

# THE SELINOS RIVER IN PERGAMON

## Investigating the Relations Between Urban Development, the Alteration of Natural Space and Changing River Dynamics

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In Pergamon, the Selinos river (today Bergama Çay) emerges as a central element that shapes the urban physiognomy of the city. Despite its importance, previous research has seldom noticed the impact of the Selinos river on the settlement history and urban development of the city. In the context of the TransPergMicro project, the river is being examined as a case study to investigate the relationship between human activities, changes in the natural environment, and the resulting consequences. One of the focal points of the study is the impact of construction activities on the dynamics of the river. In order to investigate these questions, several buildings associated with the river (an ancient river enclosure along the Selinos, the amphitheater, and the substructures of the ›Red Hall‹ complex) have been studied, alongside the archaeological landscape and the geomorphology of the entire river and its alluvial fan.<sup>1</sup>

### 1. The Selinos and its catchment



Fig. 1: Elevation map of the Selinos river and its catchment (DAI Pergamongrabung 2024 | Bernhard Ludwig)

Originating in the Kozak mountains, the Selinos river and its valley served as a vital connection between the resource-rich Kozak plateau and the city of Pergamon (Fig. 1). Water pipelines and a transportation route through the valley ensured the supply of the city.

After resembling a mountain stream in its headwaters, the Selinos widens as it enters a partially unconfined valley. Subsequently, the river flows through a narrow, confined valley with steep banks before reaching its alluvial fan, where the modern city of Bergama and remains of the Roman lower city of Pergamon are located.

After 21 km the Selinos joins the Bakırçay river. Since the 1950s at the latest, modern engineering measures significantly altered the channel of the lower Selinos. Much of the Selinos' water is currently diverted north of the city into the Kestel reservoir in the neighboring river catchment. In return, the natural course of the Kestel river is diverted into the Selinos river southeast of the city. Both measures apparently changed the discharge of the river. In recent years, the banks of the Selinos have been reinforced with stone walls. On the alluvial fan, the channel was additionally straightened, deepened and widened.

### 2. Urban Development and the Alteration of Natural Space

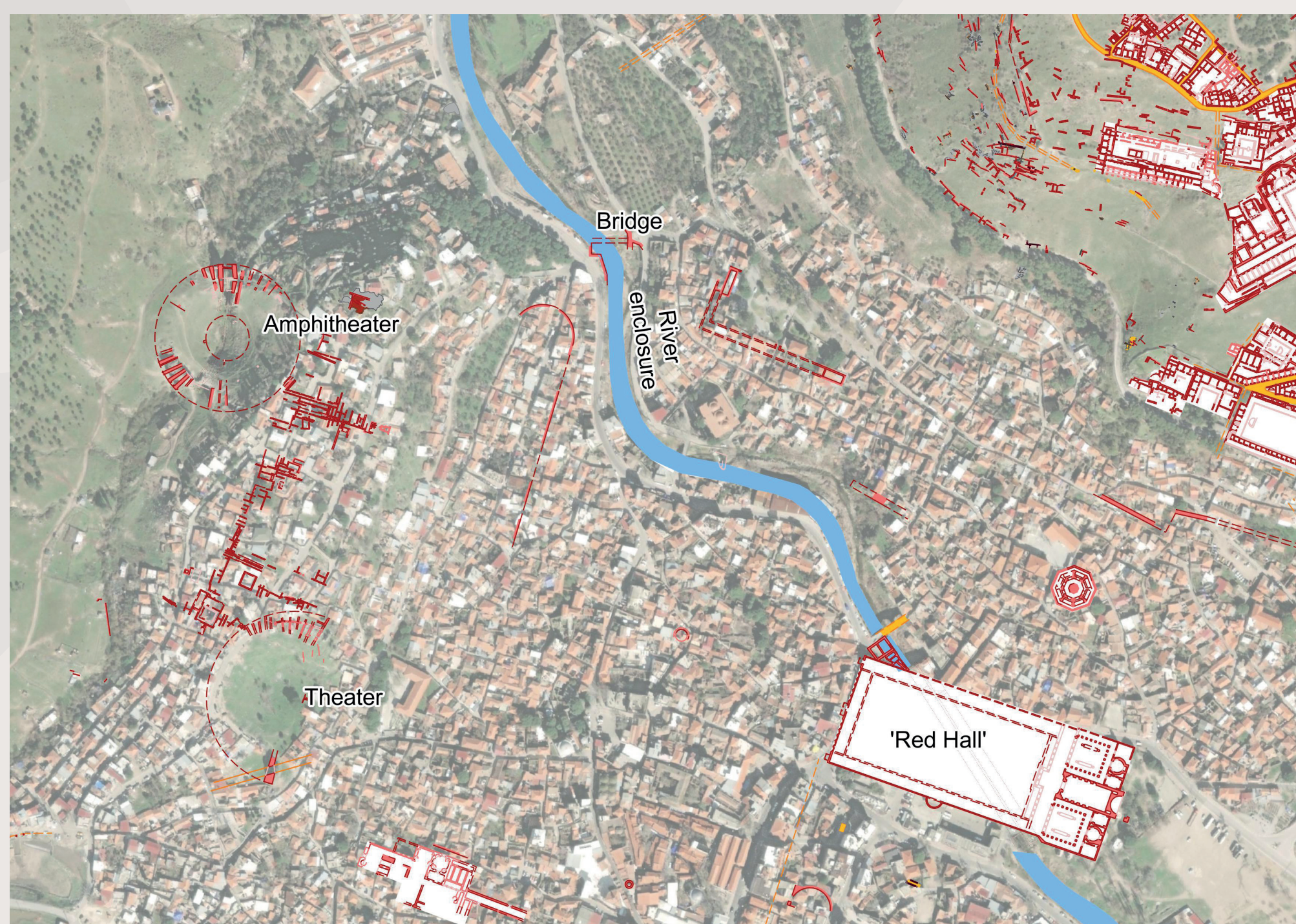


Fig. 2: Ancient structures along the Selinos river (DAI Pergamongrabung 2024 | Pergamon Digital Map 1.1 2020, Bernhard Ludwig)

During the Hellenistic period, the inhabitants of Pergamon primarily settled on the city hill. An urban expansion occurred from the 1<sup>st</sup> century BC onwards, extending to the alluvial fan of the Selinos. One notable structure of this expansion is the ›Red Hall‹ (Fig. 2), which was built over the river and stands as a remarkable example of Roman river engineering. For its construction, the natural riverbed was covered with two parallel barrel vaults of mortar masonry over a length of 180 meters. The floor was paved with massive andesite blocks, and the upstream openings of the culverts were equipped with a system to regulate the waterflow and protect the structure from damages caused by the stream.

### 4. Conclusions

The combination of archaeological, architectural, and geoarchaeological results reveals a significant transformation of the banks and riverbed of the Selinos that occurred with the expansion of the Roman lower city. This transformation is paralleled by increased sedimentation of the alluvial fan and archaeological sites in the southeastern periphery. Ongoing research is analyzing the available data and refining the calculations. As part of the TransPergMicro project, it will be further investigated whether the various measures implemented during the Roman period were primarily driven by efficient land use for urban development, flood control, economic exploitation of the Selinos (and its tributary), or to some extent motivated by a mindset of asserting dominance over nature that emerged during the Roman period.



Fig. 3: Drone image of the river embankment and the current Selinos during the recent construction work (DAI Pergamongrabung 2023 | Gökhan Günay)

Further ancient constructions, which were realized during the urban development and changed the natural space of the Selinos, are situated a few hundred meters upstream of the ›Red Hall‹. The site shows the remains of an artificial **river enclosure** and representative structures from the Roman Imperial period, as well as later remains of artisanal activities (Fig. 3). Close to the ancient riverbank, a late Hellenistic bridge (Kazancı Köprüsü) was located. Originally showing three arches, one arch was closed off during the Roman Imperial period, when the river enclosure was constructed. Both, the closure of the bridge's arch and the construction of the embankment had a significant impact on the river, in particular increasing the velocity of its flow due to the steepening of the banks and the narrowing of the river's cross-section. A presumably Roman weir between these buildings and the ›Red Hall‹ would also have had an impact on the water flow.

The **amphitheater**, which also dates back to the Roman Imperial period, was built in the valley of a tributary of the Selinos, about 300 meters above the confluence with the main river. Parts of the substructure of the amphitheater were built directly on the slopes of the valley to the west of Musalla Mezarlığı hill, taking advantage of the topographical conditions. The integration and modification of the natural environment on this site includes the passage of the stream through an artificial channel below the building that follows the natural course of the terrain (Fig. 4). This is reminiscent of the culverts under the ›Red Hall‹. The construction of the amphitheater above the river suggests its potential use for naumachiae, small naval battles. This hypothesis implies the channeling of water into the arena and also drainage via the stream below.



Fig. 4: Drone image of the amphitheater, clearly showing its location above a creek (DAI Pergamongrabung 2018 | Ihsan Yeneroğlu)

### 3. Changing river dynamics

The various studies of how the natural course of the Selinos was altered in Roman times have stimulated a closer examination of the changing **flow** characteristics. Recent calculations have led to a better understanding of the effects of the ›Red Hall‹ culverts and the upstream weir. The gradient of the river was reconstructed thanks to airborne LIDAR elevation data, Structure-from-Motion data, and architectural surveys of the ›Red Hall‹. Using these data sets in conjunction with the Manning-Strickler formula, it was possible to demonstrate that the ›Red Hall‹ culverts have sufficient capacity to accommodate flows even during rare flood events. The increase of the flow velocity in the culverts reduced erosion of the pavement and sedimentation. Concerning the river enclosures the calculations demonstrate that its walls were high enough to prevent its terraces from regular flooding.

**Geomorphological** observations in the confined valley above the fan apex and on the alluvial fan also indicate that the areas of the Roman lower city were protected from flooding. Sedimentological analyses conducted on the alluvial fan of the Selinos river southeast of Pergamon show that the deposition of flood-related sediments primarily occurred in downstream areas outside the urban region. Maps by Otto Berlet and Alfred Philipson from the late 19<sup>th</sup> and 20<sup>th</sup> century as well as the analysis of longitudinal profiles of the Selinos river, depict a braided-like channel structure downstream of the ancient city, suggesting flooding and deposition in this area. Within this vicinity, two kilometers south-east of the city, a large estate or



Fig. 5: Walls of the farmstead in suburban Pergamon (today a gravel quarry) filled with alluvial fines (DAI Pergamongrabung 2020 | Xun Yang)

farmstead from the late Hellenistic-early Roman period was discovered. During the documentation process, it became apparent that the rooms were completely filled with alluvial fines (Fig 5). Sediments from several outcrops in the gravel pit were analyzed, revealing a chronological sequence indicating increased morphodynamic activity during the Roman Imperial period, particularly between the 2<sup>nd</sup> and 4<sup>th</sup> centuries, probably following the construction of the mentioned river structures.

The anthropogenic changes to the natural environment within the ancient city may have caused, or at least accelerated, the loss of nearby estates or farmsteads. Similar correlations between habitat creation and anticipated loss of livelihoods have been noted in Elaia, where port siltation is associated with increased agricultural activity in the city's chora.

<sup>1</sup> The excavations at the Selinos river were directed by Nilgün Ustura (Bergama Museum). Further research was conducted under the direction of Prof. Dr. Felix Pirson (Director of the Pergamon Excavation project of the DAI)

Read a detailed version of the research in the corresponding blog article

