

## **Urban spatial analyses of geophysical archaeological prospection data from the Roman civil town Carnuntum, Austria**

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The archaeological landscape of Roman Carnuntum is situated in the Vienna basin just south of the Danube, on gravel terraces some 45 km to the east of Vienna. As the capital of the Roman province of Pannonia, Carnuntum was an important town during the first four centuries of the first millennium AD. The remains of the Roman town extend over an area of 5 km<sup>2</sup>, most of which is used today for agricultural purposes. They consist of the civilian town, a legionary fortress, *canabae*, burial grounds, temples, and two amphitheatres.

Over the past 50 years the Carnuntum landscape has been the focus of aerial archaeology and geophysical prospection (Neubauer *et al.* 2012). Hundreds of aerial photographs have been used for

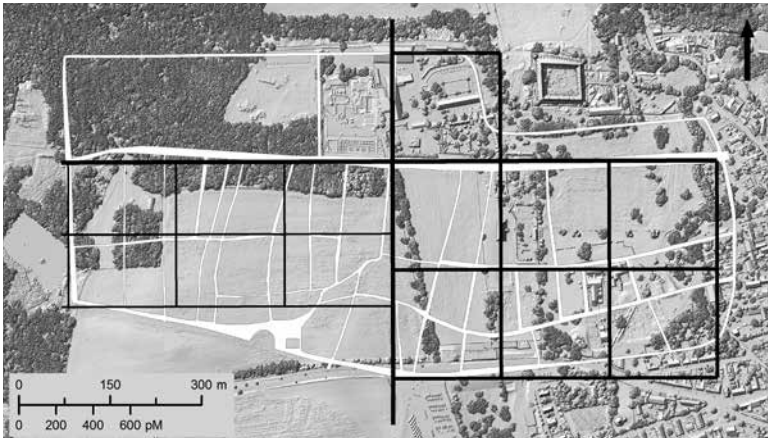


Fig. 1. Overview of the reconstructed street network with hypothetical planning grids

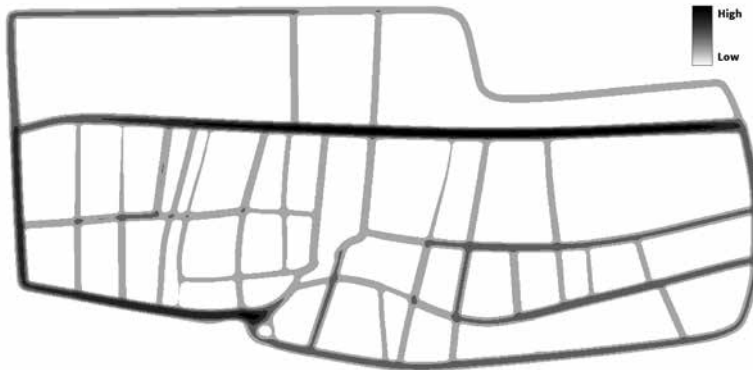


Fig. 2. Results of agent-based simulation of movement; agents were released from different locations within the reconstructed street network. Dark tones indicate areas with the highest intensity of agent movement

systematic archaeological mapping (Doneus *et al.* 2013). Additionally, some 50 ha have been surveyed using various, manually operated geophysical prospection techniques by ZAMG *Archeo Prospections*®. Currently the archaeological landscape of Roman Carnuntum has been surveyed in full using state-of-the-art magnetometry and high-resolution GPR within the frame of a research project implemented by the Ludwig Boltzmann Institute for Archaeological Prospection and Virtual Archaeology (Trinks 2011; <http://archpro.lbg.ac.at>). In combination, these prospection projects have gathered wealth of new data on the buried cultural heritage and significantly contributed to a massive expansion of knowledge on

the Roman town of Carnuntum. The Carnuntum prospection project aims to generate a preliminary master plan of the town structure and layout.

When archaeological interpretations of prospection data are conducted within a GIS environment, the results are in general compatible with modern excavation plans (Neubauer 2004). The developed GIS project combines all available data and information and permits the study of urban planning as well as the recognition of its practical implementation and the evolution of the town plan.

Despite the different approaches, most archaeological theories agree that the way the people construct and organize their living space is reflected in social, cultural and political, even symbolical structures (Cutting 2003; Stöger 2011). One possibility to investigate this relationship is space syntax analysis. This approach comprises a theoretical and analytical set of techniques used to identify, compare and interpret patterns in the spatial configuration of space. It offers a combination of tools that are able to quantitatively and qualitatively capture the configuration of space, and to visualise important correlations between human movements and their use of space (Hillier and Hanson 1984). The paper focuses on the layout of the street system of the Roman civil town of Carnuntum, demonstrating the application of this innovative approach to analysis of archaeological prospection data.

The organisation of Roman urban space is closely connected with the layout of the street system, which can be regarded as the neural system of each city. The street network carries all movement and communication and facilitates orientation in a town. A regular grid makes orientation in the town easier: basic knowledge of the major roads leading to the town centre is essential for both inhabitants and visitors. The configuration of this network is a determining factor for variations in movement rates (Hillier 2014). The location of these arteries within the town relates to commercial activities, the presence of public entertainment possibilities and meeting places for public interaction or control and the like, which on the one hand can generate high rates of movement, while on the other hand they are a prerequisite to have them in the first place. In contrast, luxury residential areas tend to be placed in rather quiet locations permitting a greater degree of privacy.

The first look at the reconstructed street network of Carnuntum reveals a regular pattern of intersecting, yet not orthogonal streets. The town is organized into more or less rectangular blocks. These blocks have various dimensions that vary across the town. In the eastern part of the civil town, the size of these blocks more or less fits a grid of 600 by 600 pM (*pes monetalis*, Roman unit of length, approximately 0.296 m, thus 600 pM = 177.6 m), while the blocks in the western part of the civil town are more suited to a grid of 600 by 400 pM (Fig. 1). This change may indicate a different planning strategy and is likely to have been caused by an extension of the town area.

Previous studies (Kaiser 2011; Stöger 2011; Benech 2010) have shown that syntactical analysis is well-suited to the investigation of Roman urban environments. This approach can support the localisation of areas related to particular activities within the town. An analysis of street configuration clearly shows a main road running parallel to the Danube bank as the most integrated street within the grid of Carnuntum. It forms the main transit route for movement through the town. The application of agent-based simulation supports this evidence (Fig. 2). This finding indicates the high potential for commercial activities in building plots bordering this main road. The aim of the present study is to understand the organisation of the space and to propose an initial model of land use for the civil town of Carnuntum.

## REFERENCES

- Benech, C. 2010. The use of space syntax for the study of city planning and household from geophysical maps: the case of Dura Europos (Syria). In S. Ladsstätter and V. Sheibelreiter (eds), *Städtisches Wohnen im östlichen Mittelmeerraum 4. Jh. v. Chr. -1. Jh. n. Chr.*, *Archäologische Forschungen*, 18: 403-416.
- Cutting, M. 2003. The use of spatial analysis to study prehistoric settlement architecture. *Oxford Journal of Archaeology* 22/1: 1-21.
- Doneus, M., Gugl, C. and Doneus, N. 2013. *Die Canabae von Carnuntum: eine Modellstudie der Erforschung römischer Lagervorstädte: von der Luftbildprospektion zur siedlungsarchäologischen Synthese*, Wien.
- Hillier, B. and Hanson, J. 1984. *The Social Logic of Space*, Cambridge.
- Hillier, B. 2014. The Generic City and its Origins. *Architectural Design* 84(5): 100-105.
- Kaiser, A. 2011. *Roman Urban Street Networks: Streets and the Organization of Space in Four Cities*, New York.
- Neubauer, W. 2004. GIS in archaeology—the interface between prospection and excavation. *Archaeological Prospection* 11(3): 159-166.
- Neubauer, W., Doneus, M., Verhoeven, G., Hinterleitner, A., Seren, S.S. and Löcker, K. 2012. Long-term Integrated Archaeological Prospection at the Roman Town of Carnuntum/Austria. In P. Johnson and M. Millett (eds), *Archaeological survey and the city*, 202-221. Cambridge.
- Stöger, H. 2011. Rethinking Ostia: a spatial enquiry into the urban society of Rome's imperial port-town, Leiden.
- Trinks, I. 2011. The new Ludwig Boltzmann Institute for Archaeological Prospection and Virtual Archaeology. *Newsletter of the International Society for Archaeological Prospection* 26: 9-11.