At present time, the issue of chronology of the archaeological cultures in Russian Altai (Southern Siberia, Russia) is still debated. Peoples settled this area from the beginning of the 1st millennium BC can be regarded as nomads of arid piedmonts and mountains of temperate zone. However, both the names of cultures and the periods of their existence are debated. Climatic reconstructions within Russian Altai in Holocene also vary considerably. This complicates the correlation between geological/geomorphological events and changing of archaeological cultures. By now, there are just single attempts to provide such correlation.

This study focuses on investigating of climate changes, estimating of paleoseismicity, catastrophic outbursts of landslide dammed lakes and their correlation with the changing of archaeological cultures within SE part of Russian Altai during last 3 ka. This time period covers the life span of Siberian Scythians, Hun-Sarmatians and Turks. Paleoclimatic reconstructions and estimating of paleoseismicity are based on absolute dating (using radiocarbon and dendrochronological methods) of landslides, fossil soils, moraines, lacustrine sediments, as well as archaeological sites located within Kurai-Chuya system of intermountain depressions and framing ridges.

Recent glacier retreats and ice degradation in moraines lead to exhumation of organic material which makes possible the radiocarbon dating. Newly obtained a numerous set of radiocarbon dates together with previously published data has been used for basing the glacier activity at the second half of the Holocene.

Data provided by archaeological sites of Scythian, Hun-Sarmatian and Turk epochs have been used for reconstruction of landscape prevailing at the time of these interments. Existence of landslide dammed lake and water discharge define altitudes of sites of each archaeological culture in Chuya basin. On the other hand, absolute dating of archaeological sites allows estimating the time of lake lowering events and its final outburst.

A continuous 2367-years absolute tree-ring chronology "Mongun" developed for Tuva (the region adjacent to Altai) has enabled using dendrochronology for absolute dating of seismically triggered landslides. Both dead and living trees on landslide bodies have been analyzed. The date of previously unknown earthquake, which occurred in SE Altai during medieval times, has been obtained using dendrochronological analysis of tree injuries and independently verified by radiocarbon dating of seismically cut fossil soil overlapped by that undistorted.

In general, suggested chronology of the most important climatic and seismic events which caused glaciers expansion, outbursts of landslide dammed lakes and seismically induced slope processes with disastrous effects may provide insights for pattern of changes in archaeological cultures and migrations of nomadic population inhabited the south-eastern part of the Altai Mountains during the Late Holocene.
Collaborative studies between Quaternary scientists and archaeologists increasingly provide new and informative discussions about the nature and timing of cultural change and links with variation in the natural world (particularly climate). In the Eastern Mediterranean region, human occupation has been extensive throughout the Holocene period and climatic change has repeatedly been acknowledged in the area as a fundamental component in the rise and fall of these cultures; commonly linking climate perturbations to societal collapse (e.g. Cullen et al., 2000). The contemporaneity of changes in culture and climate however has been poorly demonstrated (Berger & Guilaine, 2009) and palaeo-climate records have often been collected from regions distant from the human record.

Varved sediment data collected from Nar crater-lake and archaeological archives from the same region, Cappadocia (Turkey) allow these chronological discrepancies and problems with spatially variable data sets to be addressed. Recovery of an annually laminated sequence from Nar Lake provides a fine temporal detail and a well dated record of Holocene climate variability which is highly suited for studies into human/climate relationships. Variations in the frequency and amplitude of Holocene climate are demonstrated from differences in the chemical composition of varve deposits from ITRAX XRF core scanning and other sedimentary techniques. The detail of these temporally constrained records are correlated alongside settlement histories and culture change profiles to 1) gauge their development side by side; 2) investigate the sensitivity or resilience of past people to unstable climates; 3) identify when cultures were ill-prepared and fail to initiate effective management strategies during times of stress and vulnerability created by climate variability. ITRAX scans document a shift from a predominately stable system (high authigenic Ca & Sr) to one exhibiting much higher annual variability, including clastic in-wash events, characterised by peaks in Fe, Ti, Si, K and Rb. These high detrital components indicate strong erosion input into the lake which is related, in part, to the impact of increasing human occupation and catchment use. Increased catchment sediment supply is particularly prevalent between 8800-7840 varve years (vy) B.P. and 2600-0 vy B.P. Both periods coincide with the growth of Neolithic populations and the development of obsidian ‘factories’ on near-by Nenezi Dag, and the establishment of Phrygian, Persian, Hellenistic-Roman, and Byzantine rule respectively. The former may also have been influenced by volcanic activity. Less variable conditions and reduced detrital input between 7840 and ~6200 vy B.P. occurred during times when archaeological survey data suggests less intensive human occupation of central Anatolia. The Nar lake geochemical record thus records both natural (e.g. climatic) and human-induced processes, with the balance between them changing over time.

References:
Poster

Dating the earliest human occupation of Western Europe: New evidences from the fluvial terraces system of the Somme basin (North France)

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Dating the earliest human occupation of Western Europe and reconstructing its relations with climatic and environmental constrains is becoming a central question, especially with the discovery of Palaeolithic artefacts allocated to the Early Pleistocene in south-east Britain and in Central France. In this context, the Quaternary sequences of the Somme basin, where is located Saint-Acheul, the type-site of the Acheulean, is a key location. Research undertaken for more than 15 years on both fluvial and loess sequences of the Somme basin and on the main river valleys of Northern France (Seine and Yonne) provide a unique dataset for the study of the relations between human occupations and environmental variations.

Studies have been based on an interdisciplinary approach combining stratigraphy, sedimentology, palaeontology and geochronology using the following methods: U-series, ESR, OSL, and ESR/U-series. Meanwhile, the palaeoenvironmental interpretation of Pleistocene sequences containing Palaeolithic levels has been refined with several biological proxies (molluscs, beetles, mammals, pollen, plant remains) and sedimentological data (grain size, geochemistry, magnetic susceptibility, palaeopedology, micromorphology) obtained on both loess and fluvial sequences. Moreover the investigations lead on the bottom valley fluvial sequence (Lateglacial and Holocene) allowed to the elaboration of a model concerning the response of the Somme fluvial system to climatic changes for the last Myrs. Our data have highlighted the impact of the 100 kyr cycles on terraces formation since ± 1Myr, and the fluvial terraces system of the Somme basin has become a reference model for the study of the response of fluvial systems to Milankovich cycles in areas characterised by slow continuous uplift.

Compilation of the whole results from modern archaeological excavations within this chronoclimatic reference system of Northern France shows that human occupation of this area has been discontinuous and highly influenced by climatic and environmental factors. Indeed human occupations are quite systematically related to full interglacial or to transitional climatic contexts (Early or late glacial), as it is demonstrated from a large number of sites for the Last climatic cycle (Eemian-Weichselian). In the Seine basin, the oldest in-situ Acheulean archaeological level has been evidenced within a tufa sequence dated from MIS 11 (La Celle) but older sites including Acheulean handaxes are known in the middle terraces (early MIS 14?). In the Somme terraces system in situ Acheulean settlements where dated to early MIS 12 at ± 450 ka in the 1990s, but new field discoveries allowed to push significantly the age of the oldest human occupation during the Early middle Pleistocene. The first one discovered in 2009 in Amiens was recently dated at ± 550 ka using ESR and terrace stratigraphy (early MIS 13). The newest findings have been done in 2011 in Abbeville, where evidence of human occupation occurs in calcareous fluvial deposits of the "High terrace" (+ 40 m relative height above the modern valley bedrock). According to terrace stratigraphy, ESR dating (quartz) and large mammal assemblages, these artefacts can be dated from 600 to 670 ka. They are contemporaneous of the site of Mauer, the type-site of Homo heidelbergensis.
Central American rainfall changes over the past 2 ka and implications on the Classic Maya society

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We discuss the role of rainfall variability on the fate of the Classic Period Maya civilization on the base of new high-resolution speleothem data from Yok Balum Cave, Belize. The precisely U-series-dated sub-annual stable isotope-based climate record from stalagmite YOK-I is comparable with historical records for the past 2000 years. The YOK-I δ18O and δ13C both record hydrological conditions above the cave, variations of which are linked to mean ITCZ position. More negative stable isotope values are interpreted as reflecting wet, less negative values drier conditions.

We observe a significant relation between the oxygen and carbon isotope records and northern hemisphere temperature and NAO reconstructions. We argue that the YOK-I record reflects the influence of the NAO on the wet season length. The NAO, affecting summer rainy season length by repositioning the Bermuda-Azores High (BAH) likely governs moisture transport from the Atlantic to Belize. NAO+ produces a strong BAH extending far to the southwest, thus displacing the trade winds and carrying moisture to Belize. Positive δ13C excursions correlate with NAO- conditions recorded in a Scottish stalagmite, while negative excursions are predominantly related to NAO+ conditions. The observed correlation indicates that a significant amount of rainfall variability is related to the NAO and supports our hypothesis that the NAO strongly influences drought/rainfall conditions in the tropical Maya lowlands via its influence on ITCZ position.

Comparison of paleoclimatic and archaeological records implicates climate change as a significant factor in the florescence and disintegration of Classic Maya civilization. Gradual rainfall reduction resulted in drying after AD 660, culminating in multi-decadal droughts at AD 820-870, and especially AD 1000-1100. We propose a two-stage collapse beginning with balkanization of polities, increased warfare, and ultimate disintegration of Maya centers between AD 660-900 related to diminishing rainfall, followed by population collapse driven by extreme drought that peaked between AD 1000-1100.
Poster

Megalake Chad occurrences in the Pliocene: An insight into early hominid environment

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The occurrence of large lakes episodes in the Chad basin during the Mio-Pliocene has been demonstrated through the analysis of sedimentary deposits located in the presently arid area of the Djurab desert (Schuster, 2002, Schuster et al., 2009). There, the Mission PalÉo-Franco Tchadienne (MPFT) identified four main paleontological sites, ranging from 7 to 3 Ma. All of them are extremely rich in vertebrate fauna remains and in two of them, remains of early hominids have been collected. Australopithecus barhelghazali (Koro-Toro site: 3.6 Ma; Brunet et al., 1995; Lebatard et al., 2010), the first australopithecine ever found out of the classical hominid sites, is associated to fauna assemblages showing the presence of a mosaic landscape typical of a perilacustrine area, and habitats from wooded savanna to open grassland (Brunet et al., 1997, 1998, 2000). Sahelanthropus tchadensis (Toros-Menalla site: 7Ma; Brunet et al., 2002; Lebatard et al., 2010), the earliest known hominid, was found in comparable perilacustrine environment. It is worth noticing that these four major continental vertebrate sites are always associated to large lake episodes. This suggests that there is a strong link between large lake episodes (megalakes) and fauna dispersal/presence of early hominids. This link highlights the need for a comprehensive understanding of the rise, culmination and demise of megalakes in the Chad basin during the Neogene.

From 7 to 3 Ma, the climate was globally warmer than present (e.g. Zachos et al., 2001, Haywood et al., 2010), and the Hadley circulation might have been slowed, leading to a poleward shift of the Inter Tropical Convergence Zone during the whole Pliocene interval (e.g. Brierley et al., 2009, Kamae et al., 2011). Insolation changes related to the 23 kyr precession cycles might have also played a role on the monsoon, providing a sufficient amount of water to fill in the vast endorheic region of Chad basin (Braconnot et al., 2008).

In order to better characterize the forcings leading to these Mega-lake Chad occurrences during the late Cenozoic, we use a coupled ocean atmosphere climate model forced with four different orbital configurations and mid-Pliocene boundary conditions. The four orbital configurations, all around 3 Ma, correspond to 1/ maximum insolation at 30°N during summer solstice (precession maximum); 2/ minimum insolation at 30°N during summer solstice (precession minimum); 3/ maximum insolation at 30°N during autumn equinox; 4/ minimum insolation at 30°N during autumn equinox. The simulated climates are then used to force the river routing model HYDRA (Coe, 2000), which calculates the water balance, river discharge and potential lake areas. Related vegetation changes are also investigated and compared to fauna assemblages. Lake Chad extent and vegetation changes will also be compared to the mid-Holocene.

Thanks to this study, we will be able to determine favorable/unfavorable conditions for megalake Chad occurrences during the Pliocene and the associated changes in vegetation, bringing insights to the possibility for early hominids populations to live in this region throughout the Mio-Pliocene period.
Impacts of climate variability and Maya settlement on Laguna Tuspán (Petén, Guatemala) during the past 5000 years

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Even though several studies (Curtis et al., 1996; Haug et al., 2003; Leyden et al., 1997; Medina-Elizalde et al., 2012) prove the occurrence of severe droughts between 800 and 900 AD, some studies have demonstrated that the reduction of rainfall was not the only cause of the collapse of Maya civilization at that time. There is some evidence that the Mayas caused deforestation (Galop et al., 2004), which potentially changed the properties of soils (composition, sensitivity to erosion). In this case, human activities would have increased the vulnerability of their cultures to natural phenomena. Droughts, combined to a long-term decreasing productivity of fields, would have led the Mayas to migrate.

Here we present a multi-proxy study of lacustrine sediments from laguna Tuspán, near the Maya city of La Joyanca (Petén), designed to test the relative impact of climate variability and human activities on the environment. Results on the clay composition clearly show environmental changes in the drainage basin of the lake around 3000 BP (950 BC), when the La Joyanca plateau is first inhabited by the Mayas (Arnauld et al., 2004). Before human settlement around the lake, the ostracod abundance decreases while the percentage of organic matter increases during humid periods. Such variability decreases in amplitude around 4000 BP, when the Caribbean zone gets drier (Haug et al., 2003; Malaizé et al., 2011). Halloysite is the main clay across the whole period preceding the arrival of the Mayas, which proves the formation of stable soils due to a dense forest cover (Galop et al., 2004).

After 3000 BP, none of our proxies follows the drying trend that is observed in the rest of the Caribbean zone (Hodell et al., 2005). Interstratified smectite-chlorite are the main component of the clay fraction, which reveals increasing erosion of the substratum. Litter thickness and forest density are much reduced, which enhances the destabilization of soils under humid conditions. The lake receives much more detritic particles than before, especially during the deposition of Maya clays.

This study clearly indicates that the Mayas changed their environment even before they built cities. Erosion was enhanced by deforestation and land-use but its intensity does not depend on human density.
Poster
Assessing impacts of climate variability on the demography of pre-Hispanic societies from the Atacama Desert over the past three millennia

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Multiple paleoclimate reconstructions reveal that the hyperarid Atacama Desert has experienced important hydroclimate variations on centennial and millennial timescales over the past 18,000 years. These past hydroclimate anomalies are known to have affected significantly regional hydrological patterns and distribution of terrestrial biota. The relationship between such paleoclimate events and population dynamic of pre-Hispanic societies that inhabited the driest desert on Earth, however, remains unclear. Here, we tackle this issue by reconstructing the long-term population history for the Atacama Desert (16\textdegree-24\textdegree S) over the past 3,000 years. Specifically, we evaluate changes in population size by examining the summed probability distribution of 334 calibrated 14C dates from 123 archeological sites across the interior of the Atacama (>900 masl). Our results point to important centennial-scale variations in demographic patterns for agricultural societies from the Atacama throughout the late Holocene. The resulting curve indicates that population started to increase gradually at 3.0 ka and then stabilize at relatively high level between ~2.8 and 2.3 ka. A strong decline in population size is evident between 2.3 and 1.4 ka. Population recovered again by 1.4 ka and peaked at 1.05-0.5 ka. Thereafter, demographic levels decrease sharply. Overall, these demographic changes in the Atacama Desert occurred at the same times as the major late Holocene paleoclimatic changes of that region. Actually, increased population levels by 1.05-0.5 ka are coeval with a prominent positive hydroclimate anomaly detected regionally during the so-called Medieval Climate Anomaly (MCA). Conversely, the sustained decline after 0.5 ka coincide with a protracted negative hydroclimate anomaly during the Little Ice Age (LIA). Our findings indicate that pre-Hispanic agrarian populations from the hyperarid Atacama Desert were sensitive to Late Holocene hydroclimate variability. Moreover, the observed relationship between paleoclimatic and long-term population trends over the past 3,000 years, suggest that regional hydroclimate was a first-order factor for the past demographic structure of these societies.

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The history of climate is treated amusingly as an occupation for the retired, according to its creator Emmanuel Le Roy Ladurie (2009) in a long interview included in number 4 of "Ethnologie Française" devoted to the close relations between meteorology, climate and societies. Le Roy Ladurie was not brought up in the French tradition with French historians but outside of France with a wide intellectual lineage in Belgium, Central Europe, Italy, Latin America where many have been profoundly influenced by his publications and teaching.

However the impact of the progress in "L'histoire du climat depuis l'an mil" has been like a thunderclap on European climatology because this publication of 1967 shows clearly that climate has not been a terrestrial constant (apart from changes on a geological scale brought about in the Holocene by the disappearance of the Ice Age about 12 000 years ago and since the great Saharan Pluvial period) but that it varied more or less on an annual, decennial, secular or pluri-secular scale. This new paradigm goes hand in hand for scientists with the following great discovery: humans, after suffering continually climatic hazards were now able to have a strong effect on the geosphere and the biosphere by a perceptible increase in carbon dioxide - a fact that was accepted at the international level following measurements made in 1957-58 on the side of a volcano in Hawaii during the International Geophysical Year (IGY).

We shall follow this journey, initiated by Le Roy Ladurie in Europe, by a trip around the world so as to try to demonstrate why and how historians can Poster about climate.
Poster

Mineral Magnetic studies to indicate Paleo-anthropogenic loading of particulate matters in the Mumbai and Delhi metropolitan regions

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Surface loading of anthropogenic dust and aerosol particulate matters plays significant role in deterioration of the natural condition of soil, wind and water in the urban and industrialized areas. It is essential to know the extent of anthropogenic particulate loading and their seasonal dumping to envisage its long term residence effect in the urban soils. By presenting a first order linkage between ferrimagnetisms and heavy metal concentration in the soils of Delhi and Mumbai Metropolitan Regions (DMR & MMR), we identify the areas of dispersal, redistribution and seasonal dumping of the particulate matters by systematic spatial sampling in these regions. Further a historical data was generated by sediment cores samples from the soil profiles, flood plains, lakes and creek. The comparative mineral magnetic studies decipher the highest loading in the top soils as compared to the seasonal dumping in depressions like lake and floodplains. This indicates the topsoils as the best absorbents (and adsorbents) for the heavy metal loading playing a significant role in effective seasonal dumping as well as redistribution of the heavy metal load. The results suggests that the depths of enrichment of topsoils is largely independent of the bedrock-soils composition which is proven by the contrasting set up of ferrimagnetically reach MMR and that of ferrimagnetically poor DMR region. We further compare the role of geomorphology, wind circulation and surface water run-off as some of the most important factors of redistribution and dumping of anthropogenically loaded soils and therefore needs special attention.
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Although freshwater lakes make up a small proportion of the Earth’s surface, they act as sentinels of global climate change by providing signals of regime shift and adaptability of past ecosystems for environmental change. In particular maar lakes archive high-resolution biological and chemical proxies that are becoming increasingly valuable for unravelling the impacts of climate change and understanding ecological adaptation to change. To extend this understanding to global scale, we studied two maar lakes, Lake Schalkenmehren maar (SMM), Germany and Lake Onepoto maar (ONM) in northern New Zealand. Both maar lakes were formed by phreatomagmatic explosions and have been infilled by sediments spanning at least the last glacial period. The response of these maar lakes to global climate change is astonishingly synchronous. Biological and chemical proxies for environmental change retrieved from maar lake sediment cores indicate that the lake ecosystems and biodiversity switched to different regime following the end of the Last Glacial Maximum c. 18 kyr BP. Although the ability of the cold preferring taxa such as cladoceran zooplankton to adapt to change generally declined during the postglacial warm period, some species were able to show their ability to colonize the new habitats. Adaptability of cladocerans to change increased further following the smaller climatic oscillations such as the 8.2 ka Event in Lake SMM and the Antarctic Cold Reversal in Lake ONM. However, unlike at Lake ONM, where the human influence is recent, and resilience of the Lake SMM ecosystem to climate change declined significantly once the widespread human disturbances began in Roman time leading to a poorly functioning lake ecosystem and biodiversity. We argue that compared to natural climate variability, the human disturbances have greater impacts on social and ecological system (SES) of the maar lakes. However, lessons of ecological adaptations following the disturbances can have profound implications for future ecosystems management and building ecological resilience in maar lakes.
Talk
Integration of regionally resolved decline models for the Indus Valley Culture

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The causes for the 600 year long decline of the Bronze Age Indus Valley Culture (IVC) in the 2nd millennium BC are heavily debated. Monocausal theories like aridity, floods, invasion and river course shifting were used to explain the demise of various cultural traits, foremost urbanization. Are explanations required that involve synergies between different factors and regional sub-domains to understand deurbanization and associated technology loss? We believe they are, and introduce four spatial subdomains of the IVC, where decline is dominated by different actors. The Punjab (Northwest) went through a regime change by elite dynamics, Sindh (Southwest) experienced extreme floods, the Thar Desert (East) faced drying of the Ghaggar Hakra river, whereas Gujarat (South) went through economic collapse. We reconstruct the regionally resolved decline factors to assess their synergistic effects for the entire IVC domain. The resolution of inter-regional dependencies suggests reduced resilience of urban centers throughout the IVC. This low resilience in combination with environmental disruptions ultimately led to a regionalization.
Poster
On the sensitivity of the simulated European Neolithic transition to climate extremes

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Was the spread of agropastoralism from the Fertile Crescent throughout Europe influenced by extreme climate events, or was it independent of climate? We here generate idealized climate events using palaeoclimate records. In a mathematical model of regional sociocultural development, these events disturb the subsistence base of simulated forager and farmer societies. We evaluate the regional simulated transition timings and durations against a published large set of radiocarbon dates for western Eurasia; the model is able to realistically hindcast much of the inhomogeneous space-time evolution of regional Neolithic transitions. Our study shows that the consideration of climate events improves the simulation of typical lags between cultural complexes, but that the overall difference to a model without climate events is not significant. Climate events may not have been as important for early sociocultural dynamics as endogenous factors.

Reference:
The role of climate and social changes in the rise and fall of past civilizations as well as in fundamental changes in human societies (e.g., the move from hunting and gathering to agriculture) has been a focal discussion point in the social and environmental sciences over the last couple of decades. It is clear that the complex socio-ecological systems that result from the interplay of human populations and their environments are defined by overall climatic cycles. However, it is currently difficult to clearly understand social resilience over centennial and/or millennial scale and to untangle the chain of action/reaction between climate and populations. To approach this problem in a novel and experimental way we are applying Agent-Based Model simulation of hunter-gatherers and agro-pastoral groups to explore population dynamics such as behavioural change and resilience. Our simulation is inspired by realistic scenarios and calibrated with real world data from prehistoric, Holocene hunter-gatherers and Chalcolithic groups of North Gujarat (India).
Early human evolution is characterised by pulsed speciation and migration events that cannot be explained fully by global or continental paleoclimate records. We propose that ephemeral East African Rift System (EARS) lakes are a proxy for regional paleoclimate conditions. The presence of these lakes is associated with low levels of dust deposition and periods of rapid climate turnover in both West African and Mediterranean, but not with long-term global trends evidenced by stacked benthic foraminifera oxygen isotope records. We show statistically that speciation and migration events in African hominins are temporally associated with regional climate pulses evinced by the lakes. Hominin expansion and diversification are associated with periods of productivity during periods of wet and variable climate characterised by the appearance of deep EARS lakes. Around 1.9 Ma was the most profound period for hominin evolution; it was associated with the highest recorded diversity of hominin species ever, the appearance Homo and major migration events out of East Africa and into Eurasia. During this period, ephemeral deep-freshwater lakes appeared along the whole length of the EARS, fundamentally changing the local environment. In contrast, after this major step brain size increases in African hominins are associated with very dry periods with no lakes. Plio-Pleistocene East African climate pulses are, therefore, fundamental to hominin speciation, encephalisation and migration.
During the Late Middle Pleistocene (MIS 5/6) humans were a very widely dispersed species broken up into distinctive "populations", including at least Modern Humans, Neanderthals and Denisovians. It is likely that additional archaic populations occurred in Africa, China and the Indian Subcontinent. Modern Humans and Indian Archaics, in contrast to other populations such as Neanderthals and Denisovians shared an adaptation to tropical environments, thus competition between them would have been intense. It now seems likely that during MIS 5 modern humans were present not only in the Middle East but also Arabia, SE Asia and China. There is no evidence for modern humans in India during MIS 5, and the archaeological evidence indicates strong continuity during MIS 5 times to the preceding Acheulian. We suggest that during MIS 5 times, modern humans did not expand into the Indian subcontinent as conditions favourable for range expansion of modern humans were also favourable for Indian. During MIS 4 times however when archaic such as the Neanderthals re-occupied areas like the Middle East, and the Sahara desert became uninhabited, we see a dramatic change in the archaeological record in the Indian Subcontinent with the appearance of microblade technology which can be associated with modern humans due to its continuity up to the Iron Age. Modern Humans therefore appear to have replaced Indian archaic during a time unfavourable to both when modern humans disappeared from many previously occupied areas such as the Middle East. The re-expansion of modern humans during MIS 3 times may have the Indian subcontinent as the ultimate source.
Cambodian pre-Angkor and Angkor societies are known by remarkable brick and stone monuments, widely developed in monsoon-affected Indochina. Cultural activities in monsoon region are principally supported by abundant precipitation, and water availability is a key factor for perpetuating human society. During Holocene, Indochina region has experienced summer monsoon seasonality and multi-decadal variability, which controlled water availability and contributed to the major cultural events of pre-Angkor and Angkor societies. After the establishment of Isanapura, the pre-Angkor capital in the early 7th century, the monsoon intensity declined and consequently prompted abandonment of the city and relocation to the Angkor region, whereas the drought conditions resulting from the decreased monsoon intensity enhanced baray (reservoir) construction and water imbalance was rectified during the Angkor period. In contrast, a strengthened summer monsoon was coincident with the period of flourishing of Angkor society from the 10th century onward. Pre-Angkor Isanapura was highly dependent on the river and tried to use water resources efficiently, whereas the Angkor dynasty without large rivers tried to manage water imbalances and increase its water resources by hydraulic construction to sustain prosperity. It is reasonable to understand barays were constructed as a part of water management system, and also represents an abandonment of river-dependent governance and a shift to a new state of control of water resources.
Climate in Sahel region of West Africa is of crucial importance for the mainly rural population, (83% of the agriculture is rain fed). The main objective of this work is to understand farmers' perception of climate change and their adaptation strategies. By interviewing 2459 farmers on their perceptions of climate change over the past 30 years, and compare it to historical climate data (rare in this part of the world compared to other regions), we show that peasants have a rather good perception of past climate variability. A designed methodology offers the opportunity understand their vulnerability and to propose adaptation solution. Climate risks are classified and both temperature increase and precipitation variability are classified over the whole study sites as the first major risks, even if risks related to precipitation patterns (such as drought, shortening of the crop season etc are noted as more important overall).

This work is done by a compilation of 2459 interviews, done by 14 master students of the Regional Center AGRHYMET in Niamey, Niger, a technical institution of the Permanent Interstate Committee for drought control in Sahel and spans 10 countries over West Africa (Benin, Burkina Faso, Cape Verde, Chad, Guinea, Mali, Mauritania, Niger, Senegal, Togo). This study is one of the first one based on such a large number of people interviewed, the variety of localities (agro-ecological and socio economic differences between, for example herders form Niger to agriculture form Togo), which is, at the end, targeted to concrete propositions of operational projects to be achieved by field actors e.g. Mainstreaming Climate Change in the Communal Investment Plan of Diofior (Senegal), Sarr, 2012 or Adaptation and restocking poultry flock in Tondikiwindi municipality (Niger), Magagi, 2012 ).
Talk
Late Pleistocene to Holocene climate and seasonality in North Africa from $\delta^{18}$O, $\delta^{13}$C and Mg/Ca analysis of marine and terrestrial mollusc shells (Haua Fteah, Libya)

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The Haua Fteah cave in Libya contains one of the longest and most complete sequences of human occupation in North Africa. This rich archaeological assemblage occurs in tandem with abundant material for paleoenvironmental reconstruction. In this study, stable isotope and element ratio analyses of the archaeological mollusc assemblage from the Haua Fteah have allowed the reconstruction of paired marine and terrestrial climate records that extend from c.120,000 to c.5000 years ago. These analyses have been interpreted with reference to analogue studies on modern marine and terrestrial molluscs from Libya. In the marine topshell Osilinus turbinatus, $\delta^{18}$O and Mg/Ca ratios record fluctuations in sea surface temperature. In the terrestrial mollusc Helix melanostoma, $\delta^{18}$O varies according to the water ingested by the animal as the shell grows, which in turn is linked to water and air temperature at the moment of precipitation whilst $\delta^{13}$C provides a proxy for palaeovegetation patterns and water stress. Intrashell stable isotope series from these shells record snapshots of sub-seasonal climatic variations covering rapid and profound climatic fluctuations from MIS 5 to MIS 1. This high-resolution climatic framework coupled with the well-dated record of cultural change, allows an examination of human-environment interactions during critical periods of late Pleistocene to Holocene climate change in a region of North Africa with comparatively few climate records.
Poster
Peat in the desert: A local environmental history for the Holocene in semi-arid Jordan, and its comparison to the evolution of societies

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The Southern Levant (roughly corresponding to modern Jordan, Israel and Palestine) is a key region to understand past interactions between human communities and their environments. This region is part of the ‘Fertile Crescent’, where agriculture first developed, around the beginning of the Holocene. Since then, human impact on surrounding landscapes has steadily increased, which renders the causes of environmental change (climate- or human-induced) more and more difficult to unravel when we progress towards the present. However, if one wants to compare climate fluctuations with the evolution of human communities, and determine the role of such changes in major societal developments, one needs a good assessment of climate evolution - progressive or abrupt - throughout the Holocene, within an accurate chronological framework. Such an assessment is particularly difficult to achieve in the most arid regions of the Southern Levant, where archives of climate or environmental change are usually badly preserved and difficult to date. However, the potential of the arid environments of the Southern Levant to harbour records of Holocene past climate change is far from being exploited to its full extend.

The unique discovery of Holocene organic, peat-like deposits in the rain-shadowed Dead Sea area allows studying past climate change at the local scale for arid Southern Levant. This will be achieved primarily through pollen analyses, but ultimately through a multi-proxy approach, including charcoal for the occurrence of fires, spores and fungi (potential indicators of past grazing activities), and detrital content (enhanced erosion), at a high-resolution constrained by radiocarbon dating. This contribution will present the first results of this multi-proxy approach applied to thick and well-preserved organic sequences obtained from the mountain slopes east of the Dead Sea in February 2012. Such local-scale, continuous records are crucial for an in-depth evaluation of potential relationships between climate and cultural development, including settlement history, the development of agriculture, and the evolution of water management practices, especially in Levantine desertic and semi-desertic environments.
-talk

Medieval climate change and the end of the Norse settlements in Greenland

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The response of modern society to future climate scenarios is greatly dependent on our knowledge of past human societies, and how these may have been affected by climate change. The fate of human settlements in the Arctic region is particularly interesting in this respect, because the effects of climate change are amplified in the Arctic, and survival is tightly connected to adapting to extreme environmental conditions. Greenland has a rich and dynamic history with multiple episodes of human migration during the past few millennia. In the late 10th century, Greenland was settled from Iceland by the Norse (at c. AD 985). The Norse occupied sheltered inner fjord areas, where they sustained communities based on farming, pastoral activities and hunting. They established two main settlements: the Western Settlement (in the region of present-day Nuuk) and the Eastern Settlement (in southernmost west Greenland). The Western Settlement was abandoned c. AD 1350 and the larger Eastern Settlement after c. AD 1400.

A wide range of data from historical, archaeological, and climate studies indicate that environmental deterioration and climate change played an important role in the demise of the Greenland Norse settlements. We will present an overview of the impact of climate change on the two main settlements of the Greenland Norse, based on evidence from several marine records collected in offshore and fjord areas from the vicinity of the Western and Eastern Settlements, as well as a high-resolution record from Disko Bay, where the main Norse hunting grounds were located.
The Plague of Justinian was a pandemic that struck the Byzantine Empire in AD 541–542. It affected much of west and south Asia, North Africa and Europe and recurred periodically until AD ~750, leading to the premature death of up to a quarter of the human population in this region. Its likely cause was bubonic plague - which later caused the Medieval Black Death - and its epidemiology is complex and multi-causal, perhaps including climate change. Human plague is caused by fleas infected with the bacterium Yersinia pestis, which in turn are carried by rodent hosts. Modern studies show that wetter climatic conditions can lead to increased host and flea populations and heightened plague risk (Stenseth et al. 2006).

Stathakopoulos (2004) used documentary sources to compile a detailed record of epidemics, famines and extreme weather events in the eastern and central Mediterranean between AD 284 and 750. Independently, Nar lake provides an exceptionally well-dated proxy record of climate and land use since AD280 from central Anatolia, then in the agrarian heartland of the Byzantine Empire (Jones et al. 2006; England et al. 2008; Woodbridge and Roberts, 2011). Decadal or better dating precision is possible due to its annually-varved lake sediment record. Analysis of δ18O (3-5 yr interval), diatom-inferred salinity (10 yr) and Itrax-derived elemental chemistry (sub-annual sampling) shows that the largest dry-to-wet climatic shift of the last 1,720 years occurred during the 6th century AD, centred on 530-560 AD, and led to conditions conducive to the rapid spread of plague. We use pollen analysis to test if there was a fall in the proportion of cultivated tree crops and cereals after the onset of the plague, linked to reduced agricultural activity and rural de-population. Inferred climate remained humid until AD 750, after which a return to drier conditions lowered the plague risk. These results contribute to wider debates about the role of climate change in past and possible future plague activity (Kausrud et al 2010).

References:
Kausrud, K.L. 2010. Modeling the epidemiological history of plague in Central Asia: Palaeoclimatic forcing on a disease system over the past millennium. BMC Biology, 8.
Stathakopoulos, D. Ch. 2004 Famine and Pestilence in the Late Roman and Early Byzantine Empire. Ashgate.
Stable isotope records from high-latitude European lakes reveal common responses to precipitation forcing over the past 5000 years indicating that changes were the result of significant regional shifts in atmospheric circulation. We show that abrupt changes in the seasonality of precipitation occurred, some of which have influenced human society significantly. A major increase in winter precipitation occurred after 4200 cal yr BP which prolonged the snowmelt period and shortened the vegetation period. Together with a minor lowering of temperature, this change had a significant effect on natural resources and on human society in northern Sweden. Several European famines occurred during the last Millennium. Tree-ring based temperature reconstructions show that some of these famines coincided with low, but not unusually low, growing season temperatures. We infer increased summer wetness and a dominance of North Atlantic derived precipitation in northern Sweden for these periods, indicating that shifts in precipitation strongly influenced human society at these times. The recurrence of the recorded changes would greatly affect future regional climate conditions in the North Atlantic region.
Recent explorations along the lower reaches of Narmada River in Western India revealed interesting evidence regarding association of microliths with vertebrate fossils within the gravel lenses. These gravels occur as intercalated lenses within sand and silt facies. The gravel lenses form a part of a regional landform referred to as ‘palaeo-bank’, which comprises of Tertiary rocks towards eastern margin followed by gravel-sand-silt sequence in the middle reaches. On its further west, there occurs sandy-muddy facies. The palaeo-bank is of a regional significance that extends for almost sixty kilo meters laterally along the southern bank. The palaeo-bank is tentatively datable to the end phase of last glacial. The archaeological artefacts recovered from here included geometric and non-geometric tools, scrapers and cores. The vertebrate fragments included cattle bones, jaw fragments and tooth; fragments of elephant tusk; and fragments of rhino bones. The presence of these vertebrate remains along with microliths indicates that a congenial environment was available in the lower Narmada Valley. The gravel lenses as lobes and in situ artefacts together with the vertebrate remains suggest a wetter climate.
This poster will summarise the aims, objectives and findings of ongoing doctoral research investigating the complex interactions between peatland hydrology, climate and human societies. Using a combination of testate amoebae and humification analyses, in conjunction with AMS radiocarbon dating, the bog surface wetness of several raised bogs across central Ireland has been reconstructed. The hydrology and ecology of these wetlands are intimately linked both to global climatic variation during the Holocene and to the experience of the societies that lived around them. Whilst the forcing effects of climate on the hydrology of raised bogs has been a focus of previous research, this project will focus directly on the interactions between human societies and the climate as experienced through changes in environmental conditions. Assumptions of simplistic linear relationships between climate change and societal transitions have been shown to be inadequate and naïve; however, some well recognised climatic fluctuations appear to be broadly synchronous with gross changes in material culture: for example the ‘2.8kyr event’ around the Late Bronze Age-Iron Age transition. Through the construction of detailed, high-resolution records, this project examines the ways in which changes in local environments as a contingent (as opposed to deterministic) part of the human experience can be useful in interpreting changes in the archaeological record. Data from a number of sites indicate that construction of timber structures in wetlands was notably intense during the late Bronze Age, at around the same time reconstructed water tables show marked variability. A simple correlation between dry bog surface conditions and increased human activity on the bogs does not appear to be tenable. More detailed and plausible hypotheses concerning human response to changing environmental conditions are being developed by examining inter- and intra-site variability of the climate signal, investigating which variables of climate are driving the proxy record, and by carrying out more detailed analysis of the archaeological record.
The impact of environmental change on past human societies in the Central Peloponnese (Greece)

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Sediment cores from inland lakes typically express a more constant sedimentation rate and thus provide a more continuous palaeoenvironmental archive than alluvial or near-coastal sediment archives. The central Peloponnese has been lacking detailed palaeoenvironmental reconstructions, although a direct comparison of sedimentary and other geoarchives of climate and environmental changes against the rich archaeological and historical records of ancient Greek societies may shed new light on human-environmental interactions.

In 2010 we recovered four sediment cores from a former lake bed in the valley of Asea near Tripolis. Especially the 8 m long core Asea-1, covering the entire Holocene, has the potential to provide a detailed palaeoenvironmental reconstruction. In the same year, we also retrieved a 15.5 m long core (STY-1) at the center of Lake Stymphalia, the only remaining natural lake on the central Peloponnese and only 30 km west of the ancient city of Mycene.

Our initial work focuses on sedimentological and geochemical proxies of the last 8 ka. High-resolution AMS-14C dating and Bayesian age-depth-modeling was used to establish time series of climatic and environmental variables. We attempt to correlate our records from the Peloponnese with (1) other Mediterranean and global patterns of Holocene climate change, and (2) with archaeological and historical information for this region. While there is a profound archaeological record of cultural changes in mainland Greece covering the last 4200 years BP (back to ca. 2200 cal BC), there is still a lack in linking this record with natural archives recording climatic and environmental changes, which might have influenced the cultural development. Going into more detail, we focus on the balance between sustainability and exploitation, trying to answer questions like: How did the different ancient cultures manage their water resources? How sustainable was their agricultural land use?

So far, our geochemical analyses of sediments from Lake Stymphalia have shown that the water supply in the region fluctuated over time in response to changing climate. The Rb/Sr ratio as a proxy for changes between dry/warm and wet/cold conditions indicates pronounced wet phases around 6800, 4000–3700, 3500–3000 and 500–200 cal BP, partially corresponding to known phases of rapid climate change. The geochemical data mentioned here are the starting point for a more detailed and comprehensive environmental reconstruction of the central Peloponnese.
The development of modernity in human populations in Africa has been linked to pulsed phases of technological and behavioral innovation within the Middle Stone Age (MSA) of South Africa, which are associated with early evidence for symbolic behaviour, personal ornaments, complex tools and sophisticated hunting techniques. However, the trigger for these intermittent and sometimes very short-lived (<1000 years) pulses of technological innovation is an enigma, as is the reason for sudden abandonments of occupational sites and reoccupation thousands of years later. Here we show that, contrary to some previous studies, these intervals of innovation were tightly linked to local climatic ameliorations. We demonstrate that major MSA innovational pulses occurred at times when South African climate changed rapidly towards humid conditions while northern sub-Saharan Africa experienced widespread ‘megadroughts’ as the Northern Hemisphere entered phases of extreme cooling. These millennial-scale teleconnections result from a southward shift in the austral summer position of the Intertropical Convergence Zone (ITCZ) in combination with warmer conditions in the Agulhas current regime during North Atlantic cold events. Humid pulses in South Africa contributed to the creation of a refugium with favorable environmental conditions. This strongly implies that innovational pulses of early modern human behaviour were climatically forced, linked to the adoption of new refugia. These required adaptive change, but also subsequently provided favourable conditions for population growth, supporting models linking such pulses with changes in demography.