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A Landscape Archaeological Approach to Link Human Activities to Past Landscape Change in the Built-up Area of the Late Bronze Age Enclosure Cornești-Iarcuri, Western Romania

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A Landscape Archaeological Approach to Link Human Activities to Past Landscape Change in the Built-up Area of the Late Bronze Age Enclosure Corneşti-Iarcuri, Western Romania

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This study exemplifies the theoretical and methodological process of integration of disciplinary results, the joint development of new hypotheses and its interdisciplinary interpretation in the framework of landscape archaeological research. A conceptual model is introduced to visualize the integration process. The findings of two recently published studies and the archaeological state of the art regarding the largest known prehistoric enclosure in Europe – Corneşti-Iarcuri – are used as exemplary data to demonstrate the applicability of the conceptual model. The presented discussion shows how integration of disciplinary findings leads to a more holistic and more rigorous interpretation and opens the opportunity to jointly develop new hypotheses that can be integrated subsequently.

Human-environment interactions; hollow ways; interdisciplinary research; landscape archaeology; conceptual model.

In diesem Beitrag werden der theoretische und methodologische Prozess der Integration disziplinärer Ergebnisse, die gemeinschaftliche Entwicklung neuer Hypothesen und ihre interdisziplinäre Interpretation im Rahmen landschaftsarchäologischer Forschung veranschaulicht. Der Prozess der Integration wird anhand eines hier vorgestellten konzeptionellen Modells visualisiert. Die Ergebnisse von zwei kürzlich publizierten Fallstudien sowie der archäologische Stand der Forschung über die größte zur Zeit bekannte prähistorische Wallanlage Europas – Corneşti-Iarcuri – dienen als Beispiel um die Anwendbarkeit des konzeptionellen Modells aufzuzeigen. Die Diskussion verdeutlicht, dass durch die Anwendung des vorgestellten Konzepts, die Integration disziplinärer Ergebnisse in einer holistischeren und stringenteren Interpretation mündet und die Möglichkeit eröffnet gemeinschaftlich neue Hypothesen zu entwickeln, die nachfolgend eingearbeitet werden können.

Mensch-Umwelt-Interaktionen; Hohlwege; interdisziplinäre Forschung; Landschaftarchäologie; konzeptionelles Modell.

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1 Introduction

Landscape as a – by itself – transdisciplinary term[1] offers more than the opportunity to simply combine disciplinary results in order to achieve a multidisciplinary interpretation.[2] It offers the possibility to perform interdisciplinary research[3] including the joint interpretation of findings, the re-formulation of hypotheses and the joint development of new questions.

We understand landscape as a physical phenomenon that is modified by economical and socio-cultural utilization, which causes a constant transformation of the landscape and which is followed by a changing perception and the assignment of a new meaning.[4] Thus, in the context of our study, the term landscape has two primary meanings: first, landscape is seen as a geographically delimited area whose natural factors can be investigated using scientific methods. Second, landscape is seen as a social construct of an area which owes its existence to the human assignment of meaning and which needs to be investigated hermeneutically.[5]

This study aims to draw conclusions on the value of an interdisciplinary approach from the field of landscape archaeology. This is realized by: i) summarizing the main findings presented in two recently published studies[6] in connection with the archaeological state of the art,[7] ii) discussing the applied work flow, which allowed the integration of results achieved by the disciplines of archaeology and physical geography, and iii) emphasizing the importance of a mutual discussion of disciplinary findings across the disciplines, the joint development of hypotheses and their interdisciplinary interpretation.

The two recently published studies deal with the human-environment interactions in the environs of the Late Bronze Age enclosure Corneşti-Iarcuri in Western Romania.[8] The findings indicate the degree and the kind of human impact related to Copper Age and mainly Late Bronze Age settlement activities and the large-scale Late Bronze Age enclosure. A series of hollow ways were identified that could relate to the developing Copper Age and Late Bronze Age structures. They were formed due to compaction and reduced infiltration capacity[9] along regular footpaths fostering gully development due to retrogressive erosion.[10] Hence, the prehistoric human impact on the development of the local relief and drainage network can be inferred. Moreover, first ideas regarding the network of Late Bronze Age intra-site pathways that connect settlement clusters can be developed.

Our example illustrates how integration leads to a more holistic interpretation, which is more rigorous than a purely disciplinary research could be in this regard, and how new hypotheses can be jointly developed and interpreted.

1 Legler 2012, 39.
2 Meier and Tillessen 2011, 30–31; Meier 2012, 509.
3 Meier 2012, 509–511.
4 Gramsch 2003, 40; Legler 2012, 47.
5 Kluiving, Lehmkuhl, and Schütt 2012, 1–2; Legler 2012, 39–40.
6 Nykamp, Heeb, et al. 2015; Nykamp, Hoelzmann, et al. 2016.
7 Heeb, Szentmiklosi, and Wiecken 2008; Szentmiklosi et al. 2011; Heeb, Szentmiklosi, Harding, et al. 2012; Heeb, Jahn, and Szentmiklosi 2014; Heeb, Szentmiklosi, and Krause 2015.
8 The studies of Nykamp, Heeb, et al. 2015 and Nykamp, Hoelzmann, et al. 2016 are realized in the context of the Excellence Cluster (EXC 264) Topoi project A-6-8 and in close cooperation with the DFG project WE4596/5-1.
9 Goudie 2006, 105–106.
10 Tsoar and Yekutieli 1992, 213.

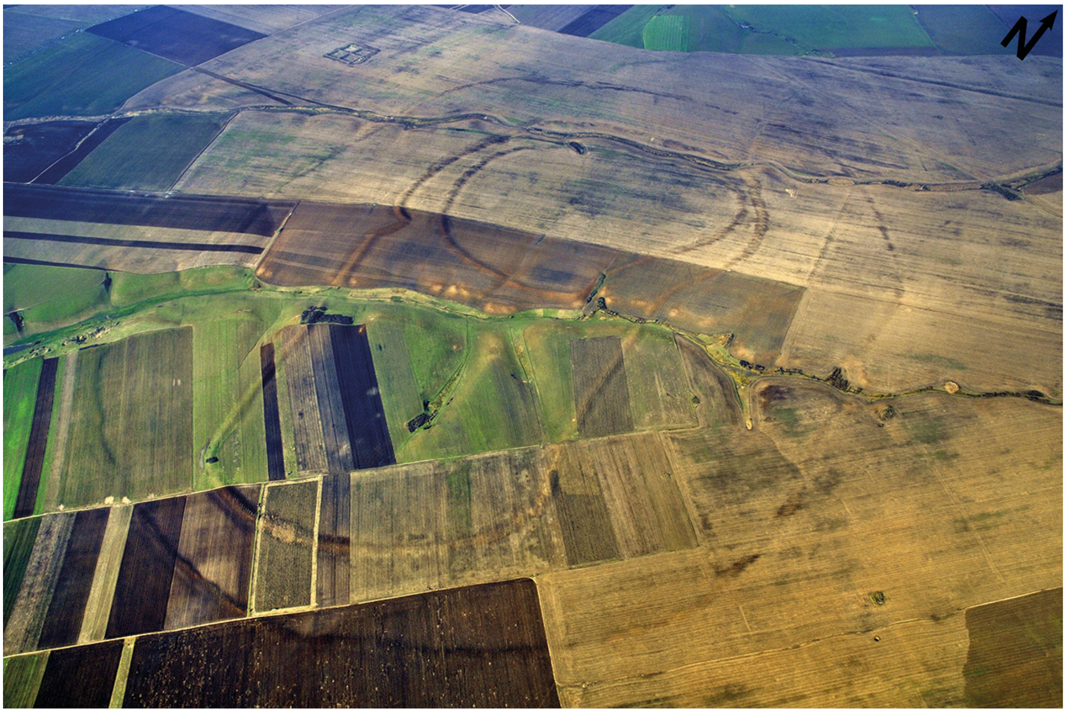

Fig. 1 | Corneşti-Iarcuri. The photograph gives a good overview of the prevailing landscape; three of the four enclosing ramparts are clearly visible. The innermost rampart I (in the upper central part of the picture) measures c. 1 km in diameter.

2 The environs of Corneşti-Iarcuri and its archaeological background

Corneşti-Iarcuri is located at the eastern rim of the Great Hungarian Plain, in the area of the Romanian Banat, c. 20 km north of the city of Timişoara. The surroundings of Corneşti-Iarcuri belong to the Vinga Plain that is geomorphologically characterized by loess covered interfluves and wide saucer-shaped valleys that generally drain southwestwards (Fig. 1).[11] The hillslopes of these valleys are commonly dissected by hollows and gully-like first order tributaries that frequently form well-pronounced alluvial fans at their outlets.[12] The prevailing climate is moderate temperate with mean annual precipitation of 550 mm.[13] Today, most of the area is intensively used for arable farming; some smaller areas where steppe grass vegetation persists are used for sheep herding.[14]

With its four earth-filled wooden ramparts Corneşti-Iarcuri (Fig. 1) is the largest known enclosure of the European prehistory.[15] The enclosed area totals c. 17.6 km^2 and the four ramparts have a total length of more than 33 km[16] and at least ten gates.[17] Settlements with varying density have been identified within the two innermost ramparts (Fig. 2).[18] Based on a series of radiocarbon dates it is known that the ramparts of the enclosure date to the

11 Grigoraş, Piciu, and Vlăduţ 2004, 33–34; Nykamp, Heeb, et al. 2015, 78.
12 Nykamp, Heeb, et al. 2015, 78; Nykamp, Hoelzmann, et al. 2016, 192.
13 Grigoraş, Piciu, and Vlăduţ 2004, 35.
14 Nykamp, Hoelzmann, et al. 2016, 194.
15 Szentmiklosi et al. 2011, 819.
16 Szentmiklosi et al. 2011, 819; Heeb, Szentmiklosi, Harding, et al. 2012, 47; Heeb, Szentmiklosi, and Krause 2015, 57.
17 Heeb, Szentmiklosi, and Wiecken 2008, 180–181; Szentmiklosi et al. 2011, 830; Heeb, Szentmiklosi, Harding, et al. 2012, 51–54; Heeb, Jahn, and Szentmiklosi 2014, 86; Nykamp, Heeb, et al. 2015, 85.
18 Heeb, Szentmiklosi, Harding, et al. 2012, 56–57; Nykamp, Heeb, et al. 2015, 85.

Late Bronze Age until the transition to the Early Iron Age. The two innermost ramparts I and II date to c. 1500–1300 cal. BCE (3450–3250 cal. BP) at 2σ and the outermost rampart IV to c. 1300–1000 cal. BCE (3250–2950 cal. BP) at 2σ. Rampart III is undated so far, but it is assumed that it dates to the same period of time, because the ramparts do not cut each other.[19] To date, ten gates (Fig. 2) have been identified by the combination of excavation and the interpretation of satellite and aerial images and LiDAR and magnetic data.[20] The interpretation of magnetic data and extensive systematic field walking also allowed identifying subsurface settlement structures and estimating the density of settlement areas within the two innermost ramparts I and II (Fig. 2).[21] Based on the chronology of documented artifacts, mostly pottery sherds, it turned out that its predominant majority date to the Late Bronze Age (Cruceni-Belegiş I-III). Besides, fewer quantities of Copper Age (Tiszapolgár), Early Bronze Age (Makó), Middle Bronze Age (Vatina) and Iron Age (Gornea-Kalakatča) artifacts have been identified, too.[22]

The archaeological research conducted since 2007 allows differentiating areas within the two innermost ramparts I and II that were densely settled during the Late Bronze Age in comparison with other areas that show substantially lower settlement densities (Fig. 2).[23] Other areas, in turn, show higher densities of Copper Age settlements (Fig. 2).[24] It turned out that the southern part within rampart II shows the highest Late Bronze Age settlement densities of the total investigated area (Fig. 2). Another area that shows signs of dense Late Bronze Age settlements is located in the northeastern part within rampart I (Fig. 2). However, the comparison of the obtained amount of pottery sherds per square meter shows that the assumed Late Bronze Age settlement density within the southern part of rampart II is much higher than in the northeastern part of rampart I.[25] In the southeastern part of rampart II a round enclosure of four ditches and settlement structures have been identified. Based on the shape and orientation of the houses and the clear concentration of Tiszapolgár pottery sherds this area is regarded to represent a Copper Age settlement (Fig. 2).[26]

19 Szentmiklosi et al. 2011, 827–828; Heeb, Szentmiklosi, Harding, et al. 2012, 55–56; Heeb, Szentmiklosi, and Krause 2015, 61.

20 Heeb, Szentmiklosi, and Wiecken 2008, 180–181; Szentmiklosi et al. 2011, 830; Heeb, Szentmiklosi, Harding, et al. 2012, 51–54; Heeb, Jahn, and Szentmiklosi 2014, 86; Nykamp, Heeb, et al. 2015, 85.

21 Szentmiklosi et al. 2011, 830–834; Heeb, Szentmiklosi, Harding, et al. 2012, 56–57; Nykamp, Heeb, et al. 2015, 85.

22 Nykamp, Heeb, et al. 2015, 832–834; Heeb, Szentmiklosi, Harding, et al. 2012, 50–51.

23 Heeb, Szentmiklosi, Harding, et al. 2012, 56–57.

24 Szentmiklosi et al. 2011, 832; Heeb, Szentmiklosi, Harding, et al. 2012, 56.

25 Heeb, Szentmiklosi, Harding, et al. 2012, 56–57; Heeb, Szentmiklosi, and Krause 2015, 67.

26 Szentmiklosi et al. 2011, 832.

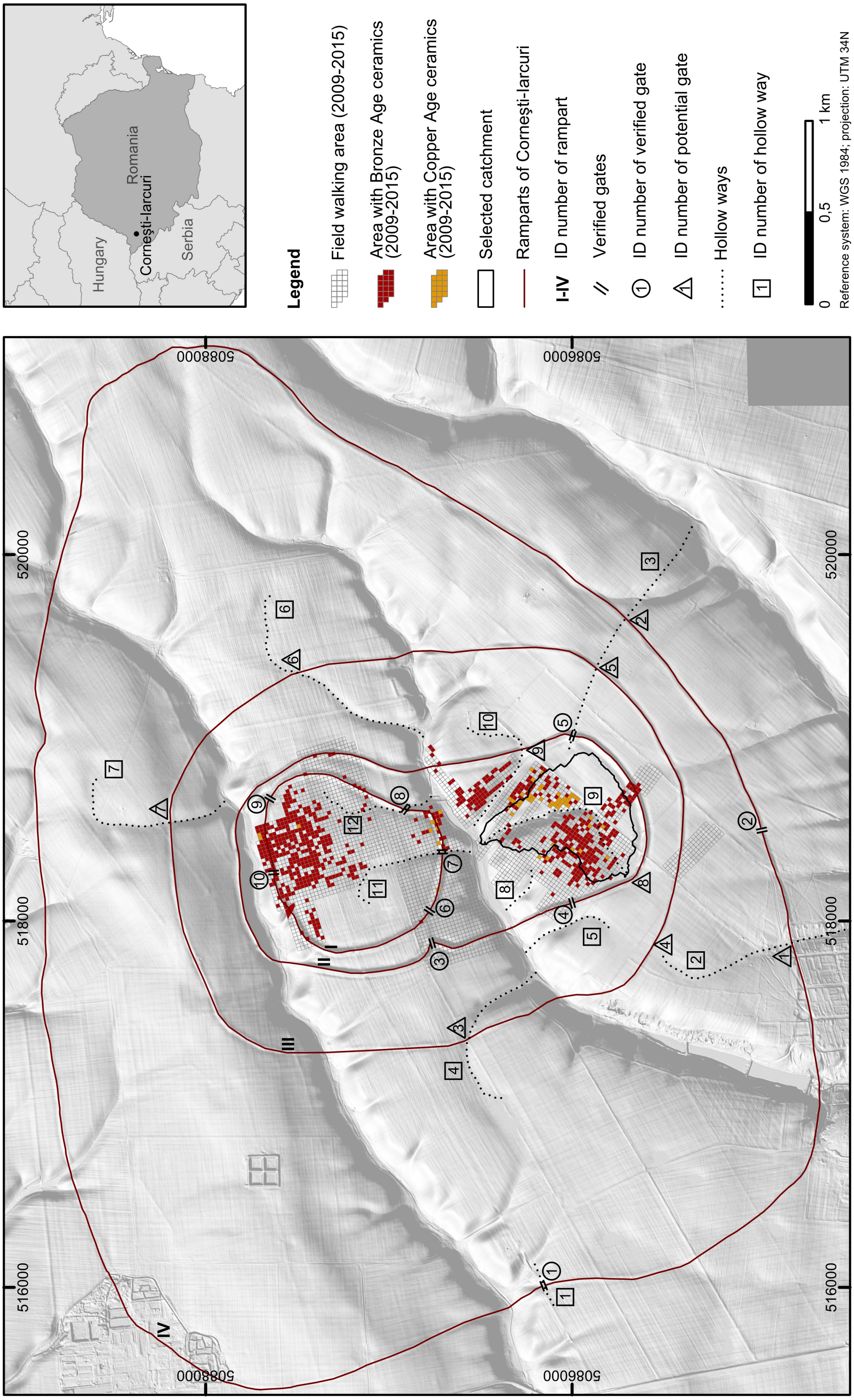

Fig. 2 | Results map indicating the Bronze Age and Copper Age settlement clusters, the gates in the ramparts and the identified hollow ways in the built-up area of Corneşti-Iarcuri.

3 Summary of complementary studies

The archaeological state of the art demonstrates that the picture of settlement locations from the different cultural epochs becomes more and more explicit within the two innermost ramparts I and II. However, many questions remain open, e.g. how did people move through the enclosed area and the adjacent landscape, where were the main trajectories of movement and how did the regular movement of people transform the landscape at a certain time.

A complementary landscape archaeological study deals with these questions for the first time. Amongst others, GIS techniques are applied to link hydro-morphological relief anomalies to archaeological evidences regarding settlement distribution in the built-up area of Corneşti-Iarcuri.[27] The results show that in the wider settlement area of Corneşti-Iarcuri substantially more first order tributaries bend unnaturally in comparison to three reference-catchments in the close vicinity but beyond the Late Bronze Age settlement area.[28] Some of these tributaries have a short, strongly bending section in their course (i.e. hollow way ID nr. 2, 4, 5, 7, 9 and 10 in Fig. 2) or a section that runs reverse to the direction of the general surface gradient (i.e. hollow way ID nr. 4, 5, 9 and 11 in Fig. 2).[29] Natural factors, such as the local climate, geological underground, catchment geomorphology and soils, can be excluded largely to play a role on the occurrence of unnaturally bending first order tributaries. It is argued that the presence of the enclosure, the settlements within and an interconnecting intra-site path network are the determining factors for this phenomenon.[30] Moreover, the study reveals that the unnaturally bending tributaries tend to cluster in the central part of the enclosure (Fig. 2), partially run through verified gates in the ramparts (i.e. gate ID nr. 5, 7 and 8 in Fig. 2) or seem to link the areas where signs of dense settlement structures occur (i.e. hollow way ID nr. 9, 10, 11 and 12 in Fig. 2).

Paths that developed to hollow ways due to increased surface runoff triggered by soil compaction caused by the repeated passage of humans and animals are well known[31] and it is suggested that similar processes occurred in the time when Corneşti-Iarcuri was occupied.[32] In this regard, the locations where hollow ways run through the gates or seem to link densely settled areas are of particular interest, because by applying the principle of active association[33] the assumption can be made that both features, e.g. the hollow way and the Late Bronze Age gate where it is running through, were in use at the same time. For the principle of active association the following example was given by Wilkinson: "[…] if a feature such as a hollow-way road leads directly to another feature (e.g., a gate) that forms part of a site the occupation phases of which are known, then the hollow way and the gate were likely, but not necessarily, in use at the same time."[34]

However, the study of Nykamp, Heeb, et al.[35] lacks geomorphological and sedimentological evidence and particularly independent age control to further verify the hypothesis of contemporaneous hollow way formation due to soil compaction and reduced infiltration capacity along regular footpaths. In order to overcome this shortcoming comple-

27 Nykamp, Heeb, et al. 2015.
28 Nykamp, Heeb, et al. 2015, 82–83.
29 Nykamp, Heeb, et al. 2015, 87.
30 Nykamp, Heeb, et al. 2015, 85–86.
31 Brice 1966, 313; Denecke 1969, 40–44; Piest and Ziemnicki 1979, 826–827; Tsoar and Yekutieli 1992, 209; Wilkinson 1993, 548; Ur 2003, 102; Wilkinson et al. 2010, 763–767.
32 Nykamp, Heeb, et al. 2015, 87.
33 Wilkinson 2003, 66.
34 Wilkinson 2003, 66.
35 Nykamp, Heeb, et al. 2015.

menting geomorphological investigations, geophysical and -chemical sediment analyses together with ^{14}C dating were conducted and presented in Nykamp, Hoelzmann, et al.[36]

The catchment of a first order tributary showing signs of Copper Age and Late Bronze Age settlement structures in its terrain was selected. Also, this catchment is drained by an unnaturally bending tributary that has a section running reverse to the general surface gradient (i.e. hollow way ID nr. 9 in Fig. 2).[37] The alluvial fan that is deposited at the outlet of the catchment into the receiving alluvial plain was chosen as an archive for complementary sediment analyses. The sediments that built up the alluvial fan are interfused with daub pieces between c. 225 and 100 cm depth and the obtained ^{14}C datings yielded maximum deposition ages of 2877–2561 cal. BCE (4510–4239 cal. BP) at 2σ in 222 cm depth and 1107–832 cal. BCE (3056–2781 cal. BP) at 2σ in 146 cm depth.[38] Thus, the maximum deposition ages roughly coincide with the development of the Copper Age and Late Bronze Age settlements in the catchment, even though a Tiszapolgár impact is not evident in the sedimentary record. This suggests that the development of the settlements and the formation of the fan sediments – and finally also the initial facilitation of the hollow way formation – were closely coupled.

4 Integration of disciplinary results

The process of integration of disciplinary results, their interdisciplinary discussion and interpretation and the following re-formulation of the hypotheses or the development of new ones is illustrated and discussed using a conceptual model (Fig. 3). The research objective, i.e. the landscape as a sphere of natural, economical and socio-cultural interactions, represents the basis on which questions are asked, hypotheses are formulated and research is conducted. The two participating disciplines, i.e. archaeology and geography, are represented by two individuals. The conceptual model is read from bottom to top and starts with a disciplinary hypothesis or question (Fig. 3, level one), i.e.: how is the drainage network characterized? Or: where are settlement clusters located? Each level in the consecutively running model represents a step of data production and interpretation that is dependent on the earlier steps. Thus, each level shows a path dependency, produces results that can enhance the rigor of the interpretations and can lead to new questions or hypotheses.

On level one disciplinary results, i.e. identification of hydro-morphological relief anomalies or the localization of settlement clusters, are achieved (Fig. 3, level one) applying methods from physical geography or archaeology, i.e. the morphometric study of the drainage network or systematic field walking. At this point the two disciplines do not interact, but use their disciplinary methods and concepts to answer purely disciplinary questions. The following integration of the disciplinary results leads to the joint interpretation that the hydro-morphological relief anomalies could represent hollow ways since they seem to link the settlement clusters (Fig. 3, level one). Thus, the interaction between the two disciplines starts at this point, from where on the two individuals start to talk to each other, jointly develop new questions and hypotheses and start to change their positions (Fig. 3, level two).

Gates are not simply a gap in an enclosure, but have the function to direct the passage of people and to control pathways.[39] Thus, they have a meaning to people. As a next step, all gate situations in the enclosure of Corneşti-Iarcuri are mapped. By this means, a new

36 Nykamp, Hoelzmann, et al. 2016.
37 Nykamp, Hoelzmann, et al. 2016, 202.
38 Nykamp, Hoelzmann, et al. 2016, 197 and 199.
39 Heeb, Jahn, and Szentmiklosi 2014, 68–69.

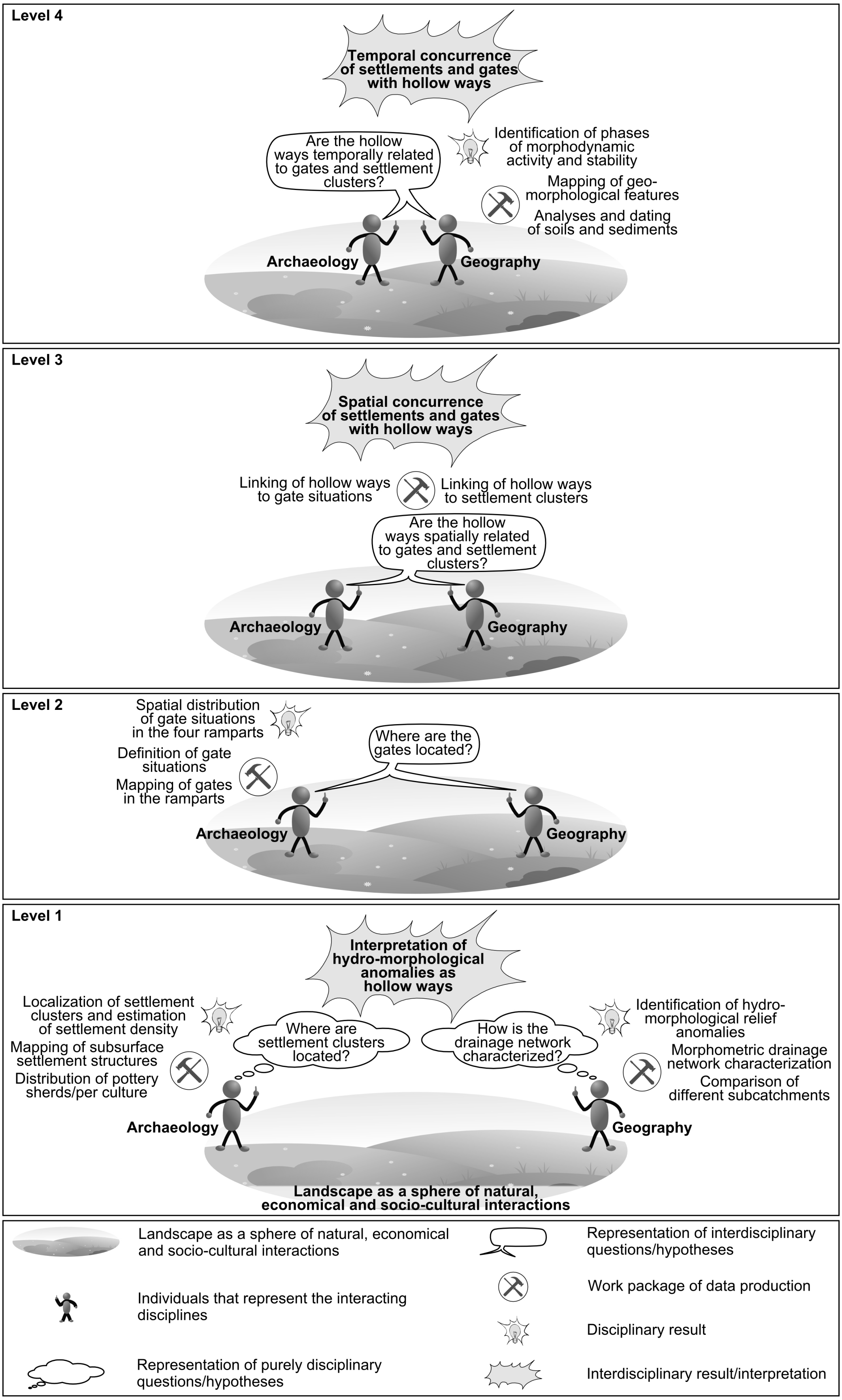

Fig. 3 | The conceptual model is applied to the landscape in the environs of the Late Bronze Age enclosure Corneşti-Iarcuri.

disciplinary dataset, i.e. the spatial distribution of gates (Fig. 3, level two), is produced following the further development of the hypothesis that paths not only link settlement clusters, but that they should run through the gates in an enclosure.[40]

At this point a new question arises, i.e. is there a systematic spatial relation between the hollow ways and the gates and settlement clusters? The spatial link of the hollow ways with the, so far, ten verified gates and known settlement clusters (Fig. 2) is examined systematically yielding the new interdisciplinary result, i.e. the spatial concurrence of gates and settlement clusters with the hollow ways (Fig. 3, level three). At this point it even might become possible to state a first idea concerning the formation period of the hollow ways. This can be achieved through active association of archaeological features of a known cultural epoch, e.g. Late Bronze Age gates or settlement clusters, with landscape features of unknown age, e.g. hollow ways, assuming that both were in use at the same time.[41]

However, without independent datasets, i.e. sediment analyses and radiometric dating techniques, the interpretation must be viewed as preliminary and the question whether the hollow ways and the gates and settlement clusters temporally coincide cannot be answered convincingly. Thus, a new disciplinary dataset is generated, i.e. in the form of ^{14}C-dated sediment cores, to obtain independent results, i.e. identifying phases of varying morphodynamics (Fig. 3, level four). Through the integration of the newly achieved results into the interdisciplinary interpretation obtained on level three the rigor of the re-interpretation of the hydro-morphological relief anomalies being hollow ways that formed during the Late Bronze Age as path-oriented gullies along frequently used footpaths connecting settlement clusters or running through the gates of the enclosure is substantially enhanced (Fig. 3). Thus, at this point we are able to more far-reaching interpretations than to generally state that phases of intensified morphodynamics in a small-scale catchment often occur as a result of exceeded geomorphic thresholds due to local land use change and intensified human activities in the upslope catchment area rather than as a result of climate change; a concept that is well established for Central Europe.[42] Among the factors that control threshold-dependent processes such as gully erosion and hollow way formation local land use and frequency of extreme rainfall events are considered to be the main driving forces.[43] Thus, our results might reflect both: the compaction-induced reduction of the infiltration capacity due to trampling along frequently used footpaths and the occurrence of precipitation events that are severe enough to let overland flow develop.

The process of integration and re-formulation of hypotheses not necessarily stops at the point that is reached by the conceptual model in this study. New hypotheses may arise, e.g. if the hollow ways serve to localize, so far, unknown gates (i.e. the potential gates in Fig. 2) or settlement clusters or if the importance of a certain gate or settlement cluster is mirrored by the expression of a hollow way. Thus, on the one hand appropriately targeted measures to identify unknown gates can be applied and, on the other hand, new ideas regarding the socio-economic structure can be deduced from the location of the most important settlement areas or most representative gates in relation to the location of hollow ways showing specific expressions. The conceptual model illustrates that the two interacting individuals that represent the disciplines of archaeology and geography constantly change their positions during the process of integration. These changing positions also represent the feedback of the jointly achieved interpretations back into

40 Wilkinson 2003, 66.
41 Wilkinson 2003, 66–70.
42 Chiverrell, Harvey, and Foster 2007, 317; Dotterweich 2008, 192; Dotterweich et al. 2012, 51.
43 Valentin, Poesen, and Li 2005, 136 and 148; Chiverrell, Harvey, and Foster 2007, 340.

the disciplines, as described by Meier.[44] The feedback into the discipline of archaeology might be that Holocene geomorphic features such as hollow ways are usable as indicators of settlement structures, while the feedback into the discipline of geography might be that anthropogenic features such as pathways are important features to understand the Holocene origin of hollow ways.

5 Conclusions

This study summarizes the main findings of current research on the landscape development and human-environment interactions in the environs of the Late Bronze Age enclosure Corneşti-Iarcuri in Western Romania. The process of integrating disciplinary results, jointly developing new hypotheses and interpreting the findings interdisciplinarily is illustrated. Our example shows how integration leads to a more holistic and rigorous interpretation that would not have been possible by only one discipline; neither archaeology nor physical geography. The example clearly shows that while studying the same object, the different participating disciplines focus on different phenomena. The interdisciplinary collaboration and intellectual exchange allows putting these disciplinarily examined objects into an integral context. In consequence physical objects, e.g. unnaturally bending first order tributaries, become archaeological artifacts, e.g. hollow ways. Thus, the procedure corresponds to the point made by Wilkinson that landscape features should not be viewed in isolation, but jointly with other types of evidence so that the interpretations become more comprehensive and plausible.[45] The conceptual model we introduced in this paper opens the opportunity to, either jointly or disciplinarily, develop new hypotheses and to integrate new findings into an interdisciplinary interpretation. The process of integration also results in feedbacks into the participating disciplines. By emphasizing the value of using a landscape archaeological approach we would like to encourage researchers from different disciplines to continue working together on the development of integrated hypotheses and to further improve the discussion of disciplinary findings across the disciplines of archaeology and physical geography.

Illustration credits

1 Photo: Daniel Baltat, Bucharest, 2009. 2 Moritz Nykamp. 3 Moritz Nykamp.

44 Meier 2012, 510.
45 Wilkinson 1993, 561.

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