi (phD Candidate at University of Tehran and Lumière University Lyon 2) |
| 11:10 | Reconstruction of Vaqf-Abad Qanat in the Urban Landscape of City of Yazd in Two Historical Periods (13th and 20th Century)  
Semsar Yazdi Ali Asghar (Senior advisor to the International Center on Qanats and Historic Hydraulic Structures (ICQHS)) |
| 11:30 | Mediaeval and post-mediaeval artificial water reservoirs like a sources of information about landscape, vegetation and subsistence practices changes  
Libor Petr (Department of Botany and Zoology, Faculty of Science, Masaryk University, Czech Republic) |
| 11:50 | Discussion |
| 13:30 | Hydrogeological investigation in the ancient region of Stymphalos  
Keynote lecture: Eleni Zagana (Department of Geology, University of Patras, Greece) |
| 14:00 | Stalagmites as archaeohydrological archives: a case/cave study from Korinthia (N- Peloponnese, Greece)  
Tobias Kluge (Heidelberg University) |
| 14:20 | Resilience patterns in the Argolis - a model approach to investigate land-use characteristics under changing climatic conditions  
Wolfgang Hamer (CRC 1266, Kiel University) |
| 14:40 | Discussion |
| 15:30 | Water management for bathing facilities: its effects in the landscape and cityscape of Catina and Syracusae (1st BC – 4th AD)  
Paola Santospagnuolo (Freie Universität Berlin - Institute of Classical Archaeology) |
| 15:50 | Evaluating the influence of climate on the Late Bronze Age collapse in the eastern Mediterranean  
Lydia Bowler (University of Reading) |
| 16:10 | Water availability and hydrological soil properties around the ancient settlement of Stymphalos (Greece)  
Ingmar Unkel (Kiel University) |
| 16:30 | Discussion (including Summary by the Organizers) |
**SESSION 12**

**ABSTRACTS**

**Archaeohydrology – natural water supply and cultural water demand in the past**

*Keynote speaker: Eleni Zagana (Department of Geology, University of Patras, Greece)*

*Session organizers: I. Unkel*, T. Kluge, E. Zagana, M. Finné

*corresponding chair, iunkel[at]ecology.uni-kiel.de*

Archaeohydrology investigates water in an archaeological context and searches for connections between natural water supply, natural hydrological conditions, and socio-cultural developments of human societies in the past. We invite papers related to this definition of archaeohydrology which can range from rivers to drops, from seas to mountain lakes, from fertile soils to deep gullies, from climate to culture, from early Neolithic farmers to medieval hydraulic engineers, as long as the subjects correspond to a historical or archaeological period and are related to water. The session deliberately focusses on hydrological aspects of the climate-culture-interaction topic. Specifically, we want to encourage a closer look at the hydrological hazards to societies. This would mean in humid areas like Northern Europe for example flood events, in more arid regions like the Mediterranean or the Middle East dry periods of different scale and magnitude. While contributions from the natural science perspective may focus, for example, on the natural water availability, carrying capacity of environments, and aspects of variability in the hydrological system, contributions from the archaeological perspective may focus for example on adaptation and management strategies of different societies, and the resilience or vulnerability of certain societies to hydrological hazards.

We also welcome papers dealing with eco-hydrological aspects of ancient water management, with hydrological-cultural modelling, or papers which discuss new developments in proxies applicable to archaeohydrological research. With this session we want to contribute to a more specific view of the role of hydrological climate patterns in the development of societies, going beyond the often simplistic view of a general climate event causing a sometimes arbitrary society to rise or fall.

**Archaeohydrology: A discipline at the interface of archaeology, hydrology, and hydraulic engineering**

*Kai Wellbrock (Technische Hochschule Lübeck - University of Applied Sciences) Co-author: Matthias Grottker*

The need of hydrological approaches became increasingly evident in archaeological projects within recent years. This is even more applicable in arid and semi-arid
environments when water availability had to be ensured by means of specific water management and engineering. Water abundance and reliability including the development of innovative water management has been the major cause for the development of early permanent occupations in arid environments or promoted the sustainable city life. Diverging archaeological and hydrological understanding and concepts in hydraulic analysis created an urgent need of a discipline at the interface of both subjects.

Works of this discipline, to be called archaeohydrology if defined from the hydrological and hydraulic perspective, are presented by several archaeohydrological case studies from prehistory and antiquity. The contribution will focus on the technical methods needed in archaeohydrology; hydrological approaches and appropriate support from sub-disciplines will be explained. It is stressed that not only hydrological concepts, but also the technical manipulation of natural water resources by means of hydraulic engineering should be taken into account. It is highlighted which additional questions are likely to be answered by archaeohydrological approaches.

Hitherto, hydrological research in archaeology is dominated by rather technical (hydrological, engineering) than societal (archaeological) aspects and aims. Research practice in water history projects clearly points out the imperative need for multidisciplinary approaches, with methods and research agendas of their own right, in order to achieve the understanding of hydraulic structures and the lessons they might provide for present-day sustainable water management.

**Flood Risk Management in Classical Antiquity. The case of the sanctuary of Amphiparos at Oropos**

Anna Androvitsanea (Technical University of Berlin)

Identifying and interpreting the traces of an ancient water culture is a challenging task. In this paper, we make use of an interdisciplinary approach, drawing from hydrological modeling and archaeological research in order to investigate the effect of flood risk management in ancient hydraulic infrastructures and contemplate on the awareness of flooding risks in antiquity. We focus on the sanctuary of Amphiparos in Attica. The sanctuary is located in a deep and steep-sloped gorge within which flows a river. The gorge consists largely of lacustrine-fluvial coarse deposits, enabling percolation and seepage and has a steep slope (22%). The river drains a broader basin of circa 1700 hectares to the Aegean sea. We show that, subsequent to extreme amounts of precipitation, the river would overflow its cross section and flood the surrounding areas, including the sanctuary. As the sanctuary is built next to the river, water management has been a concern, a fact attested to both by the archaeological remains and by inscriptions dated to the 4th century BCE. Using a simple hydrological model, we estimate the basin’s response to flooding events of different return periods. Specifically, we make use of the Intensity-Duration-Frequency curve calculated for the surrounding area in previous work. From this curve, we derive the maximum intensity of precipitation over a given recurrence interval, i.e. the likelihood of a given intensity, over this time period. We then use the Rational method to estimate the expected flow rates over each time interval. Conversely, we use the Gauckler- Manning-Strickler formula to calculate the volumetric flow rate that can be accommodated by the river cross section, as defined by the embankment found in situ. With this quantitative information, we can get a sense of the frequency of flooding events at the site. What’s more, we make inferences regarding the effectiveness of the hydraulic works, reconstructed in this paper, as mitigation measures against flooding. Informing this analysis with archaeological data, we cast some light on both the engineering and the societal considerations of the era in Attica. Combining hydrological observations and analysis with archaeological data, this paper casts some light into the natural conditions under which building projects in the sanctuary had been designed, tendered and implemented, as well as their significance in a ritual, societal and urban context.

**Archaeology between the Danube and the Timiş rivers: multi-proxy investigations of the Pančevački Rit alluvial plain near Belgrade, Serbia**

Dragana Filipovic (Institute for Pre- and Protohistory, Kiel University; Institute for Balkan Studies, Serbia)

Co-authors: Milorad Ignjatović, Belgrade City Museum, Serbia Jelena Bulatović, Laboratory for Bioarchaeology, University of Belgrade, Serbia Kristina Penezić, Biosense Institute, University of Novi Sad, Serbia

The area of about 400 square kilometres delimited by the Danube and the old and new beds of the Timiş river near Belgrade was, until mid-last century, a mosaic of low-lying wetlands and dry higher ground, and frequently flooded. Nowadays, it is an area split between densely populated Belgrade suburbs and highly fertile agricultural land. Few decades ago, surface prospection documented traces of potential archaeological sites scattered over this area and dating from different prehistoric and historic periods. This demonstrated that, despite being prone to flooding and waterlogging, the area was an attractive location for anthropogenic activity, possibly including residential use, for millennia before modern day drainage and engineering works. Recently, a multidisciplinary study was completed aimed at evaluating the potential of the area for inhabitation and use during prehistoric and historic times and at identifying the likely locations of short- or long-term settlements. In the initial phase of research, the methods included surface survey by field walking, examination of satellite and aerial photography, geophysical prospection and geoarchaeological coring. The results were...
used to create GIS-models of the terrain, informed also by the available data on soil and vegetation cover. In the second stage, the assumptions based on GIS were tested in a case study that included excavations of one of the detected sites and the archaeobotanical and zooarchaeological analysis. The multi-proxy approach enabled initial reconstruction of the pre-industrial landscape and an assessment of the favourability of the area for human occupation. It also allowed assumptions to be made about the land use and land management, and the overall quality of life in the past in a hydrologically rich and dynamic environment. This paper presents the research process and outcomes.

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**Monsoon, climatic anomalies and society in late medieval India: introduction to the MANDU Project**

Anne Casile (Research fellow, IRD (French National Research Institute for Sustainable Development), PALOC)

This presentation will introduce the newly ANR (French National Agency of Research) funded project called MANDU, focusing on the interplay between societal change, hydroclimatic variability and water management from a landscape perspective in late medieval times, a period of both significant climatic disturbances and sociopolitical/cultural upheavals in India. On the archaeological ground, the late Medieval is a most poorly documented period of the history of India, and our understanding of the big scale society change that took place remains limited in a number of ways. Scholars have paid little attention to the environment in general and to the role of climatic variability in particular. Scientific advances on climate change and a growing network of palaeoclimatic proxies from Asia have recently unraveled long unknown aspects of the Indian monsoon behavior over the past two millennia, pointing to important variations of the Summer monsoon and the occurrence of climate extremes in late medieval times. What were the impacts of climatic anomalies and related environmental disasters on society, and on the transformations of the cultural landscape that took place in late medieval times? How society responded to hydroclimatic extremes? How did people live in and transform the environment to adapt to monsoon rain variability in a semi-arid environment? What can the study of the long-term lives of water bodies tell us about vulnerability, adaptation and resilience in the face of climatic disturbances? These interrelated questions are all-inherent in land/waterscape histories, and resonate with present concerns about climate change in general, and water scarcity in particular. The ambition of the MANDU project is to address the same and open ways to interdisciplinary research on impacts and feedbacks between society, climate and environment during the first half of the last millennium in India. To investigate the above questions, the project will aim to trace continuities and discontinuities in the historical land/waterscape, and analyse them in ways that give insight into the nature of change, vulnerability and adaptation, and into the ability to absorb perturbations or shocks. The research will focus on the region of Malwa in Central India (Madhya Pradesh) and carries its field investigations on the area of Mandu, a famous historical place known as the capital of the Malwa Sultanate from c. 1400 CE. Situated in the semi-arid part of Malwa, it is now a vast rural area inhabited by adivasis of the Bhil tribal community, one of whose major concerns relates to water scarcity and insecurity. Untouched by recent urbanisation, the area of Mandu encompasses rich archaeological records of long-term human occupation, cultural and institutional changes underpinned by a variety of processes, and offers potential from scientific perspective to investigate various facets of the society-climate-water interplay in late medieval times. To explore the landscape and watersheds sensitivity and vulnerability to hydroclimatic variations through time and the ways society adapted, the project will have recourse to a variety of disciplines by bringing together scholars from the humanities, social and environmental sciences.

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**The remain of supply water systems in soltaniyeh plain, Zanjan, Iran**

Mahsa Feizi (phD Candidate at University of Tehran and Lumière University Lyon 2)  
Co-author: Nasim Feizi (ph.D. Candidate to university Tarbiat Modares)

Soltaniyyeh plain located in the north-western of Iran, approximately 35 km to the east of the town of Zanjan. The plain is very important in term of strategy. The reason for this is that the central and northwestern of Iran are connected together by this plain. Natural condition, including Favorable geological condition, abundant precipitation, geology structure, low slope, and sufficient moisture created a supportive environment for human settlements. In the summer of 2016, an archeological survey was conducted therein, in which 90 sites and a large number of ancient water supply systems were registered. This plain has taken his name from a city which the Mongol Ilkhans built in 1304 A.D therein. The construction of the city lead to a series of changes in the region’s landscape and it marked a turning point in the cultural continuity of locality. The author set out to explain the way in which the human has used the potential environment to reach the water and how this usage changed to provide a systematic network of water supply which must have supported a city. Soltaniyyeh plain, with relative height about 1800-2000m from sea level, is surrounded in the north and south by mountains. Calcareous geological structure caused a deeps groundwater, at the foothills, in the mountains, so that, once these aquifers reach hard and impenetrable stones, springs are flows. There are a large number of such springs which irrigate the plain in the north and south. The result of the archeological survey, the GIS analysis and the Statistical Analyses show that the springs are the most important sources to
supply the water for human settlement. They profited these springs with different structures such as low-depth dams, canals, watercourse and floodgate which some of them remained until now. There are several deep aquifers in the different part of the plain. In the southern mountains, a network of faults has created a complex and deep underground water which progressed to the center of the plain. In addition, in the plain, there are about 150 to 200 meters of alluvial deposits with high permeability and rich in term of aquifers. However, the underground water of southern mountain and its northern side also join in them. On the other hand, its geological structure keeps the surface of these underground water high. In each part, once the slope of grounds and depth of underground water reached the minimum level, Qanats have been made. As noted in written sources, with the construction of the city, a large number of Qanats were made, such immense construction required an adequate knowledge of the hydrology science, a huge number of workers and a Supportive power which were provided very well during the construction of the city. The result of the archaeological survey, the study of written sources, the GIS Maps and the cluster analysis show that there is three group of human settlements in the different part of the region. In addition, in three group, springs, rivers and Qanats, are three manners of supplying water, respectively. In the second group, which located in the central and southeastern plain, and is at almost 1949 m above sea level, are situated the sites of around 150 to 200 meters to underground water which progressed to the center of the plain. In addition, in the southern mountains, a network of faults has created a complex and deep underground water which progressed to the center of the plain. In the southern mountains, a network of faults has created a complex and deep underground water which progressed to the center of the plain. These sites have maximum coherence with Qanats and springs. In addition, several canals carried the water from the southern mountain to the city and a large number of Qanats were used for water supply and the irrigation of garden and farms.

Reconstruction of Vaqf-Abad Qanat in the Urban Landscape of City of Yazd in Two Historical Periods (13th and 20th Century)
Semsar Yazdi Ali Asghar (Senior advisor to the International Center on Qanats and Historic Hydraulic Structures (ICQHS))
Co-author: Ameneh Karimian, Architectural Designer and Researcher
The 700 year old Vaqf-Abad Qanat has provided water for drinking and urban usage in the city of Yazd (Iran) until the late 60s. Recent developmental projects, climate change and the modern city’s infrastructures such as performing the city’s potable water network has affected the role of qanat in the people’s lives and the urban context. As a result qanat, its related structures and its pathway are going into oblivion. The lack of information on the exact pathway of this qanat and its related hydraulic structures led us to carry out this research. Therefore, as a first step the historical texts and documents related to Vaqf-Abad qanat, the interconnected mansions and hydraulic structures have been reviewed. In order to have a better understanding of the city’s texture in the 13th century, the city and its defensive wall has been closely investigated. After compiling and analyzing the existing information, a 2 dimensional image of the city with a focus on Vaqf-Abad qanat’s pathway has been reconstructed. In the second part of the study, the books, documents and endowments of the past 100 years existing on this qanat have been studied. Through field investigations and interviews with the local practitioners of different neighborhoods of the city, the exact pathway of the qanat was recognized. Then the pathway was illustrated on the recent city’s map. Key words: Qanat, Vaqf- Abad, Yazd City, Reconstruction, mapping

Mediaeval and post-mediaeval artificial water reservoirs like a sources of information about landscape, vegetation and subsistence practices changes in Czech republic.
Libor Petr (Department of Botany and Zoology, Faculty of Science, Masaryk University, Czech Republic)
Co-Author: Petr Kočár
First distinctive human impact to major river stream in Czech republic is recorded in Mikušice. Early mediaeval stronghold on Morava river existed in 9th century AD, there is several bridges and river bank reinforcement. The high mediaeval period brings increasing of human utilisation of water streams and construction of artificial fishponds. Fish breeding was induce by fasting and difficulty of herring import. First fishpond is known from Praha dated to 12th century. The peak of fishpond building is dated to 15th century and early postmediaeval period. Fishponds sometimes cover former landscape including forest remains. Fishpond are still neglected by archaeology research, dam construction was investigated in Smolina in peripheral Western Carpathians region. Fishpond create new wetlands habitats and contains paleoecological record. Mediaeval colonisation and founding of new villages cause urgency of water supply. One way was building of artificial water reservoirs, such as small dammed ponds or pit hole. This structures are preserved in deserted villages, sometimes has still wet infill, which provide excellent pollen record about landscape changes after settlement decline (Petř and Vařeka submitted). The mining activities and metal processing needs water and energy provided by water. This activities leads to construction of metal washing and building of pond for propulsion. This construction had only short life, depending on mining process, quickly were abandoned and vanished due to deforestation and subsequent erosion. Recent remains are investigated in context of mountain archaeology and shows changes in landscape relief. Fishponds and water stream were employ to hemp leaching. First evidence hemp processing in Czech republic is known from alluvial castle in Veselí nad Moravou dated to mid of 13th century. Several early post mediaeval pound were used to hemp
leaching recorded in pollen and macroremains record. This activities ended during 19th century. The historical landscape was fill up of small streams and water reservoirs, which keep up water balance in deforested cultural landscape. Industrialization and field connection during 20th century vanished this network and reduced volume of accumulated water. Landscape turn over to drought sensitive.

Hydrogeological investigation in ancient region of Stymphalos

**Keynote lecture:** Eleni Zagana (Department of Geology, University of Patras, Greece)

**Co-authors:** Eleni-Anna Nanou (Department of Geology, University of Patras, Rion, 26500 Patras, Greece), Ingmar Unkel (GSUHL, Kiel University)

The karstic environment (polje) of Stymphalia located at Northeastern Peloponnese is known not only from the ancient mythology, the fighting of Heracles with Stymphalian birds, but also from the ancient Greek and Roman periods. The surrounding area is characterized from large karstic springs, the front of Stymphalia – Driza springs and Kefalari spring, which discharge the karstic groundwater system named Ziria. The importance of water in the evolution of the ancient and the Roman city is an issue that our ongoing research aims to investigate. Nowadays the water management of the area is crucial as the springs water is used for drinking water supply of the city of Corinth, while a big debate is in progress for the further use of the spring water for the drinking water supply of city Kato. Water sampling of the springs is carried out for the last two years in a monthly basis, while the water level of Stymphalia springs is measured in a daily basis. The first results of this study are presented in this presentation.

Stalagmites as archaeohydrological archives: a case/cave study from Korinthia (N-Peloponnese, Greece)

**Tobias Kluge (Heidelberg University)1,2**

**Co-authors:** Tatjana Sarah Münter1, Elisabeth Eiche3, Martin Finne4, Ingmar Unkel5

1 Institute of Environmental Physics, Heidelberg University, Germany
2 Heidelberg Graduate School for Fundamental Physics, Heidelberg University, Heidelberg 3 Institute of Applied Geosciences, Karlsruhe Institute of Technology
4 Department of Archaeology and Ancient History, Uppsala University
5 Institute for Ecosystem Research, Kiel University

Caves have been occupied by humans since pre-historic times for various purposes. Indicators are archaeological artefacts such as pottery, but also soot layers that settled on the cave surfaces. Speleothems are carbonates that form quasi-continuously in many caves and allow a precise dating of enclosed soot layers. The speleothem carbonate also contains many proxies that enable the reconstruction of the paleoenvironment and paleoclimate. We analysed several speleothems from the Peloponnese that were carefully selected from caves used for religious devotion in the antique Greek period. U-Th analysis provides age constraints for the individual soot layers to originate between 2.5 and 3.2 ka BP. Independent estimates based on pottery suggests ages of cave occupation between 2.5-2.7 ka BP. Stable isotopes of the speleothem carbonate (δ18O, δ13C) are used together with clumped isotopes and elemental ratios to infer the paleoclimatic history at the cave region. Preliminary data suggest significant variation in the paleoclimatic conditions during the Holocene growth period of the speleothems. For quantitative paleoclimate assessment clumped isotopes will be evaluated together with carbonate δ18O to infer rainfall changes and its potential influence on water availability for the local societies. Acknowledgements: We thank Norbert Frank, Andrea Schröder Ritzrau and Rene Eichstädt for support in U/Th sample preparation and analysis; Denis Scholz and Regina Mertz for analysis of elemental ratios. We are grateful for support by Chryssa Contaxi and Dimitris Karoutis.

Resilience patterns in the Argolis - a model approach to investigate land-use characteristics under changing climatic conditions.

**Wolfgang Hamer** (CRC 1266 - Kiel University)

**Co-authors:** Dr. Daniel Knitter Priv.-Doz. Dr. Oliver Nakoinz Prof. Dr. rer. nat. Rainer Duttmann

The variability of rainfall – visible not least in the droughts of summer 2018 – is a threat for all societies, especially in the Mediterranean and sub-tropical climate region, where sufficient precipitation is limited to winter season and evapotranspiration is high. To which degree does this variability of rainfall, in combination with the socio-economic characteristics of a society, influence the resilience patterns of an area? We investigate these questions using the situation in the Argolis in the first millennium BCE as a case study, where geoarchaeological research indicates, that precipitation amounts dropped up to 20 %. We examine the spatio-temporal climatic and environmental dynamics and integrate these in a fuzzy model of available resources, with a special focus on water availability. The latter is of particular importance, as the investigated area benefits not only from precipitation in the direct catchment area but also from more distant precipitation, whose waters are transported in the Argolis by means of extended groundwater aquifers. Based on empirical data and the fuzzy model of resource potential, land use is quantified. Different scenarios are used to estimate potential influences on supply patterns. This allows us to make assumptions about the inter-relationship and dependence of a society on environmental and socio-economic dynamics and offers insights into the resilience patterns of the area.
Bathing buildings depended on water and represented one of the main places where Romans daily came into contact with it. In a sense, this type of building was the actual link between the natural element and the anthropized contexts, but also the symbol of man’s ability to bend the nature to his needs. In detail, during the Roman period, the presence of volcanic thermalism in Campania (Phlegraean Fields) favoured a twofold consequence: first, the creation of engineering solutions intended to exploit steam and hot water; second, the attempt to recreate these conditions in other contexts, such as in the urban space, led Romans to develop new techniques of water management and water supply. Accordingly, from the last centuries of the Republican period onwards, all cities of the Empire were provided with public baths, which became essential features both of urban and rural areas. This paper centres on the role played by water in the transformations of the rural and urban landscape over time, by focusing on the bathing culture of eastern Sicily, specifically, the provinces of Catania (Catina) and Syracuse (Syracusae) between 1st and 4th centuries AD. The analysis will proceed, firstly, by examining the different geological structure distinguishing the two provinces (the lava stratifications around the volcano Etna and the limestone plateau of the Hyblean Mountains), its consequences on the water canalization ways (channels carved into the rocks, aqueducts, etc.) and the subsequent use and/or abandonment in the following periods. With special regard to the urban environment, evidence of public baths coming from the two main Roman colonies will be compared: Catina (‘Terme dell’Indirizzo’; ‘Terme della Rotonda’) and Syracuse (Terme Corso Gelone). By scrutinizing the original environmental features of these places (presence of hills, rivers, etc.), their topographic articulation and infrastructures, the paper will try to answer some questions concerning the position of the buildings in the cityscape: which were the reasons lying behind the site choice? Were the already structured urban zoning or the accessibility to the water resource implied? As to the extra-urban environment, different dynamics were involved. In fact, on the one hand, the existence of natural thermal springs influenced itineraries since Prehistory, (e.g. the baths of ‘Santa Venera al Pozzo’), on the other hand, during the Roman period the presence of important routes led to the creation of staging areas furnished with bathing facilities for travellers. In particular, it is interesting to note that among the baths analysed (Noto – Passo di Miele; Calatabino – Imperio; Flumenfreddo – Torrerossa), those linked to extra-urban roads were characterized by a direct connection to a stream. It is likely, therefore, that these buildings received water directly from these small rivers and streams.
providing precise and robust chronologies from U-Th dating with low chronological uncertainties (between ±15 to ±35 yrs). This is of significance as many of the existing climate records across this region are of low resolution with high chronological uncertainties. This work also holds relevance to the current hydrological situation in the eastern Mediterranean, as well as the Middle and Near East, as it can inform us about the resilience and vulnerability of past societies to severe and persistent droughts and thereby contributes to a better understanding of current and future responses to anticipated water scarcity. This is important as the Mediterranean is recognized by the IPCC as one of the world’s global hot spots of climatic change, witnessing increasing frequency of drought events. As a result, the issue of water is and will remain a core concern in the sustainability challenge of the region as well as possessing implications for global food security due to likely increased agricultural stress.

**Water availability and hydrological soil properties around the ancient settlement of Stymphalos (Greece)**

*Ingrid Unkel (Kiel University)*

*Co-authors: Thomas Birndorfer, Hans-Rudolf Bork, Svetlana Khannueva-Wendt*

The impact of climate events or changes in the environment on the development of ancient societies is often discussed in a very general or simplified way. It is often neglected that in some regions people and the environment they are living in, are more sensitive to changes in hydrology, while in other regions changes in temperature play a greater role. For understanding the critical hydrological thresholds of food and energy supply for a society in the context of land-use and land-cover, it is not sufficient to investigate changes in precipitation patterns alone, but also the characteristics of the geological and pedological regime in the respective region has to be taken into account. We here present preliminary archaeohydrological investigations from the Lake Stymphalia catchment in Greece testing and complementing paleoenvironmental and paleoecological reconstructions from lake sediment cores and archaeological excavations by analysing the fertility and hydrological properties of the different soils in the catchment around Lake Stymphalia, and differentiate according to site characteristics (e.g. topography, climate, bedrock and initial substrate, land use history). As there is hardly any pedological information available from the region, these first analyses shall answer questions like: Which soil types are characteristic of the study area? Are there any differences in pedogenesis, e.g. due to the geological structure of the basin or due to different land use patterns? Is the human impact (footprint) visible in the soils of the study area? Can we identify changes in land use patterns and human activity in the past, especially concerning forest clearing, agriculture, and hydrology?

**POSTER SESSION: Groundwater use at the Heraion of Samos in Antiquity – Technology and Adaptation**

*Anna Androvoltsana (Palacky University Olomouc, Czech Republic)*

The water supply of the ancient extra-urban Sanctuary of Hera at the Greek island of Samos is currently studied by an interdisciplinary team. Simultaneously to an inventory and review of the archaeological evidence of wells and other water supply structures at the site, a thorough study of the hydrology of the catchment and aquifer system has been carried out. The combination of both disciplinary studies and the synopsis of archaeological and hydrological data provides new insights into the scientific understanding and the technology needed to develop and maintain water supplies. Changes in types and location of wells and other hydrological infrastructure shed light on adaptations to possible environmental and societal changes. The Samian Heraion is situated in an alluvial coastal plain in the Southeast of the island. The site is linked to the Imbrasos river, which drains a basin of approximately 27 square kilometers. The geology is defined by travertine, marble, schist and alluvium formations, while all carbonatic strata are strongly karstified. The basin forms a complex system of surface run off and groundwater flow. Both components are strongly interconnected. The study proposes an approach of analysing invariant system characteristics with modern hydrological methods such as numerical surface and groundwater modelling. The surface and groundwater hydrology of these fixed basin properties is modelled as a function of climate and land cover, derived from palaeoclimatological studies. Numerically calculated groundwater levels under different climate and land use scenarios, ranging from multi-year to centennial droughts or extreme floods, can then be compared to the depth and levels of excavated wells and water supply infrastructure. Results indicate that the Sanctuary is characterised by very beneficial hydrological conditions: It is located at the confluence of several hydrological basins, characterized by high groundwater recharge and seasonal runoff production. In addition, the archaeological site is situated directly on top of springs stemming from a deep groundwater flow system. The groundwater model emphasises the exceptional stability of the system towards climate change and its very slow response. Still, results of the numerical model and archaeological evidence suggest, that the site has been affected by a decline in groundwater levels requiring adaptations of the water supply technology.

**POSTER SESSION: Palaeoenvironmental and archaeohydrological data from Lake Vouliagmeni (Greece): a sneak preview**

*Ferry Schiperski (TU Berlin)*

*Co-authors: Alexandros Emmanouilidis1, Pavlos Avramidis1, Thomas Neumann2, Thomas Birndorfer, Hans-Rudolf Bork, Svetlana Khannueva-Wendt*

The water availability and hydrological soil properties around the ancient settlement of Stymphalos (Greece)
The Perachara peninsula (Greece) was known in antiquity as Peiraion or Peiraia, the land beyond the sea from Corinth. The earliest evidence of habitation in the area, dating back to the 3rd millennium BC, was found on the north shore of Lake Vouliagmeni, where an Early Helladic settlement and tomb have been excavated. The best-known archaeological site is however the sanctuary of Hera (Heraion) west of Lake Vouliagmeni. Remains of ancient water storage systems have survived in several places of the peninsula, such as an elaborate hydraulic installation consisting of three main sections: a staircase leading through an underground shaft towards three wells, a large tunnel for collecting the water from the wells, and a fountain house with three storage chambers and three draw-basins. However, little is actually known about the natural availability of fresh water for the people in ancient time, about hydrological variability in the region due to changes in the climate and the tectonic setting. We here present first, preliminary results of a varved lake sediment record recovered from Lake Vouliagmeni in April 2018. A 20-cm long test-section of the core was analyzed in high resolution with X-ray fluorescence (XRF) and X-ray diffraction (XRD) methods to disentangle the environmental history of the lake, which (hopefully) provides insight into the water quality, which was essential to the people at its shores in the past. The XRD analyses show, that the mineralogical composition of the sediment core consists mainly of quartz, calcite and aragonite. Nevertheless, certain mineralogy can be assigned to the individual layers. Light aragonite-rich laminae show low content in clay minerals and vice versa. This might indicate cyclic changes in the hydrochemical and sedimentary conditions of the lake (salinity, flow velocity) and/or variations in sediment sources (siliciclastic vs. biogenic detritus) during deposition.

POSTER SESSION: Wooden well from Uničov (CZ) – archive for water management and palaeo-environment in the first farmers’ society

Ivana Vostrovska (Palacky University Olomouc, Czech Republic)

Transition to the Neolithic way of life has taken place in eastern Central Europe about the mid-6th millennium BC. The sedentary way of life was related to plant cultivation and livestock breeding, consequently people lived in larger groups and built up permanent settlement areas. By the time the first farmers settled down, they needed permanent water sources in close neighbourhood. One of the Neolithic phenomena is wooden well, which was an additional and new aspect of human redesigning domestic and public spaces. The active digging of wells reaching the underground water table reflects an innovative approach to water provisioning in sedentary communities. It was a testimony to the hydrological knowledge, technological capacities, environment and landscape of the first farmers. In this research we aim to explore firstly the water management in the first farmers’ society. Secondly, we look into ecological history and strategy in exploitation of surrounding landscape, which is related to the water among others. The study site is situated in the central east of the Czech Republic.

Excavation at Uničov-U kravína has uncovered Linearbandkeramik settlement area with 10 longhouses, hundreds of pits, remains of an oven and a wooden well, which is the most unique feature. To achieve our goals, we want to combine archaeological and environmental methods. Wooden well construction has been studied by dendrochronology, archaeobotany and trasology. A chest-like well lining was dated to ca. 5278–5104 BC. Construction was formed by four oak corner posts, each with two longitudinal grooves, in which oak boards were inserted horizontally. The boards formed the wall of the well lining and simultaneously ensured its cross reinforcement. The surfaces of the boards showed tool marks typical for stone adzes. Sedimentary infill of well has been investigated in detailed by geoarchaeology, archaeobotany, osteology and entomology. Sedimentary environment of the deposits inside the well has been determined to explore water management and usage of well itself. The homogenized silt grade material at the bottom is associated with everyday water pumping. Following layer with coarser material and undecomposed organics presents partly damages by well usage and it also documents water pollution. In subsequent period muddy environment overgrown by roots points to that groundwater level decreased. Further silt grade layer supports cleaning of the well and follow-up usage. Decline of the well was documented in the final layer. Our reconstruction of a landscape and its changes over time is based by several environmental proxies. These results confirm the dominance of oak in the forest around the settlement area, which evidenced mesophilic oak forests. Hazel populations reached their Holocene maximum in this period. The settlement area itself was a markedly warm and dry forest-free zone with shrubs, in some parts surrounded by a mixed deciduous forest influenced by humans.

We can reconstruct the site environment like a farming village in a mosaic forested and forest-free landscape with xeroteric pasture and the river around. The palaeoecological reconstruction of course has only a local interpretation capability, but the general ecological relation between biological proxies or even species can give much more contribution to our knowledge of past environment of the first farmers.
SESSION 13

Human, beast and landscape. A diachronic study of hunting and human-animal-relationships in Northern Europe and in the Baltic Sea area

Thursday March 14th and Friday March 15th, Room 204
Session organizers: Ulrich Schmölcke, Oliver Grimm

THU
13:30 Introduction
Oliver Grimm, Ulrich Schmölcke

13:50 From Late Glacial hunting to Early Neolithic animal husbandry: a perspective from Britain and southern Scandinavia
Keynote lecture: Peter Rowley-Conwy (Durham University)

14:20 The hunter’s path. Some remarks on the role and meaning of osseous hunting equipment in the Final Palaeolithic and Mesolithic
Justyna Orlowska (Institute of Archaeology, Nicolaus Copernicus University in Torun)

14:40 Human-bear interactions in Lateglacial and Holocene Britain
Hannah O’Regan (University of Nottingham)

15:30 Animals and the human social landscape in medieval Icelandic sources
Harriet Evans (University of York)

15:50 Reindeer migration routes and distribution in the Late Glacial in Lithuanian territory
Linas Daugnora (Institute of Baltic Sea Region History and Archaeology, Klaipeda University)

16:10 Significance of caribou and reindeer fur for artic hunters
Kerstin Pasda (Institut für Ur- und Frühgeschichte, FAU Erlangen-Nürnberg)

16:30 Hunting native reindeer, while domesticating imported ones – Some thoughts on the development of the Sami pastoralism
Jostein Bergstøl, Museum of Cultural History, University of Oslo

16:50 Look back on the afternoon

FRI
08:30 Look on the present day
Oliver Grimm, Ulrich Schmölcke

08:50 Imagining hunting landscape in contemporary Germany: correspondences between animals’ movements singnatures and hunting practices
Dr. Thorsten Gieser (Institute for Cultural Studies, Koblenz University)

09:20 Seal exploitation in Šventoji subneolithic sites (SE Baltic) during 3900-3000 cal BC
Giedrė Piličiauskienė (Department of Archaeology, Vilnius University, Lithuania)

10:30 Environment and human subsistence on the western coast of Sweden during the Mesolithic and Neolithic
Leif Jonsson (LJ – Osteology)

10:50 Hunting mentality in agrarian environments. Wild animal skins in Iron Age and medieval graves in eastern Fennoscandia
Tuija Kirkinen (University of Helsinki, dept. of Cultures)

11:10 Carved bird pendants of forest hunter-gatherer-fishers (East European Plain, 3.500-2.700 BC) – the edible totems
Ekaterina Kashina (State Historical Museum, Moscow)

11:30 A preboreal relation with elks – the ritual elk deposits from Lundby Mose
Kristoffer Buck Pedersen (Museum Southeast Denmark)
13:30 European bison hunting and butchering at Vilnius Lower Castle during the 13th–17th century  
Giedrė Pilčiauskienė (Department of Archaeology, Vilnius University, Lithuania)

13:50 The aurochs (Bos primigenius) in prehistoric Switzerland: humans and wild cattle in a diversity of landscapes  
Lizzie Wright (University of Basel)

14:30 Human-deer spiritual connection: offering places of Northern Eurasia from Neolithic to modern times  
Nataliia Mykhailova (National Academy of Sciences Ukraine)

13 ABSTRACTS

Human, beast and landscape. A diachronic study of hunting and human-animal-relationships in Northern Europe and in the Baltic Sea area

Keynote speaker: P. Rowley-Conwy (Durham University), T. Gieser (Koblenz University)  
Session organizers: U. Schmölcke*, O. Grimm

*corresponding chair, ulrich.schmoelcke[at]schloss-gottorf.de

This session will provide a diachronic consideration of human, animal, and landscape interplay with an emphasis upon Northern Europe and the Baltic Sea area. Focusing on, amongst other aspects, periods of change it follows a multi-perspective approach. The considered time frame covers the late Palaeolithic up to the Middle Ages, and the central topic is hunting and, more broadly, human-animal-relationship, against the background of human's dependency on landscape and climate. Thus, in particular for the period of hunters and gatherers, hunting techniques, strategies, and motivations are as relevant as the union formed between human and dog, as are the indications for the veneration of hunted animal species. For the Neolithic and later periods, hunting for the protection of acres and flocks will have to be considered alongside the hunt for the acquisition of raw materials, as opposed to, for example, trophy hunting and 'princely hunt'. For the session, papers from various disciplines in the Natural Sciences and Humanities are welcome. Thus, the session will bundle different aspects connected with hunting, and the overall diachronic view, given by one of the keynote speakers for parts of Northern Europa, and will imply the chance to trace red threads and changes. Furthermore, the focused analysis on certain periods and regions will enable us to see specific hunting patterns and more individual solutions, related to the landscape. Questions, central for the session, are as follows: to which extent were intensity and purpose of hunting linked to cultural transformations (example: Neolithisation)? Were times with changing hunting patterns also times of general changes in the human-environmental interaction or interplay (example: wolf and bear extirpations in Christian societies)? What about the dynamics of human-animal-relationship, from dogs to other true mates of humans (example: late Palaeolithic dog burial from Bonn-Oberkassel), in relation to domestic animals (example: Neolithic cattle graves) and wild beasts (example: bear symbolism)? What about the reconstruction of hunting episodes at particular sites, what about the earliest indications for the veneration of hunted animal species and, finally, what about the beginning of trophy hunting and the development of "princely hunt"?
From Late Glacial hunting to Early Neolithic animal husbandry: a perspective from Britain and southern Scandinavia

**Keynote lecture: Peter Rowley-Conwy (Durham University)**

In this contribution I will emphasise the dynamic and changing nature of Late Palaeolithic and Mesolithic hunting; this was not just a static period that gave way to animal husbandry. I will consider three areas. 1. In the Late Palaeolithic and Early Mesolithic there are several sites with individual skeletons of aurochs and elk, both comprising both butchered animals and those that escaped from the hunters. These large animals would have been difficult and sometimes very dangerous to hunt, and I will consider the hunting methods probably employed for both species. 2. By the Earlier Mesolithic the landscape and vegetation had settled down, and settlement and hunting practices became more regular: we know a good deal about the hunting of land mammals. The sea shore is however hardly visible in this period due to sea level being lower. Recent discoveries in Sweden suggest that marine mammal hunting and fishing may however have been of considerable importance at this time. The flooding of the North Sea was also a major factor in this period. 3. Domestic animals appear as part of the Neolithic package c. 4000 cal BC. This change is coming to appear much more abrupt. The nature of the change, and any interactions between last hunters and first farmers, will be discussed in the light of recent evidence.

**The hunter’s path. Some remarks on the role and meaning of osseous hunting equipment in the Final Palaeolithic and Mesolithic**

**Justyna Orlowska (Institute of Archaeology, Nicolaus Copernicus University in Torun)**

Co-author: Grzegorz Osipowicz Institute of Archaeology, Nicolaus Copernicus University in Torun

Hunting equipment made of osseous materials of the Late Glacial and early Holocene huntergatherers is most commonly represented in archaeological record with various types of points, harpoon heads and fish hooks. Studies on these types of prehistoric weapons have a longstanding tradition and are important way of discovering information about the societies that existed in those days. The main objective of our study is to present results of extensive traceological analyses concerning Late Glacial and early Holocene bone and antler artefacts usually associated with hunting from Polish Lowland. Examined prehistoric material for most consist of so-called stray finds and represent various forms of harpoon heads, points and fish hook. During the traceological analysis of the included artefacts a wide spectrum of technological traces was identified that allowed to reconstruct chaîne opératoire of their production process. It allowed also to make some suggestions concerning probable function of the prehistoric specimens.

Moreover, traceological analysis enabled to the identification on selected finds specific traces that were possibly not purely practical, but served a symbolic purpose. These information were a starting point for discussion about non-utilitarian behaviors associated with these kind of artefacts and their symbolic meaning for people that used them. For the purpose of the project we gathered also morphological, technological and functional data about similar finds from Europe and discussed them with our results.

**Human-bear interactions in Lateglacial and Holocene Britain**

**Hannah O'Regan (University of Nottingham)**

The brown bear (Ursus arctos) is Europe’s largest terrestrial carnivore, and it has played an important symbolic role in cultures throughout its geographic range from Europe to North America. How can we begin to determine what role bears played in these societies? Were they predators, competitors, companions or prey? Using Britain as an example, this paper will examine human-bear relationships from the Lateglacial to early modern periods. Although bear remains are known from all periods, there are big differences in how they are incorporated into the archaeological record. For example, two Lateglacial bear tooth pendants were found in Kendrick’s cave, North Wales, and skull fragments and a cervical vertebra are known from the Mesolithic wetland environment of Star Carr. These finds contrast with the Bronze Age and Iron Age record, when bear remains are only found with human cremation burials, and again in the early medieval period when considerable numbers of phalanges are also found in cremations. This paper will examine what these differences might mean in terms of human-bear interactions, and will also consider when the bear became extinct in Britain and what impact this might have had on how bears were subsequently perceived and treated.

**Animals and the human social landscape in medieval Icelandic sources**

**Harriet Evans (University of York)**

In Finnboga saga (ch.11), a bear who is causing trouble among the communities of Halogaland is outlawed by the assembled farmers, before being hunted and killed by the hero of the saga. In this episode, the bear will only fight with Finnbogi once the man has removed all his armour and his sword, and the saga depicts the bear having the desire for the fight to take place on equal terms. In addition, the need to outlaw a bear before hunting it suggests that this wild animal is perceived as part of the community who must be excluded for its actions before it can be dispatched. This is the only instance of such an animal outlawry in the Sagas of Icelanders, and
it takes place in Norway. In contrast, the laws of medieval Iceland known as Grágás suggest that certain animals, including bulls, pigs, horses and dogs walk the border between legal inclusion and exclusion, and can be legally outlawed for certain actions. However, these are all domestic animals, and in the Icelandic settings of many of the Sagas of Icelanders, depictions of wild animals are rare; these texts demonstrate instead that the line between the categories of human and domestic animal was capable of being breached. This presentation will explore the depiction of these animals as both objects and agents in the legal texts of early Iceland, and how both Viking age funerary contexts and later medieval narratives offer us interpretations of animal-human relations that seem to engage with conceptualisations of animals as persons capable of interacting with both human legal codes and the social landscape of medieval Iceland.

Reindeer Migration Routes and Distribution in the late Glacial in Lithuanian Territory
Linas Daugnora (Institute of Baltic Sea Region History and Archaeology, Klaipėda University)
Co-author: Algirdas Girininkas

During the Late Glacial in the territory of East Baltic region after retreat of the glaciers, the main hunting object was reindeer (Rangifer tarandus L.). Baltic region specimens would considerably help in the reconstruction of the origin and migration routes of the extant wild reindeer populations in northern Europe. In 20 localities of the territory of Lithuania and radiocarbon dates from antlers of reindeer between 12 085 and 10 435 yr BP were collected. The majority of radiocarbon dating results show that reindeers colonized the eastern Baltic region quite rapidly and possibly all at once – 13400-12300 yr BP. The results of cosmogenic dating of boulders indicate that the ice sheet which covered a large East Baltic area melted at almost the same time – about 13500-13000 yr BP. Along with the reindeer population, the first inhabitants – the reindeer hunters must have appeared who produced different tools and weapons from the reindeer skeletal parts. On both sides of the Nemunas and other rivers shoals, most sites and finding-places of the Late Palaeolithic period occurred (Fig. 8). They were left by communities of Hamburg-, Federmesser-, Bromme-, Ahrensburg- and Swiderian cultures. Analogous campsites of the Late Palaeolithic period in Lithuania were at the Neris-, Ula-, Šešupė rivers and other water basins where reindeer crossed waters through wades and shoals. The earliest reindeer antler of the Older Dryas period was found in Debeikiai (Anykščiai district). However, among the radiocarbon-dated artefacts, the earliest are a Lyngby axes, discovered in Nemunėlio Radviliškis (Parupė) (Biržai district), Kalniškiai (Jurbarkas district), Šnaukštai (Klaipėda district) in 2014-2015, which provides new data on the Eastern Baltic area population processes and the economic activities at the end of the ice age. The traceological, isotopic and zoo-archaeological analysis of the artefacts and reindeer skeletal parts, as well as the palynological and archaeological studies of the find spots, proved that the dated back to c. 14000-10000 BC and was to be assigned to the Older Dryas – Younger Dryas period. As witnessed by the radiocarbon date, the artefact perfectly fitted in the general context of the Upper Palaeolithic in Northern Europe and, on the basis of the radiocarbon dating, it ought to be considered one of the earliest items not only in the Eastern Baltic Region, but all over Northern Europe.

Significance of caribou and reindeer fur for arctic hunters
Kerstin Pasda (Institut für Ur- und Frühgeschichte, FAU Erlangen-Nürnberg)

The arctic climate requires an effective protection against the coldness. The significance of caribou fur in the past became obvious in interviews with Greenlandic hunters. However, caribou fur was the warmest accessible fur in Greenland. Some interviewees suggested that the fur was for a time even more substantial than the meat. At least since the Thule period until the beginning of the 20th century the fur played a major role in Greenland. Historical and archaeological sources in the 18th century about mass hunting and lists of fur trade indicate, that this mass hunting was mainly aimed at getting caribou fur. The evidence of the hunt taking place with the specific aim of obtaining the fur is difficult to render osteoarchaeologically. However, there may be indications of reindeer being hunted for their fur in European Palaeolithic sites, as in the Ahrensburgian site of Stellmoor.

Hunting native reindeer, while domesticating imported ones - some thoughts on the develop-oment of the Sami pastoralism
Associate Professor Jostein Bergstøl, Museum of Cultural History, University of Oslo (Norway)

Studies of the genetics of prehistoric reindeer during the last two decades have shown that the reindeer had two different immigration routes into Scandinavia after the Ice Age. In addition to that, the researchers have seen traces of another genetic marker in the domesticated reindeer, from around 1500 AD. New published research have now shown that this type may be traced to the Yamal region in Northern Russia. This insight opens for new perspectives on the start and development of the intensive reindeer herding. Is it possible to imagine the import of a fully developed pastoral package together with the new animals? Or was the system developed here in Fennoscandia, but with a new breed of calmer animals that maybe made it easier to control larger herds? It has been commonly believed that the Sami pastoralism developed from small-scale husbandry in the Iron Age, into large scale intensive herding during
the Late Middle Ages, but this new genetic research suggests that the large semi-tame herds were bred on imported animals, while they still kept hunting the native ones. Excavations and surveys have revealed different types of mass trapping systems from the Iron Age and Middle Ages in Southern Norway. The later, funnel shaped traps have striking similarities to the driving fences in modern reindeer herding. In this paper, I will discuss the possibilities of influences from wild reindeer trapping in Norway on the development of the Sami pastoralism.

Imagining hunting landscapes in contemporary Germany: correspondences between animals’ movement signatures and hunting practices

Keynote lecture: Dr. Thorsten Gieser (Institute for Cultural Studies, Koblenz University)

“People are known and recognized by the trails they leave behind them...Animals, likewise, are distinguished by characteristic patterns of activity or movement signatures, and to perceive an animal is to witness this activity going on...” (Ingold 2011:72)

In this brief lecture, I will sketch a contemporary hunting landscape in Germany by tracing the material trails of hunters and game animals. Drawing inspiration from what hunters call Pirschzeichen (animal movement signatures) I follow the often miniscule ways in which animals shape the land and its vegetation and become known to hunters. In a second step I link these animal movement signatures to hunters’ landscaping practices (pathways, architecture, lines of fire, feeding sites, etc.). In analogy to the heuristic model of the ‘operational chain’, which reconstructs successive steps in the production and use of material artefacts, I suggest that the material remains of hunting practices in the landscape can be linked up and integrated into a larger hunting landscape by considering their correspondences to the Pirschzeichen.

Seal exploitation in Šventoji subneolithic sites (SE Baltic) during 3900-3000 cal BC

Giedrė Piličiauskienė (Department of Archaeology, Vilnius University, Lithuania)
Co-authors: Grzegorz Osipowicz, Institute of Archaeology, Nicolaus Copernicus University, Torun, Poland; Gydis Piličiauskas, Archaeology Department, Lithuanian Institute of History, Lithuania; Ulrich Schmölcke, Centre for Baltic and Scandinavian Archaeology, Schleswig, Germany

Šventoji sites are of supra-regional importance due to brilliant preservation conditions and the degree of research done there during the last decade. Some of ca. 60 Stone Age sites are contemporaneous and represent highly elaborated settlement systems with dwelling areas on the eastern bank of the ancient lagoonal lake and fishing stations on western part of the lagoon. Bone collagen stable isotope analysis combined with zooarchaeological data demonstrate seals being of high importance to coastal Subneolithic people. First seal bone analysis (NISP=2132) made in 2016 show already significant differences in seal species, skeletal part distribution and animal age among sites that generated preliminary ideas about the differences in Šventoji sites chronology, function and seasonality. However, analysis of the complete zooarchaeological assemblages from studied sites and additional detailed microscopic analysis of seal bone fractures were necessary for final conclusions. In 2018, microscopic analysis of seal bones fractures, technological and use wear analysis of seal tibia scrapers were completed and they demonstrate new evidences concerning the technology of seal hunting, butchering and even possible rituals in Šventoji sites. Furthermore, we obtained new and very significant data concerning the sites seasonality. In this presentation we’ll demonstrate our final conception about seal hunting and exploitation in Šventoji Subneolithic sites.

Centrality of Seals: Ålandic clay paw rite on the edge of Occam’s razor

Kristin Ilves (Helsinki University)

There are just over 110 small claw paws recovered in the Late Iron Age (550-1050 AD) burials on the Åland Islands of the Baltic Sea. These paws, which have only been found in burials, were made in connection with the cremation burial ritual that was typical for this period. They are of low-fired clay with little or no tempering material. The execution of modelling is rough. Clay paws are oblong in shape, broadening towards one end, and generally, with four to five short digits at the wider end. They measure between 4 and 14 cm in length and have a rounded to oval cross-section. Often, one side of the paw is slightly concave and the opposite side slightly convex. Despite an evident uniformity of the idea, there is a notable variation in the design. Identified as bearers of symbolic meaning, clay paws have been variously associated with bear or beaver. Both these species, however, were absent in the natural environment of Åland during the period of the rite. Therefore, the symbolic significance of the either animal has been interpreted to have been carried to Åland by immigrant groups to accommodate the absence of the relevant animal in the ecology. Reasons for either one of these species becoming important for the Late Iron Age society on Åland are mainly sought outside the archipelago and/or in the mythological narratives of surrounding areas. Following the principle of Occam’s razor, I suggest that clay paws should be identified with seals – living animals present in the environment and significantly important in both diet and economy of the Late Iron Age Åland. By suggesting the paw symbol being metonymic of a seal, also, the dichotomy between symbolic and functional is broken concerning this animal becoming a totem. The clay paw rite is...
a distinctly Ålandic innovation. It emerged in the Late Iron Age, in connection with a rapid and large-scale colonization of the archipelago. The colonization process has been recently explained in the framework of global climate catastrophe following the large volcanic events in the middle of the 6th century AD that in many agriculturally dependent areas in the Northern Hemisphere led to famine, resulting in mass starvation, disease, and death. In contrast to the many neighboring areas with a widespread decline of settlements and concentration in to fewer villages, on the Åland Islands, settlements become visible in drastic manner. There is an agreement that in the middle of the 6th century Åland saw the greatest increase in human population and activity that cannot be understood as an endogenetic demographic process. I argue that maritime resources, seals in particular, served as a driving force for a colonization of Åland from neighboring areas in order to tackle the effects of the climatic catastrophe. The emergence of the clay paw rite is linked to this process.

Environment and human subsistence on western coast of Sweden during the Mesolithic and Neolithic
Leif Jonsson (LJ – Osteology)
The earliest immigrants to the area were heavily dependent on marine resources. It is also likely that they were migratory spending the warmer part of the year on the coast and the colder part on the continent in the south. When local, stationary populations of deer, aurochs and wild boar had become established hunter gatherers could also form more or less sedentary groups. Marine resources remained the prime source of food throughout the Mesolithic. The introduction of agriculture was done by immigrating groups from the south but marine resources remained important to varying degree.
In middle neolithic times the marine environment goes through great changes with abundance of fish and marine mammals, especially harp seal and southern fish species. During this period a new group of people settle at the Coasts of Southern Scandinavia, the Pitted Ware Culture. This group were mainly hunter-Fishers but also had some domesticates. Their relation to earlier farmers is not well understood. Later the PW culture dissapear and are succeed by farmers but their economy is poorly known.

Hunting mentality in agrarian environments. Wild animal skins in the Iron Age and medieval graves in eastern Fennoscandia
Tiujia Kirkinen (University of Helsinki, dept. of Cultures)
Co-author: Kristina Mannermaa, Dept. of Cultures, University of Helsinki, Finland, Osteological Research Laboratory, University of Stockholm
In this paper, we discuss the role of big game hunting among the Late Iron Age and medieval (AD 800-1500) farming populations in eastern Fennoscandia. In Finland, the importance of hunting and fur trade as supplementary economies have been considered an outgrowth of area’s location at the northernmost limits of the cultivation zone in Europe. The study area is situated on the palearctic zone, having characteristics of Continental fauna (pine marten [Martes martes]) as well as Siberian species (European elk [Alces alces], wild forest reindeer [Rangifer tarandus fennicus]) and marine mammals (ringed seal [Pusa hispida], grey seal [Halichoerus grypus]). The transition to productive livelihoods in the southern Finland took thousands of years, and in the northern and eastern parts of Finland hunting retained its central role up to the Modern Age. Our study indicates that from cultural and mental point of view the change was even slower than previously suggested. We base this argument on the animal hair and skin material collected from Finnish and East-Karelian inhumation burials, in which the wrapping of the deceased in European elk and (wild forest) reindeer skins indicates the longevity of a hunting mentality long after having adapted to farming. Our first argument rests on the tradition of wrapping in hunting cultures. The earliest evidence of wrapping bodies in Northern Eurasia derives from the Mesolithic Stone Age, after which animal skins were repeatedly used for wrapping the deceased. As a second argument, we suggest that the act of wrapping had its origins in hunting rituals, in which the wearing of a skin helped the hunter to become an animal. Rane Willerslev (2007) has interpreted that this ritual was practiced especially in big-game hunting, which demanded close contact with the game animal. In burials, the act of wrapping controlled the liminal stage of death and facilitated the transformation from a human being to an animal-ancestor. This is in line with the Finno-Ugrian worldview in which animals such as brown bear (Ursus arctos) and reindeer were ex-humans, fore-fathers, or relatives. We suggest that wrapping of bodies in wild animal skins during the Iron Age has a direct continuation to the prehistoric hunter-gatherers, and represents a several thousand years long, unbroken tradition. For interpreting our results, we estimate the interaction between food supply and ritual treatment of bones and skins, and, on the other hand, past cervid population history in the accumulation of archaeological data. The results are based on a somewhat heterogeneous and fragmented body of source material, but they clearly underline the importance of hunting and wild animals in the Late Iron Age and Early Medieval world in northern Europe.

Carved bird pendants of forest hunter-gatherer-fishers (East European Plain, 3500–2700 BC) – the edible totems
Ekaterina Kashina (State Historical Museum, Moscow)
Bone bird figurines used as personal adornments disseminated during the period between 4000–2300 BC in the territory of the current Baltic states, Republic of Belarus
and the center of East European Plain, at the interfluve of Volga and Oka Rivers. The excavation of several sites seems to show year-round habitation, due to the presence of large semi-subterranean dwellings in locations where fish was very abundant. Additionally, these communities’ spiritual life is reflected in mobile art, mostly small sculpture pendants, depicting humans and animals made of bone, flint, and amber. This talk focuses on carved bird pendants morphology, technology, functional use, and symbolism. There are two kinds of pendants: the full-figure bird representation and the partial one. All full-figure sculptures represent bird silhouettes and lack any details except drilled holes for fastening, but partial sculptures (bird head and neck/rod) usually have drilled eyes and carved mouth line, and also a perforated hole or carved incisions for fastening. In the Baltic region only full figure pendants are known, while both kinds are common in the central part of East European Plain. In terms of species, waterfowl (small ducks, swan and goose), mergansers, marshland (crane, heron, sand-piper) and woodland species (capercaillie, partridge, grouse) are present. The species with the highest representation is the capercaillie (Tetrao urogallis, 40 of circa 100 pieces), which is of great interest for the discussion of pendants’ functional use and symbolism. The total absence of raptor birds is also remarkable, which drove me to compare species representation in both pendants and bird bones. According to research into the faunal remains, performed at three sites of the Oka River basin, it can be said that the bird species represented in pendants were pretty much the same as those which were hunted. Ducks (especially Anas platyrhynchos) is the most represented (near 50%). Their wing bones (antebrachium) were used for making awls, humeri for making awls/tools for sinew-thread treating, and feathered carpometacarpus could have been used for decoration. The capercaillie usually comes second among bird bone remains (near 10%). The significant number of finds allows us to suggest that each community member obtained the bird pendant and wore it in everyday life. According to my recent studies, bone, amber, and flint zoomorphic pendants could represent a totem ancestor of a community/kin. The presence of various bird species images buried in one dwelling may be the evidence of different clan members communal living. The abundance of duck and capercaillie bones in faunal collections means that obviously no nutritional taboo existed regarding all bird totems. The capercaillie pendants is the most represented and disseminated pendant in the Volga–Oka interfluve, which suggests that they reflect the possible existence of a large number of kin. The choice of this particular totem animal could have been driven by the similarity between animal behavior and that of humans. It seems that capercaillie fitted quite well for this purpose, considering these birds’ abilities to stay at the same place during winter season (sedentarism), to hide in snow caves (semi-subterranean dwellings), to consume berries, to dance, sing and fight during the mating period, and so on.

A preboreal relation with Elks - the ritual elk deposits from Lundby Mose
Kristoffer Buck Pedersen (Museum Southeast Denmark)

The early preboreal in southern Scandinavia is an enigmatic period. As the environment was recovering from the severe cold of younger dryas, people were re-colonizing the barren landscape. But the earliest traces of people in the preboreal are not settlement sites, but bones from elks deposited in small kettleholes. At Lundby Mose bones from at least 13 elk were deposited in 6 different concentrations. The Elks were deposited at - at least - four separate events. The earliest elk-deposits were made in the very early part of the preboreal (L1, L2 & L3). The deposits consisted only of elk-bones, and they are interpreted as an expression of a ritual human-animal relationship, a communication between the hunter and the souls of the elks. A large concentration of bones from elk (L5), and other animals, is dated to a later part of the preboreal. Its composition and characteristic is more reminiscent of settlement refuse as we know it from the subsequent Boreal period. Together with similar finds from Skottemarke and Favorbo, and some newly interpreted sites of same age, it is proposed that Lundby mose is part of a special ritual horizon. This could be seen as the newcomers attempt to colonize the new landscape with souls - a ritual game management - to secure a good stock of game for the future.

European bison hunting and butchering at Vilnius Lower Castle during the 13th-17th c.
Giedrė Piličiauskienė (Department of Archaeology, Vilnius University, Lithuania)

Vilnius Lower castle and the Palace of the Grand Dukes of Lithuania (13th-17th c.) are objects of an extraordinary importance for Lithuanian state history. Dwellers of various social strata – kings, dukes, bishops, knights, officers, soldiers as well as craftsmen and servants lived in the territory of the castle through the centuries. Since the middle of the 20th c. an area of about 18,000 m2 was excavated there. Dozens of latrines, sewers and water-supply pipelines were examined, more than half of million archaeological artefacts were collected and ca. 70,000 animal bones fragments were analysed. Hunting was very important in the life of the residents of Vilnius Lower castle. Therefore, remains of wild game consist even 11-28 % of the zooarchaeological assemblages. European bison was the second most hunted animal during the all historical stages of the castle, despite permission of the king was needed for bison hunting. Almost 2000 bison bones fragments were found in Vilnius Lower castle, most of them were dated to the end of 14th-15th c. Synthesis of zooarchaeological and historical data allow us to take a look at royal hunting, consumption and value of this
animal during the 13th-17th c. Moreover, in this presentation we also would like to demonstrate unique material of one waste pit, dated to the end of 14th – beginning of 15th c., where remains of at least 29 bisons were found. Zooarchaeological data and historical sources concerning the royal bison hunting, butchering and meat conservation allow us to reconstruct this one bison hunting and butchering episode.

**The aurochs (Bos primigenius) in prehistoric Switzerland: humans and wild cattle in a diversity of landscapes**

**Lizzie Wright (University of Basel)**

Co-author: Marguerita Schafer

The area now occupied by current day Switzerland has an incredibly rich prehistoric archaeological record, due in part to the fantastic preservation conditions at waterlogged sites by many of its lakes. These lakeside settlements - dated mostly to the Neolithic period - have produced very well preserved organic remains, including many large assemblages of animal bones. During the Neolithic period domestic cattle, pigs and sheep/goat provided an important part of the economy, but a number of wild animals were hunted to supplement this. Although red deer is the most commonly found wild aurochs remains are also found frequently, and in much higher concentrations than during the Mesolithic period. There are, however, fluctuations in the intensity of hunting across time and in different landscapes. This paper will present the current evidence for aurochs remains in Switzerland. We will bring together data from multiple sites in different geographical regions and across time, and will consider the role of different landscapes in the exploitation of these animals.

**Human-Deer spiritual connection: offering places of Northern Eurasia from Neolithic to Modern time**

**Nataliia Mykhailova (Institute of Archaeology of National Academy of Sciences of Ukraine Senior Researcher Department)**

Cult of the Deer, which was formed in Upper Paleolithic, has become dominant in mythosritual complex of the people of Europe and North Asia in Mesolithic and Neolithic time and was preserved in the world outlook in Bronze and Iron Ages. The main components of the cult were myths and rites of fertility and hunting success, which included the sacrifice of a deer. Sacred places were the material component of the cult. Numerous archaeological evidences of the Neolithic deer sacrifices were found in Northern Europe and Siberia. As usual, they were connected with the outstanding places of landscape, deer calving places, ways of deer migrations, hunting grounds. Deer cult ceremonies were held near the rock art depictions frequently. More than a hundred offering places, connected with the rock depictions, are known in Fennoscandia and Northern Russia. The stylistic diversity of images and the presence of cultural layers of different eras testify to their prolonged functioning, sometimes before historical or even contemporary times. Most researchers are tracing a clear connection of images with water, which plays the role of boundary between worlds in the spiritual culture of indigenous peoples. Through comparing of the archaeological and ethnographical materials with the synchronic and diachronic aspects we can assume, that deer/elk offering places were perceived as dwellings of the spirits mediators between people and Great Mother, which had the form of the female elk in ancient times. Thousands of her images were reflected in rock and mobile art of Northern Europe and Siberia in Neolithic time. The inventory of the offering places included the attributes of ritual offering: deer/elk sculls, antlers and bones, weapons – sacred deer slaughtering tools; flints for making sacral fire, bowls for the sacred meal; and gifts to the Great Mother: deer figurines, jewels, coins and so on. The tradition of the deer offerings was kept in Bronze and Iron ages. There were great offering places with the sculls of the elk, bear and other animals in Northern Russia, which were common to several neighboring settlements. The surrounding area was considered sacred. Some sacral places were functioned till modern time.
The implications of the study of the past for the anthropology of health

Friday March 15th, Room 207
Maria Carolina Avila Testa

15:30 POSTER SESSION Cesspits as source of reconstruction of health conditions in medieval towns – a case study of Kiel
Anna Wierzgon (GSHDL, Kiel; Institute of Pre- and Protohistoric Archaeology, Kiel University)

08:30 Health and sanitation as a public responsibility in medieval Trondheim
Sean Denham (Museum of Archaeology, University of Stavanger)

08:50 Archaeological perspectives on past and present perceptions of the plague
Doris Gutsmedi-Schuenmann (Freie Universität Berlin, Institute of Prehistoric Archaeology)

09:10 Who were the first inhabitants of medieval Kiel? - A contribution of archaeobotanical investigations from medieval cesspits and contemporary studies in medicinal anthropology focusing on developing countries to the knowledge of health and hygiene of the population of the Old Town of Kiel between the 13th and 15th century
Anna Wierzgon (GSHDL, Kiel; Institute of Pre- and Protohistoric Archaeology, Kiel)

09:30 Historicism and ahistoricism in Medical Anthropology
Keynote lecture: Josep Comelles (Medical Anthropology Research Center (Universitat Rovira i Virgili))

10:30 Rain water and health in the Roman ancient time
Yasmina Benferhat (University of Lorraine, Campus Nancy)

10:50 When medical anthropology meets Linguistics. Language, context and disease analysis in guarani manuscripts of colonial Paraguay (18th Century)
Leonardo Cerno (CONICET)

11:10 Historical and anthropological notes of an Andean diagnostic medical practice and healing
Rocio Rebata (UNMSM; UPC)

11:30 The medicine of the priest Taddeo de Wiesent in South America, the method, its scopes and current uses
Maria Carolina Avila Testa (GSHDL, Kiel University)

11:50 Discussion

13:30 Health and social rank of the Corded Ware population from Żerniki Górne, Poland, dated to 2600-2300 BC
Rafał Skrzyniecki (University of Adam Mickiewicz in Poznan)

13:50 Discussion
The implications of the study of the past for the anthropology of health

Keynote speaker: J. Comelles, Universitat Rovira i Virgili, Spain
Session organizers: C. Avila Testa*
*Corresponding chair, caroatesta@gmail.com

Societies have lived through centuries of migration, disaster, and change, exchanging knowledge that has taken root in other societies and shaped syncretisms today. In parallel, various historical, ecological, and industrial events have altered lives and societies, specifically through their impact on the health of the population. These processes have had widespread cultural, environmental, and other consequences, in some cases disadvantaging the health of the population, or generating new epidemics, or the appearance of new diseases and health problems. Despite a significant body of work on historical studies of health, the study of health and medicine in the past are rarely thought in tandem with medical anthropological work today. This panel focuses on the dialogue between anthropology, history, and health, and welcomes papers that contribute to thinking about how historical approaches to health can be brought to bear on the theoretical or practical concerns of contemporary medical anthropology, and vice versa. Potential questions include: How can studies from archaeology and history contribute to the study of contemporary disease developments or patterns? Likewise, what concepts, theories, and interventions have emerged within the field of medical anthropology that might contribute to the study of the past? How are environmental processes and ruptures part of health concerns not only of the past, but also of the present? What critical intersections can be identified between the fields of health, environment, and the past that might open up productive lines of research for the future?

Health and sanitation as a public responsibility in medieval Trondheim
Sean Denham (Museum of Archaeology, University of Stavanger)

One of the first steps in developing a public health policy is the recognition of the link between health and sanitation. A second step is the realization that as populations and population densities increase, sanitation infrastructure and sanitary practices are most effectively organized at the communal/administrative level. This talk will present Medieval Urban Health: From Individual to Public Responsibility, AD 1000-1600 (MedHeal600), an ongoing research project which seeks to identify this process in the well-preserved urban medieval layers in Trondheim, Norway. MedHeal600 takes a three prong approach, looking at the bioarchaeological, archaeological and historical records. The bioarchaeological aspect acknowledges that health is inextricably linked to both environmental conditions and access to adequate nutrition. This particular work packet, therefore, involves not only more direct methods of evaluating health conditions, but also indirect methods involving the study of environmental conditions and the use of proxy data from historical sources. The archaeological and historical research focuses on possibilities of gaining information of health conditions from medieval cesspits in Kiel using archaeobotany, with proxy comparison from pollen and macro-remains analysis. This case study is based on four medieval cesspits in Kiel dated between the 13th and 15th century. The cesspits provide plenty of information about environmental, nutritional, hygienic and sanitary conditions in the medieval town, which can affect human health. First, the detected botanical species inform about plant foods, as they are direct evidence of not digested plant remains or kitchen waste. These macro-remains enable to reconstruct the medieval diet of inhabitants and have a potential to detect the malnutrition or lack of certain food substances in daily nutrition. For this purpose, an approach to quantifying nutritional plants by investigating proportions of calories and possibly daily caloric intake in medieval Kiel was applied. In addition, some plant species provide information about waste, moisture, high nitrogen content in soils, which informs about potential health risks. It presents a broad picture of hygienic and living conditions in the town. The pollen analysis carried out in the soil samples from the cesspits of Kiel detected a high rate of intestinal helminth eggs of Trichuris trichura and Ascaris. The research questions to be answered here are: What does it mean for health of the inhabitants of medieval Kiel? Does the presence of these parasite eggs indicate a disease affected Kiel inhabitants? What diseases can cause these specific parasites? The additional information provides historical sources. From Kiel there are known some documents providing information about diseases, beginning in the foundation phase of the town in the 13th century. Is it visible in the botanical samples to see environmental changes affected by plague and other diseases? All these proxies enable reconstruction and enhance interpretation of health and hygienical conditions in the medieval Kiel.
levels (palaeopathology, mortality patterns, pathogen aDNA), but also methods of providing an environmental and nutritional context (stable isotopic analysis, palaeobotany, zooarchaeology) within which health levels can be viewed. The archaeological aspect focuses on the changes in infrastructure over time, particularly fresh water supply and waste disposal systems. The historical research looks at both the legislative and social aspects of health and sanitation over the course of the medieval period. How were health and sanitation perceived by the medieval population? When and how did preventive measures against infectious disease become a communal rather than a private effort, and how has this affected the historical development of Norwegian public health policies? What effective measures could an urbanizing population in a relatively low resource environment take to promote health and, more importantly, what lessons might this provide for modern analogous situations? In MedHeal600, it is the interplay of the bioarchaeological, archaeological and historical records which help to illuminate the development of the concept of health and sanitation as a public responsibility, as well as the steps taken to act upon that responsibility.

Archaeological perspectives on past and present perceptions of the plague
Doris Gutsmiedl-Schuemann (Freie Universitaet Berlin, Institute of Prehistoric Archaeology)

Diseases have both a biological as well as a social dimension. To address their biological dimension, research from disciplines as modern medicine, physical anthropology as well as paleogenetic, which became more and more important over past years, are needed. To address their social component, it is needed to examine such aspects as popular perception and response as well as the effects that the disease had through disciplines like archaeology, history or cultural anthropology. To get the best view on diseases in the past and how people dealt with them, interdisciplinary research and exchange is crucial. Furthermore, modern perceptions of how a disease should be handled, have to be made explicit, to avoid unreflected transformations of modern views to the past. In this paper, I would like to discuss the different dimensions of diseases and how different disciplines perceive and interpret them at the example of the plague. The plague, caused by the bacterium yersinia pestis, is on the one hand a disease, that is still present today and causes several dozens to hundred of deaths worldwide every year, but it is also a disease that was researched at least since the 1830ies. First, research on the plague was conducted by historians of medicine and mainly from written evidence they had from the past. From written evidence, two main plague events were identified in the past: First the so called Justinianic Plague in late antique and early middle ages, and second the so called Black Death at the end of the middle ages. But this first research was also conducted in a special historical and political setting and had a very contemporary aim: to create awareness of epidemics in contemporary European politics. Since then, the modern perception of historical plague events was shaped as catastrophic epidemic outbreaks. In recent times, archaeology and paleogenetic were able to contribute to the history of the plague, and could show, that on the one hand the Justinianic Plague was not the first time, when past populations had to deal with the plague, but the history of the plague goes back at least to the late neolithics/early bronze age. On the other hand, the archaeological record proves different and diverse handlings of plague victims in the past, which often contradict the modern assumption of past plagues equalling epidemic outbreaks and catastrophic events.

Who were the first inhabitants of medieval Kiel? - A contribution of archaeobotanical investigations from medieval cesspits and contemporay studies in medicinal anthropology focusing on developing countries to the knowledge of health and hygiene of the population of the Old Town of Kiel between the 13th and 15th century.
Anna Wierzgon (GS HDL, Kiel; Institute of Pre- and Protohistoric Archaeology, Kiel)
Co-author: Yasmin Dannath, GS HDL (Botanical Platform)

The archaeobotanical studies on medieval cesspits from the Schlosstrasse in the Old Town of Kiel reveal numerous information regarding daily life in the Middle Ages. Seeds, fruits and pollen are a tangible evidence of nutrition and agriculture in the old times. Furthermore, based on the micro- and macro-remains from the soil samples, health conditions in the medieval Kiel can be reconstructed. The investigation of seeds and fruits from cesspits provide information about quantity and calorie content of consumed plant food and meal preparation. Also, hygienic conditions and social status of inhabitants of medieval Kiel can be obtained from plant remains. In addition, the palynological analysis of cesspits revealed human intestinal helminths. A summary of this information built a fundament on studies about health conditions in the medieval Kiel. The present paper goes one step further and compares the results of archaeobotanical remains from medieval cesspits with results obtained from studies on stool samples of people in developing countries to gain information about health conditions in the foundation phase of Kiel. Despite spatial and temporal differences, we can observe in the both population groups environmental and socio-economical similarities. In the both investigated groups an urban development is still in progress. Furthermore, the medieval inhabitants of Kiel and contemporary inhabitants of developing countries use cesspits, often together with neighbours. In addition, the palynological analyses of soil samples from cesspits in Kiel dated between 13th and 15th century has revealed numerous parasite eggs. The same intestinal helminth species
were present in the stool samples collected during the medical studies in several developing countries. The results from the anthropological studies and archaeobotanical analyses were compared to gain more information about the medieval cesspit users. The attempt of the investigations is to answer the questions concerning health, hygiene, socio-economic conditions and individual behavioural habits of inhabitants of medieval Schloßstraße. The research questions to be answered are: How many people were infected? How old were the cesspits users? What social groups are mainly carriers of these parasites? What are the risk factors in the developing countries to be infected by the parasites and how can we relate it to the medieval cesspits? Moreover, the investigations give additional information about the environment in medieval Kiel such as drink water quality, hygiene of finger nails, wearing shoes, eating of raw or under cooked vegetables as well as about agricultural management, such as pouring the contents of cesspits into gardens and fields, and potential contamination of useful plants with faecal material in the farm. The example of medieval Kiel shows that multidisciplinary studies of archaeobotany and contemporary medicinal anthropology open new possibilities to investigate health, sanitary patterns and environment in the past times.

**Historicism and a-historicism in medical anthropology**

*Keynote lecture: Josep Comelles (Medical Anthropology Research Center (Universitat Rovira i Virgili))*

Although medical anthropology since its constitution between the 50s and 80s as a subfield of social and cultural anthropology has been inscribed in what can be called the classical anthropological model, the current agenda of the discipline has been profoundly transformed. At the time some anthropologists warned of the “current medicalization” of medical anthropology. In this lecture I will take a different approach that has to do with the application of a historical perspective. My position is that medical anthropology is the fruit of the “process of medicalization,” a historical process that has led to the current conception of global health from a redistribution of objectives and roles. From a historical perspective, ethnography and the clinic were two complementary strategies that the medical paradigms inherited from Greek technical medicine that were used systematically until the XXth century, in which ethnography remained a subaltern practice in medicine and became a hegemonic tool of professional anthropology. Just as the ethnographic methodologies of medicine, like those of anthropology, shared a common feature of a-historicism and were distinguished by the assumption by cultural anthropology of an indifferent, ignorant or hostile relativism with respect to the historical perspective in which events observed and described were framed. If this was the dominant trend, there were also alternatives. The main one was the historical-geographical-ethnographic conception sustained in Germany in the XVIII-XIX century by a series of authors who highlighted the need of also applying a historical perspective to the ethnographic view. This line had a continuity at hand of critical “salubristas” like Maxime Kusinski Godard, anthropologists of Marxist orientation, as well as Ernesto de Martino and Tullio Seppilli in the Italy in the fifties, and with the development in Latin America of a critical medical anthropology that precedes, chronologically, the development of Anglo-Saxon critical medical anthropology in the eighties. All these developments are the result of the limits posed by an ethnographic view that has been, and will be, an indispensable tool in the different stages of the medicalization process. A fundamental tool insofar as the ethnographic dimension of medical practice has been key in articulating the mechanisms of persuasion, later critical in education aimed at facilitating the embodiment by the population of a medicalizing discourse.

**Rain water and health in the Roman ancient time**

*Yasmina Benferhat (University of Lorraine, Campus Nancy)*

I would like to submit a project of talk on rain and health in the Roman World (ancient world might be too vague, it is about Greece and Rome). The corpus would be the Hippocratic treatises (especially Aer.; Epid.; Morb.; Humor.) and Pliny’s HN. The idea would be to search on the connections between rain and health: what is the quality of rain water for healthy and ill people? Does the rain water can bring diseases and which ones? There are two different aspects to be taken in account: the rain as vector of diseases (or not), so meteorology, and the rain water which can be kept and drunk later, but in which conditions, and it is more a question of archeology. My paper would be a first attempt to see what kind of results we can expect, which would be a first base to keep on searching on this matter.

**When medical anthropology meets Linguistics. Language, context and disease analysis in guarani manuscripts of colonial Paraguay (18th Century)**

*Leonardo Cerno (CONICET)*

This presentation is about the use of linguistic methodology for the study of social practices, particularly for the research on medical practices in colonial South America. In this context, some indigenous languages became writing systems, were standardized and latterly used in dictionaries and texts which in turn contributed to normalize name of native plants, diseases and therapies. Bilingual and monolingual
The intersection between history and current developments in medical folklore led us to know the itineraries as curators of some Capuchin missionaries in South America. We will develop in this opportunity, a tour about the diffusion of medical prescriptions, the relationship with humoral medicine and the current uses for the cure of illnesses among Peruvian immigrants. We find recipes of doctors, curators and priests of the Capuchin order who developed the so-called modern hydrotherapy (Sebastian Kneipp) and naturism. Some of them were missionaries, doctors and others developed as laymen, this is the case of "Father" Tadeo de Wiesent in Chile and Colombia, although his work reached other Latin American countries. Tadeo built a hospital (and other works) to treat those suffering from arthritis, and he also attended consultations in the current style of the healing cures with the method of hydrotherapy. Then his disciples would continue to develop this medicine based mainly on water baths and would call it natural medicine, among the most popular were Manuel Lezaeta Acharán and Carlos Kozel, who continued to use 16th century biomedicine (modern medicine) in the 19th century until today. The priest Taddeo de Wiesent was a popular curator, who cured a large number of people in Chile and Colombia, his method and works continued to develop in several places in Latin America. He developed social actions of great importance to local ethnic and cultural societies, despite resistance and confrontations with certain local power groups. We also asked ourselves: How is the diffusionism of this medicine present in home medicine and in beliefs about the natural etiologies of the disease?

**Health and social rank of the Corded Ware population from Żerniki Górne, Poland, dated to 2600-2300 BC**

Rafał Skrzyniecki (University of Adam Mickiewicz in Poznan)  
Co-authors: Marta Krenz-Niedbala, Sylwia Łukasik, Wenesa Woźniak

Site 1 in Żerniki Górne, Małopolskie voivodeship, Poland, is mainly known for its large necropolis of the Cracow-Sandomierz group of the Corded Ware Culture, dated roughly to the second half of the 3rd millennium BC. It consists of 63 human graves, mostly of niche construction. Access to the necropolis was not age- or sex-restricted, although differences in treating the deceased with regard to their biological sex were clearly emphasized. Men and women were buried according to different rules – the former usually on their right side with head towards S, the latter on their left side, heads towards N. Nevertheless, some deviations from this pattern are also present. Moreover, large number of graves contained sets of standardized grave goods. Some of them, e.g. weapons and large bone tools, were deposited exclusively in objects containing male individuals lying on their right side. Variations in number and quality of funeral equipment, along with the presence of sex-determined burial ritual, are

## Historical and anthropological notes of an Andean medical practice of diagnosis and healing

Rocío Rebata (UNMSM; UPC)

The explanation of the causes of diseases and their treatments in the Andean medical system have been historically considered as “archaic beliefs”, “popular superstitions”, and even as “irrationalities”. Today this position reveals a limited understanding of the value of the intercultural conception of health in the Andean context. The healing with the guinea pig (limpia con cuy), also known as caypada, jubeo or soba, is framed in this context. Although there are no precise references about their origin, it is possible to find evidence of their pre-Hispanic background in chronicles and colonial documentation of the sixteenth and seventeenth centuries, particularly during the Extirpation of idolatries in Peru. This Andean medical practice of diagnosing and healing diseases has remained alive in the Andes at the present —with changes in its meaning and practice— within the cultural framework of popular Catholicism. This scenario is transformed and complemented with the advance of the institutionalization of Western Biomedicine and with the expansion of the Pentecostal Christian churches. The purpose of this paper is to present a study about the historical evolution of the healing with the guinea pig, and to report on progress and preliminary results of qualitative fieldwork about its current practices in the Northern Peru. The main objective is to contribute to an intercultural dialogue of knowledges.

## The medicine of the priest Taddeo de Wiesent in South America, the method, its scopes and current uses

Maria Carolina Avila Testa (GS HDL, Kiel University)

The medicine of the priest Taddeo de Wiesent in South America, the method, its scopes and current uses
often interpreted in terms of social divisions. Therefore, the aim of the present study was to assess the health status of the human Neolithic population from Żerniki Górne as well as to check whether the relative position in the social rank system influenced health of the examined individuals. In total, the analyses involved 52 adolescent and adult individuals excavated at Żerniki Górne, including 31 females, 17 males and 4 individuals of undetermined sex. The most numerous age-at-death category were young adults (N=26), followed by middle adults (N=18), and adolescents N=(4), while old adults were not recorded in the examined sample, and four individuals could not have been categorized given the lack of diagnostic skeletal elements. The basic characteristics of the biological profile were determined through the standard methods applied in physical anthropology. Sex assessment was made according to dimorphic features of the skull and pelvis. Age-at-death was evaluated on the basis of age-related changes in the pubic symphysis, dental wear, and, as a complementary method, cranial suture closure. The health status was assessed through the analysis of: enamel hypoplasia (EH), cribra orbitalia (CO) and porotic hyperostosis (PH), Harris lines (HL) and caries. Additionally, body height calculations, as well as paleopathological and taphonomic analyses were made. The social status of particular individuals was determined on the basis of the funerary equipment, among others, copper jewellery and weapons. Then each individual was categorized into one of the two arbitrary social ranks - lower and higher, according to their “wealth”. The general frequencies of individuals displaying particular skeletal indicators were as following: enamel hypoplasia 50.0%, cribra orbitalia 18.2%, porotic hyperostosis 0%, Harris lines 69.2%, and caries 35.7%. The position in the social hierarchy did not reflect in the health status of the examined individuals, but was related to body height – higher-rank males and females were on average taller than their lower-rank counterparts, which suggests better overall living conditions for the individuals of higher social status. Generally, low number of health-related observations for the sample divided into social rank categories could have influenced the results obtained for health status.

**16 Trends, phases, events – temporal scales in archaeological and palaeoenvironmental data**

**Tuesday March 12th, Room 106**

Session organizers: Ingo Feese, Walter Dörfler, Nils Mueller-Scheeßel, Johannes Müller

**TUE 08:30 Scales, Frequencies and semantics. On the meaning and comparison of proxies in (environmental) archaeology**

Keynote lecture: Niels Bleicher (Underwaterarchaeology / DendroLab City Of Zurich)

09:00 A Revised Chronology of the Mesolithic in Southeast Norway

Gaute Reitan (Museum of Cultural History, University of Oslo)

09:20 How can changes be traced? Multi-scalar studies of the built environment in prehistoric Southern Turkmenistan

Ilia Heit (Freie Universität Berlin, Institut für Vorderasiatische Archäologie)

09:40 Prehistoric landscapes of north Mayo, western Ireland: an overview from a palaeoecological perspective

Michael O’Connell (University of Ireland Galway)

10:00 On house generations, C14-dates and house orientation: Putting together pieces for an integrated LBK chronology

Nils Mueller-Scheeßel (Institute of Pre- and Protohistoric Archaeology, Kiel University)

10:50 Can archaeologists obtain generational precision on a calibration plateau?

John Meadows (Centre for Baltic and Scandinavian Archaeology (ZBSA), Schleswig)

11:10 Synchronicity and asychronicity in pollen signals: high resolution pollenanalysis 11.10 and radio carbon based time models for the Neolithic period in the Lake Constance

Jutta Lechterbeck (Arkeologisk Museum, Universitet i Stavanger)
11:30 Bronze Age Archaeological and Radiocarbon Chronologies of the Southern Urals (Russia/Kazakhstan) – Results and Problems
Finn Schreiber (Free University Berlin)

11:50 Discussion

13:30 Archaeological chronologies as sensor of the different pace of cultural change
Keynote lecture: Frank Siegmund

14:00 Land use, social transformations and woodland in Central Europe – past, present and future of the research
Jan Kolar (Institute of Botany, Czech Academy of Sciences, Brno, Czech Republic)

14:20 Late Holocene land-use history in coastal areas: palynological case study from south-eastern Sweden
Olena Vinogradova (Södertörn University, Stockholm Sweden)

14:40 Dating the Balts. At the Crossroads of GIS, Statistics and 14C.
Roman Shiroukhov (Centre for Baltic and Scandinavian Archaeology (ZBSA), Schleswig)

15:30 Österild – 2500 year record of human–environment interaction
Morten Fischer Mortensen (National Museum of Denmark)

15:50 Temporal scales of succession and regeneration in natural and in disturbed landscapes
Walter Dörfler (Institute of Pre- and Protohistoric Archaeology, Kiel University)

16:10 Boom and bust cycles during the Slavic period in NE-Germany
Martin Theuerkauf (Institute of Botany and Landscape Ecology, Greifswald University)

16:30 Discussion

WED POSTER SESSION Geoarchaeological analyses at Tiryns (Peloponnese, Greece)
Tent Thomas Birndorfer (Institute for Ecosystem Research, Kiel University)

POSTER SESSION Steppes of southern Ukraine in Boreal and Early Atlantic period: archaeological and palaeoenvironmental data on the common timescale
Dmytro Kiosak (Odessa I.I. Mechnikov National University)

POSTER SESSION Were there changes in agricultural practices that coincided with changes in material culture at Middle Neolithic Oldenburg settlements in N Germany?
Dragana Filipovic (Institute of Pre- and Protohistory, Kiel University)

POSTER SESSION Trends, phases and events in palaeoenvironmental records from Northern Germany
Ingo Feeser (Institute of Pre- and Protohistoric Archaeology, Kiel University)

POSTER SESSION A high-precision absolute chronology for Ribe, the oldest town in Scandinavia
Bente Philippsen (Centre for Urban Network Evolutions, Aarhus University)
Trends, phases, events – temporal scales in archaeological and palaeoenvironmental data

Keynote speakers: N. Bleicher (Underwaterarchaeology / DendroLab City Of Zurich), F. Siegmund (WWU Muenster)
Session organizers: I. Feeser*, W. Dörfler, N. Müller-Scheeßel, J. Müller
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Archaeological as well as palaeoenvironmental transformations can be observed on different time scales. Hereby, it is generally possible to identify rapid and longer lasting changes as well as periods of rather stable conditions. In order to distinguish such processes “trends”, “phases”, and “events” are commonly described. This relates also to the question of continuity vs. discontinuous transition processes. Whereas trends could be regarded as a continuous transition, phases can be interpreted to reflect a transition by replacement of one state by another. The definition of such processes and their absolute time scale, however, very much depends on chronological constraints. Archaeological as well as palaeoenvironmental data have a specific uncertainty regarding the dating and the time span they represent. Therefore, considering and defining temporal scales is essential for data comparison and reconstructing or modelling processes in prehistory, and to estimate the probabilities of causal dependencies. For example, if we are interested in reconstructing human-environmental interaction we have to consider that events of a certain scale in one sphere do not necessarily result in changes on a similar time scale in the other sphere. On the one hand, a short-term event can trigger a longer lasting change. On the other hand, a longer lasting trend can result in a sudden change, if a certain threshold is reached.

Burial archaeology for example can focus on a single event, i.e. an individual burial, or a longer phase, i.e. the age and occupancy of a cemetery as well as on greater trends, such as general changes in burial behavior. On each of these temporal scales social structures are recorded and transformation can be studied. These scales also imply the timing from events to processes to structures, even if social processes cannot necessarily be read with a purely ‘linear’ notion of time. Therefore, this session aims at discussing the following questions:

- How can temporal scales of one archive be methodologically sound and translated to that of another?
- Does the temporal range of a transformation represent its duration or rather dating uncertainties?
- Do our explanatory models depend on the definition of temporal scales of transformations?
- And how do our pre-conceptions about the velocity and duration of processes influence our interpretation of transformations?

We invite contributions from archaeology and natural sciences with a transdisciplinary research focus. The papers should focus on examples from different disciplines regarding the identification and description of different temporal scales in their data and their (potential) consequences for interpretation.

Scales, Frequencies and semantics. On the meaning and comparison of proxies in (environmental) archaeology

Keynote lecture: Niels Bleicher (Underwaterarchaeology / DendroLab City Of Zurich)

Many studies on the human environment or the influence of humans on it are based on time series and often on the comparison of such. Obvious examples of such time series are annual ring and pollen data, but ultimately diachronic data on settlement intensity, find density or even the rate of change of typological elements are nothing more than time series.

For the handling of time series there are well defined methods in other disciplines. These show that variability in time series often occurs in different frequency bands and that the significance of variability differs in these different frequencies. It therefore makes a difference to the interpretation of many data whether they are viewed on a large or small scale. There is also the problem when comparing time series that causal relationships can only be inferred under certain circumstances. In this presentation, examples for shifts of meaning with scale changes within time series are presented and related problems with the comparison of time series are brought up for discussion.

A Revised Chronology of the Mesolithic in Southeast Norway

Gaute Reitan (Museum of Cultural History, University of Oslo)

Since the turn of the millennium, more than 400 Stone Age sites have been excavated in Southeast Norway by the Museum of Cultural History, University of Oslo. What implications does this tremendous amount of recently obtained data have for the understanding of the period in question, not least in terms of trends and breaks in the archaeological material? In a study published in 1975 the Mesolithic of Southeast Norway was divided into four subsequent phases. This was the first chronology outlined for Southeast Norway, which was based on local finds, local shoreline-displacement curves and typological patterns expressed in the native archaeological record, but no radiocarbon dates were directly included. Nevertheless, this four-phased division is still the established reference for the Mesolithic in Southeast Norway, albeit...
also Denmark in terms of contact networks.

The chronology of Mesolithic periods in Southeast Norway is due for a revision. Based on radiocarbon dates and archaeological evidence from the Neolithic-Aeneolithic tell of Monjukli Depe in Southern Turkmenistan offers a possibility to take a closer look at processes of change at multiple levels, with a focus on built space. The small prehistoric village settlement yielded multiple layers of substantial mudbrick architecture which give insight into building and dwelling practices of past inhabitants. Its excellent preservation allows us on the one hand to trace the phenomena on a small scale of single events or repeated actions that were potentially perceived by past inhabitants and consisted of constructing, using, modifying or abandoning living space. On the other hand the multilayered evidence of superimposed mudbrick architecture at Monjukli Depe gives a possibility to look at middle-term processes, which involved changes in living environment occurring during the whole period of site occupation. The question here is which techniques and ideas of organizing living space were transmitted over generations by the site’s inhabitants and how they changed during this time. The long-term processes encompass changes in spatial organization that took place over longer periods of time and therefore lie beyond human experience but can be grasped analytically. Extensive Soviet excavations on numerous Neolithic and Aeneolithic sites in the region provide a good basis for a diachronic analysis of longterm change in domestic architecture and spatial organisation on settlements that span the 6th through 3rd millennia BCE. The talk will present methods and results of a multi-scalar approach to architectural evidence from Monjukli Depe and prehistoric Southern Turkmenistan based on small-scale stratigraphic analysis, Bayesian radiocarbon modelling and micro-scale diachronic observations of architectural forms and settlement layouts.

**How can changes be traced? Multi-scalar studies of the built environment in prehistoric Southern Turkmenistan**

Ilia Heit (Freie Universität Berlin, Institut für Vorderasiatische Archäologie)

Recent decades of archaeological research have seen a variety of theoretical discussions of concepts of time. Besides a greater focus on the emic perspective – on time experienced through social practices of past people – considerable effort has been spent on differentiation among temporal processes in terms of their speed and range when looking at material change over time. This multiscalar consideration of time in archaeology has deep reaching roots in the works of Braudel and his notion of history as a composite of varying temporal rhythms – longue durée, moyenne durée or conjuncture and événement. It provided an epistemological potential for archaeological inquiries into change and its temporal dimensions and created opportunities for the integration of small-scale research questions into an area in which scholars have traditionally operated with diachronic comparisons in a long-term perspective. However, how can these theories be implemented on a practical level? The archaeological evidence from the Neolithic-Aeneolithic tell of Monjukli Depe in Southern Turkmenistan offers a possibility to take a closer look at processes of change at multiple levels, with a focus on built space. The small prehistoric village settlement yielded multiple layers of substantial mudbrick architecture which give insight into building and dwelling practices of past inhabitants. Its excellent preservation allows us on the one hand to trace the phenomena on a small scale of single events or repeated actions that were potentially perceived by past inhabitants and consisted of constructing, using, modifying or abandoning living space. On the other hand the multilayered evidence of superimposed mudbrick architecture at Monjukli Depe gives a possibility to look at middle-term processes, which involved changes in living environment occurring during the whole period of site occupation. The question here is which techniques and ideas of organizing living space were transmitted over generations by the site’s inhabitants and how they changed during this time. The long-term processes encompass changes in spatial organization that took place over longer periods of time and therefore lie beyond human experience but can be grasped analytically. Extensive Soviet excavations on numerous Neolithic and Aeneolithic sites in the region provide a good basis for a diachronic analysis of longterm change in domestic architecture and spatial organisation on settlements that span the 6th through 3rd millennia BCE. The talk will present methods and results of a multi-scalar approach to architectural evidence from Monjukli Depe and prehistoric Southern Turkmenistan based on small-scale stratigraphic analysis, Bayesian radiocarbon modelling and micro-scale diachronic observations of architectural forms and settlement layouts.

**Prehistoric landscapes of north Mayo, western Ireland: an overview from a palaeoecological perspective**

Michael O’Connell (University of Ireland Galway)

Co-author: Karen Molloy

County Mayo in mid-western Ireland has a wide variety of landscape and a rich archaeological heritage that includes considerable field evidence for human activity...
in all the major cultural periods. It is particularly noted for the high concentration of megaliths of court-tomb type, datable to the early Neolithic, in the northern part of the county (de Valéra and Ó Nualláin 1964. Survey of the Megalithic Tombs of Ireland. Vol. II. County Mayo). Here too, stonewall, pre-bog, field systems have been recorded, the most extensive (>1000 ha) and regular system being Céide Fields. Recently, the uniqueness of Céide Fields and nearby similar field-wall systems, e.g. at Belderrig and Rathlackan, has been accorded international recognition in the form of the Carlo Scarpa Prize for Gardens awarded by the Benetton Foundation (March 2018; Boschiero et al. 2018. The Céide Fields, Ireland. Publisher: Fondazione Benetton). In this presentation, an overview of the palaeoecological evidence — including radiocarbon dating and dendrochronology of pine, and several pollen profiles — for woodland dynamics, farming history, climate change and landscape development at a regional level will be presented.

On house generations, C14-dates and house orientation: Putting together pieces for an integrated LBK chronology

Nils Mueller-Scheßel (Institute of Pre- and Protohistoric Archaeology, Kiel University)
Co-author: Tine Karck, stud. phil.

For the time being, LBK chronology is a mess, and this is true in relative as well as absolute chronological terms. Only for the Rhineland and adjacent regions was it possible to define a fine-grained supra-local relative chronological system, which is solely dependent on ceramic decoration (“house generations”). However, even this system has recently undergone serious criticism (Fridrich 2016). In terms of absolute dates, the available dendrological ones cannot be brought in conformity with the radiocarbon dates, and those not with the relative chronology. Even more so, the relevance of radiocarbon samples for dating LBK events have been thoroughly questioned (Strien 2017). To remedy this situation somehow, we bring in house orientation as a new independent measure of time. Taking large scale excavations like Erkelenz-Kückhoven or Ulm-Eggingen as starting point, we can show that across the LBK world there is a significant correlation between the orientation of houses and the respective settlement phases. On settlement level, this allows new phasings based on house orientation that can be compared both to the ceramic development and absolute dates derived from C14- samples. We thus hope to get to a better understanding of trends, phases and events within the development of the LBK.

Can archaeologists obtain generational precision on a calibration plateau?

Synchronicity and asychronicity in pollen signals: high resolution pollen analysis and radio carbon based time models for the Neolithic period in the Lake Constance area

Jutta Lechterbeck (Arkeologisk Museum, Universitet i Stavanger)

For the Western Lake Constance region a number of high resolution pollen analyses have been carried out in the last decades, each of which is dated by at least ten radiocarbon dates. Moreover, a non-glacial varve chronology exists for Lake Steisslingen. The time-depth model for each profile was constructed with the time-depth model tool from Oxcal. All profiles from the Lake Constance area show a very similar vegetation development in the Neolithic displaying a number of alternating Fagus and Corylus/ Betula peaks. The independent chronology for each profile reveals that despite of the
visual similarity those peaks are not synchronous. On the contrary – it can be shown that the actual vegetation changes occurred in a very small-scaled pattern in the landscape, reflecting the spatial shifting of land use. Also the immigration of Fagus does not occur synchronous in all profiles. On the whole the example of the Western Lake Constance area shows that biostatigraphical correlation can be very much misleading even in the case of obviously very similar developments in a small area.

Bronze Age Archaeological and Radiocarbon Chronologies of the Southern Urals (Russia/Kazakhstan) – Results and Problems
Finn Schreiber (Free University Berlin)

Bronze Age chronology of the Southern Urals (Russia/Kazakhstan) is characterized by a several different cultures with just vague insights into their chronological relation regarding both, the connection between the cultures and the absolute chronology. A new ceramic chronology based on multivariate analyses of burial finds in the Southern Urals area now provides a framework for dating finds of the late Bronze age (1800-1400 BC). The results can be summarized in a phase model with three successive chronological stages with major changes visible in ceramics and burial customs. Comparative analyses show similar chronological features for sites in the Trans-Ural steppe and forest steppe areas. This indicates comparable cultural characteristics in different parts of the Southern Urals. A series of new radiocarbon dates (AMS) was established to provide an absolute dating for this ceramic chronology. However, comparison of all available dates shows very different results for the steppe and forest steppe areas. Possible reasons for this could be found in the archaeological record and biases in the radiocarbon dates as well. The paper will focus on possibilities and problems, both of developing and correlating of typological chronological and Bayesian radiocarbon modelling in the Southern Urals Bronze Age and present the current state of research and potential future goals.

Archaeological chronologies as sensor of the different pace of cultural change
Keynote lecture: Frank Siegmund

Well established traditional archaeological chronologies reflect the pace of change in the material culture and social behaviour of past societies. More change allows more detailed chronologies, and vice versa. Thus, we can take our chronologies as a detector of the very different pace of change in the past. A systematic collection of central European chronologies shows, that the duration of the single phases of archaeological chronologies doesn’t follow a general pattern in the sense of “the older the longer, the younger the shorter”. Instead, shorter and longer phases can be observed in every era. In early historical situations, which thanks to written sources can be cross-referenced to a certain extent, the duration of the phases corresponds well with historical events and developments. Archaeological chronologies can therefore be used as a comparative diachronic and intercultural tool to assess cultural changes as well as to assess the force of traditions and innovations.

A major cause of the variation in the duration is seen in the way culture is transmitted to young people: short phases are mainly linked to cultural transfers between peers; medium-length phases result principally from the transfer of culture from parents to children; long phases from the transfer from grandparents to grandchildren. The introduction of major technological innovation like agriculture and animal husbandry, the “secondary products evolution”, the beginning of the Bronze Age, or the beginning of the Iron Age is accompanied by relatively long phases, i.e. periods with fewer changes in the material culture.

Land use, social transformations and woodland in Central Europe – past, present and future of the research
Jan Kolar (Institute of Botany, Czech Academy of Sciences, Brno, Czech Republic)
Co-authors: Vojtech Abraham; Martin Macek, Peter Tkáč

Prehistoric land use changed according the several factors such as subsistence strategies, population dynamics, technological innovations or transformations of social structures associated with land ownership rules. These phenomena did not occur or transform in large areas of Central Europe at the same time and they were influenced by specific modes of human mobility, environmental conditions, availability of natural sources etc. Taking the transition from hunting and gathering to farming and herding as an example, we know that the change was somewhere sudden, somewhere it took several hundreds of years until the communities became fully agropastoral. What was the impact of such a rapid or gradual change on the land use? Can we register the velocity of the social transitions in the palaeoarchives? Are we able to effectively compare palaeoarchives and archaeological datasets and knowledge? In the previous project (http://longwood.cz/) archaeological evidence on human presence from the eastern part of Czech Republic from the period between 10,000 BCE and 1,250 CE served as a data input for a spatio-temporal modelling of the intensity of human activity. So far, our modelling approach represented an effective tool for overcoming spatial and temporal uncertainties of the archaeological dataset and for producing of the quantified human activity model, which is easily comparable with palaeoenvironmental proxies. In the upcoming research project, which starts in 2019, we will use the
fact that Czech Republic is currently fully covered by archaeological databases of sites and finds and we will create a quantified model of land use based solely on the archaeological evidence. This will be easily comparable with quantified vegetation models. Nevertheless the incorporation of non-quantifiable knowledge on the prehistoric societies such as technological innovations, social structure or ways of communications is still a challenge which needs to be discussed.

Late Holocene land-use history in coastal areas: palynological case study from south-eastern Sweden

Olena Vinogradova (Södertörn University, Stockholm Sweden)
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Introduction of agriculture in Sweden is dated to ca. 6 ka BP. Earlier studies indicate that fertile coastal areas generally have the longest and most continuous history of crop cultivation (e.g. Berglund et al. 1991). However, this conclusion was never tested systematically along the coasts of Sweden. Moreover, the effect of long-term land-use in coastal areas on e.g. the Baltic Sea is still debated (Conley et al. 2011). In this context, palorecords from lake sediments and marine deposits have the potential to provide useful information on the impact of early agriculture on the Baltic Sea environment. In this study, we focus on environmental transformations of the south-eastern coastal zone of Sweden during the last 3 ka BP. This area has a long agrarian and human occupation history, but so far detailed land-use reconstructions are scarce. The general trend of land-use intensification from the establishment of permanent fields ca. 3 ka BP was interrupted by decrease during the Migration Period (ca. 1.5 ka BP) and the Medieval crisis caused by plague outbreaks (ca. 700-500 yr BP) (Myrdal and Morell 2011). Our case study is based on pollen and microcharcoal data from Lake Lillsjön (N 57°35.934’, E 16°23.342’, 16 m.a.s.l; surface area 0.16 km2) located in the hemiboreal zone of south-eastern Sweden. The area is rich in archaeological findings that evidence human activity from the Mesolithic time onwards. The pollen data from such a small lake provide information on the local land-use and vegetation. The type of land use is reconstructed based on the modern analogue approach and the “indicator-species approach”. We use the synthesis of human-impact pollen indicators of Gaillard (2013). The underlying assumption is that pollen types represent plant species that are indicative of specific soil, nutrient and climatic conditions, as well as types of anthropogenic activity. Our first results show the occurrence of pollen types indicative of various kinds of pastures and meadows, ruderal communities and cultivated land (Cerealia type pollen). The reconstructed land-use changes are then compared with the archaeological record of the area.

Literature

Dating the Balts. At the Crossroads of GIS, Statistics and 14C.

Roman Shiroukhov (Centre for Baltic and Scandinavian Archaeology (ZBSA), Schleswig)

Iron age chronology of the East Baltic region is more intuitive, than relative, based mainly on typological dating of sequences of cemeteries artefacts. The Western Balts late iron age cemeteries data gives an opportunity to establish a new combination of dating methods for this area, applying typology, GIS, R-statistics and 14C. The situation of the Balts region in the 10-13th century is rather peculiar, as it was by this time “an island of prehistory”, surrounded by „the continent of history”. The double-sided periphery between the Old Rus’ and Scandinavia. The historical perspective of the absolute time of dates, events and written sources is juxtaposed here to the relative time of pre-history (mythology) and processes decoded in archaeo-logical remains. The goal of the project is to develop an example of georeferenced statistically modelled radiocarbon-dated time-scale. Initially the data of 9 Prussian, Curonian and Scalvian cremation cemeteries (about 800 graves) is used. Every cemetery is represented here as the set of “events” or “time capsules” – sealed deposits, created for some reason, at a certain place, and in a short passage of time. The relative-dating part of the study is dedicated to the correlation between the date of cremation and the dating of the types of artefacts. Mainly the metalwork based chronological schemes are used. The date of a certain grave represents a correlation of possible dates of production of type + use of type + deposition of type. The next stage of research is GIS analyse of typological data. GIS, as the tool of georeferenced past visualisation, places the typological data on multi-layered time-maps. The horizontal “time maps”, with a chronological and semantic layers, are created for every cemetery. So, already in the GIS-analyse of 3 smallest cemeteries: Alejka-3 (Prussians), Bandužiai (Curonians) and Viešvėlė (Scalvians), it is visible, that the two first are dated both later on the georeferenced- typological scale, then the third one. Than Alejka-3 is slightly later than Bandužiai, having only few chronological analogies to Viešvėlė. Already at this scale we can divide them to the 3 relative dating periods. Typological georeferenced data is statistically analysed
with R. Gradation-typological method is used for determination of the direction of typological series, and verification of expansion and randomness of typological series in time. Correspondence analysis is needed to correlate the possible date of the use of artefacts with the date of the construction of the deposit. GIS and statistically-verified relative chronology is connected to the AMS 14C absolute dates of the samples from the same graves. During the 2018 24 samples from 7 cemeteries were successfully dated. The most stable dating material for radiocarbon dating turned out to be burnt human bones, textile and horn (drinking horn mount fragments), and unburnt horse bones, leather, wood and charcoal on a lesser scale. The most of gained 14C samples correspond to the preliminary relative dating of the cemeteries. This is the first case of the successful complex dating for this data. At the end of the project author hopes to elaborate absolute chronology system for the period in a local scale. Which could connect the archaeological pattern of local processes with the set of external historical sources events.

Österild – 2500 year record of human–environment interaction

Morten Fischer Mortensen (National Museum of Denmark)

Environmental changes in the past are, for obvious reasons, expected to have had an impact on human life but it is often difficult to establish a solid link between any changes in the climate/environment with human responses in palaeoenvironmental studies, as they operate on different time scales. However at the small-scale site of Österild in Northern Jutland, Denmark a very distinct human-environment interaction was revealed during a rescue excavation in 2012. Here a field system dating to the early pre-roman Iron Age was overgrown by peat due to rising ground water. Later during the Little Ice Age the area was covered by aeolian sands and today the area is covered by woodland. This study which combines archaeology with pollen and macrofossil analyses shows how people adapted to the environmental changes during a 2500 year time period.

Temporal scales of succession and regeneration in natural and in disturbed landscapes

Walter Dörfler (Institute of Pre- and Protohistoric Archaeology, Kiel University)

Succession is a process that describes the steps from a disturbed landscape into a more natural environment. Abandonment of settlements and arable fields initiate a succession that typically can be divided in several steps. In woodlands we can identify an initial phase, primary and secondary forest and the terminal phase that finally results in climax vegetation. It depends on growing conditions, inter species compe-

Boom and bust cycles during the Slavic period in NE-Germany

Martin Theuerkauf (Institute of Botany and Landscape Ecology, Greifswald University)

Slavic people populated parts of eastern Germany after 600 CE. Archaeology separates various cultural stages, recognizable for example in the ceramics. Beyond that, new high resolution pollen records from central and eastern Mecklenburg-Vorpommern also show pronounced variations in land-use indicators during the Slavic settlement period, with peaks around ~700 and ~1000 CE, followed by again low values around ~800 and ~1100 CE. Apparently, Slavic populations flourished and subsequently sharply declined twice, with the peaks in population lasting only 50-100 years. No such variations in land use indicators are observed further west (western Mecklenburg-Vorpommern and Lower Saxony) and further east (Poland), suggesting that the observed fluctuations are a regionally limited phenomenon. The presentation first aims to delineate the region, in which the fluctuations are observed, using pollen records from across NE-Germany. Secondly, synchroncity of the fluctuations is tested. Thirdly, pollen based reconstructions are used to quantify the changes in forest cover versus open land during the boom and bust cycles, and to find spatial patterns in the fluctuations. Finally, additional proxies, including archaeological, historical and climate data, are used to develop a theory about the causes and mechanisms of the phenomenon.

POSTER SESSION: Geoarchaeological analyses at Tiryns (Peloponnese, Greece)

Thomas Birndorfer (Institute for Ecosystem Research, Kiel University)

Excavations in September 2017 in the Lower Town at Tiryns revealed fluvial deposits dating between the Late Helladic IIIA1 (1.400 BC) and the Late Helladic IIIB2 (1.200 BC) period. According to the current state of research, the related river traversed the alluvial plain and passed the Upper Citadel of Tiryns in the north. Previous geoarchaeological investigations in the Argolid, performed by E. Zangger 1993, described several meters of floodplain deposits burying the Lower Town of Tiryns. Zangger argued that these deposits originate from a single catastrophic flash-flood event, which served as a trigger for the people of the Late Bronze Age to erect the dam of Kofini with a large artificial channel to redirect the river to the south of Tiryns. Nevertheless, there is
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The Middle Neolithic (3300-2800 BC) is in northern Germany and southern Scandinavia portrayed as the time of full establishment of agrarian economy, increased importance of livestock (mainly cattle), emergence of new settlement clusters near water reservoirs as well as inland, construction of numerous megalithic tombs, and technological innovations in pottery and tool production. The period is associated with later phases of the development of the Funnel Beaker cultural phenomenon, to which earliest farming in the region was credited. One of the densely populated regions of the time was the Oldenburger Graben, a peninsula in northeast Holstein characterised by undulating Young Drift landscape, several small river systems, and the ‘ditch’ (Graben) – a narrow, low-lying zone cutting across the peninsula in NW-SE direction and representing remnants of a former fjord. In the west part of the ditch, excavations were conducted at several sites and analyses performed of seed/fruit, charcoal and pollen, animal and human bone, and inorganic materials. They showed that the area was continuously occupied for almost a millennium by communities who lived in structures made of daub and wood, practiced crop and animal husbandry, plant and shell gathering and hunting, and made tools and pottery. A palaeoenvironmental model for the wider region, which was devised from several high-resolution pollen archives in eastern Holstein, suggests alternating phases of landscape opening vs. forest recovery during the period of occupation of the Oldenburg sites. These shifts may reflect varied and/or changing methods of land use, principally those applied in agriculture. Additionally, some changes through time in the settlement size and structure, as well as in the artefact assemblages (e.g. pottery shape and decoration) were observed at some of the Oldenburg settlements. There may have also been shifts in the crop production and plant use. This paper combines previous and recently produced archaeobotanical information for the Middle Neolithic occupation of Oldenburger Graben in order to identify potential changes in the plant production and use that may have coincided with new developments in some other aspects of life in this region. In this, the paper highlights (un)suitability of the available Oldenburg archaeobotanical record for tracking changes/phases/events in plant-based subsistence strategies during the Middle Neolithic in the region.

POSTER SESSION: Trends, phases and events in palaeoenvironmental records from Northern Germany

Ingo Feeser (Institute of Pre- and Protohistoric Archaeology, Kiel University)
Co-Author: Stefand Dreibrodt (Institute for Pre- and Protohistoric Archaeology, Kiel University)

Palynological and geoarchaeological data from Northern Germany reveal distinct synchronous changes of human environmental impact on different temporal scales. On a long-term, multimillennial scale a general increasing trend is detectable. On a

POSTER SESSION: Steppes of southern Ukraine in Boreal and Early Atlantic period: archaeological and palaeoenvironmental data on the common timescale

Dmytro Kiosak (Odessa I I. Mechnikov National University)
Co-authors: Nadia Kotova, Willy Tinner, Sandra Bruegger

Two stratified archaeological sites (Kamyana Mohyla 1 and Melnychna Krucha) were systematically excavated and C14 dated in order to produce the refined chronological framework for societal change of hunter-gatherers groups up to the secure arrival of farming and herding in the region. Archaeological record is confronted to the paleoclimatic data, both available through the published descriptions and obtained via small scale on-site analyses. Some suggestions about the timing and character of human/ environment interactions are put forward.

POSTER SESSION: Were there changes in agricultural practices that coincided with changes in material culture at Middle Neolithic Oldenburg settlements in N Germany?

Dragana Filipovic (Institute of Pre- and Protohistory, Kiel University)
Co-authors: Jan Piet Brozio (Institute for Pre- and Protohistory, Kiel University), Johannes Müller (Institute for Pre- and Protohistory, Kiel University), Wiebke Kirleis (Institute for Pre- and Protohistory, Kiel University)

The Middle Neolithic evidence pointing at building development in this period. This contradiction makes it necessary to investigate the area of the Lower Town of Tiryns under geoarchaeological aspects. The objective of this study is to reconstruct fluvial-morphological dynamics, runoff characteristics as well as sedimentation- and erosion processes in the Lower Town of Tiryns. The investigated profile, the exact chronological limitation by ceramic fragments under the first fluvial deposits and the first building development above the youngest river gravels, which covers 150 to 200 years of river history, is unique for such semi-arid areas. Therefore, the investigated archive represents a very valuable event stratigraphy, which helps us to reconstruct the palaeoenvironment conditions in the Late Bronze Age. Furthermore, the project tries to answer the following questions: How was the undeveloped area of the Lower Town used and how was the floodplain area prepared for the building development? Concerning the cultural-historical context, the investigations should provide detailed information about the extent of the flooding events caused by the river, which was directly linked to the impact on the settlement system of the Lower Town.
multi-centennial scale phases of rather stable human impact seem to be interrupted by short-term, multi-decadal, lulls of human activity. Comparing these patterns with archaeological and palaeoclimate data point to possible correlations on different temporal scales. Hereby main cultural changes seem to coincide with palaeoenvironmental changes on a multi-centennial scale. With respect to climate change, however, no general uniform relationship is obvious, but the correlation of climate and human impact patterns seem to change in the course of time. Interpreting such correlating patterns in context of human-environment interaction raises the question of causal relationships. In this context it is necessary to think about different models of potential temporal connectivity of the involved processes/developments. Environmental stress for example can influence human activity in several ways, be it as trigger, driver or catalyst. Whereas a trigger can be considered as a short-term influence or relationship, respectively, a driver can be defined as a direct relationship on longer time scales and generally identifiable by a significant correlation. A catalyst can be described as an indirect relationship, which generally raises the susceptibility for internal or external disturbances on varying time scales. This paper aims at discussing the presented palaeoenvironmental data in context of such considerations.

POSTER SESSION: A high-precision absolute chronology for Ribe, the oldest town in Scandinavia
Bente Philippsen, Søren Sindbæk, Claus Feveile, Jesper Olsen

Ribe is known as one of the oldest towns in Scandinavia. From the early 8th century on, it was an emporium, a marketplace and node in a maritime trade network. A new research excavation was accomplished in the context of the Northern Emporium project in order to gain insights about the emergence and apparent decline of the trading port, as well as about the permanency and density of settlement. The Northern Emporium project is an archaeological research project funded by the Carlsberg Foundation (Semper Ardens Fellowship). The project is affiliated to the Centre of Urban Network Evolutions (UrbNet) at Aarhus University and carried out in close collaboration with the Museum of Southwest Jutland. Two plots with settlement and workshop layers as well as parts of the adjacent street were excavated with high-definition methods and detailed digital recording.

The aim of this study is to provide a radiocarbon chronology for Ribe that matches the degree of detail of the excavation, where the length of the phases in the age model reflects the actual duration of the activities, rather than the dating uncertainty. To achieve this, we are currently performing high-precision radiocarbon dating of annual tree ring samples to construct a new calibration curve for the period AD 650-900. We will present preliminary results of this effort and of radiocarbon dates made on bone, wood and charcoal samples from the Ribe excavation. We will exemplify how the calibrated age ranges are changed when the annual calibration curve is used instead of IntCal13, which is based on decadal samples. The detailed stratigraphy of the excavation is used to construct an age model for the development of Ribe’s marketplace. This will be of importance not only for understanding the study region, but also for the chronology of the Viking age in general. Many Viking Age artefact types are dated based on their stratigraphical position in the Ribe sequence. The older layers, containing preserved timber, are well-dated by dendrochronology. However, not all of the phases in Ribe have been dated by absolute dating methods yet. The latest dendro-date from this part of the site is AD 741, but activities at the site continue more than 100 years after that date. The calendar ages of some important typological reference points for Viking Age chronology are thus only estimated by relative methods, e.g., the duration of phases derived from the thickness of the layers. Therefore, a precise radiocarbon chronology of the entire occupation history of Ribe has the potential to consolidate or shift the dating of important artefact types. As Ribe was embedded in global networks of transcontinental trade, reflected by finds such as Early Islamic trade commodities, our results have the potential to resonate in the wider research field of urban networks.
Determinism in archaeology: What is it and why does it matter?

Friday March 15th, Room 105
Session organizers: A. Ribeiro, V. Arponen

FRI 08:30 Landscapes as the Context of Semiosis
08:30 
Keynote lecture: John C. Barrett (University of Sheffield)
R 105
09:00 Understanding Determinism in Archaeology
VPJ Arponen (CRC 1266, Kiel University)
09:30 From Hobbes, Rousseau, and Mauss to the determination of prehistoric actors
Arne Windler (Deutsches Bergbau-Museum Bochum)
10:30: 10:30 Determinism and the other: Archaeological and historical narratives as theft
Guy Middleton (Charles University)
11:00 Easy and wrong. Social and political functions of determinism
Thomas Meier (Heidelberg University)
11:30 Constraint and freedom: comments on the “theoretical gap” in archaeology
Artur Ribeiro (Graduate School “Human Development in Landscapes”, Kiel University)
12:00 Types’, ‘Groups’ and ‘Cultures’: How the European legacy of categorization haunts Archaeology
Martin Furholt (University of Oslo, Institute for Archaeology, Conservation and History)
13:30 Discussion

ABSTRACTS

Determinism in archaeology: What is it and why does it matter?

Keynote speakers: J. Barrett (Sheffield University, Department of Archaeology)
Session organizers: A. Ribeiro, V. Arponen*
*corresponding chair, varponen[at]gshdl.uni-kiel.de

Elizabeth Arkush and Travis Stanton have described archaeological research as operating primarily under two modes: either archaeology is the study of processes, which is recognized as involving some form of determinism, or it is the study of human agency, which is generally understood as non-deterministic research (Arkush 2011, Stanton 2004). But, is this necessarily an accurate representation of archaeological research and determinism?

With the rise of new scientific techniques (e.g. isotope analysis, aDNA), the study of Big Data, and the application of new and better scientific models (Kristiansen 2014), as well as a desire to return to a processual way of doing archaeology (Kintigh et al. 2014), the issue of determinism is topical again. In light of this situation, this session aims at demystifying determinism by trying to understand what it is and why it matters. Some of the questions that can be considered in the session include:
• Why are certain ways of conducting empirical research deemed deterministic or non-deterministic?
• Where in resides the core of the idea of environmental determinism, a topic of heated debates in archaeology since the 1960s?
• Do agency focused studies actually counter determinism?
• What is cultural determinism as opposed to environmental determinism?

We welcome papers from archaeologists and paleoenvironmental scientists alike and hope to see empirically but also theoretically mature and ambitious contributions. The session is jointly organized with Arbeitsgemeinschaft Theorien in der Archäologie (AG TidA).

Literature
Landscapes as the Context of Semiosis

Keynote lecture: John C. Barrett (University of Sheffield)

In the study of the history of life (and this is what I take archaeology to be) determinism is only ever likely to explain why things died or why life, under certain circumstances, was not possible. This is because all forms of life exhibit certain boundary requirements that might, or might not, be satisfied by various environmental conditions. When those boundary requirements are no longer satisfied, for whatever reason, then we can say that this failure determined the death of that form of life. If, on the other hand, our concern is to understand the diversity through which various forms of life have developed, then we will not be able to identify what determined that diversity, although we may be able to trace some of the conditions under which that diversity became possible. The reason for this is that forms of life develop, from fertilized cell to maturity, by growth in their embodied forms, in their physical abilities, and in the ability of some to replicate successfully. All these complex biological practices are achieved by means of a process of semiosis. It is by this means that forms of life learn of their various environments (including the available sources of sustenance and security), learn of their place within those environments and of their relations with others, and by these same processes, others are able to recognize them. The conditions from which those lives originated, and the conditions towards which those lives appear to be directed, do not determine this path of development. This development is contingent upon the moments in which a form of life is able to interpret the signs amongst which it is attempting to develop and to act upon that interpretation.

Understanding Determinism in Archaeology

VPJ Arponen (SFB 1266, Kiel University)

Archaeology is a discipline between the natural and human sciences. As a data collection based science, archaeology has a fundamental interest in natural scientifically produced and analyzed data. Archaeological interpretation, however, also builds upon human scientific theories of social and cultural dynamics. The question of environmental determinism in archaeology appears to us against that heterogeneous disciplinary background. This contribution aims at understanding how the charge of environmental determinism arises from that background as well as where the substance of the debate lies.

From Hobbes, Rousseau, and Mauss to the determination of prehistoric actors

Arne Windler (Deutsches Bergbau-Museum Bochum)

Only a few books had a comparable impact on the archaeological research as Marcel Mauss’ (1900 [1923/24]) eminent ‘Essai sur le don’. But since its publication, the connection between donor and receiver of a gift as well as the question of why gifts are returned are recurring topics. The discussion about reciprocity can be condensed into a non-individualistic, normative and an egoistic, utilitarian notion – the modern dichotomy of altruism and egoism is omnipresent (Adloff 2016). The former is represented by Karl Polanyi (1978 [1944]), and his idea of pre-modern embedded societies in contrast to modern capitalistic economies. Another protagonist of the normative concept is Alvin Gouldner (1984), who represents the opinion that reciprocity is a universal, internalised norm, which unites the exchange partners. The latter notion is connected to Peter Blau (1967) and his idea, that social exchange is characterised “by voluntary actions of individuals that are motivated by the returns they are expected to bring” (Blau 1967, 90). While the concept of individualism is associated with Thomas Hobbes’ (1651 [2011]) ‘Leviathan’ and Adam Smith’s (1981 [1776]) ‘free hand’, the normative approach can be traced back to Jean-Jacques Rousseau (2010 [1755]; see Adloff 2016). This dichotomy is deeply embedded in Western thinking and can be identified in the archaeological literature on pre-modern economies: most interpretations of prehistoric exchange refer selectively to the non-individualistic views and/or apply the individualistic approach without any reflection. At the same time, the authors stress that an application of the selfish approach is only possible for modern societies. As a consequence, archaeologist tend to determine prehistoric actors as altruistic and cooperative, while modern (capitalistic) actors shall be egoistic and uncourperative. However, it remains questionable when this ‘analytical cut’ (Hansen 1995) should have taken place. The aim of the talk is to clarify the origin and effects of this dichotomy within archaeological thinking and pleads for a more reflective way to determine prehistoric actors.

Literature

events or natural laws’ (Merriam-Webster). It appears in several guises in archaeology and history, in both popular and scholarly work. Deterministic theories, especially geographic and environmental, have been used to explain social and material change and the different developmental trajectories of given groups and societies, including the formation and collapse of ‘civilizations’ and societies. Arguably, however, such ‘explanations’ oversimplify complex historical and social processes and rob past individuals, groups, and societies of agency. This reflects and reinforces an ‘othering’ of past peoples and, in this sense, determinism can be regarded as a form of colonial history that needs to be questioned.

**Easy and wrong. Social and political functions of determinism**

*Thomas Meier (Heidelberg University)*

Most archaeological debates on determinism (or what is thought to be determinism) are focussing on specific parameters (e.g. resources, precipitation, temperature etc). To my knowledge the systematic functions of determinism are, however, poorly reflected and discussed. Usually they come as an unreflected by-product, but seem to be happily received. A deterministic approach greatly reduces complexity of a given system (Komplexitätsreduktion sensu Niklas Luhmann). Non-deterministic approaches usually struggle with a multitude of factors in highly complex interactions, which needs a lot of efforts and resources to understand and identify the driving mechanisms of a system/network/process. In contrast a deterministic perspective introduces the dominant factor as an a priori and allows an early focus on only one or a small number of explanatory factors. This conceptual procedure highly enhances the effectiveness of research, the comprehensiveness of the results and the possibility to apply such results. If we understand determinism as such a measure to reduce complexity, it fulfils important functions in an academic world, which increasingly falls short of resources and is accused of being useless not the least because of its high complexity. Mostly deterministic factors are identified in the non-human sphere. They counter human agency be it on an individual or societal level turning humans (among others) and societies into victims of the “circumstances”. In consequence they offer easy excuses and deprive humans of their responsibility for the world they are living in, while they seem to explain the impossibility of structural changes. Determinism offers a narrative of conservatism and irresponsibility and serves corresponding political agendas.

**Constraint and freedom: comments on the “theoretical gap” in archaeology**

*Artur Ribeiro (Graduate School "Human Development in Landscapes", Kiel University)*

Many archaeologists have pointed out the existence of a “theoretical gap” in archaeology (Cochrane and Gardner 2011; Kristiansen 2004; Hodder 2001). On one side of the gap is the study of processes, with particular focus on the reconstruction of past environments, and how humans react to these processes and to the environment. On the other side of the gap is the study of agency, which prioritizes human decision-making in understanding how past societies developed. Most researchers describe this theoretical gap as detrimental to the development of archaeology, but it is not clear why this is so. The aim of this paper is to question the underlying assumptions that have led to the theoretical gap. First, there is the assumption that archaeology should be a methodologically monist enterprise, that is to say, a discipline that should not diverge into different methodologies, which can then lead to multiple “theoretical gaps”; second, there is the assumption that these different methodologies are mutually exclusive, for example, if a methodology identifies “constraints” on human action, it cannot be compatible with a methodology that identifies “freedom” of human action; and third, there is the assumption that “constraint” and “freedom” have the same meaning as the metaphysical notions of “determinism” and “contingency”. Overall, the paper will provide a brief survey of these assumptions, how they have affected archaeological research in the last decades, and some steps on how to move on without them.

**‘Types’, ‘Groups’ and ‘ Cultures’: How the European legacy of categorization haunts Archaeology**

*Martin Furholt (University of Oslo, Institute for Archaeology, Conservation and History)*

There is no lack of critical engagement with problems arising from epistemologically problematic practices of categorization in European Archaeology. Yet at the same time, there is a widespread, if not dominant reliance on such kinds of categories that are the results of precisely these problematic practices. This reaches from implicit reliance on Eurocentric ideas about social group composition, mobility, ethnicity and relations of power connected to prehistoric societies, to the monothetic classification of archaeological materials, from the level of ‘archaeological cultures, down to the level of artefact types. The disjunct between critical reflection and the archaeological practice has recently become apparent in the debates unfolding in the context of aDNA research and the new migration debates in European archaeology. They highlight first of all the need for a better integration between theoretical debates and our practical work, but second of all they make clear that the issue of categorization – most visibly when it relates to ethnicity and migration – is a contentious topic which goes far beyond the realm of archaeological academic research.
Transformations in geophysical and geoarchaeological methods

Tuesday March 12th and Wednesday March 13th, Room 208
Session organizers: N. Pickartz, W. Rabbel, D. Wilken, S. Dreibrodtr

08:30 Towards a geoarchaeological implementation of geophysical prospection: a perspective
Keynote lecture: Philippe De Smedt (Ghent University)

09:00 Integrating non-invasive and geoarchaeological methods to reveal the stratigraphy and functional aspects of the Middle Bronze Age fortified settlement
Jakub Niebiesczanski (Institute of Archaeology and Ethnology, Polish Academy of Science)

09:20 Improving geophysical data processing and interpretation through information gained from excavations
Ercan Erkul (Institute of Geosciences, Kiel University)

09:40 Discussion

10:30 Transforming near-surface geophysical archaeological prospection: from square metres to square kilometres – from postholes to landscape archaeology
Immo Trinks (Ludwig Boltzmann Institute for Archaeological Prospection and Virtual Archaeology)

10:50 Locating a Bronze Age Mining community: a minimally invasive combined geophysical, geoarchaeological, and geochemical approach
Roderick B. Salisbury (Department of Prehistoric and Historical Archaeology, University of Vienna)

11:10 From Susceptibility Measurements to Magnetic Inversions
Natalie Pickartz (CRC 1266, Kiel University),

11:30 Evaluating Magnetic Depth Estimation Techniques for Archaeogeophysics
Jeremy G. Menzer (Environmental Dynamics PhD Program, University of Arkansas, USA)

11:50 Discussion

13:30 A multi-dimensional approach for detecting archaeological sites in the Zitava valley, Slovakia using ground and satellite based remote sensing
David Matzig (Institute of Pre- and Protohistoric Archaeology, Kiel University)

13:50 Combining LiDAR and old peat coring data in creation of georeferenced topographical model of an overgrown prehistoric bay
Juuso Kosinen (Freelance archaeologist – Mikroliti Ltd.)

14:10 Using Colluvial Deposits and Archaeological Expertise to Decipher Bronze Age Land Use Practices at Three Landscapes in SW-Germany – Preliminary Results
Sascha Scherer (University of Tübingen, Germany)

14:30 Exploring the Archives Stored in Mediterranean Transformed Landscapes
Arian Goren (University of Tübingen, Germany)

15:30 The Impact of Geoarchaeological Studies in Paleolithic Survey; Case Study: A Middle Paleolithic Site in the Northern parts of Susiana Plain, Khuzestan, Iran
Saeid Bahramiyan (Laboratoire Archéorient; Maison de l’Orient et de la Méditerranée, Jean Pouilloux, l’université Lumière Lyon, France)

15:50 Class-based rounding – The use of a new approach to manage large sedimentological and geochemical data sets gained for multi-proxy approach
Dirk Nowacki (Goethe University Frankfurt, Main/Institute of Physical Geography)

16:10 Discussion
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10:00 Constrained Electrical Resistivity Tomography using Direct-Push Electrical Conductivity logs and vibracore data
Tina Wunderlich (Christian-Albrechts-University Kiel, Institute for Geosciences, Department of Geophysics)

10:20 Innovative application of downhole ERT for geoarchaeological research
Erica Corradini (Institute of Geoscience, Dept of Geophysics, Kiel University)

10:40 Discussion

10:30 Tracing tsunami signatures of the AD 551 and AD 1303 tsunamis at the Gulf of Kyparissia (Peloponnese) using Direct Push in situ sensing techniques
Hanna Hadler (Institute of Geography, Johannes Gutenberg - Universität Mainz)

10:50 A minimal-invasive multi-methodical approach for site investigation with direct push sensing on different spatial scales
Johannes Völlmer (Institute of Geography, Leipzig University)

11:10 Using Geophysics in Archaeological Rockshelters: Lessons from South Africa and Australia
Ian Moffat (University of Cambridge and Flinders University)

11:30 Discussion

15:30 POSTER SESSION: Direct push sensing and geoarchaeological sounding at Neolithic Pestenacker settlement (Lech catchment, SW Germany)
Anne Köhler

POSTER SESSION: 3D-Modelling of Charlemagne’s summit canal – merging remote sensing and geoarchaeological data
Johannes Völlmer

ABSTRACTS

Transformations in geophysical and geoarchaeological methods

Keynote speakers: Ph. De Smedt (Ghent University); Ch. Zielhofer (Universität Leipzig)
Session organizers: N. Pickartz*, W. Rabbel, D. Wilken, S. Dreibrodt
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In archaeological and paleoenvironmental research, geophysical and geoarchaeological data provide otherwise inaccessible quantitative information on subsurface anthropogenic structure and soils. To fully develop the information potential of this data, it is necessary to combine methods of data acquisition and interpretation from different disciplines – basically geophysics, geology, and archaeology-, thus giving rise to a new class of methodological approaches and scientific working tools. In this context the term “transformations” used in the session title has a twofold meaning: First, “transformations” is understood in a methodical sense. It indicates the first aim of the session, which is to present and discuss new ways for transferring data and interpretational results of one discipline into something meaningful for the other disciplines. This will create synergy and increase the accuracy in the interpretation of physical and geological field data with respect to the remains of material culture and environmental development. An application example are large settlement places, the remains of which can be probed only at random by drilling and excavation, and which can be surveyed and analyzed as a whole only by areal non-destructive geophysical measurements. The target parameters may be mass determinations, the shape and size distributions of buried house remains, or reconstructions of prehistoric fluxes of soil and transport energy. The methodology required for deriving quantitative results combines elements of physical and material on-site sampling, physical and sedimentological soil analysis, the determination of transfer functions relating archaeological and soil properties and their physical parameters, the development of 3D numerical models of the subsurface structure from geophysical data using transfer functions, 3D geophysical imaging and inversion, statistical assessment of the results, and so on.

The second meaning of the term “transformations” in the session title is a reference to the research subject of the Collaborative Research Center 1266. It indicates the second session goal, which is to present and discuss example studies using combined approaches such as outlined above, for analysing settlements as a whole and deriving indications of change in the remains of material cultures or soils in space and time. The session is directed especially to scientists who are working in, or are simply interested in, the developing field of combined quantitative analysis of geophysical, geoarchaeological, and archaeological data.
Towards a geoarchaeological implementation of geophysical prospection: a perspective

Keynote lecture: Philippe De Smedt (Ghent University)
Co-authors: with Jeroen Verhegge and Lieven Verdonck

The archaeological application of geophysical prospection is surging, and along with the wider use of such techniques, geophysical equipment types are advancing and diversifying rapidly. However, regardless of recent advances, a bias exists in the way geophysical prospecting is integrated into the archaeological workflow, as emphasis remains (often strictly) on finding contrasts between archaeological features and the surrounding subsurface matrix. This ‘anthropocentric’ implementation of geophysics is in part rooted in the cultural research perspective that drives archaeology, but is exacerbated by use of specific methodological strategies, such as gradiometers, that favour discriminating discrete soil disturbances over characterising and understanding natural background variation. Furthermore, the integration of geophysical prospection into archaeological programmes often remains fragmentary, as it is still frequently characterised by a strong distinction between the process of creating geophysical datasets, and their subsequent integration into further archaeological interpretation. Hereby, the lack of feedback on the fundamental relationship between investigated archaeology and the obtained geophysical measurements is commonplace. To exploit the full potential of geophysical prospecting, we advocate a more geoarchaeological implementation of the method; taking into account the underlying physical properties, both natural and anthropogenic soil variations and taphonomic processes that are determinant in the detection of archaeological remains. In addition, by putting stronger emphasis on the natural subsurface variation, regardless of the archaeological questionnaire, the potential of geophysics in revealing palaeoenvironmental information can be tapped into more easily. As the integration of geophysical methods into developer-led archaeology increases, implementing exhaustive geophysical strategies that go beyond detecting archaeological features becomes a necessity. Here, the importance of a thorough understanding of the geophysical expression of archaeological structures within varying geological conditions cannot be overstated. Such information not only allows for a better founded interpretation of survey data, but equally enables assessing the geophysical discrimination potential (and lack thereof) of specific structures under varying geological conditions. In this paper, we discuss key issues that need to be addressed to overcome bias and limitations of the current application of geophysics in archaeology. Through an overview of existing methods and case studies, we show how frameworks to tap into the geoarchaeological potential of geophysics are already available, but remain little explored. We argue that integrating such approaches into the archaeo-geophysical workflow in a more standardised fashion will not only provide a broader interpretive basis for archaeological research, but facilitate the integration and communication of geophysics in archaeology.

Integrating non-invasive and geoarchaeological methods to reveal the stratigraphy and functional aspects of the Middle Bronze Age fortified settlement

Jakub Niebiesczanski (Institute of Archaeology and Ethnology, Polish Academy of Science)
Co-Authors: Iwona Hildebrandt-Radke, Akos Peto, Gabor Serlegi, Joanna Galas, Mateusz Jaeger, Gabriella Kulcsar, Nicole Taylor, Janusz Cesbreszuk, Gabor Markus

Archaeological investigations of the vast, multi-layered or tell-like settlements by means of conventional excavation methods are always connected with extremely long time as well as high financial costs. A good alternative to obtain the basic archaeological data concerning such sites, are the non-invasive methods, such as geophysics (magnetometry, ERT or georadiars). However, in order to provide a more detailed insight into the stratigraphy, or to at least draw a background for more sophisticated archaeological explanations (function or utility in spatial aspect) it is essential to use a cross-combination of methods, which fortunately is becoming a standard in present days. Such multidisciplinary methodology, comprising of geophysics, corings, small-scale excavations and laboratory verification of samples, was used by our team in Central Hungary, on a complex multi-layered and fortified settlement of Kakucs-Turjan. In effect of spatial analysis of the non-invasive results and through the sedimentological and geochemical analyzes, as well as corings and precise trench planigraphy, we have revealed the spatial organization and division of the discussed settlement and the functional aspect of particular parts of the site. Following paper focuses on both, the usage of magnetometric survey data and its processing in the ArcGIS software as a first step of the non-invasive research as well as the subsequent verification procedures like corings and sampling of sediments for further laboratory analyzes. The latter were oriented towards the reconstruction of the sedimentary environments of the cultural layers. Thus, we have recognized the actual nature of the magnetic anomalies and were able to extrapolate these results on the overall geophysical picture, providing archaeological explanations concerning the internal organization of the fortified settlement and its main defensive components, such as ditches. Following presentation aims to not only view the results of the research, but also to discuss the methodology proposed by our team in terms of non-invasive prospection planning as well as its verification. This methodical package comprise the GIS supported spatial analysis, which was conducted to choose the most suitable anomalies on the magnetic map in order to perform the verification procedures. Moreover, the geoarchaeological methods were a combination of various fieldworks activities, which are going to be discussed in this presentation as well. Therefore, the main aim of this talk is to discuss different methodical approaches, which were used in order to reveal the stratigraphical and functional division of the multilayered and fortified Bronze Age settlement.
Transforming near-surface geophysical archaeological prospection: from square metres to square kilometres – from postholes to landscape archaeology

Immo Trinks1 (Ludwig Boltzmann Institute for Archaeological Prospection and Virtual Archaeology)
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Over the past decade, near-surface geophysical archaeological prospection methods have evolved from manually operated survey solutions for the investigation of limited archaeological sites to highly motorized multichannel sensor arrays permitting the non-destructive investigation of the buried remains of entire settlements, including corresponding cemeteries, infrastructure and the assumed empty space in-between. After pioneering work conducted since the early 2000s by Stümpel, Rabbel and Erkul at Kiel University (Erkul et al. 2003), the 2010 in Vienna established Ludwig Boltzmann Institute for Archaeological Prospection and Virtual Archaeology is attempting to push the boundaries further towards increased spatial imaging and ever-greater coverage rates (Trinks 2012). In the framework of so-called archaeological prospection case studies, the methodology, involving remote sensing in form of aerial archaeology, airborne laser scanning, hyperspectral scanning, and near-surface geophysical prospection methods with a focus on magnetometry, high-resolution ground-penetrating radar (GPR) and electromagnetic induction measurements has been advanced, tested, and applied at unprecedented scale at different archaeological sites in northern and central Europe. The generated comprehensive archaeological prospection datasets covering large parts of archaeological landscapes are analyzed archaeologically through integrative interpretative mapping. The prospection data offers insights into buried archaeological remains as well as any other naturally occurring geological and anthropogenic structures in the ground that exhibit sufficient physical contrast. In particular, extensive high-resolution GPR measurements can be well suited to provide information on paleoenvironmental conditions, mapping sediments, bedrock, filled gullies or waterways, erosion and deposition horizons. In the case of superimposed anomalies of different character or orientation, the three-dimensionality of dense GPR data sets can permit relative chronological classifications. The Valetta convention stipulates that non-destructive methods of investigation are to be applied wherever possible in a professional manner in order to preserve the archaeological heritage. State-of-the-art near-surface geophysical prospection methods play an increasingly important role in archaeological research as well as rescue archaeology for the scientific exploration, investigation, and documentation of threatened buried cultural heritage. While still much technical development for improved subsurface imaging and methodological advancements regarding data processing and modeling remain, it is likewise important to gain a better understanding of the

The ancient city of Milet is situated in the Southwest of Turkey, about 10km away from the Mediterranean Sea. Since 1993 more than 130 ha have been geophysically investigated using geomagnetics. At places of special interest additional measurements using geoelectrics and electromagnetic induction have been performed. These methods measure the electrical resistivity of the subsurface that can give additional information about building materials, for example. One of the discoveries through geomagnetic measurements is a Byzantine basilica located to the North of Kalabak Tepe. Its walls are visible on the geomagnetic map as anomalies indicating lower magnetization. Additional geoelectrical measurements have been conducted on several profiles revealing places of higher resistivity that are due to building stones. But the rectangular structure in the southern part of the geomagnetic map could not be explained by these results only. Thus several small excavations were carried out that confirmed the existence of the walls visible in geomagnetics. With the aid of these findings the geophysical data could be newly interpreted.

For the first inversion of the apparent resistivity values standard parameters were used giving a relatively smooth image of the subsurface. Due to the findings of archaeological excavations the geoelectrical data processing was revised and a robust inversion approach was used instead. This results in a relatively blocky appearance of the anomalies resembling well the shape of the walls.

The floor plan of a Byzantine basilica or cemetery church found with the help of geomagnetics was further clarified by geoelectrical measurements. Especially small excavations gave additional information about the sharp-edged shape of the subsurface structures that could be used to improve the inversion of geoelectrical profiles. Because resistivity anomalies were better limited, the interpretation became clearer. With the improved data processing it was possible to distinguish between different filling materials and thus temporal building phases. A square complex south of the basilica was built first, followed by the cemetery church about 100 years later.

Locating a Bronze Age Mining community: a minimally invasive combined geophysical, geoarchaeological, and geochemical approach

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Locating a prehistoric mine is difficult if there are no visible features in the surface morphology (e.g. sunken shafts) or if there are no historic records. We faced this problem when investigating the Late Bronze Age mining settlement of Priggitz-Gasteil, which is located at the easternmost fringe of the Alps in Lower Austria. The site was occupied during the late Urnfield Period (ca 1050 to 900 BCI. It reached a maximum extent of about 3 hectares, making it the largest known prehistoric mining settlement in Lower Austria. The site has yielded only indirect evidenced of copper ore extraction, in the form of huge piles of mining debris and some miners’ tools (antler picks and hammers) recovered during systematic excavations from 2010 to 2014. Application of several prospection techniques, including terrain walking, aerial photography, LiDAR terrain modeling, geomagnetic surveys, and percussion drillings, has failed to delineate traces of copper mines. Therefore, in a current project funded by the Austrian Science Fund (FWF), a combination of different geophysical, geoarchaeological and geochemical techniques were applied in 2017 and 2018 to investigate the stratigraphy of the mining dumps, evaluate a potential miner’s residential area, and locate the underground works and the copper vein (in case there is any copper ore left). Geophysical methods employed included Induced Polarization (IP) imaging and ground penetrating radar (GPR). The IP method is an extension of electrical resistivity tomography (ERT), and provides information of the electrical conductivity and capacitive properties of the subsurface. Electrical resistivity imaging enabled us to delineate the extent of the main geological units, as well as the position and geometry of the dump materials. Additionally, imaging of the polarization effect revealed significant anomalies related to subsurface areas with high volumetric content of metallic minerals. The seismic refraction and tomography results allowed us to distinguish the overburden (dump material) from the bedrock and aided in the interpretation of the IP imaging results. GPR images provided detailed information about structures in the near surface improving the interpretation of the IP images. After preliminary analyses of the geophysical results, we conducted two core drillings, which reached the underlying bedrock at 32 m and 37 m depth. The archaeological and geological interpretation of the two cores provided the key to the interpretation of the geophysical measurements. Another useful method to locate different activities on the extraordinary well preserved occupation surfaces were multi-element geochemical analyses. A preliminary analysis of available soil phosphates and pH was followed by ICP- OES multi-element chemistry. Results detected invisible activities on the excavated surfaces, which we interpret in terms of activity patterns associated with domestic activities of the miners, as well as copper extraction and production activities. The transformation of different prospection data – as addressed by the session title – into one overall interpretation involved both the translation of data between disciplines and the transitions of different prospection data – as addressed by the session title – into one overall interpretation of the two cores provided the key to the interpretation of the geophysical measurements. The latter in respect to the expected results: first level – geology, second level – ore veins, third level – anthropogenic dumps and mining shafts/galleries, fourth level – activity areas inside the mining settlement.

From Susceptibility Measurements to Magnetic Inversions

Natalie Pickartz (Kiel University/CRC 1266)

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Magnetic prospection has become a standard geophysical method in archaeological prospection due to its advantages. Motorized data acquisition speed is high and a variety of different archaeological structures can be mapped in various geological backgrounds. The general layout of a site can be mapped well. Yet, because of the inherent ambiguity it is challenging to determine the geometry (shape and depth) as well as the magnetization of the archaeological features. Constraints to magnetic inversion can be obtained from other geophysical prospection methods, in-situ measurements in excavations or boreholes, laboratory measurements of soil samples
and generalization of excavation results. From our work at different prehistoric settlement sites in eastern Europe we are presenting a comparison of different procedures measuring the magnetic susceptibility in the field and in the laboratory, forward calculations of high resolution susceptibility measurements in boreholes and in-situ as well as inversion results. We are especially focusing on the consistency of the measured susceptibilities as well as the pros and cons of the different measurement procedures. With forward calculations it is determined whether remanent magnetization is present or not. For the inversion we are focusing on their challenges and limits aiming to estimate the magnetized volume. The laboratory measurements have the advantage of standardized sample treatment, yet the homogenization of the samples changes especially the density which needs to be corrected. In contrast, field measurements are less affected by sample ‘alteration’ and data acquisition is faster. This advantage should be used to perform repetitive measurements.

Evaluating Magnetic Depth Estimation Techniques for Archaeo-geophysics
Jeremy G. Menzer (Environmental Dynamics PhD Program, University of Arkansas USA)
Magnetometry is possibly the most widely used archaeo-geophysical technique in the world, however, a major drawback is the lack of depth information to anomalous source bodies. In fact, many novice archaeo-geophysical users are under the impression that magnetometry does not or cannot provide depth information. Yet, depth estimation is an active area of research and is commonly used in geologic studies. Previous evaluation of depth estimation techniques on modeled data provided promising results, therefore, this study evaluates realworld data collected at a controlled archaeological test site and multiple pre-historic Native American sites in Arkansas and Tennessee, USA. The study focuses on simple depth estimation techniques including half-width rules and multi-height measurements, but, more complex methods are also considered (e.g. Euler Deconvolution and center of magnetism). Additionally, the potential benefits of deriving depth information to magnetic sources is discussed in the context of quantitative versus qualitative interpretation techniques in archaeo-geophysics.

A multi-dimensional approach for detecting archaeological sites in the Zitava valley, Slovakia using ground and satellite based remote sensing
David Matzig (Institute of Pre- and Protohistoric Archaeology, Kiel University)
Co-authors: Stefan Dreibrodt, Nils Müller-Scheeßel, Erica Corradini, Diane Panning.

Natalie Pickartz, Dennis Wilken, Wolfgang Rabbel
With the advancement of digitisation and the free and easy availability of satellite-data and open source computer applications over the last few years, the archaeological evaluation of satellite images no longer has to be limited to purely visual methods (cf. CORONA). Instead, they can encompass analyses over longer time series, which allow patterns beyond the visible spectrum to be recognized in the data. The application of multi-spectral satellite images for a semi-automatic detection of subsurface archaeological sites using Sentinel-2, Landsat and ground-based magnetic data, is based on the premise that buried remains are likely to alter the soil-characteristics in comparison to the surrounding soil. Thus differences in the surface vegetation can be detected, using vegetation-indices, derived from multi-spectral satellite images. Especially under extreme weather conditions, the plants growing above archaeological features should be less susceptible to drought stress, as the features themselves can store more water than the sterile surrounding soil. A process-oriented workflow was developed using data generated in southwest Slovakia by several subprojects of the CRC 1266 „Scales of Transformation“. It combines publicly available multi-spectral satellite data and the open source script-based programming language R for maximal reproducibility and zero additional cost, with the results of in-field magnetic measurements to improve precision in site recognition. Thus, it should be easily possible to apply this approach also to other archaeological key areas. Funding by the GSHDL is thankfully acknowledged.

Combining LiDAR and old peat coring data in creation of georeferenced topographical model of an overgrown prehistoric bay
Juuso Kosinken (Freelance archaeologist – Mikroliti Ltd.)
Combining LiDAR and old peat coring data in creation of georeferenced topographical model of an overgrown prehistoric bay Basic topographical maps still provide most important geographical tool for finding unknown prehistoric sites in Finnish environments. Nevertheless, normal maps don’t include any topographical information about prehistoric dryland areas lying under contemporary peat layers of wetlands. Therefore, topography of sub peat landscape must be reconstructed through three dimensional modelling. Wetlands provide deposits of remarkable preservation of organic archaeological materials. However, Finnish wetlands also form a dimension of research still poorly understood. The studied bog, Rajalamminsuo, lies next to a lake of the Ancient Saimaa water system which has a dramatic shoreline displacement history. Due to the shoreline displacement, the studied bog has most likely been dryland area during the Mesolithic and an open water bay during later prehistoric times. Bogs surroundings yield dwelling places and other sites of prehistoric activity spanning
from times of Typical Comb Ceramic to Early Metal Age ca. 3900 cal. BC – 200 cal. AD. In modelling of Rajalamminsuo bog, 1984 geological peat investigation data was exploited together with LiDAR point cloud to create interpolation representing bogs basal mineral soil of glaciofluvial sand. The modelling method has a benefit of utilizing formerly acquired data provided by Geological Survey of Finland and National Land Survey of Finland. Hence, creation of the reconstruction doesn’t require any field work. Accuracy of the ETRS-TM35FIN georeferenced model was tested with manual peat corings and GPR. Results of the study gave essential knowledge about challenges of the modelling method which are important to understand when applying it as such and when developing it further.

Using Colluvial Deposits and Archaeological Expertise to Decipher Bronze Age Land Use Practices at Three Landscapes in SW-Germany – Preliminary Results

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Our project aims to decipher Bronze Age land use practices following an interdisciplinary approach by combining archaeopedological and archaeological analyses at three landscapes in SW-Germany (Hegau, Western Allgäu, Baar). Based on relative comparison of physical-geographical conditions, we assess the Hegau as favourable and both Western Allgäu and Baar as unfavourable for prehistoric subsistence. Additionally, we want to develop and use a dynamic and relative comprehension of favourability and unfavourability in regard of shifting material and immaterial requirements through time (JAMES ET AL., 2019, IN PREP.).

Archaeological studies include actual excavations and GIS-analysis of known sites. The mapping of settlement structures (post holes, fire places, middens) and findings (shards, silex, bones and ores) gives insights into local land use chronologies, i.e. the size and duration of settlements. Literature work helps to transform site-specific information into the level of settlement networks and regional dimension. The archaeopedological approach comprises the analysis of multi-layered colluvial deposits and settlement structures by the application of a broad methodology. We interpret colluvial deposits as the correlative sediments of human-induced soil erosion (HENKNER ET AL., 2017, HENKNER ET AL., 2018) and as archives for the decipherment of time-specific land use practices. Their mapping within (onsite) and in the vicinity of (offsite) excavated settlements should provide indications of spatial land use patterns. The chronostratigraphy of colluvial deposits is investigated by a triple-dating approach including AMS-14C radiocarbon dating, optical stimulated luminescence (OSL) and typological classification of archaeological finds. High-resolution sampling in 5 cm increments for diagnostic colluvial layers will provide a sufficient data density within the temporal scale. Phases of pedogenesis and soil erosion are differentiated by basic soil parameters as calcium carbonate, pH-value, soil organic matter, pedogenetic oxides, grain sizes and micromorphological indices as soil microstructure or small-scale soil formation processes. Land use practices like metal or ore processing may be identified by heavy metal analyses (Ni, Pb, Zn, Hg, As). Varying amounts of phosphorus indicate direct human-environment interactions that are further differentiated by geochemical markers. The investigation of steroids like sterols, stanolanes and stanones and of bile acids helps to decipher prehistoric domestication and manure management. Deposition of faecal material – by foraging cattle or fertilizing farmer – may be identified by C-, N- and P-cycling of soil enzymes (e.g. urease activity). The analysis of black carbon indicates fire management strategies, whereas fire temperature is differentiated by calculating the ratio of B6G6 to BSCA. Anthracological research (on- and offsite) helps to decipher the usage of wooden material as lumber or fuel. Finally, the investigation of bogs in the vicinity of our settlements should provide pollen spectra that give insights in crop diversity and paleoenvironmental conditions.

With the project in its second year, the presentation gives an overview about research concepts and objectives. Completion of field analysis provides first interpretations and upcoming perspectives of the project’s laboratory phase. Finally, first data sets of heavy metal and steroid analysis as well as enzymatic activity can be discussed.

Literature

Exploring the Archives Stored in Mediterranean Transformed Landscapes

Arian Goren (University of Tübingen)
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After successfully dating terraces in-fills in the outskirts of Jerusalem using OSL dating (Davidovich et al. 2012, Gadot et al. 2016; Porat et al. 2017), the importance of applying
several methods to re-examine the emergence of complex agricultural landscapes has proven indispensable. Furthermore, manipulating measured OSL signals has shown that anthropogenic soils can carry the memory of previous sediment re-deposition cycles. The next reasonable step is to acknowledge the immense potential of terraces, as imposing features in Mediterranean landscapes, to store valuable information on active transformation of landscapes taken by humans. In this regard, terraces are a unique archive of human-landscape interaction, and hence their content can and should be explored by an array of methods, addressing the three dimensions of these features. Following previous work, unraveling the information stored in in-fills of agricultural terraces in the outskirts of Jerusalem intends to expand in order to shed light on understanding the evolution of terraced landscapes. In addition to OSL dating, the study of macro and micro botanical remains, stereo imagery classification, and marine environments, which may lead to conclusions about palaeoecology, palaeoclimate, and human influence. Beside the environmental interpretation of archaeological sites, paleoecological and paleoenvirontmental studies applying multi-proxy approaches which are based on geochemical and sedimentological data. These allow comprehensive statements on the depositional condition, for example, limnic, lagoonal, and marine environments, which may lead to conclusions about palaeoecology, palaeovegetation, palaeoclimate, and human influence. Beside the environmental interpretation of the data records the quality of the data themselves plays an important role. Differences in the composition of the sampled material, the chemical properties, e.g. the concentration of certain elements, and the accuracy of the applied analyses may way that there is limited information about the Paleolithic periods from these areas among which Khuzestan province in the Southwest of Iran, especially, its northern and northeastern areas (northern highlands of Susiana plain), could be counted as a conspicuous example that despite limited Paleolithic surveys in recent few years, the obtained evidence from these surveys are of utmost significance. The Site of Khervali is one of the very few discovered Paleolithic sites in recent years which is located in the west of Zagros Mountain in the northern piedmonts of Susa Township, close to the western bank of Karkheh River. The aforementioned site was discovered focusing on the study of the geographical characteristics of the area. The importance of the site is in its geographical landscape. The site lies directly on the Bakhtyari conglomerate formation, and its surface is covered with a high amount of round pieces of sandstone in different sizes and also an abundance of chert. In terms of geological point of view, it seems that the high elevation of this area, compared to its surrounding plain, has preserved it from the sedimentation process in Khuzestan plain and sedimentary deposits of the Holocene period. The site was surveyed systematically in 2012. Due to the vastness of the site and distribution of the Artefacts, a sampling of the entire site was impossible, for this reason, just four parts of the site which have preserved from the sedimentation process and sedimentary deposits were selected for sampling of Artefacts from which 330 Artefacts were collected in total. Techno-typological analysis of the artefacts shows that the Khervali is presumably a middle Paleolithic site with the use of the flake removal technique, along with Levallois elements, different types of the scraper and considerable ease of accessibility to the local raw materials available in the Bakhtyari conglomerate formation in the study area.

**The Impact of Geoarchaeological Studies in Paleolithic Survey; Case Study: A Middle Paleolithic Site in the Northern parts of Susiana Plain, Khuzestan, Iran**

*Saedeh Bahramian (Laboratoire Archéorient; Maison de l’Orient et de la Méditerranée, Jean Pouilleux, l’université Lumière Lyon, France)*

Because of the varied landscape and suitable environmental conditions, the Iranian Plateau has had a high potential for attracting human populations from the past to the present. In terms of geographical location, Iran is located between West and East Asia. It connects southwest Asia to the central and eastern parts of Asia, and could always be used as one of the migration routes of Pleistocene humans. In contrast to some scattered Paleolithic information revealed during the first Paleolithic studies in Iran, which were more focused on caves and rock shelters in Zagros and Alborz Mountains, in the last two decades, the studies conducted along with the presence of proficient researchers and the commenceent of interdisciplinary and professional researches such as geoarchaeology on the activities of Pleistocene humans in the mountainous regions of Zagros and Alborz, piedmont regions, plains, edge of deserts and the coastlines, have shed some new and interesting information and have reinforced the above thesis of Iran as the connecting bridge. Nonetheless, some of these areas have not received good acknowledgement and have remained rather unknown in a

**Class-based rounding – The use of a new approach to manage large sedimentological and geochemical data sets gained for multi-proxy approach**

*Dirk Nowacki (Goethe University Frankfurt, Main Institute of Physical Geography)*

By implementing new methods in geoscientific questions the amount of gained data is steadily rising and data handling gets more and more difficult. This holds especially true in geoarchaeological and palaeoenvironmental studies applying multi-proxy approaches which are based on geochemical and sedimentological data. These allow comprehensive statements on the depositional condition, for example, limnic, lagoonal, and marine environments, which may lead to conclusions about palaeoecology, palaeovegetation, palaeoclimate, and human influence. Beside the environmental interpretation of the data records the quality of the data themselves plays an important role. Differences in the composition of the sampled material, the chemical properties, e.g. the concentration of certain elements, and the accuracy of the applied analyses may
cause questions about the quality and the reliability of the proxies used. The strength of the presented class-based rounding approach is the inclusion of the accuracy of the measurement method and the resilience of the results of analyses in the multi-proxy approach. The class-based rounding allows to reduce the background scattering of the measured values. In the present paper the application of class-based rounding will exemplarily be presented on limnic sediments of the Danube-River system in Romania.

**Direct push sensing in wetland geoarchaeology**

*Keynote lecture: Christoph Ziehlhofer*

**Co-Authors:** Johannes Völlmer¹, Anne Köhler¹, Johannes Schmidt¹, Ulrike Werban², Peter Dietrich³, Sven Linzen³, Lukas Werther³, Stefanie Berg³, Peter Ettel³

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**Direct push sensing in wetland geoarchaeology**

- n pre-historic and historic times floodplain edges and lake shorelines were preferential settlement areas. Buried archaeological features like pile-dwellings, weirs, hythes, or mills are fairly abundant in wetlands. These (geo)archaeological archives are highly valuable, since the high groundwater level ordinarily provides excellent preservation conditions for organic-rich proxy-parameters and artefacts. However, wetlands are characterised by difficult exploration conditions that require complicate and costly excavation techniques due to the impact of groundwater inflow and highly unstable trench edges. Alternatively used classical driving core techniques often suffer from high compaction rates of organic layers and thus show a bias in depth accuracies. Regarding these challenging issues we focus here on direct push sensing with special interest on two key sites in Bavaria: Neolithic houses at Pestenacker (UNESCO World Heritage Site) and Charlemagne’s canal, the Fossa Carolina. Both locations represent prominent sites in wetlands, which are characterised by complex archaeological strata but also by a high diversity of fluvial, palustrine and lacustrine facies types. Direct push sensing represents a set of tools for performing subsurface records by pushing small-diameter, hollow steel rods with different probes into the ground. This technique is mostly applicable in unconsolidated sediments that are typically less than 30 m below the surface. Thus, continuous in situ measurements provide high-resolution vertical data logs up to a depth-accurate resolution in the cm-scale. In this presentation we will show the potential of direct push sensing in wetland (geo)archaeology. We focus on depth-accurate recording of buried archaeological structures and on the high-resolution detection of different facies types in wetlands. Within an integrated multidisciplinary approach, minimally invasive direct push techniques are combined with geophysical and (geo)archaeological methods.

- Our Pestenacker-specific objectives focus on the analysis of the lateral extent of Neolithic houses and their intercalation with the Neolithic water body. Our Fossa Carolina-specific objectives focus on the detailed reconstruction of buried Carolingian canal structures in zones of high groundwater-table. As archaeological excavations are difficult to conduct there, we will evaluate direct push-sensing as an alternatively concept.

**Constrained Electrical Resistivity Tomography using Direct-Push Electrical Conductivity logs and vibracore data**

*Tina Wunderlich (Christian-Albrechts-University Kiel, Institute for Geosciences, Department of Geophysics)*

**Co-authors:** Dennis Wilken, Peter Fischer, Hanna Hadler, Ercan Erkul, Rebekka Mecking, Thomas Günther, Michael Heinzelmann, Andreas Vött, Wolfgang Rabbel

In a geoelectric prospection, the apparent electrical resistivity along a profile is measured and analysed in a tomographic inversion process. This leads to images of the subsurface in terms of specific electrical resistivity that are e.g. used for an identification of archaeological features or a stratigraphical characterisation of the subsurface. Nevertheless, the tomographic inversion process is ambiguous, i.e. different subsurface models can result in the same misfit and are thus equally “true”. Therefore it is highly recommended to use additional information from other methods to constrain the inversion. In our case, we use Direct-Push Electrical conductivity (DP EC) logs and vibracore data to constrain the ERT inversion in different ways: a) Applying improved starting models derived from the DP-EC logs: Normally a homogeneous starting model is used in the inversion. By using an improved starting model that is closer to reality, the inversion process can be lead into the right direction producing better subsurface models. b) Applying structural constraints from logs and vibracore data: Structural constraints such as interfaces from sediment cores or DP-EC logs are incorporated in the subsurface model. At these interfaces, the smoothing constraints of neighbouring model parts are removed and the resistivity values of these parts are allowed to vary abruptly from one cell to the other. c) Applying both structural and resistivity constraints: Resistivity and depth information from DP-EC logs are used to constrain the subsurface model in certain regions. The resolution of electrical resistivity tomography (ERT) is depending on electrode spacing, measurement configuration and resistivity distribution, but in general, it is coarser than the vertical resolution of DP-EC logs, which is 2 cm. A DP-EC log represents the true electrical resistivity distribution with depth, but only at a single point along a profile. To adapt the high vertical resolution...
of the DP-EC logs to the coarser ERT resolution blocking of the logs in required. These blocked logs can then be used to constrain the tomographic inversion with resistivity and structural constraints in so-called regions around the log locations, which is found to be the best constraining approach. This constraining with in-situ measured subsurface information yields improved subsurface electrical resistivity models with improved depth of interfaces and resistivity values.

Innovative application of downhole ERT for geoarchaeological research
Erica Corradini (Institute of Geoscience, Dept of Geophysics, Kiel University)
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Geophysical methods combined with sedimentological information principally have the capability to provide quantitative information for determining local stratigraphies, which can be interpreted as indicators of environmental changes. Among the geophysical methods typically applied in archaeo-geophysical prospecting, ground penetrating radar (GPR) shows the highest stratigraphic resolution, but it is limited in penetration depth depending on the electric resistivity of the subsurface. This drawback does not apply to Electrical Resistivity Tomography (ERT). However, if ERT is performed at the surface, it generally suffers from spatial resolution limits. Against this background we investigate up to which degree ERT results can be improved by constraining the tomographic computation through drilling results. We present a new application of resistivity measurement in boreholes in a way to better understand the resolution of the method that can be helpful for geoarchaeological investigations. A borehole electrode array was constructed consisting of 16 electrodes with 10 cm spacing. This probe has been applied at the Mesolithic site of Dupensee along a transect with 10 corings every 5 m, crossing a former island in order to improve the understanding of the stratigraphy in that area. The probe is lowered into the boreholes to measure the resistivity in the vertical direction and can be used also for crosshole and borehole-to-surface measurements. The results of the test measurements were first individually inverted and afterwards combined with the measurements on the surface giving a good match and a detailed variation of the resistivity in the first 1.5 m. The electric measurements were then compared with GPR and drilling results to evaluate in how far the major facies can be traced into the area away from the boreholes.

Tracing tsunami signatures of the AD 551 and AD 1303 tsunamis at the Gulf of Kyparissia (Peloponnese) using Direct Push in situ sensing techniques
Hanna Hadler (Institute of Geography, Johannes Gutenberg - Universität Mainz)
Author and co-authors: Lea Obrocki, Hanna Hadler, Andreas Vött, Dennis Wilken, Peter Fischer, Timo Willershäuser, Benjamin Koster, Franziska Lang, Ioannis Papanikolaou, Wolfgang Rabbel, Klaus Reichert

The western Peloponnese was repeatedly hit by major tsunami impacts during historical times as reported by historic accounts and recorded in earthquake and tsunami catalogues. Geological signatures of past tsunami impacts have also been found in many coastal geological archives. During the past years, abundant geomorphological and sedimentary evidence of repeated Holocene tsunami landfall was found between Cape Katakolo and the city of Kyparissia. Moreover, neotectonic studies revealed strong crust uplift along regional faults with amounts of uplift between 13 and 30 m since the mid-Holocene. This study focuses on the potential of direct push (DP) in situ sensing techniques to detect tsunami sediments along the Gulf of Kyparissia. Direct push measurements were conducted on the landward shores of the Kaiafa Lagoon and the former Mouria Lagoon from which sedimentary and microfaunal evidence for tsunami landfall are already known. DP methods helped to decipher in situ high-resolution stratigraphic records of allochthonous sand sheets that are used to document different kinds of geomorphological and sedimentological characteristics of high-energy inundation, such as abrupt increases in grain size, integration of muddy rip-up clasts and fining upward sequences which are representative of different tsunami inundation pulses. This study’s investigations were completed by sediment coring as a base for local calibration of geophysical direct push parameters. Surface-based electrical resistivity tomography and seismic data with highly resolved vertical DP datasets and sediment core data were all coupled in order to improve the quality of the geophysical models. Details of this methodological approach, new in palaeotsunami research, are presented and discussed, especially with respect to the question how the obtained results may help to facilitate tracing tsunami signatures in the sedimentary record and deciphering geomorphological characteristics of past tsunami inundation. Using direct push techniques and based on sedimentary data, sedimentary signatures of two young tsunami impacts that hit the Kaiafa Lagoon were detected. Radiocarbon age control allowed the identification of these tsunami layers as candidates for the AD 551 and AD 1303 earthquake and tsunami events. For these events, there is reliable historical data on major damage on infrastructure in western Greece and on the Peloponnese. At the former Mouria Lagoon, corroborating tsunami traces were found; however, in this case it is to decide whether these signatures were caused by the AD 551 or the AD 1303 event.
A minimal-invasive multi-methodical approach for site investigation with direct push sensing on different spatial scales

Johannes Völlmer* (Institute of Geography, Leipzig University)
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Archaeological excavations on prehistoric and historic settlements and sites are often characterised by difficult underground properties like high groundwater tables and unstable trench edges. Alter-natively used vibra-corings are challenging due to inexact depth accuracy caused by high sediment compaction rates. Additionally, excavations and vibra-corings provide only a small insight of ex-terminated sites. Here, we present direct push sensing as an alternative application for subsurface in-vestigation. Direct push sensing implies different tools for the exploration by pushing steel rods with different probes in the ground to get high-resolution insitu data. The combination of direct push sensing with SQUID magnetic survey in a spatial hierarchical way provides a new approach for the exploration of ground monuments from large to small spatial scales. According to our methodical approach, large-scale SQUID magnetic surveys provide a first detection of potential archaeological anomalies. Subsequent, high resolution direct push sensing delivers in-situ sediment colour and electrical conduc-tivity to describe fillings, stratigraphy und geometry of two dimensional cross-sections on medium to micro scales. Finally, selected vibra-corings offer de-tailed sediment sampling and further laboratory analysis as ground truth. The approach was applied at the Early Medieval Fossa Carolina in S-Germany. The 3 km long Caro-lingian canal was built 793 AD to bridge the Central European watershed between Rhine- and Dan-ube-Seas and the Black Sea. The aim of our study is to investigate the depth, the geometry and the fillings of the canal at different sections to clarify its state of construction. The results show three examples of explored Fossa Carolina structures. The combination of direct push sensing with SQUID magnetic survey in a spatial hierarchical way provides a new approach for the exploration of ground monuments from large to small spatial scales. According to our methodical approach, large-scale SQUID magnetic surveys provide a first detection of potential archaeological anomalies. Subsequent, high resolution direct push sensing delivers in-situ sediment colour and electrical conductivity to describe fillings, stratigraphy and geometry of two dimensional cross-sections on medium to micro scales. Finally, selected vibra-corings offer de-tailed sediment sampling and further laboratory analysis as ground truth. The approach was applied at the Early Medieval Fossa Carolina in S-Germany. The 3 km long Caro-lingian canal was built 793 AD to bridge the Central European watershed between Rhine- and Dan-ube-catchment and was supposed to provide a navigable connection between the North Sea and the Black Sea. The aim of our study is to investigate the depth, the geometry and the fillings of the canal at different sections to clarify its state of construction progress and subsequent potential navigability. Fur-ther, we want to explore potential surrounding structures that might be part of the Carolingian hydro-engineering concept. The results show three examples of explored Fossa Carolina structures. The canal trench was ana-lysed in the Northern Section and potential hydro-engineering structures for water supply were analysed in the Northern and North-Eastern Section. For each site, in-situ colour cross-sections with 12, 5-50 cm horizontal and 1-2 cm vertical resolution were compiled and coupled with per-cussion drillings. The results show a detailed cross-section of the Carolingian canal with high depth-accuracy. How-ever, the potential hydro-engineering structures cannot be associated to the canal.

due direct push-derived clarification of the stratigraphic structures and additional 14C-dating. The study provides a new time- and cost-effective multi-methodical approach in conjunction with the implementation of direct push sensing for geoarchaeological issues. The detailed insights with direct push colour logs provide a new minimal-invasive exploration approach.

Using Geophysics in Archaeological Rockshelters: Lessons from South Africa and Australia

Ian Moffat (University of Cambridge and Flinders University)

Geophysical methods are now routinely applied to many archaeological investigations however their use on Pleistocene aged sites remains unusual. In this presentation, I showcase results from ERT and GPR investigations of rockshelters in South Africa and Australia. Geophysical survey was used to map the geomorphology of the bedrock surface in these sites and to define the stratigraphic packages with reference to adjacent excavation units. Additional sediment analysis is being conducted in order to assist with constraining the physical properties of the subsurface. Geophysics was particularly useful for locating the deepest parts of the rockshelters and validating if the excavations finished on bedrock or roof fall blocks. The results suggests a much greater potential role for geophysical methods in Pleistocene archaeology.

POSTER SESSION: Direct push sensing and geoarchaeological sounding at Neolithic Pestenacker settlement (Lech catchment, SW Germany)

Anne Köhler (Leipzig University, Institute for Geography)
Co-authors: Johannes Völlmer, Stefanie Berg, Ulrike Werban, Christoph Zielhofer

Wetland margins are valuable geoarchaeological archives due to their preferential settlement conditions in prehistoric times. A high groundwater level usually provides excellent preservation conditions for paleoecological and geoarchaeological proxies as well as for archaeological artefacts. However, this advantage also impairs classical archaeological excavations as a result of the increased groundwater inflow. Alternative percussion drillings offer inaccurate depth data due to increased compaction rates in organic rich sediments. The rarely used direct push sensing technology in paleoen-vironmental and geoarchaeological research offers the opportunity to overcome this problem. Different probes (soil colour, electrical conductivity, cone penetration testing) provide undisturbed and in-situ information with a high resolution in a time-effective manner. The Neolithic settlement of Pestenacker, near Landsberg am Lech in Upper Bavarian Alpine foothills (SW-Germany), represents an exceptionally well-preserved wooden house settlement in a wetland environment. It is located at the Verlorenen
Bach floodplain edge and was dated to the year 3.495-3.476 BC according to dendrochronological investigations. Its great archaeological and transregional importance led to the inclusion in the UNESCO list of World Heritage Sites in 2011 as part of the “Prehistoric Pile Dwellings around the Alps”. By using the direct push technology in combination with classical percussion drilling and sediment analysis, different questions on different scale levels are dealt with. The Poster shows the floodplain stratigraphy at high vertical resolution and the stratigraphic coupling with the Neolithic settlement layers.

POSTER SESSION: 3D-Modelling of Charlemagne’s summit canal – merging remote sensing and geoarchaeological data
Johannes Völlmer (Institute for Geography, Leipzig University, D-04103 Leipzig)
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The Fossa Carolina is the first hydro-engineering construction that bridges the Central European watershed in the Early Medieval. The canal was built in 792/793 AD on order of Charlemagne and should have connected the drainage systems of the Rhine-Main catchment and the Danube catchment. At that time, navigable waterways played an important role for itinerant kingships, economic exchange and communication across powerful elites and religious institutions in Europe. Hence, this hydroengineering project was of high geostrategic relevance. Current studies show, that the canal was built as a summit canal with several ponds of different levels. The canal trenches were deepened into sandy to loamy valley fills between the Rhine-Main and Danube catchments. In this poster, we show for the first time, the integration of Airborne LiDAR and (geo)archaeological datasets with the aim to create a 3D-model of Charlemagne’s summit canal. We develop an approach for handling with geoarchaeological data of different resolution. The canal trench geometry is derived from three archaeological excavations and four high-resolution direct-push transects. Schmidt et al. (2018) produced a purged Digital Terrain Model (DTM), which they purged by removing all anthropogenic structures. This pre-modern DTM reflects the Carolingian topography deals in this study as basis for the modelling approach. By means of several core drillings we interpolate the ditch floor and the adjacent escarpments through the entire canal. As a result, we are able to create 3D-model that reflects the maximum construction depth of the entire Carolingian canal. Furthermore, we calculate the excavation volume of the most important hydro-engineering construction in Early Medieval Europe. As a result, we compute an excavated volume of c. 287,000 m³. The excavated volume is not equally distributed over the whole canal length. On the contrary c. 87 % of the entire volume corresponds with just 45 % of the canal length. The present remnants of the massive dams are smaller indicating only a volume of c. 120,000 m³. This difference reflects the erosion and overprint since the 8th century AD. According to current information to the construction time by dendrochronological and historical data, we finally calculate the number of workers (c. 1725 persons) that were needed for the earthwork construction.
Scales of Transformation in Prehistoric and Archaic Societies – CRC 1266

Wednesday March 13th, Room 106
Session organizers: J. Müller, W. Kirleis, K. Fuchs

WED 08:30 Welcome by the Convener
J. Müller, W. Kirleis

08:35 Inequality as a driver of transformations
V.P. Arponen (CRC 1266, Kiel University)

08:50 Investigate transformations
Daniel Knitter (Department of Geography, Physical Geography, Kiel University)

09:05 Discussion: Theory and Modelling (Cluster A)

09:15 Pioneers of the north: Transitions and transformations in Northern Europe evidenced by high-resolution data sets
Sonja Grimm (Centre for Baltic and Scandinavian Archaeology (ZBSA))

09:30 Transformations of specialized foragers
Daniel Groß (Centre for Baltic and Scandinavian Archaeology (ZBSA))

09:45 Late Mesolithic and Neolithic transformations in the Northern Central European Plain
Jan Piet Brozio (Institute of Pre- and Protohistoric Archaeology, Kiel University)

10:30 Dating LBK houses by their orientation: the interpretative power of magnetic results as exemplified by recent research in the Upper Žitava valley (southwest Slovakia)
Nils Müller-Scheßel (Institute of Pre- and Protohistoric Archaeology, Kiel University)

10:45 Functions, development and regional variability of communal buildings in Cucuteni-Tripolye settlements
Robert Hofmann (Institute of Pre- and Protohistoric Archaeology, Kiel University)

11:00 New advances in archaeobotany at the Tripolye mega-site of Maidanetske (Ukraine) about plant cultivation and wild plant resources
Marta Dal Corso (Institute of Pre- and Protohistoric Archaeology, Kiel University)

11:15 Transformation in the contact zone, ‘Gulf of Corinth’
Torben Keßler (Institute of Classics Archaeology, Kiel University)

11:30 Human, landscape, architecture – Hellenistic building complexes in the context of human action and perception
Asja Müller (Institute of Classics Archaeology, Kiel University)

11:45 Discussion: Transformations of socio-economic formations (Clusters B-E)

13:30 Climate and society between 6000 and 3000 BP in Southern Iberia. Preliminary synopsis from overarching and local investigations
Martin Hinz (Institute of Archaeological Sciences, University of Bern)

13:45 Analysis of lake sediments as tool for high-resolution reconstructions of human- environmental interactions-examples from the Mesolithic period in northern Germany
Stefan Dreibrodt (Institute of Ecosystem Research, Kiel University)

14:00 Palaeoenvironmental transformation on different spatial scales: from local to overregional patterns
Ingo Feeser (Institute of Pre- and Protohistoric Archaeology, Kiel University)

14:15 Dynamics of plant economies in ancient societies
Dragana Filipovic (Institute of Pre- and Protohistoric Archaeology, Kiel University)

14:30 Genomic analysis of a Middle Neolithic community in Germany reveals time estimate of 5,300 BCE for admixture between hunter-gatherers and farmers
Alexander Immel (Institute of Clinical Molecular Biology, Kiel University)

14:45 Discussion: Socio-environmental Components of Change (Cluster F)
POSTER SESSION

15:30 The never-ending why – Theories on Neolithic monumen-
tality
Johanna Brinkmann (Institute of Pre- and Protohistoric Archaeology, Kiel University)

In search for the Bølling-Oscillation — new palynological
data on old questions at lake Bølling, Denmark
Sascha Krüger (Centre for Baltic and Scandinavian Archaeology (ZBSA))

Chronological models of Tripolye mega-sites development:
testing with radiometric dates
Liudmyla Shatilo (Institute of Pre- and Protohistoric Archaeology, Kiel University)

Social transformations at the end of Neolithic Central
Germany
Clara Drummer (Institute of Pre- and Protohistoric Archaeology, Kiel University)

Late Neolithic pottery production in the central German low
mountains
Marianne Talma (Institute of Pre- and Protohistoric Archaeology, Kiel University)

Bronze Age transformations in Northern Germany
Stefanie Schaefer Di-Maida (Institute of Pre- and Protohistoric Archaeology, Kiel
University)

Human and climatic landscape transformation in the
Stymphalia polje, Greece
Joana Seguin (Institute of Ecosystem Research, Kiel University)

Human/paleoenvironmental interactions in Southern Greece
during the Bronze age-Iron age transition:
a biomarker perspective
Jan Weber (Institute of Geosciences, Kiel University)

Ex oriente lux? Ex oriente luxuria? Sociocultural transform-
ination processes in the Early Iron Age Eastern Medit-
erranean
Kim Annika Kittig (Institute of Classics Archaeology, Kiel University)

Climate reconstruction and potential links to the
demographic development from the Neolithic to the Late
Bronze Age in southern Iberia
Julien Schirrmacher (Institute of Geosciences, Kiel University)

The (trans)formation of the macrobotanical archive: a
case-study from the Hungarian Carpathian Basin
Sofia Filatova (Institute of Pre- and Protohistoric Archaeology, Kiel University)

Geophysics meets geoarchaeology: 3D facies mapping at the
esosolitic site of Duvensee
Erica Corradini (Institute of Geosciences, Kiel University)

Amplitude analysis of GPR Data for Identifying Archaeo-
logical Features in Glacial Deposits
Diana Panning (Institute of Geosciences, Kiel University)

Quantification of daub masses based on magnetic
prospection data
Natalie Pickartz (Institute of Geosciences, Kiel University)

Flexible research data management
Yannic Ole Kropp (Department of Computer Sciences, Kiel University)

Changes and catastrophes? Reviewing the North Atlantic
climate during the later 3rd millennium BC
Jos Kleijne (Institute of Pre- and Protohistoric Archaeology, Kiel University)

Investigating timescales of change in material culture: a
study of the pre-roman Iron Age in Denmark
Helene Rose (Centre for Baltic and Scandinavian Archaeology (ZBSA))

Towards a deeper understanding of Early Holocene
landscape dynamics: the multifaceted contribution of palaeo-
environmental analysis within the CRC 1266
Marco Zanon (Institute of Pre- and Protohistoric Archaeology, Kiel University)
19 ABSTRACTS

Scales of Transformation in Prehistoric and Archaic Societies – CRC 1266

J. Müller, W. Kirleis, K. Fuchs

What are the substantial transformations that describe human development from 15,000 years ago to the beginning of Common Era? How did the interaction between natural environment and human populations change over time? What role did humans play as cognitive actors trying to deal with changing environmental conditions? Which factors triggered the transformations that led to substantial societal and economic inequality characterizing the development from Paleolithic camp sites to Aegean polis? Looking at the period from 15,000 to 1 BCE, the Collaborative Research Centre 1266 (CRC 1266) takes a diachronic view in order to investigate the processes of transformation that led to the development from late Pleistocene hunter-gatherers to early state societies, thus covering a wide array of societal formations and environmental conditions across Europe. In order to identify the dimensions of transformation processes on different temporal, spatial and social scales, we explore past environmental and archaeological archives of high quality in different landscapes and use a combination of archaeological and palaeo-environmental methods.

This session is dedicated to the major results obtained within first years of the CRC 1266, presented by PostDocs and PhD candidate contributions from all 18 subprojects. Since 2016 the CRC researchers concentrate on specific topics dealing with intensive comparative work on archaeological case studies, diachronic work on parameters with broad theoretical discussions, targeted model development and with cutting-edge method development in dating and sub-surface prospection in order to enable true interdisciplinarity.

We explicitly welcome audience that is interested in the CRC topics! The program will be announced by January 2019.

Inequality as a driver of transformations (A1)

Vesa J. Arponen*,1, Martin Furholt2, Carole L. Crumley3, Johannes Müller4

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2 Department of Archaeology, Conservation and History, University of Oslo
3 Department of Anthropology, University of North Carolina
4 Institute of Pre- and Protohistoric Archaeology, Kiel University

Due to recent political events, the question of elites, power, inequality, and good governance are once again in the contemporary agenda. This talk critically reflects upon and compares selected concepts of power and inequality in archaeology. Inequality is a potential trigger and driver of transformation processes, but inequality or equality of what? How if at all is inequality and power different in a modern society as compared to prehistory? What can be learned from prehistoric power and inequality with regard to the present day? The talk exhibits the kind of analytic and reflective work conducted by philosophers in collaboration with archaeologists in the Collaborative Research Center 1266.

Investigate transformations (A2)

Daniel Knitter*,1, Wolfgang Hamer1, Oliver Nakoinz2, Rainer Duttmann3

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The inter-relationship of societies with their landscape is characterized by continuous dynamics. Different disciplines do actively contribute to investigations of these dynamics, identifying phases of transformation and stability. Various terminologies and concepts, heterogeneous data and methods, as well as interpretations characterize the research on societies and their landscapes. This aggravates the identification and comparison of transformation phases or events as specific forms of societal dynamics. The aim of this talk is to present different integrative modeling approaches that are flexible to be used in different contexts in order to support the required comprehensive perspectives and enable to draw conclusions about transformations. Since models are heuristics they can be used to exemplify various discipline-specific assumptions and foster communication. Integrative modeling is a practice, that is complementary to the classical, discipline-oriented approaches. To illustrate the potential of a model-supported integrative research approach, we present models of crisp and fuzzy logic for interaction analyses and land-use quantifications. The application of this approach is shown by means of selected field studies and their hypotheses from prehistoric and classical archaeology projects in Germany (C1) and the Eastern Mediterranean (E1). We conclude with some theoretical remarks (A1) and promote the “reflective turn box” as a heuristic device to integrative research that aims to foster discussions, reflection on terms, as well as closer interdisciplinary collaboration.

Pioneers of the North: Transitions and transformations in Northern Europe evidenced by high-resolution data sets (B1)

Sonja Grimm*,1, Berit Valentin Eriksen1, Sascha Krüger1, Maria-Julie Weber1, Benjamin Serbe1, Katja Winkler1, Tobias Burau1, Moiken Hinrichs2

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2 Institute of Pre- and Protohistoric Archaeology, Kiel University

In this project, we investigate the cultural and socio-economic transformations in
mobile hunter-gatherer groups that were confronted with different and changing environmental conditions at the end of the last Ice Age. In particular, we use diverse case study regions to exemplify the socio-environmental interactions of pioneer populations and early inhabitants during the Final Palaeolithic colonisation processes in Northern Europe. Four major periods of change were originally identified based on the known archaeological and environmental data:
1. Human colonization of the south-western Baltic region at the onset of the Meiendorf interstadial,
2. Pioneers settling into this region during Meiendorf and the early Allerød interstadial,
3. Broader variation appears towards the end of the Allerød interstadial,
4. Expansion and pioneering further northwards at the end of the Younger Dryas stadial.

Having established these four phases, the task was to discuss what the changes observed are in fact representing? Were these actual transformations of a group from a prior state (α phase) over a state of transformation (β phase) to an established new state (γ phase)? Or were these actually different pioneering movements with first group A, then B, then C etc.? To investigate this, we employed both material culture studies (e.g. dynamic technological analyses of material culture variability as well as variation in spatial organisation and site distribution) and scientific analysis of high-resolution palaeoenvironmental profiles. Since the start of the project, we have not just revisited several old assemblages and profiles but also found and investigated new ones. Thus, we integrate new and old data to build solid, local environmental chronologies to approach the questions about the character of the transformation. Based on our analyses and the numerous collaborations, we have manifestly improved our knowledge concerning all our case study regions, established an additional region in Denmark, and increased our understanding of transformations in the palaeoenvironmental and archaeological record of the south-western Baltic region. Our investigations thus far imply that (1) was perhaps the most substantial transformation of the human-environmental interactions with people arriving in this region, (2) may not have been a transformation at all but a replacement, (3) needs further research to be understood, and (4) occurred later than originally thought and might be highly dependent on the environmental interactions.

The beginning of the Holocene is marked by severe environmental changes on a global such as regional scale. Several archives from the Northern European Lowlands enable us good insights into these prehistoric processes and how humans were affected and reacting to these. While the societies under consideration were non-sedentary hunting and gathering economies, they were closely interacting with their environment.

In this presentation we will present new results from the project “Transformations of specialized foragers” with emphasis on the Early Mesolithic. The regional focus is the south-eastern part of Schleswig-Holstein in northern Germany, which has been subject to intensified research during the last two years. In the interdisciplinary environment of the CRC 1266 “Scales of Transformation” we developed a workflow for reconstructing prehistoric settlement regions in cooperation with the subprojects. This comprises the interlinking of archaeological data, geophysical surveys and palaeo-environmental reconstructions. We will exemplify this by results from ancient Lake Duvensee where we can see alterations in the settlement system in accordance with changes of the lake. Furthermore, light will be shed upon typo-chronological and economic transformations of Mesolithic societies. Our results contribute to refined understanding of Early Holocene hunter-gatherers but more importantly show significant changes of the subsistence systems during the course of the Mesolithic and give hints for changes in the social sphere. Finally, we will discuss general misconceptions about the homogeneity of Holocene hunter-gatherers in the region and present perspectives for further research.

Late Mesolithic and Neolithic transformations on the Northern Central European Plain (C1)
Jan Piet Brozio*, Sönke Hartz*, Johannes Müller*
1 Institute of Pre- and Protohistoric Archaeology, Kiel University
2 Archaeological Museum Schloss Gottorf, Foundation Schleswig-Holsteinische Landesmuseen, Schloss Gottorf

This project focuses on marked socio-ecological transformations in social and environmental domains from the Late Mesolithic to the end of the Neolithic period on the Northern European Plain. To extract and compare patterns of transformation in selected test areas, archives of environmental developments and archaeological artefacts are combined with the results of new geophysical prospections and excavations. This new fieldwork concentrated on four sites which date to between the late Middle Neolithic and Young Neolithic – Oldenburg LA 225 and 232 in the former fjord region of the Western Oldenburger Graben, the inland Labenz LA 11 in the Duvensee fen area, and Brodersby-Schönhagen LA 107 on the coast of the Baltic Sea. The combination of both the archival and new datasets for diachronic analyses revealed the variable impact of economic and social practices on the Neolithic societies through
time. This paper presents both the major results of the ongoing field projects and larger chronological analysis, highlighting the main drivers of transformations and their effects on the Neolithic societies of the Northern European Plain.

Dating LBK houses by their orientation: The interpretative power of magnetic results as exemplified by recent research in the Upper Žitava valley (southwest Slovakia) (C2, G1, G2)

Nils Müller-Scheeßel*, Erica Corradini1, John Meadows1, Johannes Müller1, Diana Panning1, Natalie Pickart2, Wolfgang Rabbel2, Helene Rose4, Martin Furholt1
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Either by excavation or in the last decades increasingly by geophysical prospection (esp. magnetics) we have an ever growing body of settlement and house plans of the LBK (early Neolithic in Central Europe) at our hands. However, current discussions mostly focus on the question of the initial setup of individual settlements (house wards or rows). With the help of extensive recent research in southwest Slovakia in terms of excavations, surveys and geophysical prospection, we propose to go one step beyond this. By having dated more than one quarter of the houses of one of the three settlements of Vrabľe, we are able to explicate a link between the orientation of individual houses and their respective dating. Furthermore, we show that houses of similar orientation can be found at standard distances. Taking this evidence together, it is possible to devise a model of the settlement development which allows to make succinct statements about the succession of houses and their longevity as well as the population size of the village. We extend this model to other contemporaneous settlements in the area which are partly or completely covered by magnetic prospection to arrive at informed estimates on the settlement history and population density of an LBK micro-region, the Upper Žitava valley. In this way, we can sketch the transformations in terms of the settlement patterns and population distribution taking place during the Early Neolithic in this part of the LBK world. We will discuss the ways these transformations also changed social interaction and communication on the local and regional level.

Finally, we provide an outlook on the possibilities of similar studies in other areas of the LBK territory.

Functions, development and regional variability of communal buildings in Cucuteni-Tripolye settlements (D1)

Emergence, decline and related aspects of huge population agglomerations in Tripolye megasites with partly thousands of houses are investigated in the sub-project D1 of the CRC1266 ‘Scales of Transformations’ together with colleagues from the National Ukrainian Academy of Science, the Borys Grinchenko Kyiv University and the German Archaeological Institute in Berlin and Frankfurt. High-resolution magnetic surveys in Cucuteni-Tripolye settlements led to the discovery of large, so far unknown building structures which are located at prominent positions within settlements. Because of their extraordinary size, positioning and special architectural characteristics these structures have been identified as public or communal buildings such as “temples” or assemblage houses. Precise spatial and functional analysis of these structures in magnetics plans and new excavations allow a unique insight into the social organization of Tripolye communities and their transformation in a longer-term perspective. Within large settlements of the Cherkassy and Kirovograd regions two classes of such buildings can be distinguished: So-called high-level ‘mega-structures’ likely fulfilled functions at the level of the whole community while low-level “ring”-street (and other) buildings have been used for integrative proposes of parts of the commune. The latter category of buildings, normally shows more or less uniform distributions within settlements which likely reflect some kind of communal organisation in quarters or districts.

With the goal to understand the construction and functional aspects of such buildings, one low-level ring-street building was excavated in Maidanetske in the frame of the CRC 1266. Detailed collection and analyses of available information such as find inventories and distribution, imprints of timbers on daub, the dense sampling for botanical, zoological, pedological, and geoarchaeological investigations provide solid arguments for the evaluation of functional aspects of this building in comparison to the ‘normal’ houses and the identification of activity zones.

In order to deepen the understanding of transformations in the social organisation of Tripolye communities, the category of communal buildings as a whole is evaluated in a diachronic perspective based on old and new plans of geomagnetic surveys. Starting from analysis of size, frequency and positioning of such facilities we are now able to discuss in diachronic perspective crucial aspects such as the development of use group sizes of such buildings and the role and development of central institutions in Tripolye societies.
New advances in archaeobotany at the Tripolye mega-site of Maidanetske (Ukraine) about plant cultivation and wild plant resources (D1, A2, F2)


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Within the Project D1 of the CRC 1266 ‘Scales of Transformation’, Tripolye population agglomerations in central Ukraine have been investigated. For now, archaeobotanical research focused on the mega-site of Maidanetske. An updated overview is here presented concerning the analyses of botanical micro- and macro-remains at different scales, with focus on cultivars and natural resources. Cereal cultivation is attested by charred macro-remains, despite difficult preservation conditions. Phytolith analysis stressed proves of the high importance of cereal by-products as plant temper for house construction, hence of cereal processing in the site. Together with attestation of stockbreeding, likewise a stable community lived at the site. Furthermore, the analyses of plant remains shed light on the natural resources in use. Charcoal fragments attested the use of ash as preferred tree for fuel and construction, followed by oak and elm. These trees compose both, the mixed broadleaved woodland of the hardwood belt along river valleys and the mixed broadleaved woodland in areas less influenced by hydrographic fluctuations, suggesting that the area around the site was covered with forest at the time of settlement. However, some attestation of grassland vegetation is given by feathergrass awns, charred and recovered on-site. These remains indicate either the use of grassland spots with steppe vegetation in the landscape, or the presence of this vegetation in the close vicinity of the site. A landscape model was developed in collaboration with the Projects A2 and F2 of the CRC1266. The model is based on the topographic, soil and archaeological data, and on ethnographic comparions, and it suggests the possibility that the area around the site was forested in the Chalcolithic, in agreement with recent pedological analyses, and that only much drier conditions could have led to a severe environmental change due to human impact.

Transformation in the contact zone ‘Gulf of Corinth’ (E1)

Torben Keßler (Institute of Classics Archaeology, Kiel University)

The transition from the Bronze to the Iron Age in Greece – in the frame of our project understood as the time between the 12th and the 8th century BC – is a phase of major changes with regard to the structure of the society involved. After the destruction of the Mycenaean palaces around 1200 BC a century of relative stability set in, followed by a time which is commonly known as the ‘Greek Dark Ages’. Mainly, this name was chosen because of the loss of literacy during that period and the fact, that the archaeological remains in general are less copious than before and after. What we can recognize, however, is the emergence of the polis, the Greek city-state, which becomes visible during the 8th century and which reflects a new, and differently institution-alized, form of community than had existed before.

In our project, which is concerned with the regions surrounding the Gulf of Corinth, I am approaching this transformation by means of pottery studies, with a special focus on decoration. Two aspects render the decoration of pottery a most fruitful area of research: its high sensitivity regarding change, and its comparatively good traceability within the archaeological literature. That applies no less for pottery from the Greek Early Iron Age. I believe that the high degree of detail that I am recording (based on evidence from the material published) regarding the distinct potter’s and painter’s choices will produce some insights into spatial patterns that have not been recognized so far. By looking carefully at decorative elements of the different ceramic shapes existing, I hope to be able to advance our knowledge of when and where certain geographical areas related more closely to each other, while others seemed to develop rather isolated. In my opinion, contact between acting entities was a vehicle of major importance for the societal transformations that took place at the dawn of the polis culture. The diachronic observation of connectivity on different spatial levels – ranging from the local sphere of a site, to the regional area of a settlement chamber, and, finally, up to the level of inter-regional relations – is a useful indicator of change that accompanied these transformations. Even more so in the case of our working area and time frame, since the geoscientific proxies that have been collected by the other parts of our project do not point to any major climatic or environmental change during this transitional period.

Human, landscape, architecture. Hellenistic building complexes in the context of human action and perception (E3)

Asja Müller*, Michael Feige* (Institute of Pre- and Protohistoric Archaeology, Kiel University)

Project E3 investigates the transformation of the interrelation between built architecture and landscape during the Hellenistic period (ca. 4th to 1st century BC) in the Mediterranean. This period can be regarded as a key moment in the history of human design of landscape features since it saw a massive change in the relationship between architecture and landscape. Therefore, the project focuses on architectural interventions and their consequences for the shaping of the landscape (and vice versa) as well
as the influence that human action and perception have on this process. In order to better understand these multi-layered interactions, the project examines two architectonically related, but functionally very different action contexts: Hellenistic sanctuaries in the eastern Mediterranean and Roman Villas in Late Republican Italy. The Hellenistic sanctuaries under consideration are investigated with regard to different analytic layers. On the most basic layer the choice of location will be considered, that is to say their topographical and urbanistic embedding. This is followed up by the discussion of typical natural (e.g. groves, caves, springs etc.) as well as architectural features (e.g. stairs, retaining walls, columnar halls etc.). On the most complex level, both kinds of features are related in order to ask how these architectural complexes are structured altogether (e.g. by the principles of symmetry, horizontal and vertical graduation or rhythmization). Thus, the comparison with the sanctuaries of Archaic to Classical as well as Roman date will reveal the transformations of Hellenistic landscape-architecture interaction as well as basic human practices intrinsically linked to it (e.g. movement and perception). Using new construction techniques, from the 2nd century BC onward Roman villas copied elements originally used in sanctuary architecture, which were then applied to create and structure spaces for activities of agriculture and private leisure. More than ever before, the landscape itself became part of the architecture.

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**Climate and society between 6000 and 3000 BP in Southern Iberia. Preliminary synopsis from overarching and local investigations (F1)**

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3. Institute of Geosciences, Kiel University
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The F1 project aims to identify transformative events in societies of Southern Iberia, and whether these transformations are a result of climatic deterioration in the region. The project started with the collection of archaeological and paleoclimatological indicators, which in their current aggregation provide a complex picture of Southern Iberian societies and climate fluctuation.

From the perspective of paleoclimate, 6 drought phases between 6,000 and 3,000 BP could be identified, and these can be correlated to the archaeological record, more specifically, changes in settlement sizes as inferred from 14C sum curves. In particular, it is possible to recognize a potential relation between the rise of chalcolithic societies and their “collapse” (from 2200 to 1200 BCE) with some climatic developments, whereas Bronze Age societies (1200 BCE onwards) seemed to have been more resilient and fared considerably better in face of similar climatic developments.

Qualitative approaches are also currently being applied to the archaeological data, in order to obtain a more fine-grained perspective on how these societies developed in light of climate change. This includes the study chalcolithic ditched enclosure sites of southern Portugal, such as Monte da Contenda where we have already conducted field work, and Perdigões, which is being research by one of our close collaborators, with the aim of understanding what happened to these communities during the end phase of the Chalcolithic.

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**Analysis of lake sediments as tool for high-resolution reconstructions of human-environmental interactions- examples from the Mesolithic period in northern Germany (F2, B2)**

*Stefan Dreibrodt*, *Ingo Feeser*, *Marco Zanon*, *Walter Dörfler*, *Daniel Groß*, *Harald Lübke*

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Lake sediments prove environmental archives on the continents that store critical information about Holocene human-environmental interactions and thus transformations of landscapes and societies. Micro-structure analysis of annually laminated lake sediments allows a reconstruction of paleo-environmental processes on the continents in a unique precision. Climate variability, landscape development and hazards, like volcanic eruptions, which were people faced by, can be studied on a sub-annual level. Additionally, investigations on lakeshore sediments allow the detection and dating of lake level changes. A comparison of the paleo-environmental data with the archaeological record allows to consider about possible consequences for ancient people, and necessities of adaption strategies often considered as one driver of societal transformation. In the presented contribution, a comparison of results from early Holocene sediment sequences of northern German lakes (Pogensee, Woseriner See, Schwerner See) with the available paleo-environmental and archaeological records (Duvensee, Hohenviecheln) is presented to illustrate the potential of lake sediment studies to disentangle ancient transformation processes.

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**Palaeoenvironmental transformation on different spatial scales: from local to over-regional patterns (F2, D3)**

*Ingo Feeser*, *Jutta Kneisel*, *Stefanie Schaefer-Di Maida* (Institute of Pre- and Protohistoric Archaeology, Kiel University)

Palaeoenvironmental investigations in context of the CRC 1266 comprise analyses...
of archives reflecting human-environmental interaction on different spatial scale. Small sediment archives in the vicinity of archaeological sites, so called near-site archives, strongly reflect local land-use activities. Investigations of sediments from medium to large lakes, so called off-site archives, are commonly used to reconstruct regional developments. By comparing different archives it is possible to differentiate and identify signals of environmental change from a local to over-regional scale. This aims at evaluating the role of environmental factors during phases of archaeological identified socio-cultural transformation as well as reconstruct environmental consequences of such changes.

This paper will focus on preliminary results of palynological investigations (CRC 1266 subproject F2) of a short peat sequence from a small depression close to a Bronze Age cemetery at Mang de Bargen, northern Germany. On-going archaeological investigations at this site (CRC 1266 subproject D3) revealed evidence for local burial and settlement activities from the Bronze to Pre-Roman Iron Age. Interpreting the near-site pollen record of Mang De Bargen, we aim at reconstructing the local land-use history and compare it with the Archaeological evidence. The results are put into context of regional and over-regional developments as derived from palaeoenvironmental off-site analyses.

Dynamics of plant economies in ancient societies (F3)
Dragana Filipovic*, Wiebke Kirleis (Institute of Pre- and Protohistoric Archaeology, Kiel University)

The archaeobotanical research project of the CRC 1266 is concerned with the development and changes in plant production, i.e. the dynamics of past plant-economic systems, for which the evidence can be found in the archaeobotanical record. The geographical regions of interest to the project are central and northern Europe. We use archaeobotanical and archaeological data produced within the ongoing or already completed research initiatives at Kiel, in addition to the relevant published data. My work within this project focuses on crop cultivation and use at a selection of settlement sites in northern Germany and Slovakia dating to the Neolithic and Late Bronze Age. The Neolithic case studies include several sites in northeastern Schleswig-Holstein (in the Oldenburger Graben region) from the end of 4th/beginning of 3rd millennium BC, and the LBK site of Vrable in western Slovakia (6-5th millennium BC). The site of Wismar-Wendorf in Mecklenburg-Vorpommern (8-7th century BC) serves as a Late Bronze Age case study. The aim of my work is to investigate in more detail certain aspects and elements of past crop production that varied within and between the respective periods and regions, particularly those that changed from one period to the next. A further goal is to explore if and how agricultural change articulated with shifts and new developments in other aspects of life, principally technology, but also distribution of farming settlements and their interaction with the natural environment. The outcomes of my work contribute to the scope of the CRC1266, which seeks to identify and shed light on large-scale, profound changes (transformations) in the lifestyle and social and natural environment of prehistoric and early historic communities.

The presentation will show some aspects of crop cultivation at the Neolithic Oldenburg sites and the LBK Vrable. Further, possible cause-and-effect of changes observed in the crop spectrum and farming routine during the Bronze Age in northern Germany will be discussed. Some thoughts on the presence/absence of correlation between the trends and tendencies in agriculture and changes/advances in technology and settlement pattern will be offered. As part of this project, I designed and am conducting the so-called “Millet Dating Programme” with the idea to establish a high-resolution chronological frame for the appearance of common millet in Europe and for its full inclusion in the agrarian production systems. My presentation will include initial results of this work and will emphasise their significance, as they contribute to investigations into how this Bronze Age agricultural novelty impacted on plant economy and if/how it related to other innovations (in crop production and beyond) characterising this period.

Genomic analysis of a Middle Neolithic community in Germany reveals time estimate of 3300 BCE for admixture between hunter-gatherers and farmers (F4)

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5 Institute of Clinical Molecular Biology, Kiel University

The Neolithic period is associated with socio-cultural and technological changes and presents a major transformation in human subsistence strategies which may also have exposed humans to previously unknown diseases, which is one research focus of subproject F4. During this period, local hunter-gatherers admixed with incoming farmers from the Near East while both groups co-existed in Europe over a long period of time. Here, we present genomic data of 50 individuals from a Middle Neolithic farmer community in Western Germany that showed a very high proportion of hunter-gatherer ancestry. We estimated the admixture date of early farmers and hunter-gatherers that gave...
rise to this population around 5,300 years ago and find several hunter-gatherer-like phenotypes in this Neolithic farmer population. Our results demonstrate the ongoing admixture between farmers and hunter-gatherers that was a major driving force in the transformational processes of the Neolithic demographic transition. Despite the poor health state, as reflected by paleopathological analysis of the skeletal remains, we find no evidence of infectious disease, thus providing no support for the hypothesis that infectious crowd diseases emerged during the Neolithic transformation.

POSTER SESSION: In search for the Bølling-Oscillation — new palynological data on old questions at lake Bølling, Denmark (B1)
Sascha Krüger*1
1 Centre for Baltic and Scandinavian Archaeology (ZBSA), Foundation Schleswig-Holsteinische Landesmuseen, Schloss Gottorf

In 1942 Johannes Iversen extended the common classification of Lateglacial biostratigraphy based on a pollen analysis from Lake Bølling, Denmark. His assumptions concerning the Bølling-Oscillation were based on sedimentological features and high birch pollen values in two pollen samples before the beginning of the Allerød. In order to further refine the knowledge on the Bølling-Oscillation, Hartmut Usinger investigated the locus classicus in 1982. The method of pollen-size-frequency distribution was applied on birch pollen but never published and the results got lost over time. Therefore the method as described by Usinger (1975, 1978, 1981c) is performed on the dataset again. The general focus is set on the distinction of birch pollen types in order to shed light on the question of the migration of tree birches into northern Europe especially before the Allerød – one of the major transformations of the Lateglacial landscape. The results show that the dataset can immensely refine Iversen’s pollen zones. A clear dominance of dwarf birch pollen during the Bølling-Oscillation is demonstrated. Furthermore, the record reveals that Iversen’s assumption concerning the existence of a climatic oscillation prior to the Allerød can be confirmed at the locus classicus.

POSTER SESSION: The never-ending why – Theories on Neolithic monumentality (A1)
Johanna Brinkmann (Institute of Pre- and Protohistoric Archaeology, Kiel University)

Many scholars have approached the question of monumentality in the Northern European Neolithic, either stressing socio-functional (e.g. territorial markers, inter-group competition, cultural memory, instruments of power), economic (e.g. recruitment of labour) or ideological functions (e.g. new belief system). While a certain degree of overlap exists in terms of the general idea concerning the significance of the megalithic monuments, it becomes apparent that specific premises are often predisposed, but not reflected (e.g. predominance of intergroup competition, surplus production, necessity for leadership, connection between megaliths and recourses). In most cases these premises are not proven by means of archaeological evidence, what should, however, be viewed as an essential principle in interpreting megalithic monuments. Furthermore, the question how labour was mobilized is rarely a subject of discussion. A general lack of supporting archaeological evidence – especially the absence of settlement data in many areas – is a major obstacle in the interpretation of the northern European megaliths as well as the often applied premise that burial practices are a direct reflection of social relations. By examining existing theories on Neolithic monumentality and discussing them against the archaeological record of three study areas (British Isles, Scandinavia and northern Germany) in the period between 4500-1800 BC, a comparative approach is applied. A focal point is the analysis of continuity and discontinuity in the archaeological record (e.g. megaliths, material culture, settlements, burials rites, non-funerary monuments) and the linking of theoretical concepts to the archaeological record using middle range theories. The dissertation is part of focus 1 and sub-cluster A1 of the CRC. Sub-cluster A1 seeks a theoretical conceptualization transformation processes of prehistoric and archaic societies. Therefore, the aim of this dissertation project is to develop a theoretical reflexion of transformation processes in Neolithic monumentality visible in the archaeological material.

POSTER SESSION: Chronological models of Tripolye mega-sites development: Testing with radiometric dates (D1)
Liudmyla Shatilo (Institute of Pre- and Protohistoric Archaeology, Kiel University)

The question of Tripolye mega-sites (in Cherkassy and Kirovograd regions) chronology is still of current interest, despite the fact that there have been numerous models constructed. This is one topic addressed in subproject D1, which deals with the processes of formation and collapse of the Chalcolithic Cucuteni-Tripolye mega-sites with regard to social conditions and consequences, spatial behaviour, the organisation of subsistence and economy and the use of environmental resources. Regarding chronological models, a few blocks of questions are under discussion, among them: 1) development of one site taken separately (intra-site chronology, possible existence of several “phases” of development and its duration); 2) the position of large and small sites within one or few regional groups on the time scale, etc. Not less important is the problem regarding the correlation (diachronic or synchronous) of different pottery styles, including the ceramics of the so-called “eastern” and “western” Tripolye. Recently a large collection of radiometric dates has been obtained, including the ones that were received within the implementation of subproject D1 “Population agglomerations at
Tripolye-Cucuteni mega-sites”. Based on this database, some chronological models of the development of Tripolye in the region of mega-sites should be revised. In this work I also discuss how absolute dating can help in understanding the aforementioned issues.

**POSTER SESSION: Social transformations at the end of Neolithic Central Germany (D2)**

*Clara Drummer (Institute of Pre- and Protohistoric Archaeology, Kiel University)*

Around 2900 BCE, different burial practices indicate a fundamental change in social organization in the German Lower Mountain Range from Late Neolithic collective inhumations in megalithic graves to Final Neolithic single graves under burial mounds. Recent aDNA-studies also suggest a possible population change, triggered by steppe-migration processes to Central Germany associated with Corded Ware pottery. More detailed archaeological studies towards defining and explaining this change are still rare. In order to understand the social transformations in this region, the focus of this study presented lies on burial communities as social group identities. The aim of this study is to detect changes in group identities in two ways:

- The first examines possible elements of group identification through burial deposition rules and pottery decoration style. The second way is the identification of group communication through social networks based on personal ornaments and copper exchange. By combining both ways, a closer description of different burial practices and group identities is possible: Are there clear cuts or are there any connections between different burial communities? A comparison of these Late and Final Neolithic group identities can detect in how far a transformation took place.

First results demonstrate that in Late Neolithic are groups with different social identities, which were connected in a dense communication network based on their personal ornaments. These groups are distinguishable from each other by different expressions of burial practices, like grave architecture and deposition rules, as well as different styles of pottery decoration.

When comparing burials and settlements, the intensity of Late Neolithic group expression differs between burial and settlement context. Stronger group distinctions were visible within the burials, while in settlements the diversity is higher than within burials. This is indicated by decorations of Final Neolithic pottery, which occur more often in Late Neolithic settlements than in burials. Moreover, this pottery, which was common as Final Neolithic grave good, connects both the Late Neolithic collective burial rite and the Final Neolithic individual burial rite, because the pottery can be found also in Late Neolithic graves. It might be the case that not only immigration of new people contributed to the transformation, but also that this transformation already began in the Late Neolithic. Only later this resulted in fundamental changes visible in burial practices.

**POSTER SESSION: Late Neolithic pottery production in the central German low mountains (D2)**

*Marianne Talma*, *Susanne Gütter*

1 Institute of Pre- and Protohistoric Archaeology, Kiel University
2 Landesamt für Denkmalpflege Hessen, Außenstelle Marburg

This study is part of the CRC1266 D2-subproject Agriculturalists and early metallurgists that investigates the appearance of the Corded Ware phenomenon during the late Neolithic (3500-2800 BC) in the central German low mountains in relation to social, technological and economic changes. During this transformative period, communities continued to experiment with (the function of) materials, subsistence strategies and mortuary treatment. One of these versatile materials is clay, a rock containing clay minerals of less than 2μm in size that varies in plasticity based on the amount of water in the clay mineral structures. Clay often contains traces of other minerals and/or rock fragments, and its uses vary from polishing abrasives (i.e. metallurgy) to pottery. Based on the intended use, potters can add additional mineral or rock phases (temper) to influence the properties of the clays, and these added or naturally present phases can help to identify the geological context of the clays or temper used.

Pottery can change contexts and functions during its use, which is apparent from the vessels found in Wartberg settlements and gallery graves that range from coarse tempered cooking ware to finely polished collared flasks. Alongside what is seen as typical Warberg ceramics are pottery fragments classified as Bernburg type, Corded Ware and Globular amphora. To investigate possible connections between the local Warberg pottery and these different types, production traces and mineral phases were studied on ceramics from museum collections with microscopy, ceramic petrography, geochemical analysis (portableXRF, powder-XRD) and x-ray microtomography (μCT). This was complemented with field data (local clays, production and firing experiments) in collaboration with Susanne Gütter (Denkmalamt Marburg) and archaeological open-air museum Zeiteninsel Marburger Land.

The presence of granite in some pottery from the Warberg settlement of Wittelsberg indicates that they may not have a local but regional origin, one possibility being the Harz area as glacial erratics are less likely. The distribution of a decorative pottery style known as ‘type Lohra’ also suggests some form of regional mobility and connectivity of communities. The CRC1266 D2-subproject collaborates with the CRC1266 E1- and F4-subprojects to investigate subsistence and health of the Neolithic population from their case studies.
POSTER SESSION: Bronze Age transformations in Northern Germany (D3)
Stefanie Schaefer-Di Maida (Institute of Pre- and Protohistoric Archaeology, Kiel University)

In this contribution the PhD-project about Bronze Age Transformation processes in Northern Germany as part of the SFB 1266 Project Scales of Transformation - Human-environmental Interaction in Prehistoric and Archaic Societies - will be presented. The main aim of the project is to examine social and economic long-term changes, rapid turning points and collapses within Schleswig-Holstein. This region was selected because it provides good archaeological and environmental data collection, together with a pollen profile of the Lake Belau. The first step is to verify continuities or discontinuities in the record while as a second step, the questions of how Bronze Age transformations are recognizable, how fast they developed and how intense they were, will be addressed. More in detail, the changes in settlement activities around 1600 B.C., as well as modifications in burial rites around 1200 B.C. will be the main focus of this work.

Finally, this poster will present preliminary results from recent surveys and excavations at the site of Mang de Bargen (Bornhöved, Dist. Segeberg). The importance of Mang de Bargen, together with other sites in Schleswig-Holstein, lies in the impressive local constancy of the activities (especially around 1600 BC) and shows a record of the transition from inhumation to cremation around 1200 BC, as concrete points of transformations.

POSTER SESSION: Human and climatic landscape transformation in the Stymphalia polje, Greece (E1)
Joana Seguin*, John Bintliff2, Pieter Grootes1,2, Christian Heymann1, Sturt Manning*, Ingmar Unkel1,2
1 Institute of Ecosystem Research, Kiel University
2 Department of Archaeology, Edinburgh University
3 Graduate School “Human Development in Landscapes”, University of Kiel (4) Cornell Tree Ring Laboratory, Department of Classics, Cornell University

Studying natural lakes as geo-archives in the direct vicinity of archaeological sites hold an enormous potential for interdisciplinary research on the interconnection of climate with human history. Lacustrine sediments generally record landscape changes in the lake catchment controlled by palaeoclimatic and human-induced changes. Within the German Collaborative Research Center 1266 “Scales of Transformation”, subproject E1 focuses on transformations in early Greek societies and landscapes around the Gulf of Corinth. Our project aims to reconstruct environmental and hydrological changes and their influence on the cultural development with a temporal focus on the Bronze Age/Iron Age transition (12th to 8th century BC). Particular emphasis is placed on the complex interplay between natural and anthropogenic forcing of landscape change and the identification of suitable proxies to differentiate and better understand the diverse effects of socio-environmental interactions as preserved in the lake sediment.

Here, we present first results from the Northern Peloponnese. Sediment cores have been recovered from Lake Stymphalia, the last remaining natural lake of the Peloponnese. The chemical composition of the cores can be measured with an X-ray fluorescence (XRF) line scanner, a useful method to obtain continuous, high-resolution proxies that reveal fluctuations in the past. We use our XRF proxies in combination with sedimentological and organic geochemical proxies as well as thorough Bayesian age-depth-modeling of 14C dates to identify changes in palaeoenvironmental conditions. To sustain our interpretation, we additionally apply a Principal Component Analysis (PCA), a more complete interpretive approach, to work out the dominating process controlling the lake geochemistry. Our data provides the first continuous record for the last 2,500 years of landscape development in Southern Greece. The upper 2 m of our master core yield insights into the vulnerability and resilience of the lake ecosystem to environmental change and to anthropogenic impact. The most influential transformation in the lake development, as seen in our record, was the construction of the Hadrianic Aqueduct in 130 AD, which had a lasting effect on the lake hydrology. Furthermore, a phase of considerably high climatic instability was identified for the 7th and 8th century AD. This is largely in time with a cold anomaly termed “Dark Ages” (Helama et al., 2017) or from our perspective, more appropriately termed “Late Antique Little Ice Age” (LALIA; Büntgen et al., 2016).

Additionally, we delimited periods of strong soil erosion in the catchment during the Byzantine period indicating intensive anthropogenic land-use. Our study shows how anthropogenic land-use changes coupled with climatic fluctuations influence the sedimentation processes in a shallow lake system.

In the near future, a comparison of this geo-archive with records from neighbouring paleolakes will enable to distinguish local from regional effects. Additionally, a highly promising modelling approach, pursued in cooperation with subproject A2, will allow to transfer the results from the location of the coring points into the area.

POSTER SESSION: Human/paleoenvironmental Interactions in Southern Greece during the Bronze Age-Iron Age transition: A Biomarker Perspective (E1)
Jan Weber*, Thorsten Bauersach, Lorenz Schwark (Institute of Geosciences, Kiel University)

Lake sediments serve as archives for detailed climate and environmental reconstruction and therefore are one main research objective of subproject E1 “Transfor-
mations in early Greek societies and landscapes”. Here, we present a high-resolution climate record of Lake Stymphalos (Southern Greece) spanning the last ~14,000 years using organic-geochemical means. The focus is placed on climatic and environmental changes during the Bronze Age-Iron Age transition (12th - 8th century BC, “Greek Dark Ages”) as this period is characterized by massive social transformation in Greek societies. The end of the Greek Bronze Age is associated with the disappearance of the Mycenaean palaces while the polis system developed in the early Iron Age of the 8th century BC. It is still under debate which factor(s) triggered this crisis such as climatic or environmental changes which can be reconstructed with organic-geochemical methods. Distributions of biomolecules such as long-chain n-alkanes, n-alcohols and n-fatty acids are biological markers for higher terrestrial plants indicating changes in paleo-vegetation due to land-use during the early Iron Age. Molecular paleothermometer based on microbial membrane lipid composition (such as brGDGTs) are used for temperature reconstruction showing multiple climatic changes throughout the Holocene which are also potential factors affecting the ancient cultures.

Kim Annika Kittig (Institute of Classical Archaeology, Kiel University)

The early Iron Age, especially the 8th to 7th centuries BCE, forms a key transformation period in Greek history. The contacts with Egypt and the so-called ‘Orient’ are emphasized as an important trigger for the sociocultural transformations of this period, which include the introduction of new crafting techniques as well as the development of the polis-system and of monumental stone architecture and sculpture. The dissertation project, which is realized within the scope of the CRC subproject A1, follows the assumption that the sociocultural transformations processes of the Early Iron Age take specific local forms. Therefore, the project is based on a set of different case studies situated in the Eastern Mediterranean. With Lefkandi, the Heraion of Samos and Naukratis they cover the archaeological contexts of burials, sanctuaries and settlements. Within the case studies different settings and contexts of intercultural contacts are analyzed, ranging from the trade with luxury goods and the employment of mercenaries to the establishment of trading posts and settlements. Thus, the case studies provide detailed insights into transformation processes as well as into the ongoing scientific discussions on the interplay of intercultural contacts and the sociocultural transformations of the Early Iron Age. The aim of the dissertation project is to critically reflect those explanatory concepts and to open up new perspectives and questions by turning to the cultural sciences, which offer a wide variety of different approaches concerning the question of intercultural contacts.

POSTER SESSION: Climate reconstruction and potential links to the demographic development from the Neolithic to the Late Bronze Age in southern Iberia (F1)
Julien Schirrmacher (Institute of Geosciences, Kiel University)

Organic geochemical and foraminiferal assemblage analyses were carried out on two high resolution marine sediment cores from the Alboran Sea (ODP-161-976A) and the Gulf of Cadiz (GeoB5901-2). These are used to decipher precipitation and vegetation changes as well as the oceanic conditions with respect to Sea Surface Temperature (SST and marine primary productivity (MPP) during the mid- to late- Holocene. n-Alkane records as a proxy for precipitation changes suggest six distinct drought events at 5.40 ka BP, from ca. 5.12 ka BP to 4.85 ka BP, from 4.79 to 4.73 ka BP, at 4.63 ka BP, from 4.42 to 4.34 ka BP and, from 3.75 to 3.73 ka BP. All drought events are associated with a major vegetation change towards more C4 vegetation. The drought events are further accompanied by annual and spring/ winter SST warming as well as decreasing MPP in the Alboran Sea. Altogether, the close correlation of the observed droughts with North Atlantic Oscillation (NAO)-like variability suggests the atmospheric circulation as important driving mechanism of terrestrial and oceanic variability at southern Iberia and the Alboran Sea, respectively. Oceanic variability in the Gulf of Cadiz, instead, is related to the North Atlantic Bond Events. In particular, during Bond Events 3 and 4 we found a dramatic increase in seasonality not described for the area before.

POSTER SESSION: The (trans)formation of the macrobotanical archive: a case-study from the Hungarian Carpathian Basin (F3)
Sofia Filatova (Institute of Pre- and Protohistoric Archaeology, Kiel University)

This PhD is embedded within subproject F3 “Dynamics of plant economy in prehistoric societies” of the CRC 1266 “Scales of Transformation”. The main objective of this study is to reconstruct the plant-food production regime and land use at the settlement of Kakucs-Turján throughout its successive habitation phases and to consider the results within the wider social and geographical contexts of the site. Kakucs-Turján is a fortified settlement located in the central part of the Hungarian Carpathian Basin. An area of the settlement was excavated from 2013 until 2016, uncovering a sequence of eleven successive habitation/activity phases spanning from the Early Bronze Age (2600-2500 cal. BCE) until the end of the Middle Bronze Age (1500/1450 cal. BCE). It is mainly the Middle Bronze Age layers that have been attributed to the habitation of the settlement; due to their fragmentary nature, the activities that took place during earlier phases of the settlement could not be indicated with certainty.
A rich variety of carbonised macrobotanical remains of seeds, fruits and wood charcoal have been retrieved during the excavations. This poster presentation will focus on giving an overview of the processes/activities that have contributed to the (trans)formation of the macrobotanical assemblages in Kakucús-Turján. This includes a consideration of how the remains were deposited and integrated in the archaeological features during each of the habitation phases. The ‘depositional histories’ of each habitation/activity phase are compared in order to indicate potential changes and/or transformations of activities related to plant-food production during the Bronze Age.

POSTER SESSION: Geophysics meets geoarchaeology: 3D facies mapping at the Mesolithic site of Duvensee (G2, B2)

Erica Corradini*, Diana Panning1, Dennis Wilken1, Daniel Groß1, Marco Zanon1, Harald Lübke1, Katharina Rusch1, Rebecka Mecking1, Natalie Pickartz1, Ercan Erkul1, Ingo Feeser2, Walter Dörfler1, Wolfgang Rabbel3

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In the frame of the CRC 1266 ‘Scales of transformation’ the Applied Geophysics group (Subproject G2) in collaboration with Subprojects B2 and F2 has the main task to understand the transformation of the landscape during the hunter-gathers occupation in Northern Europe. The ancient lake Duvensee is one of the best known archaeological sites of the Mesolithic in Germany (10000-6500 cal BP). The comparison between archaeological excavations during almost the last 100 years and geophysical surveys conducted in the last 10 years has allowed a reconstruction of the palaeoenvironment during the Preboreal and Boreal. In a GPR (200 MHz) survey of the landed-up Lake Duvensee we detected five previous islands, which carried Mesolithic camps according to results of a previous archaeological field study (Bokelmann, 2012). From the GPR reflection data we created a 3D model of the lake area based on a study of the velocity of the radar waves with depth. The 3D model includes spatial information of the main facies with time information from drillings and excavations. It allows a time-dependant reconstruction of the landscape development. In particular the islands in the northern part (island 1 and 2) were probably the first outside the water, which might be a reason of a first colonisation of them during the Late Preboreal and Early Boreal. With the regression of the water the other islands have been considered as a place for roasting hearths further in time. To investigate the stratigraphy we applied a multi-methods approach consisting of GPR (Ground Penetrating Radar) ERT (Electrical Resistivity Tomography), SH-wave seismic and furthermore a transect of 50 m. The transect enables to compare the geophysical results with the stratigraphy from geoarchaeological corings and to extrapolate the drilling results in the area. The transect shows a peat layer on top, a Gyttia layer underneath, overlaying non-organic sediments. It crosses the supposed shoreline identifiable as a transition between Clay and sand. The ERT and seismic tomography computations are constrained by the depth of each layer found from the corings and GPR. The resolution of each method with respect to the major facies is investigated by model computations and comparison to measurement results.

POSTER SESSION: Amplitude Analysis of GPR Data for Identifying Archaeological Features in Glacial Deposits (G2)

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As a part of subproject G2 in the CRC 1266 "Scales of Transformation", this work is about transforming magnetic and GPR data into information, which is useful to the archaeologists of the collaborating subproject D3. Archaeological features embedded in heterogeneous soils are difficult to identify in geophysical survey data if they resemble geological deposits in shape and material contrast. This applies especially to the interpretation of GPR data compared to other geophysical data. A major task, which shall be addressed by this poster, is to find prehistoric remains that contain mainly cobblestones, such as inhumation burials, but also urns or cooking pits found in fluviolacustrine deposits consisting of boulder-enriched sand and gravel layers. Regarding geophysical prospecting the difficulty herein is to deal with the resulting ambiguities of data interpretation. This is demonstrated using GPR data gathered at the bronze age site Mang de Bargen near the village of Bornhöved, in Schleswig-Holstein (N Germany). To understand how typical archaeological features appear in the radargram, numerical models of selected key targets were created. For these synthetic radargrams were computed and compared with measured radargrams. For the modelling petrophysical properties of the subsurface were derived from electrical and electromagnetic induction data. The modelling demonstrates the influence that shape, depth of an archaeological feature and physical soil properties such as conductivity, permittivity and soil moisture have on the data. For practical purposes an amplitude analysis of the observed data can help to classify archaeological and geological features in GPR data. To support the interpretation magnetic data and archaeological documentation are used in addition. Finally a classification catalogue of signals that are characteristic to archaeological features is to be built. This shall help to understand data before excavations and thereby avoiding unnecessary excavations.
POSTER SESSION: Quantification of Daub Masses based on Magnetic Prospection Data (G2, D1)
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In many case studies the interpretation of magnetic gradiometry prospection data stops at the identification and classification of archaeological features. Especially for large sites with sizes of several hundreds of hectares and thousands of archaeological features it is desirable to gather as much information based on geophysical methods as possible. Since magnetic gradiometry has developed to a standard in archaeological prospection, a focus on this method is of great interest. We developed a new interpretation concept to quantify the masses of remains of not excavated buildings based on magnetic data and tested it at the site of Maidanetske, which is under research by the subproject D1.

Maidanetske (Cherkassy oblast, Ukraine) is a giant settlement of the Cucuteni-Tripolye culture with more than 3000 houses on an area with a size of over 300 ha. Most of the houses are burned and their remains form a daub layer in a distinct depth range. Based on soil sample analysis by subproject F2 following considerations are made. Assuming that the magnetization of the surrounding sediments is negligible compared to the present thermoremanent magnetization, the magnetic data is used to calculate subsurface magnetization under the following constraint: Only in the depth range of the daub layer a non-zero magnetization is assumed. The calculated magnetization is then related with documented masses of daub and pottery of excavated buildings. In a final step this leads to a relation which is used on not excavated buildings to estimate their mass distribution and total mass.

The application of the newly developed interpretation method to a set of example houses showed that the magnetization of those houses raises up to 5 A/m. The total masses range from few tens of kg for only softly or partly burnt houses and up to 7 t for large burned dwellings and other building structures. The potential for archaeological analysis of magnetic plans consists for example in the identification of certain architectural types. On the perspective of the complete settlement, the new interpretation concept might reveal transformation processes manifested in the remains of the buildings.

POSTER SESSION: Changes and catastrophes? Reviewing the North Atlantic climate during the later 3rd millennium BC (C1)
Jos Kleijne (Institute of Pre- and Protohistoric Archaeology, Kiel University)

CRC 1266 subproject C1 deals with Mesolithic and Neolithic Transformations in Northern Germany during seven different phases. Two late phases in particular focus on the environmental, cultural and social transformations during the 3rd millennium BC (the so-called TRANS-E and TRANS-F phases). It is around this time that the pan-European Corded Ware and Bell Beaker phenomena appear. Because of this development, it becomes possible to consider a different scale of analysis. By comparing different regions with each other, including CRC1266 subproject F1, a

POSTER SESSION: Flexible Research Data Management (Z2)
Yannic Ole Kropp (Department of Computer Sciences, Kiel University)

Collaborative research projects provide a challenging context for data managers. Deep models, namespaces, perspectives and viewpoints from multiple academic domains cause challenges within such projects. Heterogeneous data, diverging working habits, and differing standards are common. Communication and collaboration becomes a tough task in this context. In addition research itself is agile, dynamic, and evolving. Changes and revisions of data structures, requirements, and actual data values arise continuously and create a constant need for adaptations. No project wide working standards, models, or structures can be expected to be continuous throughout the complete run time of a project. Thus any static approach for managing data in research projects will fail to provide sufficient support. The CRC1266 is a typical example for these agile and dynamic interdisciplinary research projects. Its focus on transformations even encourages the diversity and evolution of structures. This contribution presents a novel approach to manage the data of such projects.

It was developed in the subproject Z2 of CRC1266 and bases on the separation of data storage and data usage. In contrast to known data management strategies it does not try to build joint working models for all project participants. The central research activities (in particular data computation and processing activities) shall be performed in the local working environments of the researchers. No researcher should need to adapt to unfamiliar structures, data models, or else just because he/she joined the project. Instead of a joint working model, a joint storage is established. This storage does not need to support (individual) research related computation requirements or reflect local working models and can thus be structured in a universal way. The structure is inspired by key-value stores and the RDF, combined with a sophisticated view generation technique. These views connect the local environments with the global store and thus transitively with each other. In case of changes within local structures, the views can be adapted way easier and way faster than any global working model could. In effect we get a flexible and modern approach for handling data in research projects.
variety of possible regional responses and transformations become visible within the same cultural phenomenon. This greatly benefits our understanding of the regional Northern German situation. In this study developments in settlement and funerary activity, subsistence economy, material culture and landscape use will be compared. For this poster, an overview of the environmental developments in Northwest Europe, at the start of the Late Holocene, the Meghalayan stage, will be given. Possible temperature and humidity changes will be reviewed on the basis of literature concerning the ‘4.2ka event’, taken from studies of several Atlantic and Nordic marine sediment cores, stalactites and peat bogs. Additionally, the volcanic eruption of Hekla-4 on Iceland, and its possible impact on climate, soils and vegetation in Northwest Europe will be assessed. How much these environmental changes affect past cultural and social transformations is however a different story.

POSTER SESSION: Investigating timescales of change in material culture: a study of the pre-roman Iron Age in Denmark
Helene Rose (Centre for Baltic and Scandinavian Archaeology (ZBSA), Foundation Schleswig-Holsteinische Landesmuseen, Schloss Gottorf)

A precise chronological framework is needed when investigating transformations and turning points in prehistory. In terms of settlement archaeology, the Bronze-Iron Age transition in Denmark (c.500 cal BC) is a continuous trend, but the introduction of urnfield cemeteries represents a clear cultural transformation. There is a great deal of stylistic variability in Iron Age cremation urns and associated metal objects, partly as a function of change over time. Pre-Roman Iron Age chronologies are based on artefact typologies, but it is difficult to harmonize metal and ceramic typo-chronologies. Due to the 14C calibration plateau between 750 and 400 cal BC, researchers have made little use of 14C dating. My PhD aims to provide robust, accurate and precise absolute dates for the main typo-chronological transitions in urnfield assemblages, by using Bayesian chronological models to interpret a large set of new 14C dates on cremated human bone from Aarupgaard, the largest known urnfield cemetery in Denmark, and smaller 14C data sets from the Arre and Sohale urnfields. The project has several components – eliciting prior information (typo-chronological attributions and horizontal stratigraphy), selecting and dating samples, quality assurance of the reproducibility of results, experimental investigation of the magnitude of wood-age offsets in cremated bone dates, and sensitivity testing of output against alternate models of the tempo of transformations. The results will provide the first independent estimates of the rate of change in material culture, indirectly providing absolute date ranges for settlements with similar ceramics, and will reveal population dynamics in urnfield cemeteries by assigning durations to typo-chronological phases.

POSTER SESSION: Towards a deeper understanding of Early Holocene landscape dynamics: the multifaceted contribution of palaeoenvironmental analysis within the CRC 1266 (F2, B2, G2)
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One of the objectives of the Collaborative Research Center 1266 is to promote a joint research effort between different disciplines in order to unravel the mechanisms behind Early Holocene cultural and environmental dynamics. The cooperation between multiple research areas is a defining feature of the analysis currently ongoing at two interlinked study locations of subprojects F2, B2 and G2: Duvensee and Poggensee. The Duvensee palaeolake is prominently featured in the archeological literature due to the excellent preservation of its waterlogged Mesolithic dwelling layers. In this context, different palaeoenvironmental analysis (e.g. sediment geochemistry, palynology) were carried out in connection with geophysical investigations in order to produce a landscape evolution model for this important wetland site. Poggensee is located ca. 17 km NW of Duvensee. The annually laminated sedimentary sequence recovered from this small water body is currently under ongoing palynological, sedimentological and geochemical analysis. Given its proximity to Duvensee and the opportunity to produce a high-resolution palaeoecological record, the Poggensee sequence is set to become a reference point to explore the relations between Mesolithic communities and Early Holocene climate/vegetation dynamics in Northern Germany.
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