

A large, stylized graphic dominates the center of the page. It features a large, black, serif letter 'S'. Inside the lower curve of the 'S', there is a silhouette of a person sitting in a boat, using a long oar. To the right of the 'S', the words 'ummer', '&', and 'ea' are written in a black, cursive script font, completing the title 'Summer & the Sea'.

Summer & the Sea

SUMER AND THE SEA
*Deltas, Shoreline and Urban Water Management
in 3rd Millennium BC Mesopotamia*

In the frame of the International Association for Archaeological Research in Western & Central Asia (ARWA), Licia Romano (Dept “Institute of Oriental Studies”, Sapienza University of Rome), with the collaboration of Franco D’Agostino (Dept “Institute of Oriental Studies”, Sapienza University of Rome), Holly Pittman and Reed Goodman (University of Pennsylvania), Marc Lebeau (European Centre for Upper Mesopotamian Studies), Cameron Petrie (University of Cambridge), and Liviu Giosan (Woods Hole Oceanographic Institution, Woods Hole, MA) proposes an International Workshop «Sumer and the Sea ». The goal of the workshop is to take stock of the present research on Sumerian society and its relationship with water and the sea, focusing on the recent archaeological and geo-archaeological research in Southern Mesopotamia.

“Sumer and the Sea” is under the auspices of ARWA, of recent creation and based in Brussels. ARWA brings together nearly 500 scholars and students, specializing in various fields related to archaeology, from 47 different countries (www.arwa-international.org). ARWA members are joined together by the common intent to establish a worldwide link between scholars, acting together in order to defend the archaeological discipline and its scientists through several services (informing, encouraging joint projects, mentoring promising students, advising international organizations). Among its different activities, ARWA will organize fourteen international research workshops within the time frame of 4 years, corresponding to the term of office of its administrators. These workshops bring together around thirty specialists and are aimed at the joint analysis of a specific topic, promoting international research cooperation.

“Sumer and the Sea” will be held online from the 2nd to the 4th of June 2021.

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The Mesopotamian culture flourished on the banks of the Tigris and Euphrates Rivers, in a landscape that was impacted by several changes during the last 6000 years following the last post-glacial rise and stabilization of the sea-level. The ancient shoreline was located about 250-260 km inland from the present coastline and was formed by Tigris and Euphrates deltas. Inhabiting an area located near the 30th parallel north, inside the semi-arid zone, the development of Sumerian society was strongly influenced by the exploitation of the fluvial systems, the sea, and the peculiar marsh environment created by them.

On the one hand, the natural occurrence of crevasse splays was surely at the basis of the first form of controlled irrigation and agriculture, while on the other, sea, rivers and channels were perfect trade routes through which Sumer was afforded access to a wide spectrum of resources. Nonetheless, 3rd mill. BC Southern Mesopotamian population had to cope with a fragile environment, strongly affected by complex natural processes, including floods, sea-level fluctuations and climatic changes occurring during the Holocene.

The Workshop “Sumer and the Sea: Deltas, Shoreline, and Urban Water Management in 3rd Millennium Mesopotamia” will focus on the interaction between Sumerians and their

water-dominated environment. The new data, obtained through remote sensing and through geological coring, will allow us to discuss the evolution of the ancient shoreline, whose progradation during the centuries profoundly modified the landscape and affected the life of Southern Mesopotamian settlements. The presentation of the recent archaeological and geo-archaeological research in Southern Iraq, together with the coeval cuneiform sources, will enrich our historical perspectives on the way in which Sumerians adapted to the marshy environment, using and managing water outside and inside the cities. A special session of the workshop will be devoted to the presentation and analysis of the different research strategies and methods which are now currently being used. This will lead to a concluding discussion of the shared practical issues and challenges encountered by archaeo-geological work in Iraq.



with the collaboration of:



SUMER AND THE SEA

Deltas, Shoreline and Urban Water Management in 3rd Millennium BC Mesopotamia

PROGRAMME

June 2nd

10:00-10:30 Institutional greetings

10:30-11:00 Dr Laith Majeed Hussein, President of the State Board of Antiquities and Heritage, Introductory speech

11:00-11:30 Coffee Break

Chair: Franco D'Agostino

11:30-12:00 Max Engel, Helmut Brueckner - Holocene Climate Variability in the Near East and its Impact on the History of Civilisation

12:00-12:30 Stacy Carolin - Timing of Regional Drying and Changes in Frequency and/or Strength of Shamal Dust Events Throughout the 3rd Mill. BC

12:30-13:00 Badir Albadran - The Effect of Tectonics on the Surface Features and River Courses Changes

1300-14:30 Lunch Time

Chair: Reed Goodman

14:30-15:00 Joerg Fassbinder - Archaeological Geophysics: Magnetic Traces in the Marshy Environment of Southern Mesopotamia

15:00-15:30 Reed Goodman, Liviu Giosan - The Tigris-Euphrates Deltaic Complex and its Relation to the Lagash Floodplain

15:30-16:00 Jennifer R. Pournelle - Islands in the Storm. Turtlebacks, Tells, and Marshland Cities

16:00-16:30 Coffee Break

Chair: Holly Pittman

16:30-17:00 Galina S Morozova - Avulsion Styles, Channel Networks, Flooding, and Bronze Age Settlement Patterns in Lower Mesopotamia

17:00-17:30 Stephanie Rost -Managing the Ancient Tigris in the late 3rd and Early 2nd Millennium BC

June 3rd

Chair: Liviu Giosan

11:30-12:00 Taher Al-Hosseini - Archaeological Activities in Iraq and Legislative Frame

12:00-12:30 Arsalan Othman - Determination of the Ancient Shoreline and Anthropogenic Sites Using Remote Sensing Techniques

12:30-14:30 Lunch Time

Chair: Marco Ramazzotti

14:30-15:00 Susanne Rutishauser, Sebastien Borkowski - The «Rivers of Mesopotamia» Research Project

15:00-15:30 Jafar Jotheri - Changing River Courses and Their Relationship to Settlement

15:30-16:00 Coffee Break

Chair: Maria Giovanna Biga

16:00-16:30 Jan Walstra - Reconstructing the Palaeo-Environment of the Ancient City of Charax Spasinou

16:30-17:00 Lorenzo Verderame - From the Marshes to the Sea: The Waterscape of Ancient Sumer

17:00-17:30 Abdulmir al Hamdani - Ethno-Archaeological Models of Waterscape and Landscape in the Marshes of Southern Iraq

June 4th

Chair: Cameron Petrie

9:30-10:00 Philippe Quenet - Eridu and the Sea: A Long-Standing Issue

10:00-10:30 Adelheid Otto, Berthold Einwag and Jurg Fassbinder - Waterways at Shuruppak and Ur. New Ideas from Old Sites

10:30-11:00 Ella Egberts - Reconstructing the Waterscapes of Tells in Southern Mesopotamia: Remote Sensing and Geoarchaeological Survey Results from Girsu

11:00-11:30 Coffee Break

Chair: Lorenzo Nigro

11:30-12:00 Licia Romano, Luca Forti, Franco D'Agostino, Salvatore Milli - Drilling is not Boring: Geoarchaeological Research at Abu Tbeirah

12:00-12:30 Stuart Campbell - Tell Khaiber and the Sealands

- 12:30-13:00 Chris Morhange, Alexandra Bivolaru, Daniela Cottica, David Kaniewski, Nick Marriner, Hadeer Sheisha, Gamal Younes - Geoarchaeology of Fluvial Harbors. Case Studies: Isonzo Delta (Aquileia, Italy), Danube Delta (Noviodunum, Halmyris, Органй, Romania) and the Nile (Giza, Egypt).
- 13:00-14:30 Lunch Time
- 14:30-14:40 Eduardo Garzanti – Short communication - Sedimentary Mineralogy as a Tool in Geoarchaeological Research
- 14:40-15:30 Final discussion

ABSTRACT

Dr Laith Majeed Hussein, President of the State Board of Antiquities and Heritage

INTRODUCTORY SPEECH

The State Board of Antiquities and Heritage (SBAH) has as its mission to protect the archaeological heritage of Iraq. In order to accomplish this, heritage monuments should undergo continual review in order to maintain world heritage protection standards. SBAH is also responsible for overseeing the relationships with the foreign exploratory expeditions of the Mesopotamian civilization. SBAH consists of seven general directorates through which it manages the archaeological affairs of Iraq. In order that foreign expeditions can achieve effective relations and communication while working in Iraq, this speech will describe the nature and functions of each of these departments. SBAH recognizes that modern archaeological fieldwork has incorporated new methods and scientific techniques that may require the export of samples for analysis. SBAH is committed to support such methods and techniques, and will strive to facilitate these studies in accordance with the rules and regulations of Iraq.

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THE EFFECT OF TECTONICS ON THE SURFACE FEATURES AND RIVER COURSES CHANGES

The southern part of the Mesopotamian Plain is under the influence of the collision of the two tectonic plates represented by the Arabian Plate and the Iranian Plate, in addition to what it causes from the compression of the ancient and deep layers of salt to uplift as salt domes, leaving its impact on the surface features in the region. Some of the salt domes appeared on the surface in the region, represented by Jabal Sanam in the far southwest of the city of Basra. Tectonics left their mark on ancient river courses, which forced some rivers to change their paths and turn to other paths, where the ground level is lower than that. The best example in this study is the course of the Shatt al-Arab River and the meanders they suffered in its course within the Basra region. One of these meanders is in the north and two are in the south of the city of Basra. Certainly, changing river courses due to tectonics calls for humans in the past to follow those streams and consequently to the continuous movement and change in population agglomerations, and this is what we see now in the pattern of distribution of ancient cities in the region.

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TELL KHAIBER AND THE SEALANDS

The excavated occupation at Tell Khaiber primarily dates to the First Sealand Dynasty, when it was the location of a large-scale, fortified building that had local administrative functions in the mid-16th century BCE. However, its connections to the sea itself are perhaps less

obvious, not least because of the arid, inland landscape that now surrounds it. Nonetheless, Tell Khaiber does sit within a wider set of connections that situate it as much in the marine region of the northern end of the Gulf as in the southern end of southern Mesopotamia. There is also surprising evidence from the site of links across the Indian Ocean that suggests access to a much wider network of maritime interactions.

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TIMING OF REGIONAL DRYING AND CHANGES IN FREQUENCY AND/OR STRENGTH OF SHAMAL DUST EVENTS THROUGHOUT THE 3RD MILL. BC

Human-timescale palaeo-climate records are a critical tool for exploring the relationship between past societies and their environment. I present here a unique archive for reconstructing past rainfall and dust events in the Mesopotamia region – a cave stalagmite collected from the Alborz Mountains in northern Iran. A majority of aeolian dust which reaches the south side of the Alborz mountains is sourced from the Mesopotamia region. The age model of the Iran stalagmite suggests that the stalagmite formed continuously through the 3rd mill. BC, producing a 1500-y climate and environmental record able to be sampled up to annual resolution. The ratio of Mg/Ca in the stalagmite exhibits sudden increases from 2560-2450 BCE (110 y) and 2310-2020 BCE (290 y), interpreted as shifts to periods of increased Mesopotamia-sourced dust. The Mg/Ca event start and end dates are based on U-Th radiometric ages, which have an average age uncertainty of 30 y (1s) in this stalagmite. The events demonstrate threshold behaviour in dustiness of the Mesopotamia region, due to either enhanced aridity, stronger winds, or change in soil properties or vegetation cover. Additional information on regional rainfall amount preceding and during the dusty periods is found in the same Iranian stalagmite sample and in other East Mediterranean speleothem records, which show increases in carbonate oxygen and carbon isotopes, interpreted as an indication of regional and local dry conditions, respectively.

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RECONSTRUCTING THE WATERSCAPES OF TELLS IN SOUTHERN MESOPOTAMIA: REMOTE SENSING AND
GEOARCHAEOLOGICAL SURVEY RESULTS FROM GIRSU

This paper presents the first reconstruction of the waterscape of Girsu, southern Mesopotamia, based on remote sensing, geoarchaeological fieldwork and C14 dating. It demonstrates that a dynamic and complex waterscape existed around this important urban centre of the Lagash city-state, consisting of multiple, shifting channels, which were used and re-used at different times. The C14 dates of shell and charcoal samples obtained from the main channels range between 5000-2000 BC. This corresponds with the main occupational phases at Girsu and with the relative chronology of channel activity deduced from the satellite imagery. Some shell C14 samples pre-date the associated archaeological evidence, highlighting the impact of the hard-water effect from the Euphrates and/or Tigris rivers, which is estimated to be 350-1000 years at Girsu. Besides providing the first detailed picture of the waterscape of Girsu, our approach, applicable to tell-sites throughout southern Mesopotamia, also offers a geomorphological model explaining channel visibility and preservation.

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HOLOCENE CLIMATE VARIABILITY IN THE NEAR EAST AND ITS IMPACT ON THE HISTORY OF CIVILISATION

Mesopotamia gave rise to the first urban-type societies with complex political hierarchies. Its rich history full of important cultural achievements was accompanied by fundamental environmental changes over the Holocene. While geo-bio-archives from the broader region reflect some variability in climate histories, there is a clear consensus on a more humid climate regime during the Early Holocene, promoting early rain-fed agricultural practices in Northern Mesopotamia, underpinning the foundation of initial urbanisation. In the southern basin, decreasing rainfall and higher competition for natural resources at a somewhat later stage in combination with the development of irrigation techniques and the transgression of the sea seem to have contributed to the formation of complex societies at sites such as Eridu, Ur, and Uruk, where landscape dynamics are well preserved in the stratigraphic record. At a more local scale, we present original sediment-core data from the tell of Uruk that provides crucial evidence for reconstructing the regional palaeoenvironmental changes, in particular regarding the transgression of the sea. In this context, we review the most important narratives of the biblical flood myth (Genesis Flood, Great Deluge) from the wider region based on the presented geoscientific evidence.

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ARCHAEOLOGICAL GEOPHYSICS: MAGNETIC TRACES IN THE MARSHY ENVIRONMENT OF SOUTHERN MESOPOTAMIA

Geophysics provides a wide range of archaeological prospecting methods that allows on the vast majority of sites a detailed view beneath the near surface underground. Among these methods magnetic, radar and electric prospection are highly efficient skills to survey the first 1-3 meters beneath the ground by a sufficient high spatial resolution.

First test measurements by high sensitive total field magnetometers in Mesopotamia took place in Iraq for the first time 1989 in Assur, since then 2001 in Uruk-Warka, furthermore in Charax-Spasinu, Ur, and Fara-Shuruppak.

Among detailed settlement features at all of the sites our magnetometer prospecting results have additionally revealed a great variety of remains from urban water management. Among them traces of canals, dams, harbours, water gates, bridges and probably shipwrecks, as well as traces of catastrophic floods.

Based on these results, I will discuss the specific capabilities and the potential pitfalls of geophysical prospecting methods and their archaeological interpretation.

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SEDIMENTARY MINERALOGY AS A TOOL IN GEOARCHAEOLOGICAL RESEARCH

1. RATIONALE

Human settlements are commonly located along major rivers or near river confluences, representing most suitable sites for transport and trade. Alluvial plains are among the most populated areas on Earth and rivers wander continuously across them. River courses may shift laterally over tens and up to hundreds of kilometers, even in a single series of floods or more gradually during dozens of years. Locating ancient river courses may be crucial in geoarchaeological research to establish preferential choices in the location of settlements and pathways of human migration and trade. Sediment mineralogy proves to be a powerful tool to solve this and other related geoarchaeological issues.

Every river carries sediment with a distinct mineralogical signature. Therefore, analysing sediment from boreholes of river terraces located near ancient human settlements can help identify why the site was originally chosen and the goods that could be most easily and cheaply transported to and from the site. Another issue that sediment mineralogy proved able to successfully solve is the identification of the origin of pottery and other tools crafted by using sand temper (Dickinson, 2006; Mange and Bezeczký, 2007).

2. METHOD

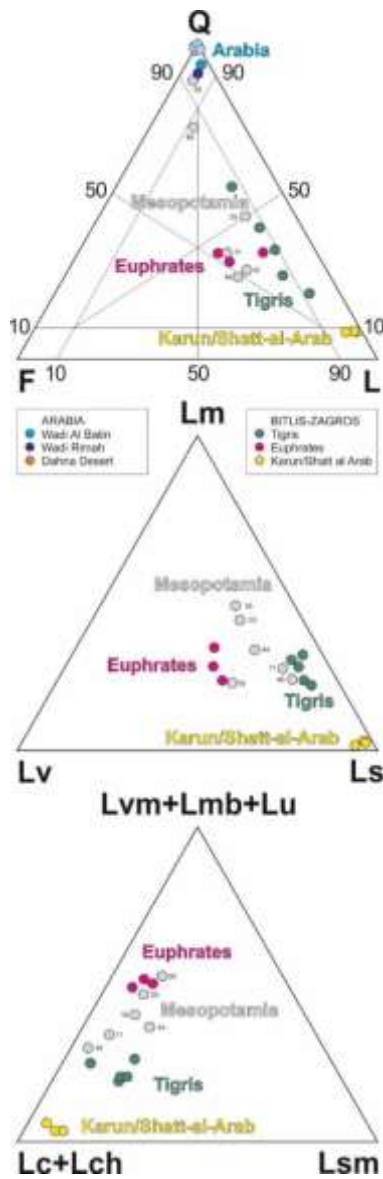


Figure 1. Comparison among the petrographic fingerprints of different sources of Mesopotamian sediments (data after Garzanti et al., 2013, 2016). Q = quartz; F = feldspars; L = lithic fragments (Lm = metamorphic; Lv = volcanic; Ls = sedimentary; Lvm = volcanic + metavolcanic; Lmb = metabasite; Lu = ultramafic; Lc = carbonate; Lch = chert; Lsm = other sedimentary and metasedimentary types).

A sample of loose sand-sized material is impregnated with epoxy resin and cut into a standard thin section, which is analysed by classifying and counting several hundreds of sand grains under the petrographic microscope (Garzanti and Vezzoli, 2003). This bulk-sediment petrographic analysis is beneficially complemented by high-resolution analysis of denser accessory minerals, which can be efficiently separated from a quartered aliquot of the same sample by centrifuging in sodium polytungstate (density $\sim 2.90 \text{ g/cm}^3$) and recovered by partial freezing with liquid nitrogen (Andr, 2020). On grain mounts, 200 transparent dense grains at least are point-counted at suitable regular spacing under the petrographic microscope to obtain real volume percentages (Garzanti, and Andr, 2019). A crucial parameter, obtained by combining the weight of the dense fraction with quantitative optical determinations, is the tHMC (transparent Heavy Mineral Concentration) index, which expresses the amount of transparent heavy minerals contained in the bulk sample (Garzanti and Andr, 2007).

Coupling petrographic and heavy-mineral analyses allows us to fingerprint each sample with over 50 compositional parameters, representing a unique signature. If the sample is an archaeological object, then its mineralogical fingerprint can be compared with those of sand found in diverse rivers or beaches in the region until a satisfactory match is obtained. Such a match is not invariably precise or univocal, but even in the less fortunate case the comparison allows us to test hypotheses and discard those that are not supported by the observations.

3. MESOPOTAMIAN CASE STUDIES

Mesopotamia hosts among the most important archaeological sites on Earth and is thus an ideal place to apply mineralogical tools to geoarchaeological research (Altaweel et al., 2019). The two main rivers, the Euphrates and the Tigris, drain different areas within the vast geological domain including the Anatolia Plateau and the northern Zagros Mountains. Additional sediment brought to western Mesopotamian lowlands is represented by dust

and sand blown by wind from the Arabian Desert, the mineralogy of which chiefly consists of quartz. The eastern side of Mesopotamia, instead, receives sediment carried by left-bank tributaries of the Tigris River draining the Zagros Mountains and, in the south close to the Gulf, by the Karun River draining mostly carbonate rocks in Iran. Sediment derived from each of these sources can be readily distinguished based on its diagnostic mineralogical fingerprint (Figure 1).

3.1. Dalmaj and Nahrawan Paleochannel Sites (Altaweel et al., 2019)

3.1.1. Petrographic and heavy mineral data. Sands collected in the Dalmaj and Nahrawan paleochannel sites (Figure 2) have both quartzo-feldspatho-lithic sedimentaclastic composition (classification after Garzanti, 2019) but can be clearly distinguished based principally on their diagnostic rock-fragment populations and heavy-mineral suites.

The three samples collected in the Dalmaj site (A1/5, A2/3, A4/4) have higher quartz, higher monocrystalline/polycrystalline quartz ratio, higher K-feldspar, higher volcanic grains, higher plutonic rock fragments, higher medium-rank to high-rank metasedimentary grains, and higher MI* and MI indices. Cellular serpentinite and serpentineschist grains are common and particularly distinctive. Micas are quite common, with biotite dominating over muscovite. Moderately rich heavy-mineral assemblages include minor hypersthene and rare enstatite.

The two samples collected in the Nahrawan site (A9/3, A10/4) have very high carbonate grains (but lower dolostone/total carbonate ratio) and much more abundant chert than Dalmaj sands. Shale/slate and siltstone/metasilstone grains are locally very common. Moderately poor heavy-mineral assemblages include more Cr-spinel and a little more epidote and prehnite. The higher HCI index reflects common presence of kaersutite and oxy-hornblende.



Figure 2. Location of samples collected in the Dalmaj and Nahrawan paleochannel sites (Altaweel et al., 2019).

3.1.2. Interpretation by comparison. Dalmaj paleochannel sands are richer in volcanic detritus (including plagioclase and volcanic lithics), contain more orthopyroxene than Tigris sand, and are richer in sedimentary detritus (especially carbonate rock fragments) than Euphrates sand. Forward compositional modelling based on integrated petrographic and mineralogical parameters (Garzanti et al., 2012) indicates contribution of Euphrates and Tigris Rivers in proportion 1:1.

Nahrawan paleochannel sands are much richer in chert, contain more kaersutite and oxyhornblende, and are poorer in quartz, serpentinite, medium/high-rank metamorphic rock fragments and mica than Tigris sand, revealing significant supply from the Diyala River. Low heavy-mineral concentration and relative abundance of Cr-spinel indicates recycling of foreland basin sediments accreted to the Zagros foothills. Forward compositional modelling based on integrated petrographic and mineralogical parameters indicates contribution from the Tigris and Diyala Rivers in proportion of about 2:1. No contribution from the Euphrates is indicated.

3.1.3. Diagnosis. The mineralogy of studied sediments indicates that the Dalmaj site was located close to, or downstream of the Euphrates-Tigris confluence and that the Nahrawan site was located close to the Tigris-Diyala confluence (Figure 3).

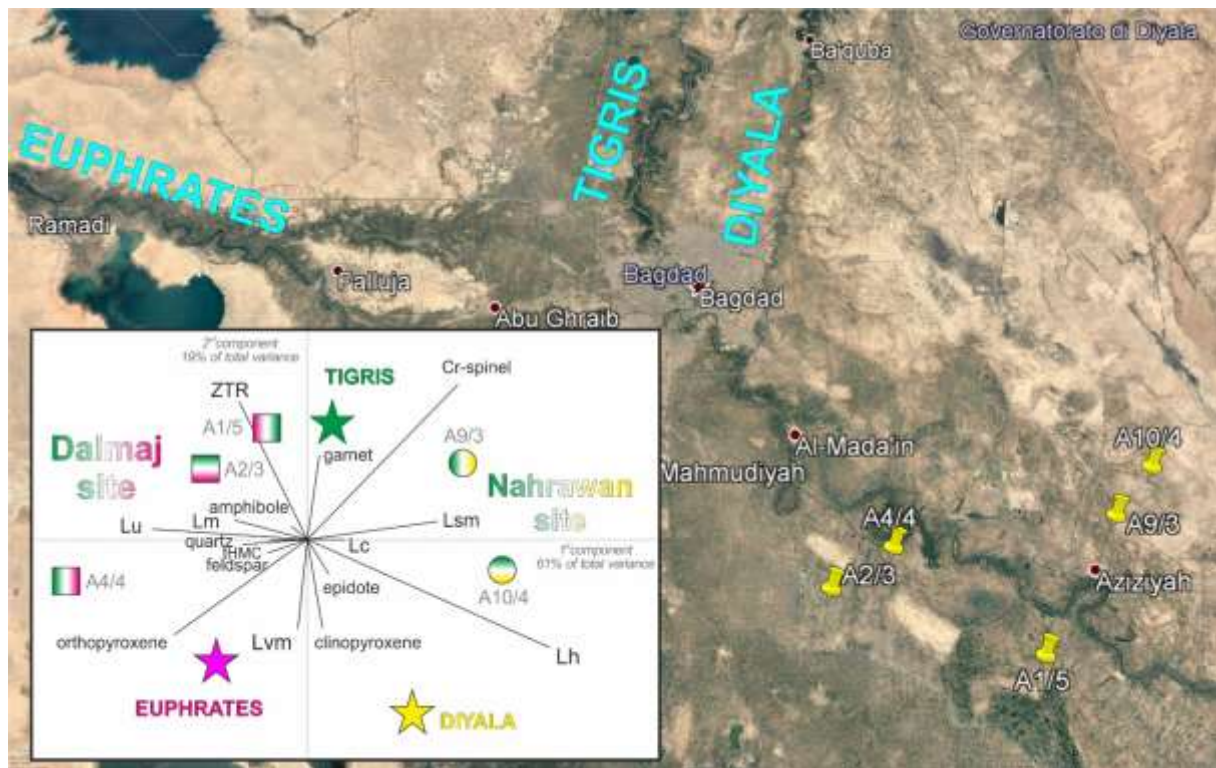


Figure 3. Coupling petrographic and heavy-mineral analyses sheds light into river drainages and landscapes of ancient Mesopotamia (Altaweel et al., 2019). L = lithic fragments (Lc = carbonate; Lh = chert; Lsm = other sedimentary and low-rank metasedimentary; Lvm = volcanic and metavolcanic; Lm = metamorphic; Lu = ultramafic; tHMC = transparent heavy-mineral concentration; ZTR = zircon + tourmaline + rutile. The compositional biplot (Gabriel, 1971) displays the relationships among both multivariate observations (points) and mineralogical variables (rays). The length of each ray is proportional to the variability of the parameter in the data set. If the angle between two rays is close to 0°, 90°, and 180°, then the corresponding parameters are directly correlated, uncorrelated, or inversely correlated, respectively.

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THE TIGRIS-EUPHRATES DELTAIC COMPLEX AND ITS RELATION TO THE LAGASH FLOODPLAIN

Settlement in Mesopotamia was determined by the size and distribution of its river channels, most notably the Tigris and Euphrates. But the delta(s) these rivers built, and the unique ecological setting that followed, resulted from an interplay between coastal (sea level) and fluvial (river) processes. This dynamic exchange supplied the necessities of life, and their location: from the basics of land and water to the more unknowable but no less significant specifics of nutrient fluxes and biota. To understand what this landscape looked like at critical points in history, we need to model the formation and evolution of the entire Tigris-Euphrates deltaic complex. We also need to define delta type. Beginning with the worldwide initiation of deltas brought on by a deceleration in sea-level rise, Iraq's southern alluvium developed in a process that continues today, in fits and starts. The growth of the Karun-Karkeh alluvial fan in Khuzestan would play a role just as important as those in the Tigris and Euphrates basin. This paper considers the timing and location of these events over the *longue durée*, with a particular focus on the period of the first cities. Analysis of geoarchaeological data recently collected from the Lagash region will be presented and contextualized with previous studies to better explain the state of Lagash in the 3rd-millennium BCE, including shifts in demography, political alliances and seats of power, as well as its proximity to the sea.

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ETHNO-ARCHAEOLOGICAL MODELS OF WATERSCAPE AND LANDSCAPE IN THE MARSHES OF SOUTHERN IRAQ

The paper will present ethno-archaeological models of waterscape and landscape in the marshes of southern Iraq that could be applied in antiquity and can enhance our understanding of settlement and canal system most-southern part of Sumer.

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ARCHAEOLOGICAL ACTIVITIES IN DHI-QAR AND LEGISLATIVE FRAME

The first part of the paper will present the work of the joint archaeological missions active in Dhi-Qar Province and the efforts carried out by the archaeologists of Iraqi State Board of Antiquities and Heritage in assisting the foreign teams. The second part of the speech will introduce the Iraqi Antiquities and Heritage law in order to provide a comprehensive normative frame for the archaeological missions working in the Country.

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CHANGING RIVER COURSES AND THEIR RELATIONSHIP TO SETTLEMENTS

Several river avulsions have been identified, five for the Euphrates and six for the Tigris. It has been found that these avulsions contributed to the shaping, formation and aggradation of both the ancient and present-day landscapes of the floodplain. Two kinds of avulsion have taken place in the floodplain, re-occupational and progradational. In the first of these types of avulsion, the major flow diverted into a previously existing channel. In contrast, the progradational avulsion began by inundating a large section of the floodplain between elevated ridges, producing prograding deposits that filled topographic lows of the floodplain.

These avulsions have affected the distribution, flourishing and degradation of human settlements of the southern Mesopotamian civilisations. The present study has demonstrated how human impact played a leading role in distribution of sediments across the floodplain and shaping both the Holocene and the recent landscapes of the Mesopotamian floodplain. By using periods of human occupation of archaeological sites to date associated palaeochannels, we can get acceptable accuracy on their timing and duration, and can give clear indications about the activity of a given channel.

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GEARCHAEOLOGY OF FLUVIAL HARBORS. CASE STUDIES: ISONZO DELTA (AQUILEIA, ITALY), DANUBE DELTA (NOVIODUNUM, HALMYRIS, ORGAMŃ, ROMANIA) AND THE NILE (GIZA, EGYPT).

In fluvial areas, at base level, under a context of relative sea-level stability during the past 6,000 years, one important question relates to the impact of environmental conditions on human settlements around rivers and estuaries. Historiography has developed a number of deterministic models but how do these fair in the light of recent palaeo-environmental data? What was the impact of these occupations on the evolution of fluvial environments? How did ancient societies use and overcome, or not, the environmental potentialities and specific constraints linked to the occupation of these environments, including accessibility, navigation conditions, sediment infilling and floods. Here we present some recent multidisciplinary case study examples of fluvial harbours. We attempt to estimate the weight of natural forcing agents on the different harbour sites and underline the important roles of environmental changes and the sedimentary infilling of the ports at different spatial scales. These processes impacted upon the infrastructure and the viability of the harbours to varying degrees.

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AVULSION STYLES, CHANNEL NETWORKS, FLOODING, AND BRONZE AGE SETTLEMENT PATTERNS IN LOWER MESOPOTAMIA

Bronze Age civilizations of lower Mesopotamia, Egypt, and Indus valley emerged in an arid and semi-arid climate and critically depended on river channel networks and irrigation for their survival. In lower Mesopotamia, urban settlements appeared during a period of rapid Tigris-Euphrates delta progradation following post-glacial marine transgression of the Gulf. The low-gradient deltaic plain with elevated alluvial ridges was a favorable site for avulsions. The Euphrates and Tigris avulsions changed the positions of river courses over time. Avulsion styles (incision, progradation, annexation) affected channel network types (single- or two-channel vs multiple-channel), the duration & extent of floodplain flooding, and the resulting sedimentation patterns.

The earliest urban settlements in the delta pre-dated large-scale artificial irrigation by hundreds of years. Unlike rural settlements that could be sustained by small-scale 'crevasse' irrigation, emerging cities required the generation of food surplus provided by large nearby naturally-irrigated areas that could be readily transformed into farmland with high agricultural productivity. Avulsions by incision and annexation created single-channel or two-channel patterns and did not result in long-term floodplain flooding. On the other hand, during progradational avulsions, large sections of a deltaic plain were flooded by avulsion lakes, multiple-channel networks (distributary and/or anastomosed) developed feeding splay complexes and lacustrine deltas and depositing sandy and silty sediment. Avulsion lakes can cover ~102-103 km² and form during large floods when the flow breaks through the levee and inundates low-lying floodbasins. On poorly-drained floodplains, avulsion lakes last for centuries until they are filled with sediment and their multiple-channel feeder networks are abandoned. Changes in avulsion styles and disappearance of avulsion lakes as a result of the Tigris-Euphrates delta evolution combined with increased climate aridity led to the decline of many ancient cities, major population migrations, and changes in settlement patterns. Urban settlements have since been sustained by large-scale artificial irrigation.

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DETERMINATION OF THE ANCIENT SHORELINE AND ANTHROPOGENIC SITES USING REMOTE SENSING TECHNIQUES

Besides the neotectonic and erosional activities, the sea level could be changed as a result of climate fluctuations. It is the case of the Gulf sea level, which changed during the geological evolution of the Tigris-Euphrates delta in the Holocene epoch. Several researches proposed that the shoreline of the Gulf was about 260 and 270 km north of the present-day shoreline at 6000 yr. BP. If so, the Ur, Uruk, Lagash, Girsu, Bad-tibira, Larsa,

Eridu, and Susa would have been covered by the seawater, which is not the fact. On other hand, these researchers agreed that these sites are coastal cities. This study comes to modify the previous shoreline suggestion and give visualization to the boundaries of the Gulf shoreline during the Sumerian period using remote sensing and GIS techniques. Moreover, we used the same techniques to detect anthropogenic sites. This study highly recommends using remote sensing data and GIS techniques with accurate methodologies and data processing to give a clear overview of the archaeological sites.

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WATERWAYS AT SHURUPPAK AND UR. NEW IDEAS FROM OLD SITES

Renewed investigations at Ur and at Fara, ancient Shuruppak, included geophysical prospections and a survey of the lower towns. These have brought to light structures which – combined with archaeological evidence and in comparison with textual evidence and archaeological evidence at other sites – can be tentatively identified with canals, a harbour with a quay wall, and possibly a bridge. The joint paper by Jurg Fassbinder, Berthold Einwag and Adelheid Otto will present the combined geophysical, archaeological and historical data of the structures.

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ISLANDS IN THE STORM. TURTLEBACKS, TELLS, AND MARSHLAND CITIES

Especially problematic in understanding interactions between Sumerians and their water-dominated environments is resolution of spatial and temporal scales. Deltaic, and especially estuarine, evolution is highly variable on both measures, whether recorded in human or geological time.

Answers to fundamental questions regarding urban emergence (Why here, and why not there?), persistence (Why now, and not earlier or later?), and lifespan (Why growth? Why decline? Why abandonment?) depend, first and foremost, on validating when and where both necessary and sufficient conditions for construction and maintenance of the architectures, enduring institutions, and material practices subsumed under the concept of civil societies existed and endured.

In this overview, I will revisit the state-of-the-field regarding the relationships among marine incursion and withdrawal, deltaic progradation and inundation, and cities and settlements in the Euphrates-Tigris-Karkeh-Karun delta. Two decades ago, that floods, sea-level fluctuations, climatic changes, and storm events left lasting impressions in arts, literature, accounting records, and physical landscapes was not contentious --- but the overarching wetland nature of those landscapes was contentious indeed.

In this overview, I will return to the model of “turtleback” towns I first posited in around 2001. Following a brief review of wetland urbanization in the Chari basin (Chad), the Nile Delta, and Sumer, I present and discuss sedimentary core facies reconstructed from a comprehensive literature review of the T-E-K-K case, in order to more fully model the evolution of an idealized Sumerian marshland settlement as it endures as an urban center, declines in importance, or vanishes entirely under coupled anthropogenic – geomorphologic influences.

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ERIDU AND THE SEA: A LONG-STANDING ISSUE

Since the very beginning of fieldwork research at Eridu the question arose as to its relation to the sea. The site might never have been near the sea shore but obviously developed in a changing and maybe alternating environment, from wetlands to a fluvial valley to a near-desert in the present days.

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DRILLING IS NOT BORING: GEOARCHAEOLOGICAL RESEARCH AT ABU TBEIRAH

The paper will introduce the geo-archaeological research carried out at Abu Tbeirah. The presence of natural channels outside the city and artificial canals and water related facilities inside it will be analysed first on the basis of satellite imagery. The evidence will be then compared with the results obtained on the field. The environmental setting of the site and the evolution of the palaeo-channel crossing Abu Tbeirah will be described and connected to the history of the settlement. As final part of the paper, the experience gained during our field research at Abu Tbeirah will be shared, highlighting the practical issues encountered and the solutions undertaken.

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MANAGING THE ANCIENT TIGRIS IN THE LATE 3RD AND EARLY 2ND MILLENNIUM BC.

This paper will present the results of the study of cuneiform administrative documents on the management of water courses in the Umma Province of the Ur III period (2112-2004 B.C.). It describes the integrated water management system that was adopted in ancient Umma during the late 3rd and early 2nd millennium BC, which controlled the ancient Tigris and its tributary not only for irrigation but also for river navigation and flood control. While irrigation was crucial for the production of the much-needed agricultural surplus, water born transportation enabled efficient distribution throughout the state and its urban centers. Furthermore, given that peak flooding of the Euphrates and Tigris coincides with the harvest, flood control was essential for the economic health of the Ur III state. The

second part of this paper will discuss how the question of water management in this region will be investigated from a geomorphological and archaeological point of view in the framework of the ongoing Umma Survey Project.

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THE «RIVERS OF MESOPOTAMIA» RESEARCH PROJECT

Throughout the millennia, the physical landscape of the Mesopotamian alluvial plain has altered continuously due to ever-shifting rivers and periodic flooding, as well as human endeavors to secure prosperity and meet the economic needs of growing populations in a semi-arid climate. The topography of the alluvial plain still bears witness of the close entanglement of these past natural and anthropogenic processes. Spatial patterns of archaeological sites indicate long-gone watercourses. And the construction of canals, the maintenance of dams, inland navigation routes, etc. are well documented by cuneiform texts from different periods. Over the last six decades, archaeologists, geoscientists, and cuneiformists have contributed pathbreaking studies on the reconstruction of Mesopotamia's ancient riverscapes. However, there remains an enduring demand for further basic research — especially in light of new technologies and today's standards for accessible and reusable digital data. Thus, in January 2019 the research project «Rivers of Mesopotamia» (RIMES) started at the University of Bern with the aim of displaying the various and heterogenous data on former river systems in Lower Mesopotamia in interactive and dynamic web-maps and network visualizations. With this in mind, our research mainly focuses on remote sensing and mapping of paleochannels and network analysis of rivers and canals in historic text sources (primarily from the Ur III period). By including data on settlement occupation from published surveys and linking the respective geo-spatial, temporal and semantic data with one another, we pursue a holistic approach to improve the knowledge on the dynamic layout of the riverscape of ancient Mesopotamia. Our paper outlines the methodology of the «Rivers of Mesopotamia» project and provides an initial insight into the current state of our research.

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FROM THE MARSHES TO THE SEA: THE WATERSCAPE OF ANCIENT SUMER

The urbanized landscape of ancient Mesopotamia, which is the only one that the texts describe in detail, is dominated by the water element. Canals and rivers cross and connect the Southern Mesopotamian cities. What's more, these cities lie on the seacoast or in the midst of lagoons and marshes. In my paper, I discuss passages from Sumerian literary texts and royal inscriptions dealing with this unique waterscape. I analyze the evidence from different points of view, from economy to ecology, from politics to religion, to illustrate that the trinomial marsh - lagoon - sea constitutes a continuum where the elements follow each other without interruption.

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RECONSTRUCTING LANDSCAPE EVOLUTION IN THE HINTERLAND OF CHARAX SPASINOU, THE CAPITAL OF MESENE

From its foundation to its heydays as trading hub and to its final abandonment, the history of Charax Spasinou was intimately connected with the evolution of the river systems of the southernmost part of the Mesopotamian plain and the shoreline of the Gulf.

This ongoing research, which is part of the Charax Spasinou Project of the Universities of Konstanz and Manchester supported by the German Research Foundation and the Culture Protection Fund of the British Council, aims to reconstruct the evolution of the landscape and palaeoenvironment around the capital of Mesene, by combining evidence from remote sensing data and geological coring. Here, results from the analysis of satellite imagery and a preliminary field campaign carried out in 2018 will be presented.

It will be demonstrated that a combined geological and archaeological survey in the wider hinterland of Charax allows an accurate reconstruction of the ancient watercourses and the landscape of Mesene, in which the capital was the nodal point for nearly a millennium.