

# Floods and soil erosion on the example of the late medieval settlement Buzadovec-Vojvodice (Northwestern Croatia)

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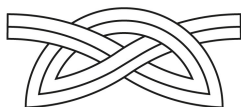
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# USING LANDSCAPE IN THE MIDDLE AGES IN THE LIGHT OF INTERDISCIPLINARY RESEARCH

## KORIŠTENJE KRAJOLIKA U SREDNJEM VIJEKU U SVJETLU INTERDISCIPLINARNIH ISTRAŽIVANJA

Zagreb, 2021.



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## UVODNA RIJEČ

U današnje vrijeme nemoguće je promatrati ljudsku prošlost bez promatranja suodnosa čovjeka i okoliša. S jedne strane, uočljiv je utjecaj okoliša pri izboru mjesta za formiranje naselja, u gospodarskoj djelatnosti koje neko naselje afirmira i razvija, kao i utjecaj o čovjeku neovisnih promjena (npr. klimatskih) koje su mogle uzrokovati i napuštanje nekih gospodarskih djelatnosti ili čak čitavih naselja. S druge strane, čovjek djeluje na modeliranje okoliša i krajolika jer su promjene u socijalnim strukturama, ekonomiji, proizvodnji, kulturnim i vjerskim izričajima svakako donosile promjene koje su uvelike sezale u prestrukturiranje i modificiranje izvornih krajolika. Za razumijevanje ovih promjena ključan je multidisciplinarni i interdisciplinarni pristup: korištenjem arheologije krajobraza i okoliša, geoarheologije, paleoekologije, paleoklimatologije i paleogeografije kako bi se rekonstruirali danas izgubljeni okolišni uvjeti te promatranjem novijeg krajobraza kao slojevite tvorevine povijesnih događanja korištenjem povijesnih izvora, bioarheoloških podataka itd. Tako se krajolik definira kroz međusoban odnos prirodnih procesa i ljudskih aktivnosti, a upravo je ovo bila tema šestog međunarodnog znanstvenog skupa srednjovjekovne arheologije održanog u Zagrebu 6. lipnja 2019. godine, pod nazivom *Korištenje krajolika u srednjem vijeku u svjetlu interdisciplinarnih istraživanja* u organizaciji Instituta za arheologiju. Tijekom skupa održano je 12 izlaganja i četiri poster prezentacije, a sudjelovalo je 37 znanstvenika, od kojih 16 iz Hrvatske te 21 iz Mađarske, Rumunjske, Rusije, Slovačke, Slovenije i Srbije. Cilj ovoga skupa bio je promatranje čovjeka u svom ekološkom, ekonomskom, kulturno-religijskom i povijesnom okruženju tijekom srednjega i novoga vijeka u svjetlu interdisciplinarnih istraživanja.

Dio predstavljenih radova obuhvaćen je ovim Zbornikom radova znanstvenog skupa. Radovi raznovrsno promatraju čovjekov krajolik: od rekonstrukcija okolišnih i ekoloških uvjeta, prostornih analiza naseļavanja, rekonstrukcija okoliša prema arheološkim kontekstima, do transformacije srednjovjekovnog grada, vodovoda kao dijela pomno planiranog gradskog krajolika te promišljanja kulturno-religijskih krajolika.

Prikupljanje radova ovoga Zbornika i priprema za tisak u vrijeme COVID-19 pandemije, potpunog zatvaranja svih djelatnosti, dva razorna potresa (onog zagrebačkog u nedjelju 22. ožujka 2020. godine u 6 sati i 24 minute te onog petrinjskog u utorak 29. prosinca 2020. godine u 12 sati i 19 minuta) te njihovih dalekosežnih posljedica koje su prisilile Institut na promjenu adrese, činili su se gotovo nemogućim zadatkom. Stoga smo posebno zahvalni autorima radova okupljenih u ovoj publikaciji koja izlazi u seriji *Zbornik Instituta za arheologiju / Serta Instituti Archaeologici* (Vol. 18) i Ministarstvu znanosti i obrazovanja Republike Hrvatske na financijskoj potpori za izdavanje ovoga Zbornika u vrijeme globalne financijske krize. Zahvaljujemo svim sudionicima skupa, kolegama iz Instituta za arheologiju za pomoć pri organizaciji i recenzentima ove publikacije. Nadamo se da će ovdje prikupljeni radovi biti poticaj i inspiracija kolegama arheolozima, stručnjacima drugih znanstvenih područja, kao i generacijama koje dolaze, za promatranje i proučavanje različitih aspekata prostornog identiteta nekog područja. Tako bismo u konačnici bolje razumjeli prošlost te iz novog kuta sagledali okruženje u kojem živimo, a koje u svojoj srži baštini svu slojevitost međuodnosa čovjeka i prirodnih procesa.

## FOREWORD

At present, it is impossible to observe the human past without observing the relationship between man and the environment. On the one hand, the influence of the environment is noticeable on the choice of places to form settlements, on the economic activity that affirms and develops a settlement, as well as the non-human influenced changes (e.g. climate) that could have caused the abandonment of some economic activities or even entire settlements. On the other hand, man influences modelling of the environment and the landscape, because changes in social structures, economics, production, cultural and religious expressions have certainly brought about changes that have largely restructured and modified the original landscapes. A multidisciplinary and interdisciplinary approach is vital to understand these changes: using landscape and environmental archaeology, geoarchaeology, paleoecology, paleoclimatology and paleogeography to reconstruct today's lost environmental conditions and observing the recent landscape as a layered formation of historical events using historical sources, bioarchaeological data, etc. Thus, the landscape is defined through the mutual relationship between natural processes and human activities, and this was precisely the topic of the 6<sup>th</sup> International Scientific Conference on Mediaeval Archaeology held in Zagreb on 6<sup>th</sup> of June 2019, entitled *Using landscape in the Middle Ages in the light of interdisciplinary research*, organized by the Institute of Archaeology. During the conference, 12 presentations and four poster presentations were held, and 37 scientists participated, 16 of them from Croatia and 21 from Hungary, Romania, Russia, Slovakia, Slovenia and Serbia. The aim of this conference was to observe man in his ecological, economic, cultural-religious and historical environment during the Middle and Modern Ages in the light of interdisciplinary research.

Part of the presented papers is included in this Proceedings of the scientific conference volume. The papers observe the human landscape in a variety of ways: from reconstructions of environmental and ecological conditions, spatial analyses of settlements, reconstructions of the environment according to the archaeological contexts, to the transformation of the medieval town, water supply as part of a carefully planned urban landscape, and reflections on cultural and religious landscapes.

Collecting the papers for this Proceedings volume and preparing them for printing at the time of the COVID-19 pandemic, complete lockdown, two devastating earthquakes (the one in Zagreb on Sunday, 22<sup>nd</sup> of March 2020 at 6.24 AM and the one in Petrinja on Tuesday, 29<sup>th</sup> of December 2020 at 12.19 AM) and their far-reaching consequences that forced the Institute to change its address, seemed an almost impossible task. Therefore, we are especially grateful to the authors of the papers collected in this publication, which is published in the series *Zbornik Instituta za arheologiju / Serta Instituti Archaeologici* (Vol. 18), and the Ministry of Science and Education of the Republic of Croatia for the financial support of this Proceedings volume during the global financial crisis. We would like to thank all conference participants, colleagues from the Institute of Archeology for their help with the organization and reviewers of this publication. We hope that the papers collected here will be an encouragement and inspiration to fellow archaeologists and experts from other scientific fields, as well as future generations, to observe and study different aspects of the spatial identity of a region. In this way, we would ultimately better understand the past and see from a new angle the environment in which we live today, which at its core inherits all the layers of the interrelationships between man and natural processes.





Tatjana Tkalčec, Tajana Sekelj Ivančan

## FLOODS AND SOIL EROSION ON THE EXAMPLE OF THE LATE MEDIEVAL SETTLEMENT BUZADOVEC – VOJVODICE (NORTHWESTERN CROATIA)

The paper presents archaeological indicators that testify to the influence of environmental factors on the formation (favourable climate, proximity to water and forests) and reorganization of settlements (due to floods – alluvial deposits), as well as, deposition of colluvial sediments that covered the already abandoned settlement. In it, we tried to connect the facts identified by archaeological research with the findings of interdisciplinary paleoclimatic research and with the research on climate and weather, based on direct and indirect data from written historical sources from the wider Carpathian Basin.

The late medieval archaeologically explored settlement at the position of Buzadovec – Vojvodice (north-western Croatia) is presented. The settlement was formed at the end of the 12<sup>th</sup> and the beginning of the 13<sup>th</sup> century in a lowland landscape, not far from the river course. Frequent floods or a major flood in the late 13<sup>th</sup> or early 14<sup>th</sup> century caused the position of the older settlement to be abandoned and moved to the slightly elevated terrain. The settlement was continuously inhabited until about the middle of the 15<sup>th</sup> century. The reason for the cessation of the settlement's existence has not been determined, but an interesting phenomenon of soil erosion of the neighbouring hill has been recognized, which caused the cultural layers of the abandoned late medieval settlement to be covered with meter-thick deposits of sterile clay.

**KEY WORDS: LATE MEDIEVAL SETTLEMENT, FLOODS, SOIL EROSION, PALEOCLIMATE, BUZADOVEC – VOJVODICE, 13<sup>TH</sup> – 15<sup>TH</sup> CENTURY**

### INTRODUCTION

During rescue archaeological excavations carried out by the Institute of Archaeology in 2011 and 2012 on the route of the A12 Sveta Helena – GP Gola motorway, section Gradec – Kloštar Vojakovački, at the AN 3 Buzadovec – Vojvodice position, a late medieval settlement dating from

the 13<sup>th</sup> to the mid-15<sup>th</sup> century was explored. Only a few pits and formations from the late Iron Age – La Tène D, have been found, or perhaps from the 1<sup>st</sup> century BC and the 1<sup>st</sup> century AD, but most of the finds consist of medieval buildings and pits (Tkalčec 2013: 80, Fig. 3).

The site is located in the valley of the river Glogovnica, along the eastern side of its course, and according to the surface findings on the fields,



**Fig. 1** — The position of the Buzadovec – Vojvodice site on a topographic map (State Geodetic Administration, TK 1 : 25,000, Haganj 322-1-1; made by: T. Kkalčec)

**Sl. 1** — Položaj nalazišta Buzadovec – Vojvodice na topografskoj karti (Državna geodetska uprava, TK 1 : 25 000, Haganj 322-1-1; izradila: T. Kkalčec)

it extends below the western slope of the hill on which the present village Buzadovec is located (Gradec municipality, Zagreb County) (Fig. 1).

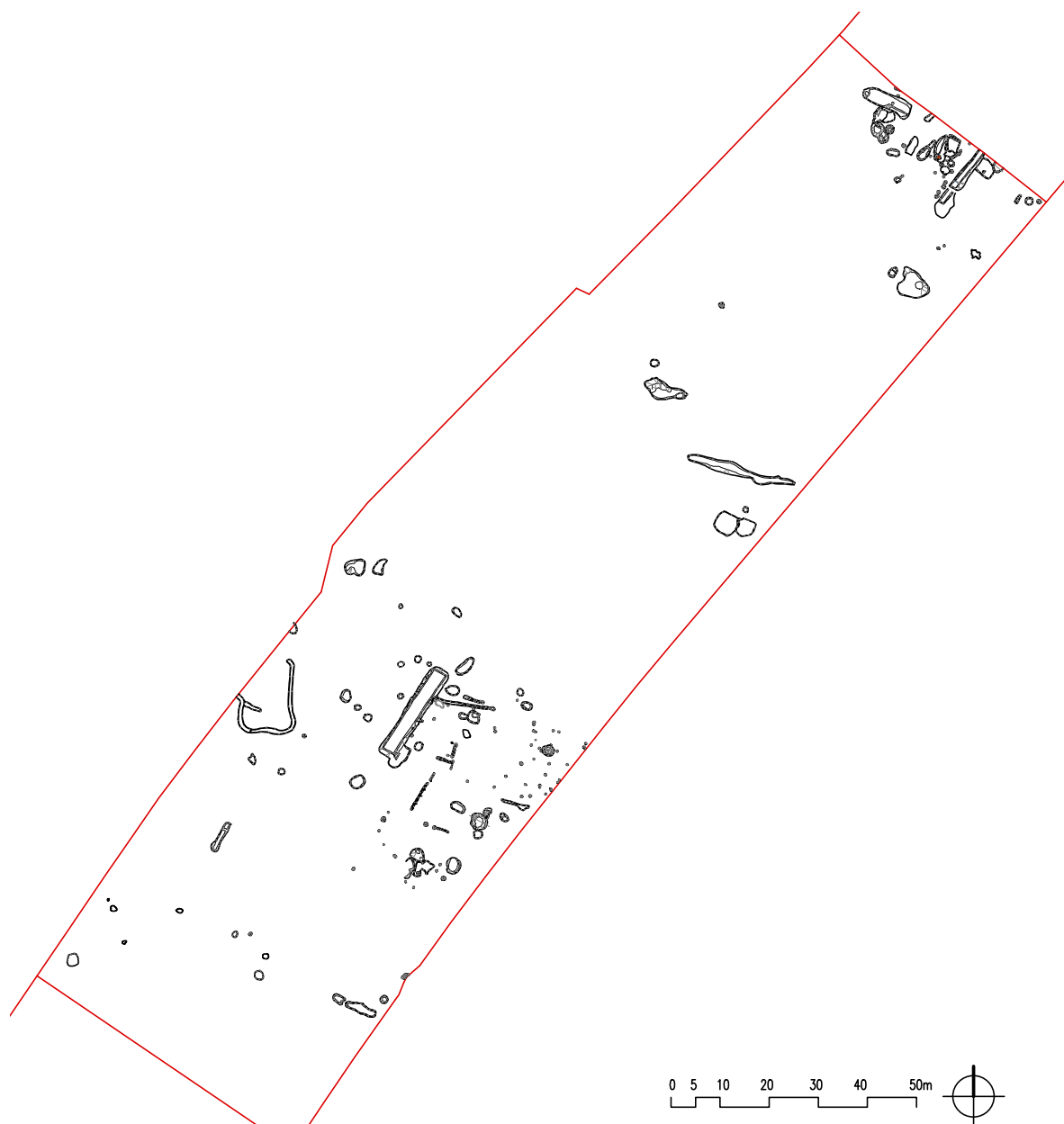
Today, arable land, meadows and pastures alternate with forest areas in this lowland landscape. Although the river Glogovnica is regulated today, the wooded floodplain is particularly noticeable in the western area towards the course of the Koruška stream that follows the course of Glogovnica.

The areas immediately east of the river Glogovnica are covered with pastures or neglected plots, while fertile arable land is spreading mainly on elevated terrain on the slopes of the hill on which the present-day village of Buzadovec developed. The part of the site through which the route of the A12 motorway passes is located at average absolute altitudes from 113.4 to 115 m above sea level.

The older horizon of the medieval settlement, which covers the period probably from the very end of the 12<sup>th</sup> and the entire 13<sup>th</sup> century, gravitates closer to the river Glogovnica. The younger medieval horizon of this site is located in the lowlands, but on a slightly higher part of the terrain, and dates

from the 14<sup>th</sup> to the mid-15<sup>th</sup> century (Fig. 2).

Although more or less elevated positions along streams were usually chosen for the formation of settlements, in different archaeological periods we sometimes encounter a different logic of locating sites either for residential or economic purposes. Accordingly, in archaeological surveys of the wider area on both sides of the river Glogovnica in the length of about 10 km, which included the area around the site Buzadovec – Vojvodice, among 55 discovered sites with surface finds ranging from prehistory to modern times, with a noticeable concentration of late medieval sites on the slopes of an elevated beam east of the course of the Glogovnica river, only five sites were detected in the immediate vicinity of the river, in a very low terrain. Late medieval finds have been discovered on all of them. Only late medieval pottery was found at two of these sites. Finds from the late Iron Age appear at the third site along with those dating to the late Middle Ages, and finds from the Bronze Age appear at the fourth (Tkalcćec, Ložnjak Dizdar 2015: 110, Fig. 1, sites no. 1, 4, 18 and 25). The fifth posi-



**Fig. 2** — Dugouts of the explored constructions (drawing by: K. Turkalj)  
**Sl. 2** — Ukopi istraženih objekata (crtež: K. Turkalj)

tion is the site AN 3 Buzadovec – Vojvodice with sporadic finds from the Late Iron Age and a rich late medieval phase of settlement. Such a choice of location for the formation of the site may lead us to think about different environmental (or meteorological) conditions during the existence of the settlement, but also that the settlement may have had a specific purpose, or economic activity which was particularly favoured by the proximity of water or perhaps forests that certainly in the Middle Ages, as well as today, covered large areas around the river valley.

On this occasion, we will focus on the basement of a multi-room house dating from the second half of the 13<sup>th</sup> century, located in the lowland southern part of the explored area of Buzadovec – Vojvodice and on the northern segment of the settlement dated to the mid-15<sup>th</sup> century, located on a slightly elevated terrain. It is these segments of the site that allowed us to see the causes of decay, i.e., abandonment of older medieval horizons, built in the floodplain, as well as the moving of the younger horizon of the settlement to the elevated terrain, and opened the possibility of interpreting the causes of termination of the entire settlement.

## ARCHAEOLOGICAL EVIDENCE

A three-room house with a basement from the older horizon of the settlement, destroyed in the flood.

In the southern lowland part of the site, a special discovery was a large building elongated in a north-south direction probably divided into three rooms, with a basement expanding under its entire surface, and whose entrance was situated on its south-eastern side (Fig. 3). This house with a basement is surrounded by numerous pits and formations which indicate outbuildings and various activities that took place in the yard of that household.

Based on the size of the building itself, i.e., the basement, as well as the findings of not only kitchen-ware but also table-ware, it can be assumed that the property belonged to a village elder or a lower nobleman who had his own separate farm here. The house is positioned about 150

m east of the river Glogovnica, and about 350 m west of the top of the hill on which the today's village Buzadovec is located (Fig. 1). Based on the findings (kitchen- and table-ware and other finds) and radiocarbon analyses, the house is dated to the second half of the 13<sup>th</sup> century (Pl. 1).<sup>1</sup>

The house manifested itself as a 21 m long and 3.5 to 3.9 m wide dark grey stain under the humus layer (Tkalčec 2013: 81, Fig. 4). The lower fillings of the dug in part of the building were lighter yellow and lighter grey in colour and contained fewer finds than the upper layer (Fig. 4). The basement of the building itself is a dug in space of almost vertical walls, about 90 cm deep, 18.9 m long and with an average width of 2.5 m. The shallow extension in the south-eastern part of the building measures 5.20 m (northeast – southwest) x 2.20 m (northwest – southeast) and is about 20 cm deep. It protrudes to the south about 1 m outside the line of the southern façade of the basement. This extension may have been the entrance to the basement. The initial situation indicates that the



**Fig. 3** — The house with a basement, dated to the second half of the 13<sup>th</sup> century, after the excavation (photo by: T. Tkalčec)

**Sl. 3** — Kuća s podrumom iz druge polovine 13. stoljeća nakon istraživanja (snimila: T. Tkalčec)

**1** — A sample of charcoal from the upper dark layer of a house with a basement, rich in archaeological finds (SU 60), gave early dates between AD 1049 and 1212 (KIA-47858, weighted mean  $890 \pm 14$  BP) that cannot be related to the dating of the material that the object contained and was probably a result of the so-called *old wood* effect. A second charcoal sample from the same layer gave a more reliable result – cal AD 1280, according to 2 sigma calibration cal AD 1260–1290 and 1 sigma calibration cal AD 1270–1280 (Beta-359209, conventional radiocarbon age  $730 \pm 30$  BP).

building was built in the *Blockbau* technique, i.e., it is an above-ground building with a basement whose construction was not supported by buried pillars but by wooden horizontal beams which left no preserved traces.

The fact that no stones were found would indicate that the horizontal foundation beams were laid directly on the ground, probably on the sub-soil itself, without digging in, because no traces of the foundation ditch have been preserved. It is to be assumed that the walking area of the house itself had to be higher than the surrounding walking level of the terrain (i.e., the house had to be entered by stairs) in order to provide more space for communication in the basement of the building. Several indicators suggest that this spacious log cabin with a basement was abandoned due to constant flooding or one significant flood. One of the indicators is the lighter clay sediments without or with a very small number of archaeo-

logical finds that were deposited in the fill of the basement, which indicates that flooded layers formed when the basement was still closed, i.e. when there was no possibility of a large amount of archaeological finds intrusion. These clay sediments were probably deposited by water deposits through the wooden walls of the building, and the material could have subsequently perished in the moist and muddy soil (Fig. 4).<sup>2</sup> Another important indicator is the specific situation relating to the findings of animal bones from the middle and upper levels of the filling layers of the building. Finds of animal bones as well as some other finds at the site (table-ware, ceramic spheres, etc.) also give us an idea of the function of the settlement.

Preliminary analysis of animal bones was made for the complete archaeozoological material and, for now, we have no data on a possible distinction in the representation of individual species in a particular horizon. Within the whole identified



**Fig. 4** — Auxiliary profiles within the basement of the house dated to the second half of the 13<sup>th</sup> century, with marked three layers of the filling (photo by: A. Kudelić)

**Sl. 4** — Pomoćni profili unutar podruma kuće iz druge polovine 13. stoljeća s naznačena tri sloja zapune (snimila: A. Kudelić)

<sup>2</sup> — We will give the amount of kitchen pottery (expressed according to the number of fragments) and animal bones (expressed according to weight, in grams) in the three observed layers, as an example. A total of 4269 fragments of kitchen utensils and 5210.86 g of animal bones were found in the upper dark layer (SU 60, SU 57 and SU 172 all belong to that upper layer). There were 306 fragments of kitchen pottery and 606.6 g of animal bones in the middle layer, and only 17 fragments of pots were found in the lower, lowermost layer, while the findings of animal bones were not noticed. The situation is similar with the distribution of other finds in the building (table-ware, daub, metal finds, slag and numerous ceramic spheres).

material, a high representation of cattle and pigs is noticeable, while other domestic animals, birds and wild animals are represented in a very low percentage. Representation of the minimum number of elements (MNE) of identified specimens in groups of animals (including a human tooth) indicates the expressive number of cattle (37.4%) and pigs (31.2%), while a large part of the elements which can be characterized as large ungulates most likely belong to cattle, as well. The remains of horses as well as the sum of the remains of goats and groups of goats/sheep are slightly below 5%, dogs and birds slightly above 2%, while deer, fox, rabbit and humans (tooth) are represented with 0.14% (Miculinić 2013: 6–7, sl. 1). More than half of the cattle were slaughtered young, in the most suitable period according to the amount of meat and the cost of feeding and maintenance. Other, adult cattle were used for milk production, breeding and labour. No old individuals were found within the material, i.e., dairy, breeding and working animals were slaughtered when their productivity lowered (Miculinić 2013: 9). Judging by the presence of skeletal elements, beef was not selectively brought or taken from the site, i.e., there was no selection related to meat quality (Miculinić 2013: 11), but as said, we do not know if there is a difference in the older and younger horizon. Pigs were slaughtered young, and only breeding animals reached adulthood. Skeletons of both young and old pigs are represented, but mostly those that would indicate the average-quality pig meat (Miculinić 2013: 11–12). The whole house with a basement was examined separately and it was concluded that the animal remains from the filling of this unit do not differ from the usual picture of the whole site. However, it is important for our review that there were no animal remains in the lowest filling of the basement “which indicates sedimentation in the closed space or some special conditions in which there was no accumulation of animal bones” (Miculinić 2013: 18). This fits into the image of the basement whose area is filled with sediments caused by floods. In the middle layer of the basement filling, a small number of animal remains appear (some of which showed traces of anthropogenic activity as well as traces of dog’s milling) as well as fragments of ceramic vessels, spheres and other material. Probably this sediment accumulated during the decay of the floor of the house. There were many animal and other remains in the highest layer. There, the highest concentration of animal bones (about 20% of all specimens of the whole site) was present, which also bear traces of human (cuts, butchering) and animal (dog) activity. Traces of roots formed in several stages were

also visible on bones. The oldest ones, of the same colour as the diagenetically coloured bones, indicate that, shortly after the bones were buried into the sediment, plants started growing on the surface (Miculinić 2013: 18). Such a picture supports the assumption that the bones were exposed to the weather on the not yet completely collapsed floor of the house for a long time, and that soon after the house collapsed the entire surface was overgrown with vegetation.

Finds of animal bones indicate that the owner of the estate raised the animals for his own needs, but probably for resale as well. Although all skeletal elements of cattle were found at the site, which would indicate that there was no selection related to meat quality, only a more detailed distinction of animal bones according to horizons and objects will provide reliable data on whether or not there are indications of beef preparation for sale. On the other hand, as far as the skeletal remains of pigs are concerned, it is already evident that certain meatier and higher quality parts of pigs were not consumed on the site and were probably intended for sale (Miculinić 2013: 20). Historical sources do not provide any information on who owned the village, i.e., this small grange. Given the modern name of the village Buzadovec, it is hard to determine if it was a nobleman from the genus Buzad-Hahot, who, however, had their estates mostly in remote areas in Međimurje or Varaždin County, or if this medieval settlement fell under the episcopal estates in the nearby town of Gradec (Tkalčec 2013: 77–78). Extremely numerous finds of ceramic spheres, found in the context of both medieval horizons, open the possibility of further reflections on some specialization of this site (Tkalčec 2013: 79, Fig. 2). The ingrained theses that the ceramic spheres were used as slingshot projectiles (Bunčić 2012) would indicate hunting activities that, on the other hand, does not correspond to the extremely small number of game bones found on our site. In addition, attention should be drawn to the fact that in the Middle Ages not everyone could hunt, only the members of the elite. Therefore, one might think that these extremely numerous findings indicate the production of slingshot projectiles at this position. However, the findings of ceramic spheres at our site allow us to think about their various purposes. If we open the possibility that cattle were not bred exclusively to be used as food and for milk and dairy products to meet the needs of the village, that is the village owner, but also for further distribution – sale of these products, then the findings of ceramic spheres could be interpreted as heaters used for the production of cheese for the wholesale. The

third possible purpose of these ceramic objects on this site is the use of ceramic spheres as a kind of means for calculating / weighing of products for sale. However, there are not enough elements for the final conclusions about the primary function of these objects in Buzadovec because they were found dispersed over the entire surface and in all archaeological units, within both the older and the younger horizon of the settlement.

The proximity of water and pastures that probably stretched between the 150 m distant river Glogovnica and the described farm with a house, favoured the cattle breeding for both meat and cheese / milk. Closeness of forests in a water-rich environment, in turn, favoured pig farming (acorns). Analysis of wood samples from the three layers of the house with the basement filling, resulted in a noticeable amount of oak (*Quercus*, 85 specimens), while in addition to oak, alder (*Alnus*, 43 specimens), elm (*Ulmus*, 23 specimens), some

hornbeam (*Carpinus*, 8 specimens), hazel (*Corylus*, 4 specimens), hawthorn/partridge (*Sorbus*, 3 specimens), maple (*Acer*, 2 specimens), poplar (*Populus*, 2 specimens) and birch (*Betula*, 1 specimens) were observed. (Culiberg 2018).<sup>3</sup> Oak, of course, could serve as a construction material for wooden house with a basement, and its presence in this context was expected. The wetland environment in the late Middle Ages is evidenced by the high presence of alder and lowland elm, and poplar is the tree that thrives best in moist habitats with enough water.

It is important to point out that the archaeozoological analysis of the bones from the upper layer of the house with the basement indicated that the bones were exposed to the weather for a long time and that, immediately after the bones were laid in the sediment, the surface was overgrown with vegetation, unlike in the other buildings on the site. Precisely this fact, as well as the



**Fig. 5** — Colluvial sediments covering the remains of the settlement from the first half of the 15<sup>th</sup> century, pit SU 439/440 (photo by: T. Sekelj Ivančan)

**Sl. 5** — Kolutivijalni sedimenti koji prekrivaju ostatke naselja iz prve polovine 15. stoljeća, jama SJ 439/440 (snimila: T. Sekelj Ivančan)

**3** — In the upper layer of the filling, the concentration of wood was the highest (101 specimens were recognized from the collected samples), in the middle layer it was lower (67 specimens), and in the lower layer there were extremely few traces of wood (3 specimens). The concentration of oak is noticeable in the upper layer of the building (32 specimens), and especially in the middle layer of the southern part of the building (48 specimens). Can we connect such a situation with the presumed entrance to the basement in that part and with the probably more massive structure of the lintel and the wooden stairs? It should also be noted that not all the charcoal was taken from the top layer during the excavation but only selected samples, because it was present in large quantities. Selection was also made in the lower layers, however there was visibly less charcoal residue.



**Fig. 6** — Colluvial sediments covering the remains of the settlement from the first half of the 15<sup>th</sup> century, pit SU 431/432 (photo by: T. Sekelj Ivančan)

**Sl. 6** — Koluvijsalni sedimenti koji prekrivaju ostatke naselja iz prve polovine 15. stoljeća, jama SJ 431/432 (snimila: T. Sekelj Ivančan)

layers of lighter fillings inside the basement dug-out, of which the lowest layer (alluvial sediment) indicates filling while the whole was still closed, tell us that the house, due to the constant intrusion of water into the basement and probably the flooded surrounding soil, at some point could no longer maintain its basic function and was abandoned. Abandoned in this way and left to the ravages of time, it was exposed to the weather for some time until it completely collapsed and decomposed. Pits and features can be seen in the vicinity, that could indicate a younger period, i.e., the 14<sup>th</sup> century, during which features generally do not reach the lowlands to the area of the abandoned estate/grange but tend to spread to the hill to the east, and especially to the north where mostly the buildings from the first half of the 15<sup>th</sup> century can be found.

### Late Medieval horizon on the north of the site, covered with layers of eroded earth

The northern part of the site was occupied mainly during the younger horizon of the medieval settlement (14<sup>th</sup>/15<sup>th</sup> century). The concentration of various pits with buildings, probably used for economic purposes, a narrow basement and several fireplaces and kilns, indicate the possibility that some intensive economic activity took place here. The findings, however, do not reveal to us what kind of activity it could be. The ceramic material shows the traditions of forms and methods of decoration as used in the previous period, but there are somewhat more complex profiles of the pot rims and new forms that did not exist in the 13<sup>th</sup> century (Pl. 1). The dating of the northern part of the settlement was also confirmed by radiocarbon analyses,<sup>4</sup> and there were

**4** — Charcoal sample from the lower, first phase of the domed clay furnace (SU 350/10) gave no reliable result, e.g. the age difference between both conventional ages was significant ( $191 \pm 27$ ) indicating that the sample was not homogenous, so calibration of the results was not made (KIA-47859, conventional age:  $570 \pm 20$  BP and  $760 \pm 20$  BP). Charcoal sample from the feature SU 407/408 gave reliable result cal AD 1410, e.g. 2 sigma calibration cal AD 1320–1340 and cal AD 1390–1440; 1 sigma calibration cal AD 1400–1430 (Beta-359210, conventional radiocarbon age:  $530 \pm 30$  BP).



no indicators of the continuation of life after the mid-15<sup>th</sup> century.

In that part of the site, a yellow-light brown layer of clay was deposited on the remains of a medieval settlement, in which there was a lot of scattered archaeological finds, unrelated to the buildings below. It seems that this layer was flooded, and the water dispersed the findings from the lower buildings and formations. This layer was between 10 and 30 cm thick. In the north-eastern corner of the explored surface, above the remains of pits, kilns and other formations, a meter-thick colluvial sediment of sterile yellow clay were deposited without finds, eroded from the hill (Figs. 5–6).<sup>5</sup> These sediments thin out to the west and southwest and then disappear.

## DISCUSSION

Archaeological methods of researching terrestrial sites seldom can identify short-lived meteorological extremes. Archaeology makes the greatest contribution in cases of geological catastrophes and destructive phenomena such as earthquakes and volcanic eruptions, as well as in recording long-term climate anomalies whose cumulative effects can be recognized, for example, in buried abandoned settlements or in bare, eroded archaeological sites (Kužić 2014: 121).

The period between 1000 and 1300 was the so-called warm medieval period of mild winters and favourable summer temperatures (Medieval Optimum) with a shorter cooling interval around 1240, but also with several particularly warm intervals during the 11<sup>th</sup> and the 12<sup>th</sup> century (Dotterweich 2008: 196; Botić 2013: 374–376). Most researchers believe that this period of optimal climate begins in the 9<sup>th</sup> century and lasts until the turn of the 13<sup>th</sup> to the 14<sup>th</sup> century. This period was recognized in the 1960s by Hubert H. Lamb and called the Medieval Warm Epoch, but in recent literature the term “Medieval Climate Anomaly” is also common because the climate during this period varies significantly from place to place and short but extremely cold climate occurred as well (Vadas, Rácz 2013: 210). The temperature display for the periods from 500 to 2000 indicates significant anomalies during the 14<sup>th</sup> century which turned out to be a transitional period from the medieval warm epoch to the Little Ice Age (Mann et al. 2009: 1257, Fig. 1).

The alternation of hot and cold periods during the 13<sup>th</sup> and the 14<sup>th</sup> century, accompanied by large floods caused by heavy rainfall (especially in the first half of the 14<sup>th</sup> century), is also confirmed in Central Europe by numerous historical sources. From the 15<sup>th</sup> to the second half of the 19<sup>th</sup> century, temperatures dropped. Longer phases without major floods were observed in the first half of the 16<sup>th</sup> century, between 1675 and 1784 and after 1890. At the end of the Little Ice Age, extreme summer hailstorms were recorded at the local and regional levels (Dotterweich 2008: 196).

Historical data related to floods and elevated water levels mainly describe individual flood events and the relatively short-term consequences of major floods. The recorded archaeological and sedimentological data can mainly be related to the consequences of large floods and catastrophes caused by floods, as well as to periods of more frequent flooding, higher water levels and long-term hydrological changes (Kiss, Laszlovszky 2013: 1). This seems to be the case in Buzadovec as well, where two climate changes are recognized at the local level. At the end of the older horizon of the settlement we recognize climate change from a dry period to more humid period accompanied by floods and elevated groundwater levels. For the younger horizon of the settlement, we recognize the covering of the remains of the settlement with extremely thick clay sediment resulting from soil erosion from a nearby hill, caused, again, by some extreme climatic phenomena, probably accompanied by heavy rainfall and floods.

Frequent floods in the Carpathian Basin were recorded between the 1330s and 1350s, with the largest floods in 1342 and 1343 (Kiss 2009), then between the late 1390s and 1430s, and during the last decades of the 15<sup>th</sup> century (Kiss 2011). Increased flooding activity in the eastern Alpine area and in the Carpathian Basin has been documented in the 15<sup>th</sup> and the 16<sup>th</sup> century, with significant flooding phases between the 1400s and 1430s, the 1470s – 1500s, and from the mid to late 16<sup>th</sup> century (Kiss 2012; Kiss, Laszlovszky 2013). Despite the floods, there were dry years in these periods as well, accompanied by heat, livestock deaths, famines and fires, and socio-economic decline, as evidenced by written sources (Kiss 2017).

Paleoclimatic research in the Alps has indicated prolonged periods of warm stages dur-

<sup>5</sup> — The northern surface has not been explored, i.e., the road was built over this, seemingly sterile, layer. The Institute of Archaeology informed the Ministry of Culture about the specific situation, but no further protective archaeological explorations were approved.

ing the Bronze Age, the Antiquity and the Middle Ages between 950 and 1350 (Theune 2019: 436), as well as in the whole area of the Western and Central Europe until the transition from 13<sup>th</sup> to the 14<sup>th</sup> century when the so-called Little Ice Age begins (Vadas, Rácz 2013: 218). The temperate climate with warm summers and mild winters, sufficient rainfall and optimal water levels, as well as the proximity of the forest, could be an incentive for choosing a lowland position near Glogovnica for the construction of settlements/granges with specific economic purposes during the 13<sup>th</sup> century or even as early as the late 12<sup>th</sup> century.

The 14<sup>th</sup> century was a part of the transition period between the Medieval Warm Epoch and the Little Ice Age when the first signs of climate deterioration became apparent. The first years of the 1300s were a turning point for climate change in most parts of Europe (cooling, rainy periods, floods), resulting in the abandonment of some settlements or even entire peripheral regions of Europe, which were inhabited earlier, during the Medieval Warm Period (Kiss 1999: 54). The rise of extreme climate changes is particularly well documented in Western Europe. The first decade of the 14<sup>th</sup> century was marked by "summerless years", great famine and shortages throughout Europe, and thus by the rise in grain prices. Data for the area of Hungary also indicates that the 13<sup>th</sup> century was drier, and that the beginning of the 14<sup>th</sup> century brought change into more humid weather, marked by floods (Vadas 2009: 23, 25, Tab. 1–2; Fraser 2011: 1271, Fig. 1). These changes that occurred in the 14<sup>th</sup> century obviously affected the settlement in Buzadovec – the flood caused the abandonment of the lowest part of the settlement, and thus the house with the basement, and the relocation of the settlement to a slightly higher position. Although, according to written documents, the peak of floods, recorded mainly for larger rivers from the wider area of Central Europe, was around 1342 (Kiss 2009), they occur more intensively as early as the beginning of the 14<sup>th</sup> century and it can be expected they could have caused problems at the local level already at the end of the 13<sup>th</sup> century. Larger rivers cause floods as a result of a large inflow of water from their tributaries, and as a result they also affect catchment rivers. The Danube basin also includes larger rivers such as the Drava and Sava River and their tributaries, including Glogovnica. We are more inclined to assume that the Buzadovec settlement experienced water problems as early as the beginning of the 14<sup>th</sup> century or even at the end of the 13<sup>th</sup> century, because the mate-

rial from the house with the basement can only be linked with the second half of the 13<sup>th</sup> century.

At the end of the High and the beginning of the Late Middle Ages, and especially in the first half of the 14<sup>th</sup> century, more than 50% of the archaeological sites mentioned in the Dotterweich's study, reveal traces of soil erosion in terms of stripping cultural layers, as well as gullies or erosion of hillsides which is attributed not only to deforestation and increased agricultural use, but to heavy rainfall as well (Dotterweich 2008: 200, Tab. 2). Buzadovec points to the lack of preservation of medieval cultural layers in the older horizon, as most of the other archaeological sites in Croatia do, which may have been partly due to alluvial activities, i.e., sediment erosion. After the mid-14<sup>th</sup> century, more significant soil erosion (erosion of hills, gullies, etc.) became less frequent, but this picture dramatically changed at the end of the Little Ice Age, i.e., from the mid-18<sup>th</sup> until the mid-19<sup>th</sup> century when, due to agriculture and especially heavy rainfalls, large soil erosions occur again throughout Central Europe (Dotterweich 2008: 201). It is not known whether, and to what extent, the floods recorded in the first half of the 15<sup>th</sup> century according to palaeoclimatic and historical research affected the Buzadovec settlement. In any case, they did not have an immediate and instantaneously negative effect on the life in the Buzadovec settlement, which took place in the northern, slightly elevated part of the site until the mid-15<sup>th</sup> century. As well as in the early 15<sup>th</sup> century, significant flooding of the Danube in the Carpathian Basin was recorded in the late 15<sup>th</sup> to the early 16<sup>th</sup> century and in the second half of the 16<sup>th</sup> century. This can be linked with the trend of elevated groundwater levels that began in the 14<sup>th</sup> century and culminated in the second half of the 16<sup>th</sup> century (Kiss, Laszlovszky 2013: 10).

Deposited colluvial sediments (precipitation) of eroded soil from the nearby hill that covered the abandoned settlement of the younger horizon in Buzadovec should, perhaps, be associated with the later period of floods and more pronounced precipitation at the end of the late Middle Ages and the beginning of the early modern period, or, more likely, with large floods and soil erosions after the mid-18<sup>th</sup> century.

It is not known if some natural phenomena such as extreme cooling recognized by interdisciplinary methods between 1430 and 1440 in the area of the north-western Europe and the Carpathian Basin (Camenisch et al. 2016) had any impact on the weakening of economic activity of the younger horizon of, it seems, specialized set-

tlement in Buzadovec, and ultimately on its abandonment in the mid-15<sup>th</sup> century.

## CONCLUSION

The archaeological site Buzadovec – Vojvodice near Križevci (north-western Croatia) is a good example of a researched site where archaeology and the application of its methods have identified certain milestones in the life of the settlement, most likely caused by flooding and / or soil erosion caused by unfavourable weather conditions.

A medieval settlement, in which two phases of occupation were identified, was explored on the site. The older horizon, to which an elongated, probably three-room house of larger dimensions with a basement and surrounding farm buildings and pits located in the lowlands of the river Glogovnica belongs, is dated to the period from the late 12<sup>th</sup> and the 13<sup>th</sup> century as shown by typological-chronological analysis of ceramics and by radiocarbon analyses. The house with the basement itself dates back to the second half of the 13<sup>th</sup> century. Archaeological records show that the house was flooded and abandoned after that time, probably as early as the 14<sup>th</sup> century. It was at this time that heavy rainfalls in Central Europe were well documented, which in turn caused major floods, which may have been the cause of the abandonment of the aforementioned house, that was not rebuilt after that.

The younger horizon of this site is located in the lowlands, but on its slightly higher northern part. A large number of discovered hearths and kilns and other archaeological units points to some economic activity that took place here during the first half of the 15<sup>th</sup> century. Significant floods and precipitation may also have been the cause of soil erosion in this part of the site, which may have occurred sometime after the abandonment of the settlement, after the mid-15<sup>th</sup> century. Namely, the entire part of the site is covered with a thicker layer/deposit of sterile soil which, due to specific natural conditions, has eroded from the elevation above this site.

Warm periods could have had a positive effect on agricultural and economic activities and the construction of settlements/granges in Buzadovec in lowland terrain surrounded by forests, near the river Glogovnica, during the 13<sup>th</sup> century. The landscape of these characteristics can be presumed according to the analysis of wood spe-

cies which show the use of wood species characteristic of lowland, wet areas such as alder, poplar, etc. A large amount of oak in the analysed sample, most likely pedunculate oak, which also tolerates such an environment, points to the fact that such wood materials were used for building of the large basement house on our site. With the rise of groundwater levels and frequent floods (or one, significant flood?), the position of the house with the basement could no longer fulfil its function. Therefore, after it was flooded, it was abandoned. The further fate of the abandoned building, i.e., the dynamics of its decay, is very well shown by archaeozoological remains, their position with respect to stratigraphy and the appearance of animal bones which indicates their longer exposure to the atmosphere. Life in the settlement continues, but the buildings move to a slightly elevated terrain. After the mid-15<sup>th</sup> century, the settlement ceased to exist. There are no traces of a violent cessation of life, such as fire or war, in the archaeological record, so the reason for leaving the settlement should be sought in some other causes, of economic or another nature. A thick layer of sterile clay sediments, deposited on the remains of the settlement in its northern part, is an indicator of the natural occurrence of erosion of the nearby hill, perhaps caused by floods and heavy rainfall, but only after the settlement ceased to exist in the mid-15<sup>th</sup> century. Given the known historical meteorological and generally accepted palaeoclimatic data for the wider area, we could assume that this erosion occurred during subsequent periods of heavy rainfall and floods, i.e., not before the end of the 15<sup>th</sup> century, and more likely in the second half of the 16<sup>th</sup> century or even in the second half of the 18<sup>th</sup> century, when due to heavy floods, greater soil erosion was recorded in other sites as well.

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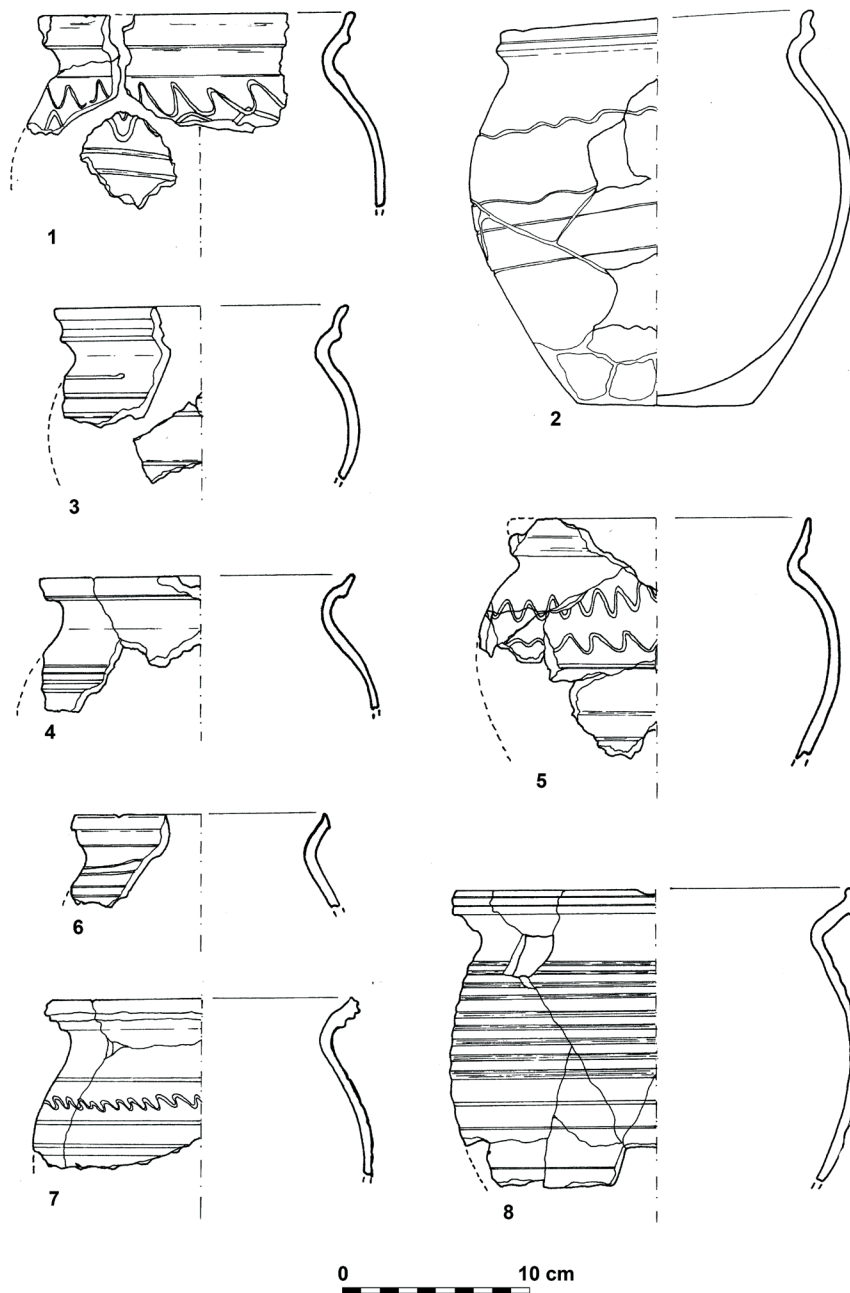
## SAŽETAK

### Poplave i erozije tla na primjeru kasnosrednjovjekovnog naselja Buzadovec – Vojvodice (sjeverozapadna Hrvatska)

**KLJUČNE RIJEČI: KASNOSREDNJOVJEKOVNO NASELJE, POPLAVE, EROZIJA TLA, PALEOKLI-  
MA, BUZADOVEC – VOJVODICE, 13. – 15. STOLJEĆE**

U radu su prikazani arheološki pokazatelji koji nam svjedoče o utjecaju okolišnih čimbenika na formiranje (povoljna klima, blizina vode i šume) i reorganizaciju naselja (uslijed poplava – aluvijalni nanosi), kao i na primjer nanosa koluvijalnih sedimenata koji su prekrili već napušteno naselje. Činjenice prepoznate arheološkim istraživanjima pokušavaju se u radu povezati sa spoznajama interdisciplinarnih paleoklimatskih istraživanja te s istraživanjima o klimi i vremenu temeljenima na izravnim i neizravnim podacima iz pisanih povijesnih izvora sa šireg područja Karpatske kotline.

Riječ je o arheološki istraživanome kasnosrednjovjekovnom naselju na položaju Buzadovec – Vojvodice (sjeverozapadna Hrvatska). Naselje je formirano krajem 12. i početkom 13. stoljeća u nizinskom krajoliku, nedaleko riječnog toka. Učestale poplave ili veća poplava krajem 13. ili početkom 14. stoljeća uzrokovala je napuštanje i pomicanje pozicije starijeg naselja na povišen teren. Život se kontinuirano odvija do oko sredine 15. stoljeća. Povod prestanka egzistencije naselja nije utvrđen, međutim prepoznata je zanimljiva pojava erozije tla susjednog brda koja je prouzročila prekrivanje kulturnih slojeva kasnosrednjovjekovnog napuštenog naselja metar debelim nanosima sterilne gline.



**Pl. 1** — Selected finds of kitchenware from the older and the younger horizon of the settlement: 1, 3, 4 SU 60; 2 SU 172; 5 SU 57, second half of the 13<sup>th</sup> century; 6–8 SJ 407, first half of the 15<sup>th</sup> century (drawing by: S. Čule)

**T. 1** — Izabrani nalazi kuhinjske keramike iz starijeg i mlađeg horizonta naselja: 1, 3, 4 SJ 60; 2 SJ 172; 5 SJ 57, druga polovina 13. stoljeća; 6–8 SJ 407, prva polovina 15. stoljeća (crtež: S. Čule)