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Plenary Agenda Report for Research Group A-I

Central Places and Their Environment – Preliminary Results from the Research Group

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- Brigitta Schütt (Physical Geography, Freie Universität Berlin)
- Stephan Seidlmayer (Cairo Department of the German Archaeological Institute [DAI], Berlin)
- Christiane Singer (Physical Geography, Freie Universität Berlin)
- Dietrich Wildung (Ägyptisches Museum, Staatliche Museen zu Berlin/Stiftung Preußischer Kulturbesitz)
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see also Table 1

Keywords: Geoarchaeology Human-Environment Interactions • Migration • Settlement History • Traditional Knowledge • Water Harvesting

Abstract: The projects of the Research Group »Central Places and Their Environment« involved investigations of individual sites having the character of central places or of limited regions within which networks of settlements were present. Cities, seats of power, and sacred sites are investigated in terms of their significance for and shaping influence on surrounding regions. These themes are explored through direct collaborations between scientists from the archaeological and earth sciences respectively. The focus of our investigations is the network of relations between central sites or settlements in spaces of limited extension and their surroundings. This involves reconstructing the development of the respective central site and of the historical landscape, as well as of various site factors, and analyzing the structure of relationships with the surrounding territory and the connecting region. The types of influence exerted by such central places on the surrounding space are compared in terms of various cultures, regions, and societal systems. The focal areas of investigation are the Mediterranean region, the Black Sea area, Central Asia, and the Middle East. Studies include central places for which adequate historical sources are available, but also sites from preliterate epochs.

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Projects:

- A-I-1 »Pyramids of the Steppe: Archaeological and Geoarchaeological Investigations in Semirechye, Kazakhstan« (Hermann Parzinger, Christiane Singer)
- A-I-2 »Taganrog: Central Sites of an Early Greek Polis in the Northeastern Black Sea Region« (Ortwin Dally, Christiane Singer)
- A-I-3 »At the Transition from Late Antiquity to Islam: Resafa in Syria: Cult Site and Center of Power in Relation to the Landscape« (Dorothée Sack, Brigitta Schütt)
- A-I-4 »Felix Romuliana: A Late Ancient Imperial Palace and Its Surroundings« (Ulrike Wulf-Rheidt, Brigitta Schütt)
- A-I-6 »Archaeological and Geoarchaelogical Investigation of the Aleppo Hinterlands« (Kay Kohlmeyer, Brigitta Schütt)
- A-I-7 »Egypt Lies in Africa: Paleoenvironmental Reconstruction in Naga, Central Sudan« (Dietrich Wildung, Brigitta Schütt)
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- A-I-9 »Monti Navegna e Cervia: Geoarchaeology and Landscape Development in an Italian National Park« (Katja Moede, Friederike Fless, Philipp Hoelzmann, Brigitta Schütt)
- A-I-10 »Settlement History of the Southern Harz Mountains« (Michael Meyer, Wiebke Bebermeier, Philipp Hoelzmann)
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- A-I-16 »Monumental Architecture in the Nabataean Capital Petra (Jordan): Graves and Palaces« (Stephan G. Schmid, Brigitta Schütt)
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- A-I-18 »Punic Settlement Strategies Using the Example of Erice Settlements« (Katja Moede, Salvatore De Vicenzo)
- A-I-20 »Topographic-Archaeological Documentation and Historical Interpretation of the Central Asian Cultural Phenomenon of the ›Long Oasis Walls‹ Settlements« (Sören Stark)

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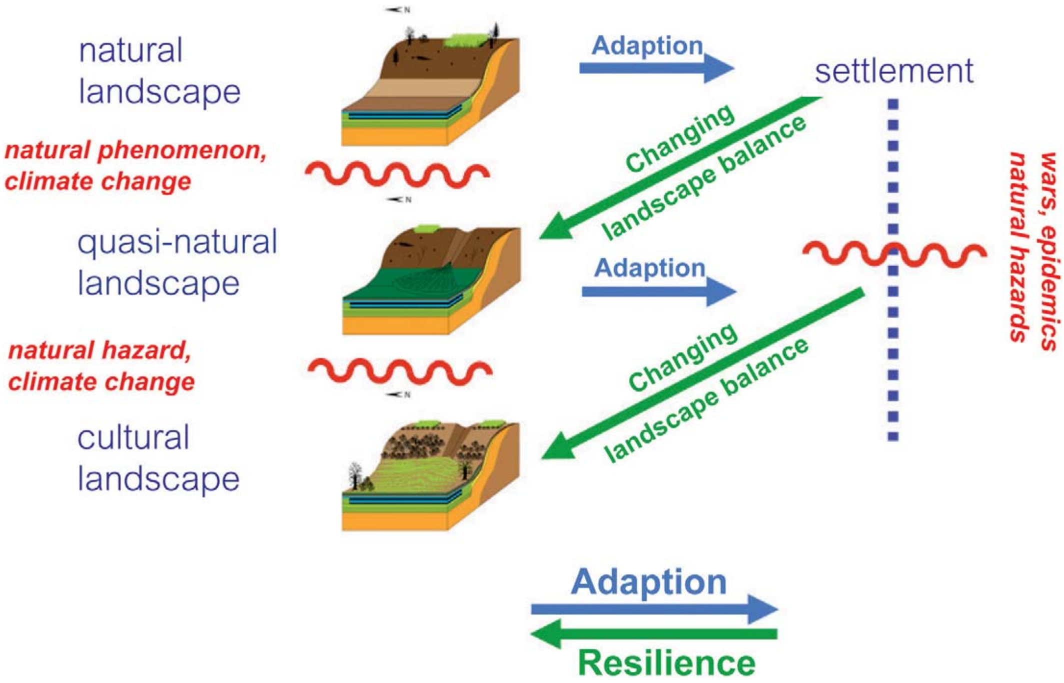

Fig. 1 | Sketch showing the dynamic relations arising as humans adapt to natural and quasi-natural environments; at the same time, this process of adaptation alters the landscape's material fluxes, challenging its capacity for resilience and triggering a readjustment of its dynamic equilibrium.

1 Introduction

The primary interest of Research Area A – Spatial Environment and Conceptual Design is the reconstruction of spatial environments and their shaping by humans as they adapt to the natural environment. This involves analyzing the interrelationship between natural conditions and modes of adaptation with a focus on the formation of space.

The conceptual model shown in Figure 1 was adopted as the basis for the process of identifying these interrelationships. It is assumed that during early settlement history, settlement characteristics corresponded to localized forms of adaptation to the natural environment. While these impacts were small or negligible during the earliest settlement phases, the ongoing development of human adaptive strategies involved increasingly substantial interventions in the natural landscape and decreasing levels of dependency on local environmental conditions (SCHÜTT 2006b). Meanwhile, each type of settlement affected the landscape's dynamic equilibrium, causing changes in material fluxes. Today, these material fluxes – which include sedimentary and hydrological fluxes – can be reconstructed by analyzing the divergent landscape configurations they engendered (SCHÜTT 2006a; SCHÜTT 2006c). In contrast, the reconstruction of fluxes such as nutrient fluxes and fluxes in the context of metalworking requires chemical analysis of the underlying sediments. While these interrelations involve ongoing processes of adaptation and resilience, natural and social catastrophes such as tsunamis, droughts, wars, and epidemics were capable of interrupting this process of development, even to the point of bringing about the total destruction of a given settlement and its environs (SCHÜTT 2006a).

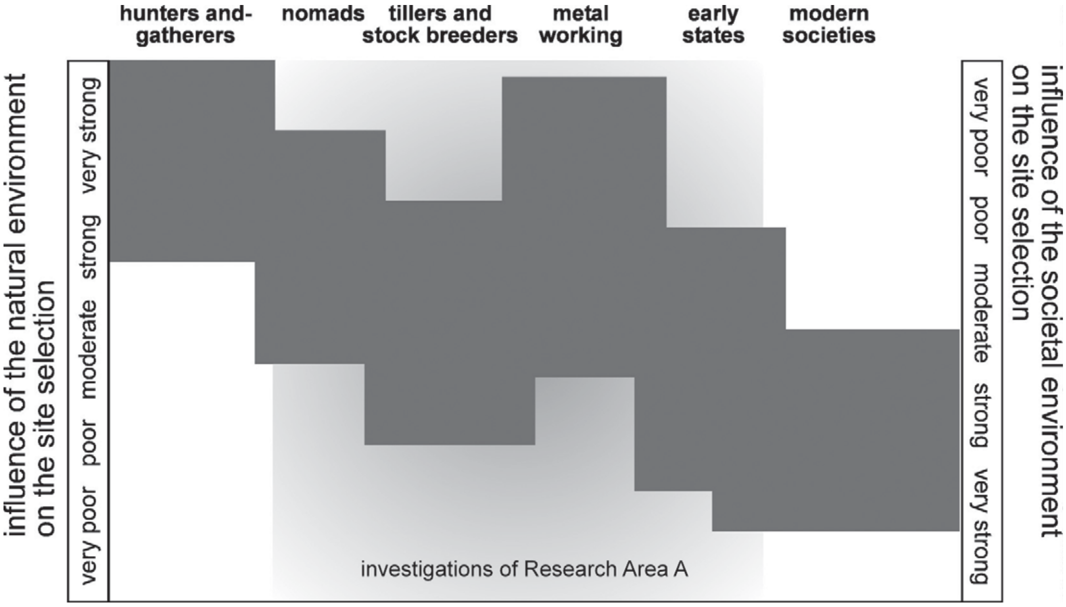

Fig. 2 | Schematic diagram showing the changing influence of natural and cultural environments on site selections throughout human development (modified according to KVAMME 2006). The gray box in the background marks the societies that are the focus of the projects of Research Area A (Spatial Environment and Conceptual Design).

The projects in Research Area A focus on human societies that emerged between the late Neolithic period and the foundation of early states during antiquity (Fig. 2). Hunter-gatherer settlements were strongly conditioned by the natural environment, on which they had little impact – hence the difficulty of reconstructing them. In contrast, societal influence has predominated in modern societies, which are to a large extent detached from the natural environment. These societies give form to cultural landscapes and shape them according to their needs. These artificial landscapes are highly sensitive to natural phenomena such as extreme weather or tectonic events, and consequently may aggravate the effects of natural hazards (Fig. 1). Societies whose members lived as nomads, agriculturalists, livestock breeders or metalworkers were extremely dependent economically on natural resources, which in turn determined the choice of settlement location. In many cases, inefficiency in the use of natural resources was heightened through the increasing division of labor. Our focus is on interactions between these early societies and the natural environment, assessing key elements of human-environment interaction, including the transformation of societies that were shaped by the natural environment into ones which instead substantially shaped their environments into cultural landscapes. As a consequence, the projects of the group apply a variety of methodological approaches in order to analyze the development of a range of strategies of human settlement.

Three different research groups have been organized, each of which carries out its research at the interface between the methods and model building found in the earth and archaeological sciences respectively. The core of Research Group A-I is the Graduate Group *Landscapes*, while Research Group A-II *Spatial Effects of Technological Innovations and Changing Ways of Life* is organized as a Junior Research Group. The projects of Research Group A-III *Archaeometry – Archaeoinformatics* are devoted to basic research oriented towards the natural sciences. The process of bundling these segments into a unified research group served to hone these methodological approaches, facilitating their continued development while at the same time concentrating the natural scientific competencies within Topoi. The following overview summarizes the activities of Research Group A-I.

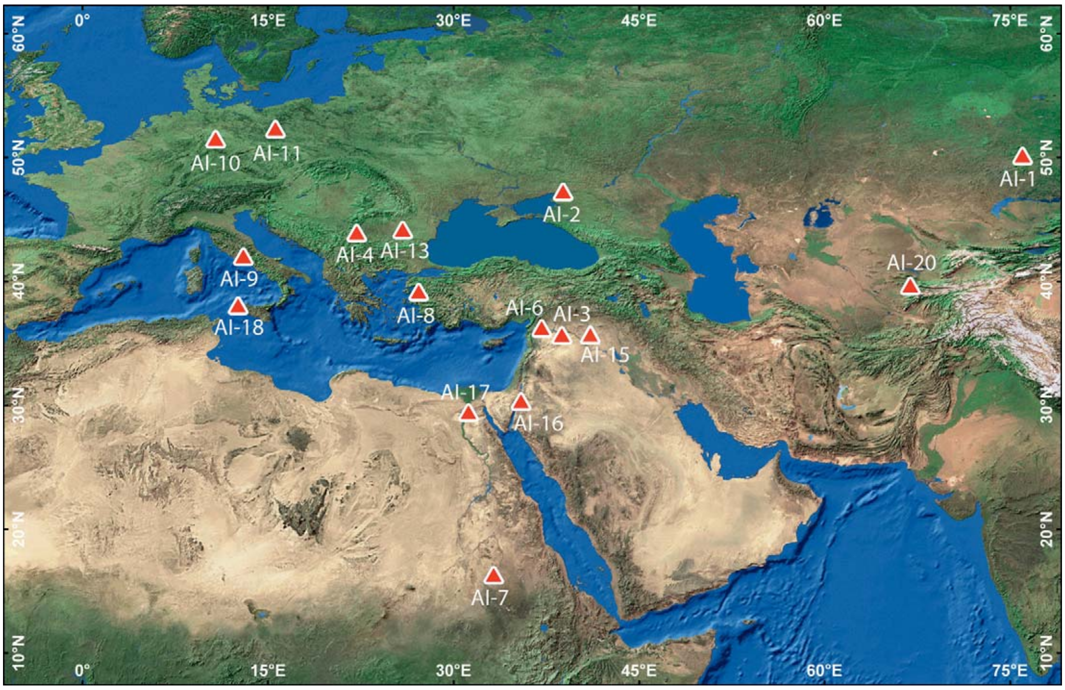

Fig. 3 | Locations of the sites investigated by Research Group A-I *Central Places and Their Environment*.

2 Research Group A-I *Central Places and Their Environment*

The primary focus of the Research Group *Central Places and Their Environment* is on individual sites having the character of central places and with delimited regions in which settlement networks were present. The identification of central and social places follows the theory of Walther Christaller, who focused on the concentration of a settlement's functions as an indicator of the existing settlement network and the hierarchical position of the individual settlement (CHRISTALLER 1941). On the basis of this concept, settlements were also included without any primary economic functions, and nodal points of each kind of settlement activity were identified (NAKOINZ 2009).

Cities, seats of power, and sacred sites are investigated in terms of their significance for and shaping influence on surrounding regions. The aim is to investigate the network of relationships between the central site or spatially limited settlements and their surroundings. This entails reconstructing the development of the respective central site and of the historical landscape, as well as of respective site factors, and analyzing the structure of relationships linking each settlement to the surrounding territory and the connecting region. The types of influence exerted by such central places on the surrounding space are compared in terms of various cultures, regions, and societal systems. These objectives are pursued at the interface between the methods and approaches to model building found in the earth and archaeological sciences respectively. The focal areas of investigation are the Mediterranean region, the Black Sea area, and the adjoining Eurasian steppes (Fig. 3). Our studies focus on central places for which adequate historical sources are available, but also on sites dating from preliterate epochs.

The research questions posed focus on the functions (religious-military-economic-administrative), scales (local-regional-supraregional), and locational factors of relevance to each selected central place, as well as on the relationship between each central place

Fig. 4 | Structure and major topics of the Research Group A-I *Central Places and Their Environment*.

and its environs or urban hinterland. It soon became evident that all of the central places under investigation featured more than one function, expanded on in different scales, and were premised on a variety of locational factors. In conceptualizing the various projects, we realized that the loading of the relevant characteristics varied between sites. On the basis of this discovery, we identified four major topics, in the process bundling the characteristics of the sites under investigation (Fig. 4). Owing to the complex character of the sites, most can be assigned to more than one major topic area.

The core of the Research Group *Central Places and Their Environment* is the Graduate Group *Landscapes*, which works jointly with supervisors and members of the research group (principal investigators). Fellows supplement the personnel infrastructure of the research group. In addition, the technical infrastructure required to conduct research is allocated by Topoi (automobiles, pollen laboratory, diverse instruments) and the Physical Geographical Laboratory (diverse lab and field instruments, corer). Additional expertise is obtained from experts who are invited to give lectures or to participate in discussion roundtables, or attend workshops.

Highlighted in the following paragraphs are selected research questions of Research Group A-I.

Principal Investigators	Topoi-Assistants, Topoi-Fellows, Other
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Prof. Dr. Georg Kaufmann, Geophysics, Freie Universität Berlin	Anton Gass, MA, Topoi-Fellow
Prof. Dr. Kay Kohlmeyer, Konservierung/Restaurierung/Grabungstechnik, Hochschule für Technik und Wirtschaft Berlin	Leon van Hoof, Topoi-Fellow
Prof. Dr. Hartmut Kühne, Ancient Near East Studies, Freie Universität Berlin	Christoph B. Konrad, Topoi-Fellow
Prof. Dr. Michael Meyer, Prehistoric Archaeology, Freie Universität Berlin	Dipl.-Geogr. Jan Krause, Topoi, Coordinator Research Area A
Dr. Katja Moede, Classical Archaeology, Freie Universität Berlin	Dr. Piotr Łuczkiewicz, Topoi-Fellow
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Prof. Dr. Dr.h.c. Hermann Parzinger, Stiftung Preußischer Kulturbesitz Berlin	Dr. Manfred Nawrozh, Assistant, Stiftung Preußischer Kulturbesitz Berlin
Prof. Dr. Felix Pirson, Istanbul Department of the German Archaeological Institute [DAI]	Karin Petrovszky, Winckelmann Institut, Humboldt-Universität zu Berlin
Prof. Dr.-Ing. Dorothée Sack, Historische Bauforschung, Technische Universität Berlin	Dr. Hervé Reculeau, Topoi-Fellow
Prof. Dr. Stephan Schmid, Winckelmann Institut, Humboldt-Universität zu Berlin	Dipl.-Geogr. Marlen Schlöffel, Topoi-Fellow
Prof. Dr. Brigitta Schütt, Physical Geography, Freie Universität Berlin	Dr. Frank Schlütz, Visiting Researcher, Physical Geography, Freie Universität Berlin
Prof. Dr. Stephan Seidlmayer, Cairo Department of the German Archaeological Institute [DAI]	Jana Škundrić, MA, Topoi-Fellow
Jun.-Prof. Dr. Christiane Singer, Physical Geography, Freie Universität Berlin	Dr. Sören Stark, Topoi-Fellow (since 2010: New York University, Institute for the Study of the Ancient World)
Prof. Dr. Dietrich Wildung, Ägyptisches Museum Staatliche Museen zu Berlin/Stiftung Preußischer Kulturbesitz	János Tóth, MSc, Topoi-Stipendiat
Dr.-Ing. Ulrike Wulf-Rheidt, Architecture Department of the German Archaeological Institute [DAI]	Dipl.-Geol. Burkart Ullrich, Geophysics, Freie Universität Berlin
	Dr. Salvatore De Vicenzo, Topoi-Fellow

Table 1 | Members of the Research Group A-I *Central Places and Their Environment*.

In February 2008, ten fellowships for graduates (each lasting three years) and two for postdocs (each lasting two years) were assigned in order to launch Research Group A-I and its Graduate Group *Landscapes*. Projects were defined in relation to the main topic of »Central Places,« and as a consequence of existing survey and excavation permits, tended to take the form of ongoing archaeological projects. Ideally, each project was to consist of archaeological and geographical investigations in equal parts, to be carried out by two PhD candidates, one from archaeology and one from physical geography, who would work together in tandem. Given the multiplicity of projects involved, this structure could not be adhered to consistently. Nonetheless, all projects of the Research Group *Central Places and Their Environment* are structured in ways that integrate the archaeological and earth sciences.

1 Projects conducted by equal ›tandems‹ consisting of two PhD candidates, one each from the archaeological and earth sciences respectively:

- A-I-1 »Pyramids of the Steppe: Archaeological and Geo-Archaeological Investigations in Semirechye, Kazakhstan« (Parzinger/Singer; 05/2008)
- A-I-2 »Taganrog: Central Sites of an Early Greek Polis in the Northeastern Black Sea Region« (Dally/Singer; 05/2008)
- A-I-3 »At the Transition from Late Antiquity to Islam: Resafa in Syria: Cult Site and Center of Power in Relation to Landscape« (Sack/Schütt; 04/2008)
- A-I-4 »Felix Romuliana: A Late Ancient Imperial Palace and Its Surroundings« (Wulf-Rheidt/Schütt; 04/2008)
- A-I-16 »Monumental Architecture in the Nabataean Capital Petra (Jordan): Graves and Palaces« (Schmidt/Schütt; 03/2009)

2 Projects conducted by PhD candidates either from archaeological or earth sciences:

- A-I-6 »Archaeological and Geoarchaelogical Investigation of the Aleppo Hinterlands« (Kohlmeyer/Schütt; 04/2008)
- A-I-7 »Egypt Lies in Africa: Palaeoenvironmental Reconstruction in Naga, Central Sudan« (Wildung/Schütt; 02/2008)
- A-I-8 »Ancient Landscape Dynamics around Pergamon« (Pirson/Schütt; 06/2009)

3 Projects conducted by a post-doctoral candidate from one of the archaeological sciences:

- A-I-9 »Monti Navegna e Cervia: Geoarchaeology and Landscape Development in an Italian National Park« (Moede/Fless/Hoelzmann/Schütt; 04/2008)
- A-I-15 »Historical Sources : Transformations in Northern Mesopotamia during the Transition from the Late Bronze to the Iron Age (12th to 10th centuries BCE)« (Kühne; 06/2008)
- A-I-18 »Punic Settlement Strategies Using the Example of Erice Settlements« (Moede/De Vicenzo; 03/2009)

4 Projects conducted by the principal investigators without PhD fellows:

- A-I-10 »Settlement History of the South Harz Mountains« (Meyer/Bebermeier/Hoelzmann; 04/2008)
- A-I-11 »Lossow Near Frankfurt/Oder – An Early Iron Age Cult Site of the Ancient Peripheral Zone« (Beilke-Voigt/Bebermeier/Kaufmann; 04/2008)
- A-I-13 »The Copper Age Tell Settlement Pietrele« (Hansen; DFG-Normalverfahren)
- A-I-17 »Palaeoenvironmental Reconstruction of the Ancient Landscape at Dashur (Egypt) with Its Graves, Sanctuaries, and Settlements« (Seidelmayer/Bebermeier; 03/2009)
- A-I-20 »Topographic-Archaeological Documentation and Historic Interpretation of the Central Asian Cultural Phenomenon of the ›Long Oasis Walls‹ Settlements« (Stark; 03/2009)

2.1 Which Religious, Military, Administrative, and Economic Functions Define the Central Places Analyzed Here? What Were Their Original Functions, and What Functions Developed at These Sites Later On?

Clearly, all of the sites studied were multifunctional, especially during their heydays, even in instances where single functions predominated during founding phases. This can be documented in an exemplary fashion through the capital of Aleppo, originally founded as a sanctuary during the mid-third millennium BCE, while shortly afterwards, i.e. by the early second millennium BCE, it became the seat of government of the Yamhad Empire, which extended from the Mediterranean all the way to the Tigris River. Owing to its geographically advantageous location at the intersection of east-to-west and north-to-south trade routes (which reached from the Middle East to the Levant, and from the Arabian Peninsula to the Black Sea, respectively), it was soon established as an important trading center as well.

In contrast, the settlement at Resafa, abandoned today, was originally established as a limes station and served primarily military functions. Immediately after the execution of the Christian soldier Sergios around 312 CE, Resafa became a place of pilgrimage, and was renamed Sergiupolis. Already during the Late Roman era, Resafa gained in importance as a marketplace. Around 728 CE, the Ummayad caliph Hisham built several palaces to the south of the fortified city and chose the place as his seat of government, now called Rusafat Hisham. Because he also built a great mosque inside the city, next to the Christian cathedral, Resafa rapidly developed into a meeting place of Arab and Christian tribes; the town was later abandoned as a consequence of the Mongol assault of 1259 CE.

2.2 How Is the Field of Tension between Center and Periphery to Be Characterized?

In the case of the central place of Aleppo, founded during the Bronze Age, the tells in the environs, most of which also date back to the Bronze Age, were mapped in detail and site locations and ages of sites were recorded (Fig. 5). This investigation was based on the assumption that Aleppo developed central functions after its original founding, serving first as a sanctuary, and later as a seat of government. Food supplies were ensured by the rural periphery, where people lived in rural conglomerations which developed into tells in the course of the settlement's history.

The distribution of tells clearly indicates that the preferred settlement locations in the lowlands were in close proximity to rivers or lakes. This preference is self-evident since water availability is the principal limiting factor for agricultural activity in the semiarid climate of northern Syria. Palaeoenvironmental studies have shown that the local climate during the Early Bronze Age was slightly more humid than it is today and can be characterized as a dry sub-humid climate (FRUMKIN et al. 1991).

The pattern of tell locations around Aleppo suggests distinctive concentrations which correspond to the following clusters:

1) to the north around the headwater area and the upper course of the Quqaiq River,
2) to the south in the alluvial plain of the Quqaiq River and the Al-Madkh marshes,
3) to the east in the western lake margins of the Djabbul plain.

To the west, the presence of the Djabal Siman Mountains promoted the development of extended settlement networks. Within the respective clusters, the tells were integrated

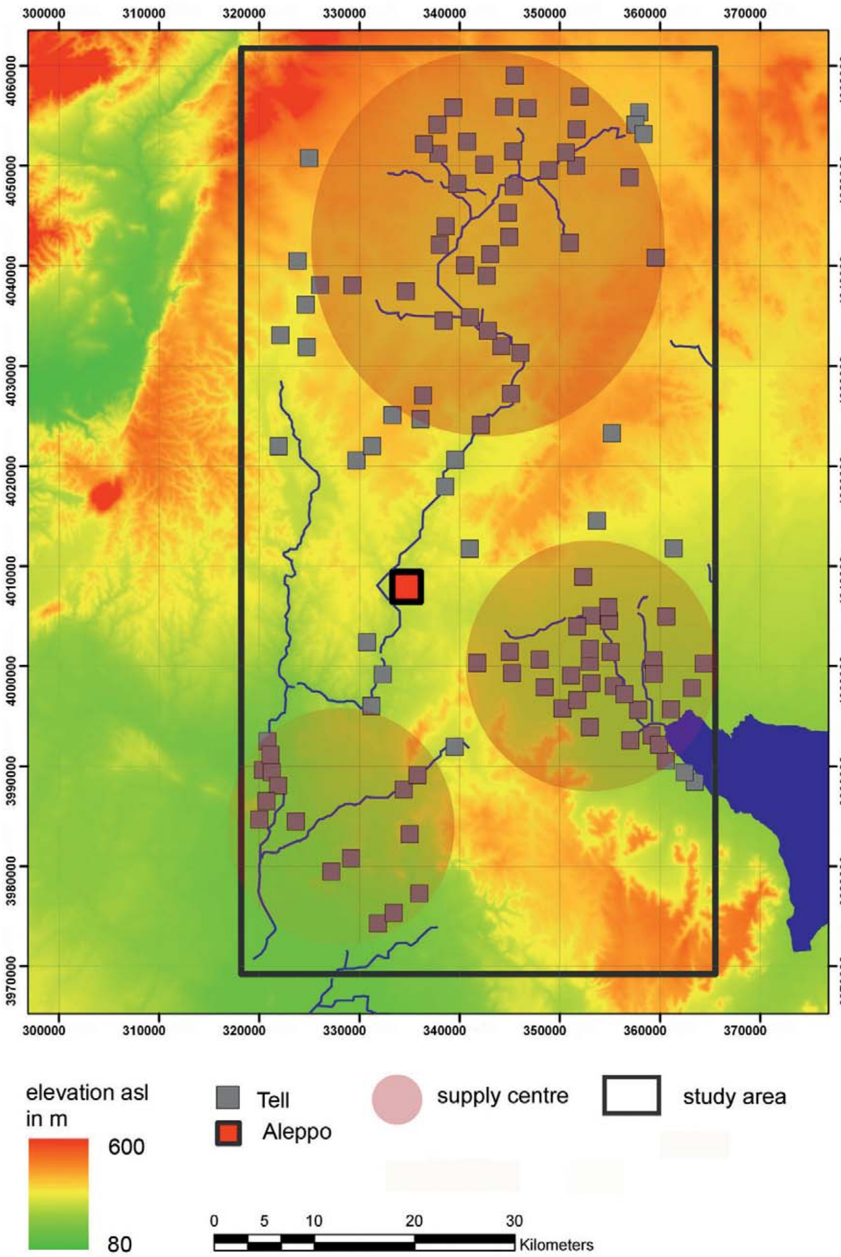

Fig. 5 | Agricultural supply areas of Aleppo.

into a complex road system all of whose members merged into a main traffic artery connecting each settlement cluster with the central place of Aleppo. In addition, the settlement clusters to the south and the east of Aleppo were interconnected by traffic routes, while the linking of the eastern and the northern settlement clusters was hindered by the Shawa Mountains.

We conclude that alongside colonization, the main function of the rural area around the central place of Aleppo was to ensure food supplies. The individual settlement locations were determined by the physical characteristics of the sites, paramount among these being the availability of water. In spatial terms, settlements were merged into clusters within which individual settlements were closely interlinked and each connected to the central place by a main transport axis. Links between settlement clusters existed to the extent permitted by the natural surroundings.

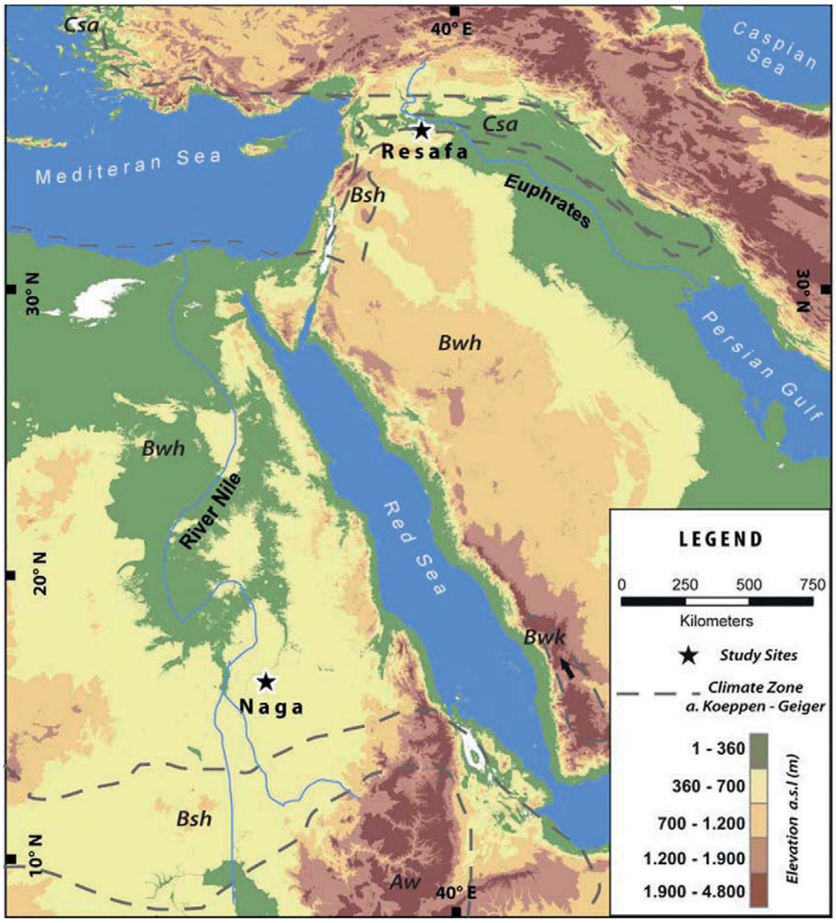

Fig. 6 | Topographic map with locations of the study sites (i) Resafa in Syria and (ii) Naga in Sudan. Elevation data is based on GTOPO30 (2000). The generalized climate zones follow the classification of Koeppen & Geiger (1961).

2.3 What Technical Preconditions Allowed Such Central Places to Develop, Even Under Disadvantageous Palaeoenvironmental Conditions? The Focus Here Is on the Availability of Water as the Limiting Factor for the Development of Settlements in Arid and Semiarid Environments

Despite unfavorable environmental conditions, permanent settlements have existed in dryland regions since prehistoric times. This is not only true for settlements along allochthonous rivers like the Nile or for oases, but also for areas without perennial water sources – which are the focus of this subproject (Fig. 6).

In locations where perennial water sources are absent, water availability – the primary limiting factor – is highly variable and is limited to brief rainfall events. Moreover, dryland ecosystems are highly sensitive and react to even small changes in amounts of rainfall. The maintenance of permanent settlements in arid regions therefore requires a knowledge of environmental dynamics, anticipatory planning, engineering, and hence a high degree of organization and substantial labor inputs. In combination with a variable environment, these requirements and challenges make permanent settlements susceptible to both environmental dynamics and socioeconomic changes. This combination of sensitive environmental and social systems makes drylands especially suitable

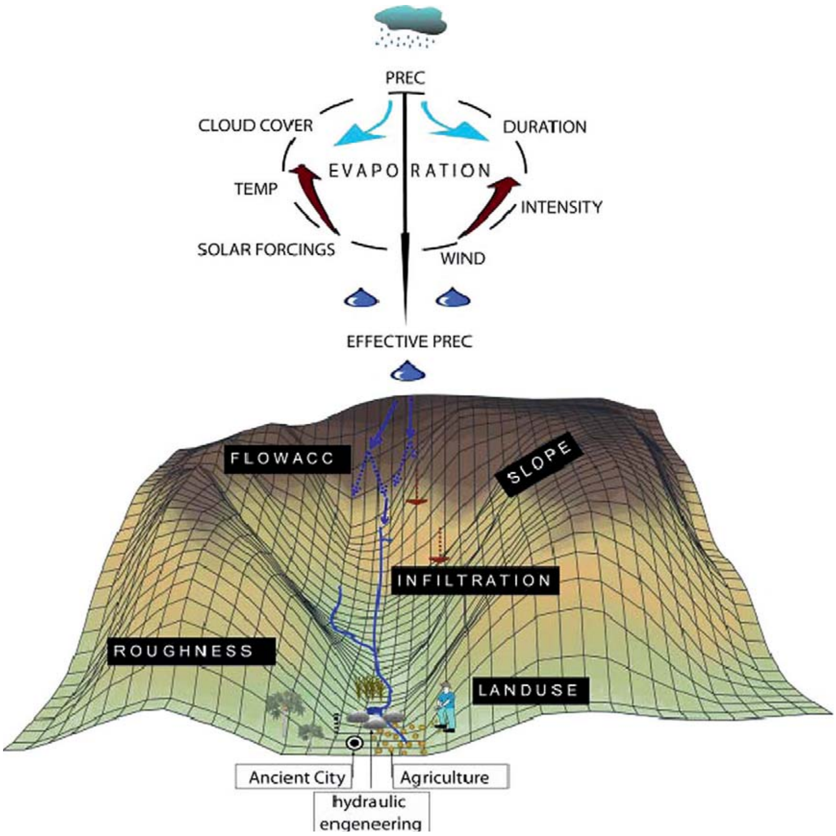

Fig. 7 | Concept for the Rainfall-Runoff Model showing the meteorological drivers (upper part) and the model parameters (black boxes in lower part).

for the study of environment-settlement dynamics, their driving factors, and their interrelationships (Fig. 7).

In order to sustain permanent settlements in arid and semiarid environments, ancient cultures developed a variety of water technologies. Among them were wells and conveyance systems that transported water to settlements via conduits, channels, and aqueducts from perennial water sources such as rivers, dammed reservoirs and/or groundwater (WIKANDER 2000). In addition, water harvesting – the collection and storing of surface and subsurface water – was a common method of water augmentation. Water supply systems were adapted to the specific environmental conditions of drylands, where rainfall character is dominated by erratic, high-intensity, short-duration precipitation events having limited spatial extension. This combination generates episodic floods whose hydrographs correspond directly to rainfall characteristics (TOOTH 2000). The harvested water was used either for animal husbandry, for irrigation purposes, or as drinking water. This was the case in Resafa as well as in Naga in northeastern Africa (Fig. 6). In both Resafa and Naga, dams and levees, cisterns, and surface reservoirs were used to collect, control, and store periodic concentrated surface runoff.

Our approach focuses on geoarchaeological questions in dryland areas where water availability is the key factor, and attempts to answer them by using climatic, hydrologic, and geomorphologic methods. For Resafa and Naga, a hydrological model was set up in order to assess water availability and the feasibility of the systems employed under different climatic and hydrologic settings.

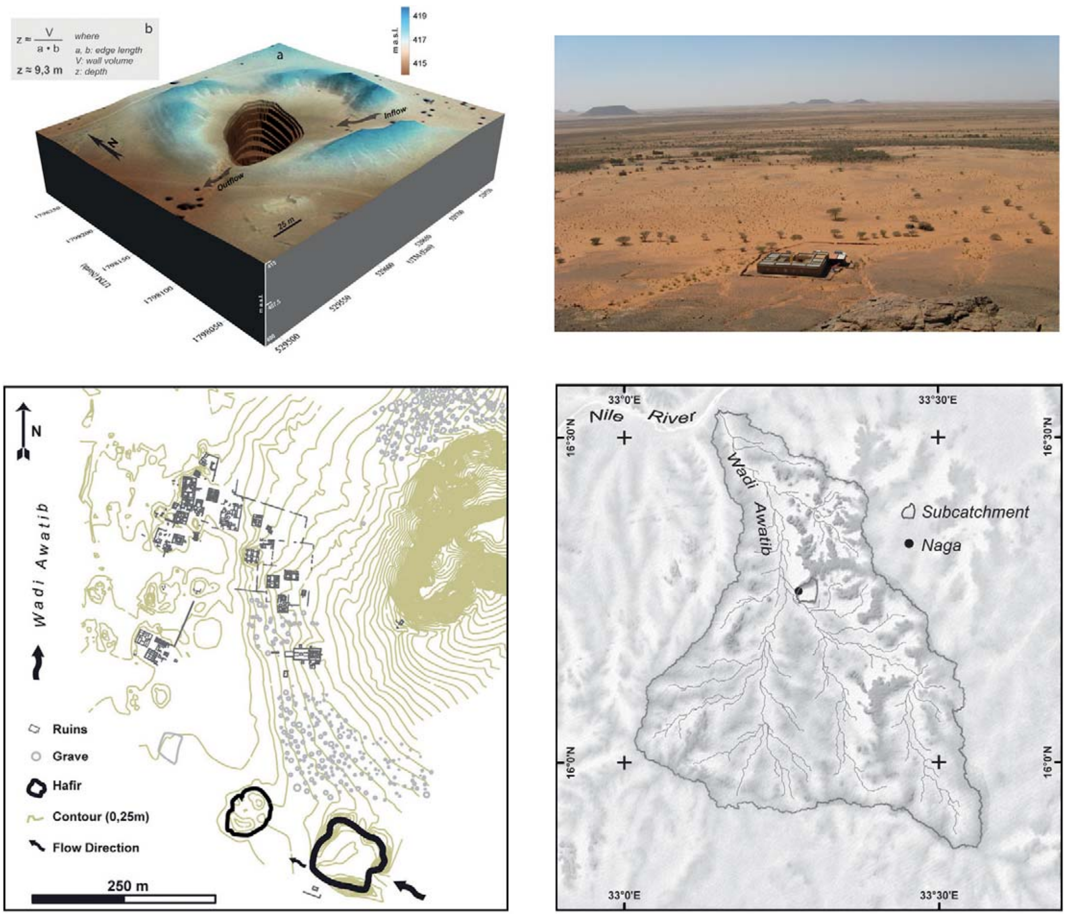

Fig. 8 | Hydrogeographical situation around the Meroitic city of Naga. Upper left: The Great Hafir of Naga. Lower left: Archaeological map of the excavation site of Naga with the Great Hafir highlighted. Upper right: Photo of the study site taken from the top of the Gebel Naga, with the excavation house in the front; line of sight: west. Lower right: the catchment of the Wadi Awatib, with the subcatchment of the Hafir highlighted.

2.3.1 Scope

The focus of Topoi projects (A-I-7) »Palaeoenvironmental Reconstruction in Naga in Central Sudan« and (A-I-3) »At the Transition from Late Antiquity to Islam: Resafa in Syria« has been the comparability of present water availability to past water-storage volumes. The first case study is the Meroitic city of Naga in the dry savannah of Sudan, where around the turn from BCE to CE, the citizens built the »Great Hafir,« with a capacity of 37×10^3 m^3,to collect surface runoff from a 14.2 km^2 subcatchment of the greater Wadi Awatib Basin totalling 2360 km^2. In the city of Resafa in the desert steppe of Syria around 300 years CE, the Romans built large cisterns having a total capacity of 21×10^3 m^3 to store surface water from a 126 km^2 subcatchment of the greater Resafa Basin totalling 7120 km^2 (Figs. 8, 9). We attempted to evaluate the physical catchment characteristics of the two semiarid watersheds and their present-day water availability by applying the rainfall-runoff model HEC-HMS. The main input is contemporary rainfall data, classified through a magnitude-frequency analysis to determine the rainfall intensity of 1-hour events (Fig. 7).

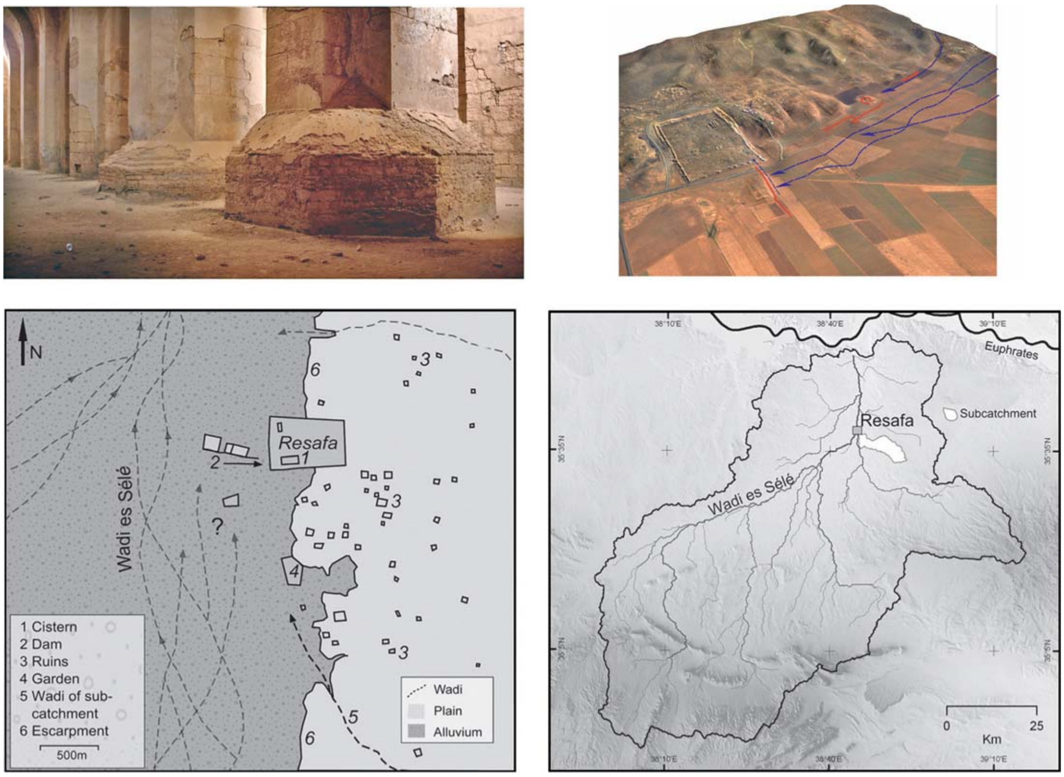

Fig. 9 |Hydrogeographical situation around the late Roman city of Resafa. Upper left: photograph of the cisterns of Resafa. Lower left: archaeological and geomorphological sketch of the major water harvesting measures at the Resafa site. Upper right: sattalite image of the Resafa excavation site and surrounding; blue lines indicate flow directions and red lines man-made dams and levees. Lower right: the catchment of the Resafa Basin, with the subcatchment of the cisterns highlighted.

Ancient water technologies typical of the antique central places were present at the study sites (Figs. 8, 9). The main questions addressed under this major topic are: What were the basic conditions required for the respective systems to function? How vulnerable were these systems to environmental changes?

2.3.2 Results

The approach presented shows that local water reservoirs at both study sites could be filled at least once every two years under present-day climatic conditions. The minimum rainfall intensities required to fulfill these conditions are 35.9 mm h^{-1} and a duration of one hour in the Resafa Basin, and 47.6 mm h^{-1} and a duration of one hour in the basin of the Great Hafir.

The application of a rainfall-runoff model to test the effectiveness of the water-harvesting facilities used in ancient cities has proven a valuable tool for estimating the water supplies available to these societies, and may be extended to such questions in other regions. The analysis suggests that the (long-abandoned) reservoir of the Resafa Basin would have been filled by a 35.9 mm h^{-1} rain event, and that of the (also abandoned) Basin of the

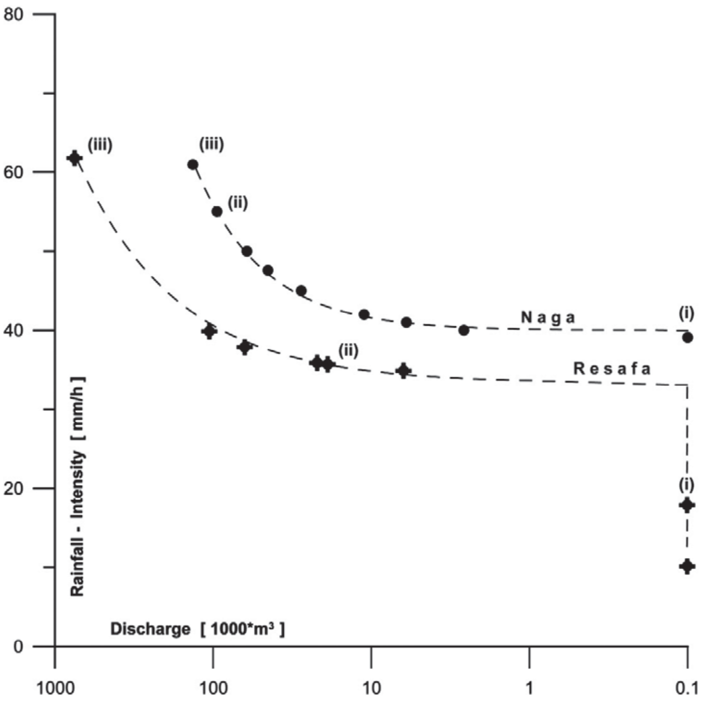

Fig. 10 | Scatter plot of rainfall intensity vs. discharge at the outlets of the derived subcatchments. Conditions are shown for rainfall intensities either generating initial runoff (i), enough rainfall to fill the respective reservoirs (ii), or maximum likely events (iii). (Note that the x-axis is logarithmic and plotted in order to highlight the values near zero.)

Great Hafir by a 39.1 mm h^{-1} rain event (Fig.10, referring to the conditions at »ii«). At present, such events occur almost annually, which suggests that water harvesting in these semiarid regions remains feasible today.

Relatively low values of runoff-effective rainfall despite high levels of evaporation during runoff processes are caused by the specific infiltration behavior found in drylands. As saturation overland flow is rarely reached, most of the runoff corresponds to Horton runoff with rainfall intensity (mm s^{-1}) exceeding infiltration capacity (mm s^{-1}) (YAIR – KLEIN 1973–1974; ABRAHAMS – PARSSONS 1991). This effect is aggravated by the presence of subsurface soil sealings forming below the desert pavement, where moisture penetration of the fine sediments during desiccation forms clay cutans at the transition to the overlying desert pavement (BRIEM 1977).

2.4 How Can Sanctuaries Be Integrated into the System of Central Places? How Should Sanctuary Territories Be Defined?

This question will be approached via an investigation of the burial mounds of the Scythians, who settled in the Central Asian steppes during the Iron Age. The Scythians were equestrian nomadic pastoralists (PARZINGER 2006, 541). From the 8th century BCE until the 2nd century BCE (PARZINGER 2004, 6–7), the Scythian settlement area (DARAGAN 2004, 55–146; GRAKOW 1978, 96–98, 144–149; ZAJCEV 2003) was subdivided into the settlement area of the Sakas in the northern Tien Shan (celestial mountains) of Central Asia (BAIPAKOV 2008) and the Scythian settlement in the Pontic-Caspian area in Eastern Europe.

While the various Scythian tribes rarely maintained permanent or fortified settlements, the most important Scythian archaeological remains consist of large burial mounds, the

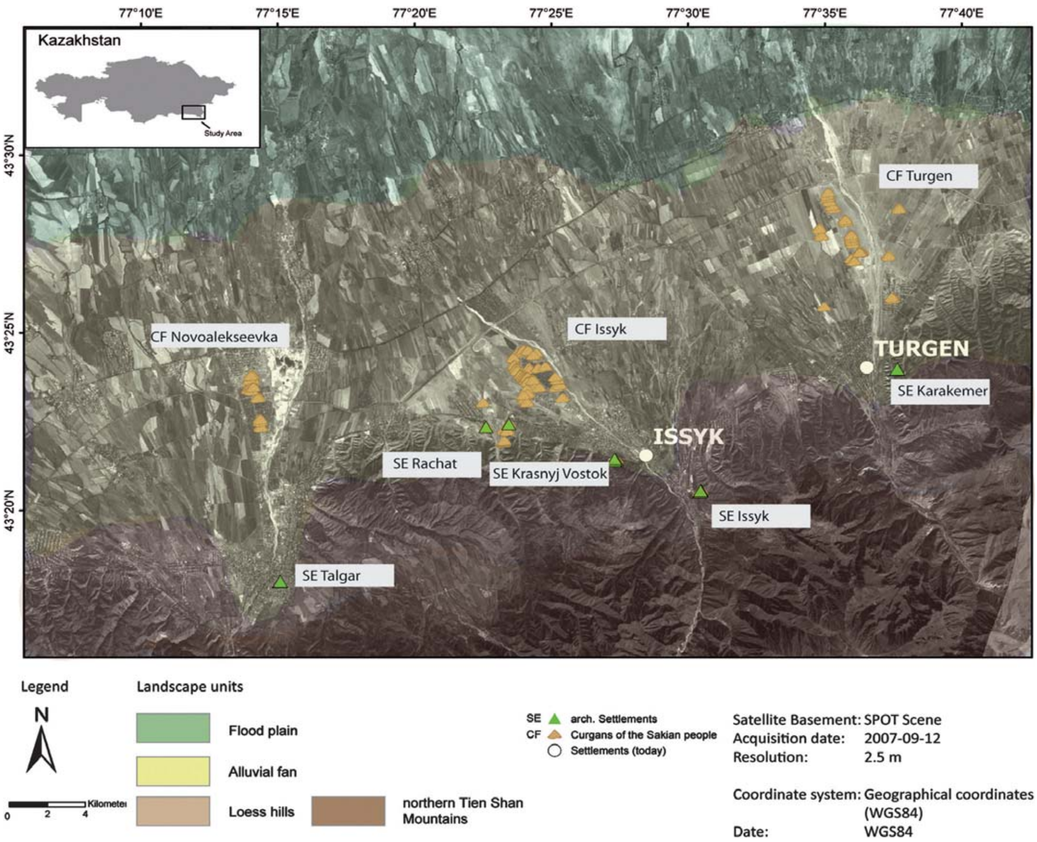

Fig. 11 | Overview map of Semirechye, showing the archaeological settlements in detail (green rectangles) and the kurgan fields of the Sakan (beige triangles). The map shows the four major landscape units: northern Tien Shan mountains, the loess hills, the alluvial fans, and a flood plain. The stream of the flood plain discharges into the barrier lake of Kapschagai. The Sakan kurgans are predominantly located on the alluvial fans. Kurgans were also found on the Asy Plateau of the northern Tien Shan mountains.

so-called kurgans (AKIŠEV 1978; SAMAŠEV 2007, 162–170). Below, the spatial pattern of the kurgans found in Semirechye – part of the Saka settlement area in the eastern Kazakh steppe region – will be compared with the spatial patterning of kurgans on the Ak Kaya escarpment, located in the central Crimean region, a former Scythian settlement area.

2.4.1 Settlements and Necropolises in Semirechye

Semirechye is located in the northern foreland of the Trans-ili Alatau, in the Kazakh part of the Tien Shan (Fig. 11), which consists of high mountainous terrain (SAVOSKUL – SOLOMINA 1996; AUBEKOREV et al. 2003), unsuitable for settlement in both ancient and present times. The extensive loess deposits are located along the northern slope of the Tien Shan (SUN 2002; MACHALETT et al. 2006), they are dissected by gully-like valleys and today form a hilly landscape. To the north of these loess hills, an extended alluvial plain leads from alluvial fans at the edges of the loess hills to alluvial plains in the more distal part (BLÄTTERMANN et al. forthcoming). All of the Iron Age settlements can be found in the apex zones of the alluvial fans at their transitions to the loess hills, and in close proximity to major rivers. These locations were easily defended, since impassable mountains are located in the south and so enemies could have approached only from the north. Most settlements were located where the rivers emerge from the mountains and were encircled toward the south, west, and east by mountains and steep slopes. These kind of settlements are situated at a distance of 10–20 km alongside the mountain foreland (GASS forthcoming a). Altogether 19 settlements have been identified between Almaty and Tausugur (GASS forthcoming c).

Like kurgan fields, the necropolises corresponding to these settlements are found downstream on alluvial plains in flood-safe locations (Fig. 11; GASS forthcoming d). The area shown in the SPOT image in Figure 11 documents a detail of the total study area, which lies between the Talgar and Turgen rivers. The concentrations of different but coeval kurgan fields to the north of the Trans-ili Alatau can be clearly identified. This kind of alignment between settlements and necropolises in the landscape can be taken as typical of the Saka settlement area: in general, the kurgan fields can be found on alluvial plains in flood-safe locations, generally 10–20 km away from the associated settlement and the adjoining highlands. Only in a single situation is a kurgan field located on the divide between two river systems (GASS forthcoming b). This demonstrates that the drainage basins corresponded to natural sacred units of the princely necropolises of the Saka elite.

2.4.2 Settlements and Necropolises at the Ak Kaya Escarpment

Ak Kaya is a late Scythian settlement (ca. 3rd century BCE) located on the western edge of the escarpment that was named after the settlement of Ak Kaya. It is located in the central Crimean region near the modern village of Bjelogorsk, approximately 80 km northeast of Simferopol. While to the west the escarpment formed a natural protective barrier against intruders, it was necessary to fortify the settlement to the east by building a wall.

Located on top of the escarpment's plateau, to the east of the settlement of Ak Kaya, are multiple kurgan fields, with 312 kurgans in all. The kurgans were identified by field mapping and by analyzing aerial photographs and high-resolution satellite images (Fig.12).

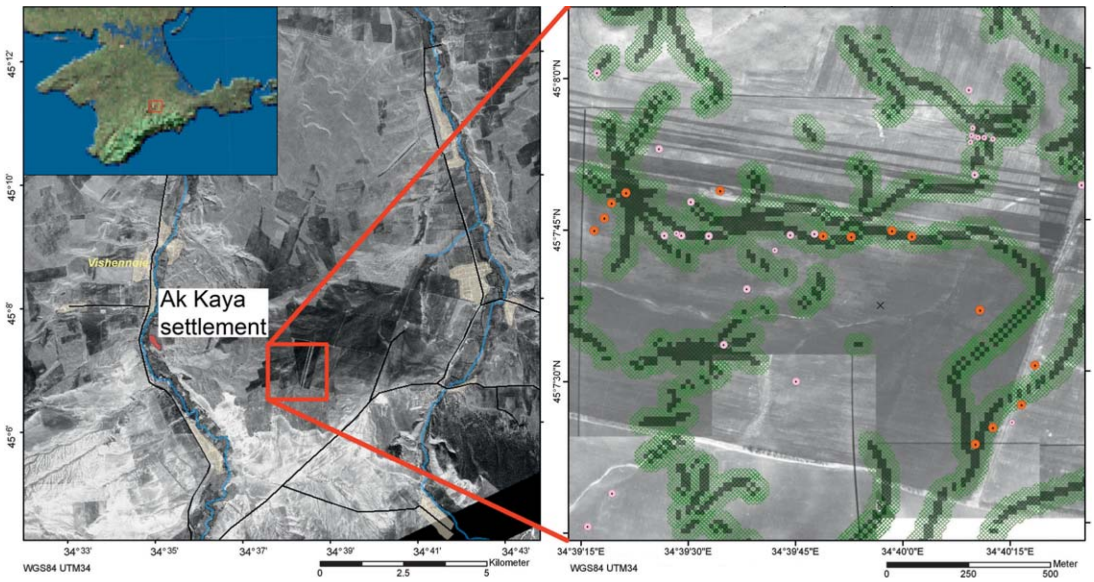

Fig. 12 | Location of the Ak Kaya escarpment and plateau in the central Crimean region with the Ak Kaya settlement located at the western edge of the escarpment (left). The enlarged cutaway view shows the locations of the kurgans as identified by the field survey (red dots) and satellite image analysis (pink dots) and the location of the divides (green dots) with a 15 m buffer zone.

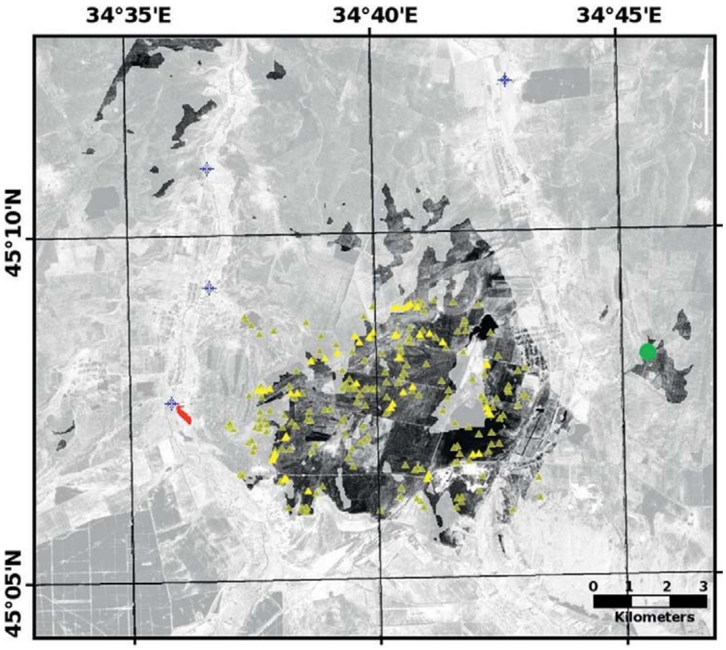

Fig. 13 | Visibility of the Ak Kaya plateau and its kurgans (yellow rectangles) from the point of view of a horseman approaching from the east (green dot).

As a rule, kurgans are positioned in clusters, each dominated by a main kurgan having a diameter of up to 65 m and a height of up to 15 m, and each associated with smaller kurgans which decrease in size with distance from the main kurgan. Although a relationship between the location of the kurgans and the character of the landscape was not evident during field mapping, GIS-based topographical analysis of a high-resolution Digital Elevation Model (15 × 15 m^2 cell size) showed that kurgan fields are regularly spaced along the divides (BOARDMAN et al. 1992). Around 41 % of the kurgans recorded are located directly on top of or along a 15 m wide buffer of the divide, while fewer than 15 % are located at distances of more than 100 m from the divides. These data are even more convincing because the divides are plateau-like without topographical evidence being visible in the field. More than 35 % of the kurgans recorded are located at distances of less than 4 km from settlements; the density of kurgans decreases with increasing distance from a given settlement (Fig. 12).

Viewshed analysis indicates that nearly 80% of kurgans are visible from the point of view of a horseman approaching the Ak Kaya escarpment from the east (Fig. 13). The same is essentially true for a horseman approaching from the south. In both scenarios, the Ak Kaya settlement is not visible. For a horseman approaching from the north, in contrast, the kurgan fields remain more or less hidden from view, a circumstance that is due to the major dipping direction of the plateau to the north, while the kurgan fields to the south are hidden behind a crest.

2.5 Which Locational Factors Favour the Formation and Decline of Central Places?

After a long period of widespread neglect, migration has been the topic of intensive discussion in archaeology over the past two decades. The presence of migratory peoples is detectable through the identification of material cultures normally found in other regions. Since the material signs of a foreign culture can also be disseminated by mechanisms such as trade, diffusion, etc., the presence of migratory peoples becomes more

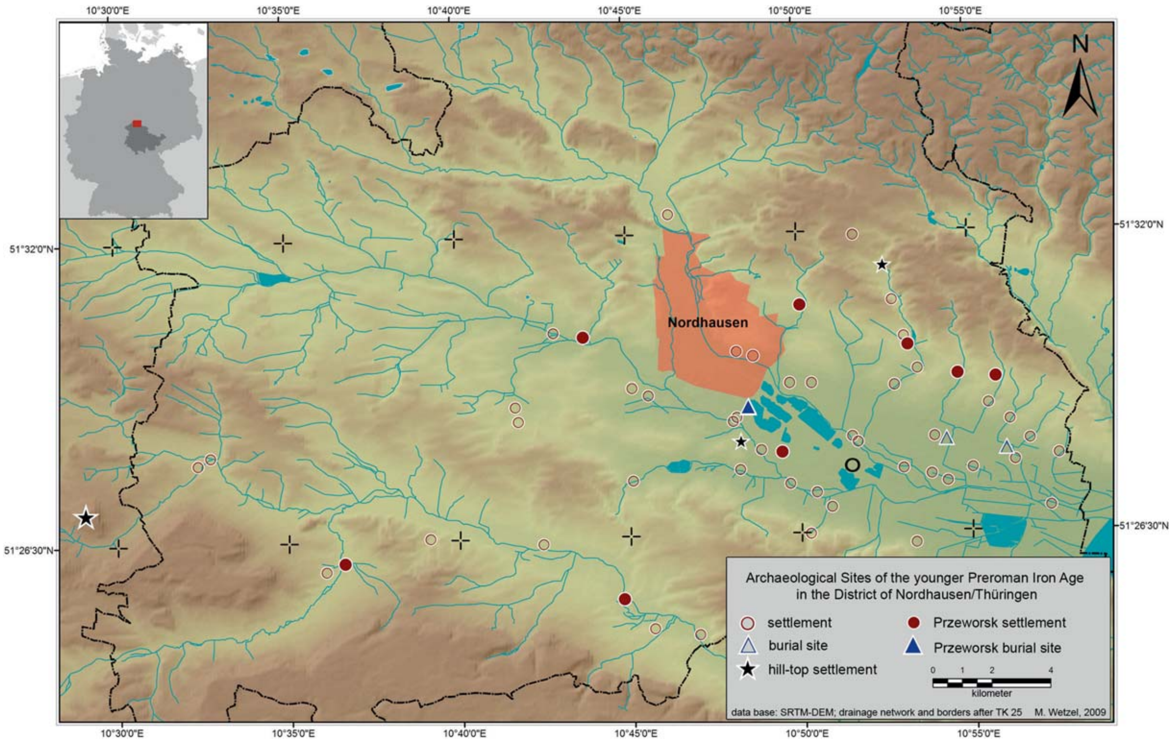

Fig. 14 | The study site of the ›Goldene Aue‹ in the southern Harz Mountains. Late Iron Age settlements are marked by black circle. Red dots mark the locations of settlements of the immigrating Przeworsk culture, blue triangle marks the area's only known Przeworsk culture graveyard.

plausible where not just foreign objects but also evidence of alien cultural practices such as burial customs can be identified in connection with such objects (ANDRESEN 2004, 439). Moreover, isotope analysis can help to identify individuals who spent their childhoods in other regions, while a DNA analysis may provide hints about nonindigenous individuals.

Migration may take various forms. Migrations of elites may involve the movements of a non-representative group which assumes political or economic control; the mass migration of a large, representative group may occur over a longer period, and the migration of specialists will be restricted to small groups which assume responsibility for restricted tasks (PRIEN 2005). Of course, these forms can be mixed: migrations can take place over extended periods and include the return of segments of the immigrant population as well as the arrival of new groups as aspects of a continuous process (Fig. 14).

From an archaeological point of view, it is difficult to determine the reasons for a migration without clear textual evidence. Many motives are plausible: overpopulation, social and/or political pressures on individual groups, ecological problems such as soil deterioration, the development of new religious identity groups (see for example ANDRESEN 2004, 408). Moreover, all of these factors may coexist, making archaeological identification even more complicated.

The same is true for processes occurring in the target region of the migration. Migration often took place as a longer process spearheaded by a small pioneer group which tested the advisability of a large-scale immigration into a given region. This testing had to discover whether a region was inhabited in the first place, and if so whether the local population was likely to accept the arrival of the new population. It is difficult to determine whether a given migration was associated with violence. Although archaeology has a variety of options at its disposal to identify evidence of war and violence (CARMAN – HARDING 1999; PETER-RÖCHER 2007; MEYER 2010), most violent group activities in prehistoric times occurred without leaving archaeological traces.

Indirect evidence of the acceptance of an immigrant group can be seen in the existence of parallel settlement systems in a single region. This is the case for the late Iron Age foreland of the Southern Harz region, where the immigration of settlers from the Przeworsk culture can be identified. This immigration penetrated into an area that had a hierarchical settlement system.

Five of the Przeworsk settlements are concentrated along the northeastern fringe of the area (Fig. 14), whereas local, late Iron Age settlements – along with some immigrant settlements – are found in the broad, fertile loess valleys (MEYER forthcoming). The northeastern settlements lie in a row at intervals of ca. 1.5 km, and seem to respect the local settlement system. Extremely interesting is the circumstance that their locations coincide exactly with the occurrence of iron ore. This mineral resource had been exploited by the local population for centuries already, but it is now generally accepted that it was used by Przeworsk settlers as well. Since no furnaces have been discovered as yet in these settlements, it seems possible that they only collected and traded the ore.

Clearly, the two settlement systems coexisted for many decades before eventually merging into a non-hierarchical settlement pattern.

2.6 How Can the Comparability of Small-Scale Investigations Be Guaranteed in the Context of a Shared Methodological Framework? Are There Differences in the Functional Networks? Are There Specific Cultural Differences in the Networks of Central Places? What Kinds of Influences Did Central Places Exert on Space?

A predictive modeling approach for prehistoric and historic settlement locations has been developed for the vicinity of the Late Roman imperial palace complex Felix Romuliana (Fig. 15). The intention was to compare different epochs, cultures, and natural landscapes in the context of human-environmental interactions. The approach was based on geomorphometric parameters that allow a quantitative and objective analysis of the natural landscape and of the archaeological sites. The application of relief-based parameters (AHNERT 2003) means that the changing environmental conditions in human-relevant time may be neglected. Hence, this predictive modeling approach is applicable to any research area that offers the necessary input data, i.e. a digital elevation model and an archaeological site database.

The model was tested in the context of Project A-I-4: »Felix Romuliana. A Late Ancient Imperial Palace and Its Surroundings.« The settlement locations of four different cultural epochs (Bronze Age, Iron Age, Late Roman, and Middle Ages) were extracted and modeled from an archaeological database that was validated and enlarged by the work of Jana Skundrić (Fig. 16). The model results allow the characterization of settlements according to their relief preferences. Preferred settlement locations are found on gently inclined slopes and plains as well as in close proximity to valleys, which mostly indicate streams.

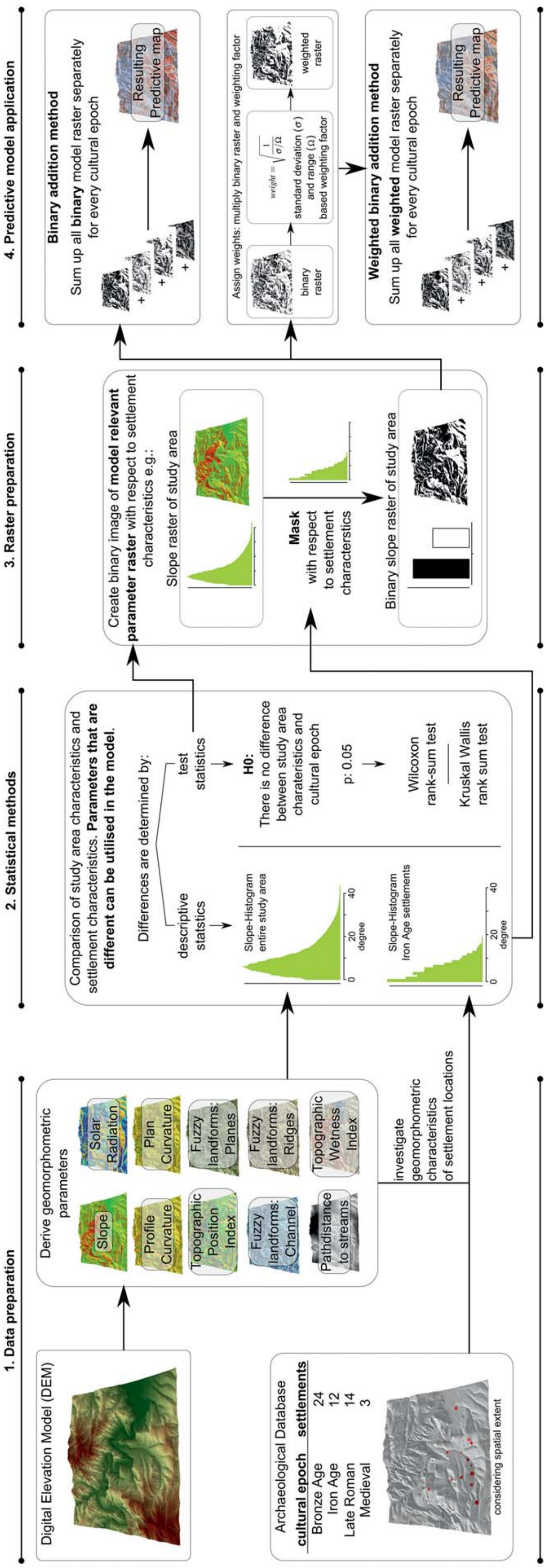

Fig. 15 | Predictive modeling around Felix Romuliana.

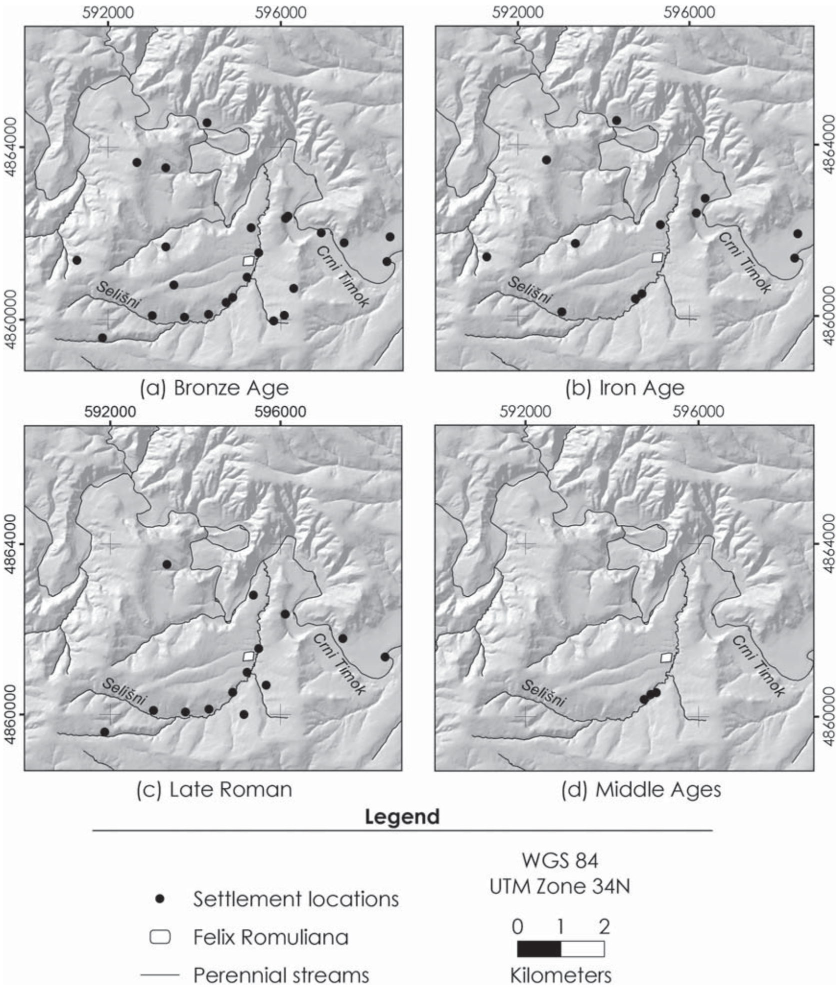

Fig. 16 | Settlements of different cultural epochs in the surroundings of Felix Romuliana.

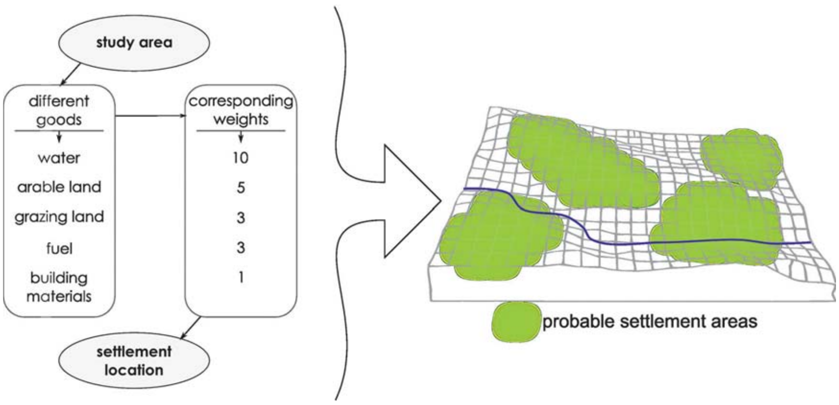

Fig. 17 | Comparison between the characteristics that determine the locations of settlements (after CHISHOLM 1973) and a modeled settlement distribution in an exemplary study area.

This pattern is often found among pre- and protohistoric settlements (e.g. CHISHOLM 1973; Fig. 17). A model efficiency calculation proved good mathematical quality and clearly showed how settlement locations were determined by natural landscape features.

In contrast to the above, a multitemporal perspective of these cultural epochs indicates the high dynamic of settlement locations, even though this is not the case for relief preferences. The model is therefore able to differentiate between natural and cultural factors, and is

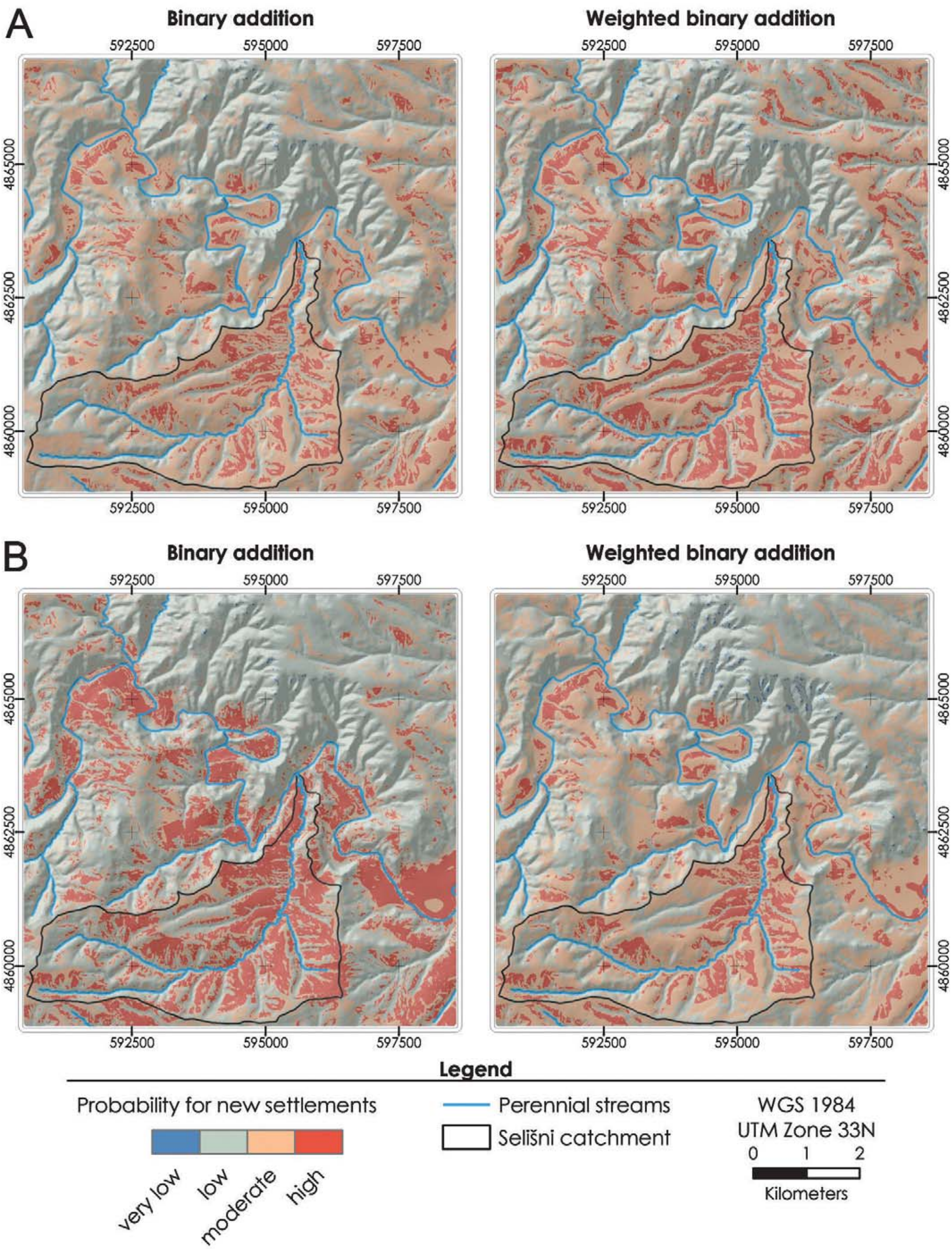

Fig. 18 | Differences between a predictive model with (a) and without streams (b). It is obvious that there are no differences in the characteristics of the area of high probability.

hence a valuable spatial analytical tool for further investigations. The historical and geographical sciences are able to answer questions related to specific sites as well as to basic settlement theory. An example of the application in a site-relevant context is the case study of the vicinity of Felix Romuliana: on the basis of modern data, it was demonstrated that the parameter distance to streams – known to be one of the main factors in settlement locations – does not have a conspicuous influence on all settlement locations (compare Fig. 16c, Fig. 18). This is not the result of changing spatial demand but instead an expression of the natural and climatic differences present in earlier periods. This knowledge leads to a better understanding of prehistoric settlement locations around Felix Romuliana and to a basic critique of predictive models that use modern data to reconstruct prehistoric and historic circumstances.

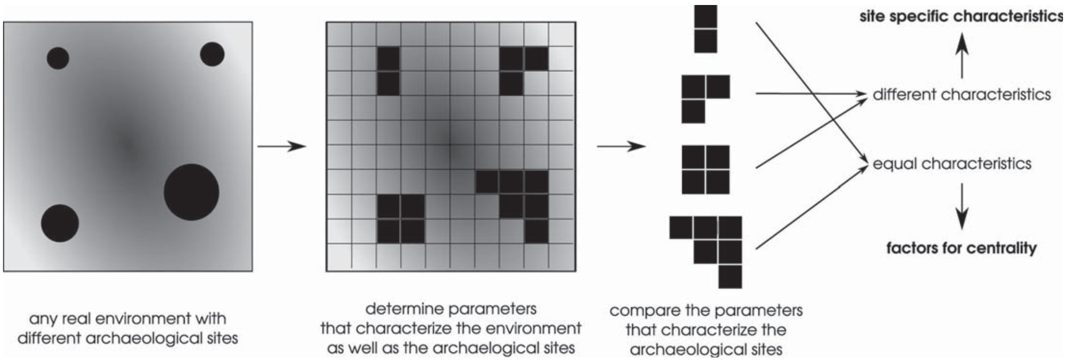

Fig. 19 | Concept for applying a predictive modeling approach to questions concerning the centrality of places.

Based on this methodological framework, the model is not limited to specific objectives. Besides generating a characterization of the natural environment of these archaeological sites, their sociocultural functions can be analyzed as well. This is of particular interest in the context of the centrality of places. The quantitative approach and the application of objective parameters make it possible to compare all the case studies of Research Group A-I. The methodological framework presented here can be used to generate a comparable and supraregional data framework which is based on the results of the different case studies. This analysis will lead to further knowledge, specifically in the context of the centrality of places and of the perception of space in general (Fig. 19). On the basis of the methodology described, this objective will be approached by means of reliable data. Nevertheless, conceptual approaches allow initial comparisons: e.g. in a spatiogenetic analysis, the Oppidium Manching might be comparable to the Tell of Aleppo. Both enjoyed good traffic connections, both functioned as nodes of empirical decision-making, and both shaped their surroundings. Other examples include the residential seats of Felix Romuliana and Resafa. Both were parts of economically favorable areas, but their locations are not consistent with the historically emergent system of the cultural landscape. Their central roles were politically determined, and their demises were caused by cultural-politic change as well. A dynamic perspective of the divergent scales of space, time, culture, and nature enables supraregional and intercultural comparisons of central places.

The results from Felix Romuliana show that prehistoric and historic settlements are to a certain degree influenced by the natural environment. Accordingly, a comparison between settlement networks is possible because identifiable differences can be regarded as being cultural in character. Therefore, specific cultural features can be derived by identifying differences between central places. In this context, the epistemological problem involves differences in the quality and density of the archaeological data. As a result, it becomes difficult to decide whether the obvious differences identified in the networks of central places are determined by social, cultural, or natural conditions – or by the archaeological method itself.

Because of problems to define central places, questions concerning forms of influences on the vicinities of central places cannot be answered. Causal relationships can be identified connecting the development of the central place and the surrounding area which are traceable back to (a) how central places influenced settlement behaviour of humans and (b) how human settlement behaviour influenced central places.Considering a temporal continuity this leads over time, this process leads to trading networks and traffic routes. Ongoing development implyed that also these processes affected centrality, and thus influenced subsequent settlement patterns. An example of this is the Roman road network north of the Alps.

3 Publications, Conference-Abstracts and Theses of the Research Group A-I

3.1 Publications

Alexanian Nicole – Blaschta, Dirk – Bebermeier, Wiebke – Ramisch, Arne – Schütt, Brigitta – Seidlmayer, Stephan. Forthcoming. »The Necropolis of Dahshur. Sixth Excavation Report Spring 2009«. *Annales du Service des antiquités de l'Egypte*.

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3.2 Conference Abstracts

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Berking, Jonas – Schütt, Brigitta. 2010. »Geoarchaeological Survey in Naga, Central-Sudan – Methods and Targets.« *International Colloquium on Geoacheaology*, Cairo.

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3.3 Diplom, Bachelor and Master Theses of the Research Group A-I

Al Saeed, Mohamed Anas. »Resafa, Syrien. Stadtmauer. Dokumentation der Erhaltungsmaßnahmen der Direction Générale des Antiquités et des Musées de la Syrie (DGAMS).« (Eng., 2008, supervision: Sack, Dorothée).

Bork, Stefanie. »Ein Konzept für einen Landschaftsgeschichtlichen Lehrpfad durch das Rio Ricetto Tal im RN Regionale Monti Navegna e Cervia, Italien« (working title, Dipl.-Geography, current, supervision: Schütt, Brigitta).

Böwe, Lukas – Horn, Tobias. »Resafa, Syrien. Zentralbau, Nordostturm. Bauarchäologische und konservatorische Untersuchungen.« (Dipl.-Rest., 2008, supervision: Sack, Dorothée).

Domdey, Christian. »Entwicklung von Hangarchiven als Teil der Landschaftsentwicklung im Bereich des Monte San Giovanni, Italien.« (Dipl.-Geography, 2011, supervision: Schütt, Brigitta).

Ducke, Katharina. »Räumliche und zeitliche Analyse ausgewählter Klimaelemente für den Raum Nordost-Afrika und Vorderasien.« (Dipl.-Geography, 2009, supervision: Schütt, Brigitta).

Flade, Anne-Sophie. »Resafa-Sergiupolis, Syrien. Basilika A. Archäologische Untersuchungen im südlichen Seitenschiff.« (MA, 2008, supervision: Sack, Dorothée).

Gieseler, Robert. »Geoarchäologie im Niltal – Erstellung geoarchäologischer Übersichtskarten zwischen erstem und sechsten Nilkatarakt.« (BSc Geography, 2009, supervision: Schütt, Brigitta).

Heise, Christian. »Geoden aus dem Unteren Buntsandstein (Nordhausen-Folge) des südlichen Harzvorlandes als potentieller Rohstoff für eisenzeitliche Verhüttung.« (BSc Geography, 2009, supervision: Hoelzmann, Philipp).

Kerkow, Daniel. »Morphotektonische Analyse des Pietra Secca Einzugsgebietes im Hohen Appenin (Italien).« (BSc Geography, 2010, supervision: Hoelzmann, Philipp).

Knitter, Daniel. »Archaeological Predictive Modelling of Prehistoric and Historic Settlement Locations in the Surrounding of the Late Ancient Imperial Palace Felix Romuliana Based on Geomorphometric Parameters.« (MSc Geography, 2009, supervision: Schütt, Brigitta).

Kückenshöner, Joscha. »Geomorphologische und bodenkundliche Kartierung auf einem römisch-germanischen Schlachtfeld am Harzhorn (Niedersachsen).« (BSc Geography, 2009, supervision: Schütt, Brigitta).

Löwenherz, Richard. »Historische Starkregenereignisse und ihre Auswirkungen auf den Bodenabtrag im südlichen Harzvorland und angrenzenden Gebieten.« (Dipl.-Geography, current, supervision: Schütt, Brigitta).

Mahnkopf, Judith. »Kulturlandschaftsstruktur und Lagestruktur von Kurganen auf Ak Kaya, Krim.« (Dipl.-Geography, 2010, supervision: Schütt, Brigitta)

Marquardt, Nicole. »Räumliche und zeitliche Analyse und Charakterisierung der spätquartären Paläoumweltbedingungen für Nordostafrika und Vorderasien auf der Grundlage von Proxydaten.« (Dipl.-Geography, 2009, supervision: Schütt, Brigitta).

Meister, Julia. »Geoarchäologische Untersuchung zur Rekonstruktion des ›Großen Hafir‹ der meroitischen Stadt Naga, Zentralsudan.« (BSc Geography, 2009, supervision: Schütt, Brigitta).

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5 Figure Source

Fig. 1, 2, 4, 6, 7, 10, 13, 15, 17 and 19: Research Group A-I • Fig. 3: map source ESRI ArcGlobeData • Fig. 5: map base SRTM30 data, 2000 • Fig. 8: Research Group A-I; lower left: copy from WILDUNG – KRÖPER 2006; lower right: data base SRTM30, 2000 • Fig. 9: Research Group A-I; lower left: mapping based on IKONOS, 2009; upper right: data base SRTM30, 2000; IKONOS, 2008 • Fig. 11: map source SPOT I • Fig. 12: map source ETM7 177/77, 05-10-2000, ch8 • Fig.14: map base SRTM30, 200; drainage network and borders after TK25 4429, 4529, 4430, 4530, 4431, 4531 • Fig.16: map base topographic map 1:10 000 K-34-9-Ad, K-34-9-Ad, K-34-9-Ad, K-34-9-Ad; Interpolation: ANUDEM/ Topo-to-Raster; cell size: 10x10m • Fig.18: map base topographic map 1:10 000 K-34-9-Ad, K-34-9-Ad, K-34-9-Ad, K-34-9-Ad; Interpolation: ANUDEM/ Topo-to-Raster; cell size: 10x10m.

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