Conference Report:

Climate Change in the Breadbasket of the Roman Empire. Reconstructing Nile Floods for the Roman Period

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Organized by: Istituto Svizzero di Roma

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Platforms for exchange bringing together scientists working on the same regions and time periods tend to be few and far between when combining the humanities with the natural sciences. Hosted at the Istituto Svizzero in Rome, »Climate Change in the Breadbasket of the Roman Empire. Reconstructing Nile Floods for the Roman Period« (23.–24.01.2020) offered just this, encompassing 10 contributions and 3 expert responses. With participants once again ranging from the fields of ancient history, classics, climate science, environmental history, marine geology, and paleoclimatology, the international conference continued the efforts of the organizer SABINE R. HUEBNER's (Basel) previous endeavor "Climate Science & Ancient History. Decoding «Natural» and «Human» Archives" (Basel, 27.–28.11.2018) in linking the historical and natural sciences, this time focusing on Egypt as an exhaustive sample region for the Roman period.[1] Considered the Empire's granary and the transportation hub linking the Mediterranean to Eastern territories, analyses of Egypt as a Roman province differ mainly in relation to the research questions posed by each discipline, but not so much in their shared aims of exploring the past.

The introduction by the conference organizer, stressing the importance of analyzing the dual impact of the environment on human society, as well as that of humans on the climate, further highlighted the relevance of this opportunity for exchange between specialists working on reconstructing the past as part of different disciplines. With the tremendous impact any increase or decrease in Nile flood could have on human lifestyle and survival – whether the fields were sufficiently or excessively inundated decided between a successful harvest, and absolute crop failure or destruction respectively. A challenge researchers from differing backgrounds face when analyzing various source types, is combining their results into a single cohesive narrative.

Dendrochronologist MARKUS STOFFEL (Geneva) chaired the first conference session, »The Nile over the longue durée«, comprising of four talks on the long-term evolution of the Nile and its population. Asking the pressing question of how we can reconstruct annual changes in Nile floods for the Graeco-Roman period, quaternary paleoecologist and biogeographer HENRY F. LAMB (Aberystwyth/Dublin) presented Lake Tana (Northern Ethiopia), the source of the Blue Nile, as a case study, itself responsible for the highest percentage of Nile discharge and sediment load. It is critically located at the meeting point of Mediterranean, Red Sea and Indian Ocean moisture sources, a shallow lake with easily disturbed sediments. The lake offers a continuous 150'000-year record,

[1] Head of the »Basel Climate Science and Ancient History Lab«, Huebner was just awarded a 4-year grant by the Swiss National Science Foundation (SNSF) titled »The Roman Egypt Laboratory: Climate Change, Societal Transformations, and the Transition to Late Antiquity« (2021–2025), in the course of which her team will explore climate variability and human adaptation to environmental challenges in Roman Egypt. https://ancientclimate.philhist.unibas.ch/en/project/

which does not so much provide exact data for annual variations, but rather highlights major climate events in its sediments (e.g. extreme drought such as the much-discussed 4.2 ka BP event[2], often considered to have caused the collapse of the Egyptian Old Kingdom). Lamb's research points out, however, that the most extreme sediment record of the 3rd millennium BCE can be dated to even before the beginning of the Old Kingdom, providing no direct correlation to its fall.

Continuing with the analysis of the Nile in pre-Roman Egypt, sedimentologist CECILE BLANCHET (Potsdam) offered insights into her work on the Nile flood during the Saharan Humid Period (11–6 ka BP[3]), a time at which, as the desert grew more fertile, the river banks were left behind by the population, dispersing into the land. Object of this research was a sediment core from the Nile deep-sea fan, the sedimentary deposit at the outlet of the Nile Delta. Due to a laminated sequence in the sediment, seasonal flood dynamics for the period between 9.5 and 7.5 ka BP[4] can be reconstructed. This type of annual layering would come close to the tradition of nilometers, the ancient structures used for measurement of the Nile's annual inundation, even offering a potential for direct comparison. Further information may in the future even be gleaned from each layer's thickness, which could allow for conclusions on seasonal flood strength.

Paleoclimatologist ELENA XOPLAKI (Giessen) introduced the use of Earth System Models (ESMs), coupled climate models also modeling carbon movements, allowing for comprehensive simulations of past climates. Analyzing the May to October precipitation in the Ethiopian highlands, the effect of various climate forcings (e.g. volcanic eruptions in both 266 CE and 536 CE) is highlighted, as well as general variability in the absence of forcings. The simulations of the years 1–700 CE register a general drying trend, with large volcanic eruptions possibly leading to lower summer precipitation and affecting Nile flow for up to two years. A tropical volcano eruption such as the one in 536 CE may, however, have caused an increased amount of Northern hemisphere subtropical cyclones, leading to wetter conditions in Northern Egypt.

Emphasizing the local Egyptian perspective, geologist JUDITH BUNBURY (Cambridge) uncovered connections between paleoclimatic records and human activity in terms of shaping and changing the environment beyond the Nile. Apart from the obvious massive interventions in the landscape throughout antiquity[5], traces of human occupation and agriculture can be found at the Kharga Oasis. A tree stump dating back to the 6th millennium BCE, remaining qanats (underground waterways) at Umm al-Dabadib, at the mouths of which plants still grow, and remnants of fields dating to the Roman period all indicate active vegetation. Another case study is offered by the Theban mountain, where pool sediments next to Late Antique »Coptic« shelters have allowed for sediment analysis, and a large amount of leaves from toothbrush trees, which no longer grow in Egypt, indicate a changed flora.

Ancient historian IRENE SOTO MARÍN (Basel) gave the first response looking back on Session 1, emphasizing the importance of time and location in analyzing past climates, often allowing for localized (e.g. precipitation patterns) rather than universal conclusions, further highlighting the important distinction between climate and weather.

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[2] ka BP (kiloannum Before Present) is a dating form commonly used by sciences practicing radiocarbon dating. Since 01.01.1950 is usually considered the »present« time, the 4.2 kiloyear event occurred starting ~2200 BCE.

[3] ~9000–4000 BCE.

[4] ~7500–5500 BCE.

[5] An example for this was the diversion of the Bahr Yusuf (the canal connecting the Nile to the Fayyum Oasis), adapting the watercourse away from the Nile. This was potentially a feat of human overengineering of the landscape, seeing as the canal required constant care and dam regulation, eventually leading to the drying up of Lake Moeris once regular maintenance was abandoned.

The morning session of Day 2 »Historical case studies of Nile flood extremes during Roman times«, chaired by ancient historian MARCO MAIURO (Rome), consisted of four select case studies of extraordinary Nile events for the Roman period. Ancient historian ANNA ARPAIA (Pavia) focused on the 1st c. BCE Herakleopolite for the analysis of the »Asklepiades« letter archive regarding the range and effect of the Nile flood in the papyrological evidence around the 20s BCE. Mentioning the ancient locations of Mouchis, Ogou, Nois and Tale (all located South of the Arsinoites and the Fayyum, thus approximately in the region of today's Beni Suef Governate), the archive allows readers to trace the daily life of farmers and trade along the Nile. The micro-history of this family correlates to the content of official documents at the time, however the direct influence of unfavorable floods on the family's lifestyle as private owners and their harvest remains unclear.

Examining Lake Menzaleh in the North-Eastern Delta between the 1st and 4th c. CE, Roman historian KATHERINE BLOUIN (Toronto) concentrated on environmental entanglements during three periods well-documented in the papyri. The first, one of socio-environmental crisis (~160–200 CE), featured the severe depopulation of villages in the Mendesian nome, epidemics and economic ruin, resulting in uprisings. It also, however, caused a diversified economy, with the population adapting to their new circumstances. The second period encompassed part of the short existence of the Nesyt Nome (2nd–3rd c. CE), attested on coins of emperors Trajan and Hadrian, as well as several papyri. Thirdly, the 4th c. CE brought maritime flooding and an earthquake (~365 CE) to the Delta, described inter alia in John Cassian's Conferences, ruining some villages, islanding others and creating saltwater marshes. Each period pays testament to the extraordinary resilience of human society, continuously shifting their occupation and livelihoods to adapt to circumstances.

Sabine R. Huebner presented the decline of the Fayyum Oasis and proposed that climatic changes could have been responsible for the abandonment of the many villages along the shores of ancient Lake Moeris (modern Birket Qarun) during the 3rd c. CE. Increased irrigation issues are documented in the papyri for inter alia Soknopaiou Nesos or Neiloupolis, continuing into the 4th c. CE (e.g. P.Sakaon 42 for Theadelphia, ~323 CE), potentially causing desertification in a region dependent on a working irrigation system. Radiocarbon data indicate the landscape had already experienced extreme dryness between the reigns of Antoninus Pius and Caracalla, during the end of the 2nd and beginning of the 3rd c. CE. Further, changes in the African monsoon in the source regions of the Nile, as well as events such as a volcanic eruption around 265 CE, traceable in both ice core and tree ring samples, may have been responsible for lower Nile floods.

Joining the conference online with a live contribution, paleoclimatologist CHRISTOPHE CORONA (Clermont) approached the decline and ultimate end of the Roman Empire in Central Italy, with data not yet collected for Egypt. Deviations from the so-called Roman Climate Optimum, which had characterized most of Roman times, may have caused crop failures, epidemics such as the Justinianic plague, and a general state of crisis, resulting in a period considered the Late Antique Little Ice Age (LALIA). Corona argued that shifts in climate had originally helped the Roman Expansion (~6th–3rd c. BCE), such as above-average rainfall, boosting the small area carrying capacity, which had incentivized the non-Roman elites to cooperate with Rome. This had worked hand-in-hand with irrigation and land reclamation technologies, market forces and successes in warfare. Climatic shifts in the opposite direction would have explained some dramatic consequences, with migrations and invasions towards Rome in Late Antiquity often being precipitated by climate events. The talk further reaffirmed the impossibility of creating a universal periodization across the entire Mediterranean, seeing as paleoclimatic and historical sources mainly allow for conclusions on local or regional trends.

Roman historian ELIO LO CASCIO (Rome) further emphasized the difficulty in comparing source types in his response to Session 2, while remarking that technological advancements in Egypt (for example the highly sophisticated irrigation system) were to be seen as intentional, politically motivated decrees.

The immense potential of tree rings and other paleoclimatic proxies was the topic of both afternoon contributions, with the third session »Natural proxies for reconstructing Nile floods during the Roman period« being chaired by conference organizer Sabine R. Huebner. Markus Stoffel provided a novel approach to gathering annual records for the Roman period by establishing a dendrochronology for Egypt. The difficulty with such a procedure is that most archaeological wooden objects discovered in Egypt were crafted from high-end imported juniper (Ethiopia) or cedar (Lebanon), therefore results using these materials would reflect the climatic conditions of the wood's origin outside Egypt. Mummy labels, however, merely intended for short-term identification within a mummification workshop, were made from local tamarix nilotica or ficus sycomorus. These species are known to grow best during the inundation of the Nile, potentially allowing for tree ring analysis of these wooden labels to build an annual chronology for Egypt.[6]

Summing up the large-scale issues and great potential by analyzing the teleconnections of the Nile to the outside world, KEVIN ANCHUKAITIS (Tucson), paleoclimatologist, dendrochronologist, and earth systems geographer, attempted to infer missing local Nile climate data through global circulation models. Initiatives such as the global tree-ring chronology network, focused mainly on North America, Europe and New Zealand, regions with little temperature or sunlight seasonality, disregard regions characterized by wet-dry seasonality, thus excluding for example hyper-arid areas with high human influence, such as the Middle East. Using paleoclimate data assimilation to fill these gaps in chronology, Anchukaitis' team used a combination of model physics and real-time data to retrospectively approximate past climates, for instance the precipitation at Lake Victoria and Lake Tana, the two sources of the Nile. Despite this experimental method gleaning some results, this research further underlined the need for local high-resolution proxy information from the Nile region.

Ancient historian FEDERICO DE ROMANIS (Rome) concluded the conference with a final response on Session 3, emphasizing the consequences of climatic change within Egypt for its surroundings, due to its importance for the whole of the Roman Empire. In its position as granary of the empire, Egypt primarily supplied the city of Rome, with only potential surplus being sent elsewhere. This focus on grain harvesting and the reliance of the capital on importing supplies came with a policy of adaptability; should an Egyptian harvest fail, grain would have to be readily supplied from elsewhere. Such a situation would have severe consequences for Egyptian local farmers losing a harvest, but guarantee the security of the capital and thus the resilience of the empire as a whole. This adaptability to circumstances was soon reflected in the population itself, often switching to various other means of farming or breeding when their usual technique failed. In summary, an important conclusion of the conference was the confirmation that the humanities and the natural sciences benefit from each other immensely when reconstructing the past: historical records are oftentimes very precise and concretely dated, but not continuously available, while the opposite is the usual case for climatological datasets.

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[6] Stoffel heads the *Climate Change Impacts and Risks in the Anthropocene (C-CIA)* (https://c-cia.ch/) Chair at the University of Geneva, analyzing the impacts and risks of climatic change in endeavors such as the SNF Sinergia Project »CALDERA – Effects of large volcanic eruptions on climate and societies: Understand impacts of past events and related subsidence crises to evaluate potential future risks« (2019–2023). https://www.wsl.ch/de/projekte/caldera.html

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Conference Program:

Session 1: The Nile over the longue durée (Chair: Markus Stoffel)

HENRY F. LAMB (University of Aberystwyth/Trinity College Dublin): "Lake Tana and the Blue Nile: the last 150,000 years"

CECILE BLANCHET (GFZ Potsdam): "Flood dynamics during the last Saharan Humid Period: clues from a laminated record from the Nile deep-sea fan"

ELENA XOPLAKI (Justus-Liebig-University Giessen): "Precipitation in variability and changes in monsoonal Africa – Associations with northern Egyptian hydroclimate in new comprehensive earth system models prior to CE 700"

JUDITH BUNBURY (University of Cambridge): "Evidence for Graeco-Roman Climate and environment; tying climate records to observations from the field"

Response & General Discussion (Chair: Irene Soto Marín)

Session 2: Historical case studies of Nile flood extremes during Roman times (Chair: Marco Maiuro)

ANNA ARPAIA (University of Pavia): "The Nile breaks the banks: unfavorable floods in some documents from the 1st century BC Herakleopolite"

KATHERINE BLOUIN (University of Toronto): "Good Flood, Bad Flood: Environmental entanglements in the Roman Northeastern Delta"

SABINE R. HUEBNER (University of Basel): "Did shifts in the African Monsoon lead to the decline of the Roman Fayum from the third century CE?"

CHRISTOPHE CORONA (University Blaise Pascal, Clermont-Ferrand): "Multi-proxy approach provides insights into climate variability in Central Italy at the End of the Roman Empire: Insights of Work in the Nile river"

Response & General Discussion (Chair: Elio Lo Cascio)

Session 3: Natural proxies for reconstructing Nile floods during the Roman period (Chair: Sabine R. Huebner)

MARKUS STOFFEL (University of Geneva): "Tracking changes in Nile floods with tree rings: Possibilities and limitations"

KEVIN ANCHUKAITIS (University of Arizona): "Inference from the periphery: large-scale climate variability and Nile riverflow during the Common Era"

Response & General Discussion (Chair: Federico de Romanis)