Climate, floods and river gods: environmental change and the Meso–Neolithic transition in southeast Europe

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Keywords

Climate, rivers, floods, Mesolithic, Neolithic, Iron Gates, southeast Europe

Abstract

A conspicuous gap in the radiocarbon record of the Iron Gates Mesolithic suggests that many riverbank sites were abandoned between c 8250 and 7900 cal BP.[1] This period of site abandonment is linked to increased flooding along the Danube, which can be correlated with a distinct global climatic oscillation. The implications of these environmental changes for the interpretation of Lepenski Vir and the timing of the Meso–Neolithic transition in the northern Balkans are examined. There is growing evidence of climatic instability during the Holocene and its effects on river systems. We suggest that climate-related flooding had a significant impact on human settlement and use of riverine environments in southeast Europe during the middle Holocene, and may even have been an important stimulus of culture change.

1 An archaeological discontinuity in the Iron Gates 8250–7900 cal BP

The Anglo-Romanian excavations at the Late Mesolithic–Early Neolithic site of Schela Cladovei between 1992 and 1996 (Boroneanț et al 1999) have generated the largest series of ^{14}C dates for any Stone Age site in the Iron Gates gorge section of the Danube Valley (figure 1). The means of 44 AMS dates on human bones and artefacts of terrestrial mammal bone range from 8105 to 6695 BP, with a distinct gap between 7460 and 7100 BP (8260–7900 cal BP) (figure 2).

The site of Vlasac, which lies some 80 km upriver from Schela Cladovei, has a large series of radiometric and AMS ^{14}C dates for archaeological

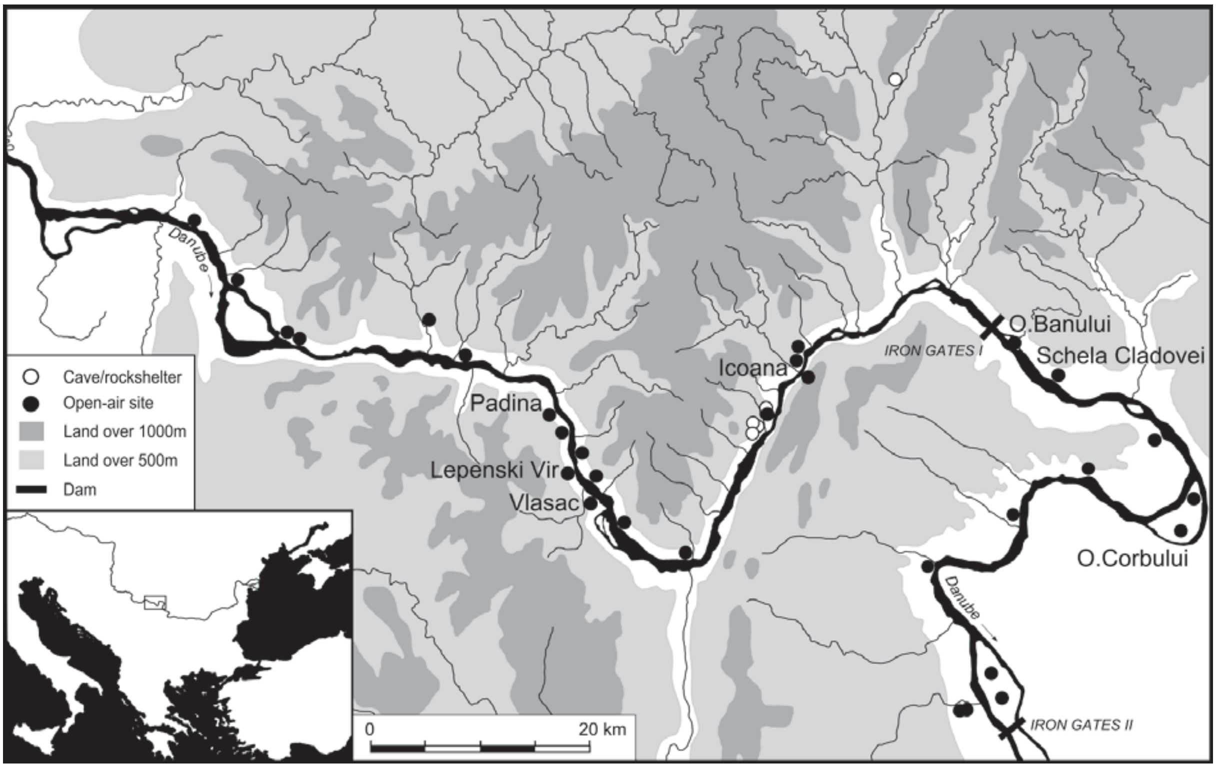


Figure 1 Stone Age sites in the Iron Gates.

samples covering roughly the same time-span (figure 2). The means of 18 age measurements range from 7935 to 6790 BP and there is a gap between 7440 and 7000 BP (8255–7840 cal BP), which is broadly coincident in time with that recorded at Schela Cladovei.[2]

Thus, there are no ^{14}C dates from either site in the age-range between c 8250–7900 cal BP. Furthermore, four other sites from the Iron Gates with multiple ^{14}C age measurements — Padina (on the right bank of the Danube in Serbia) and Icoana, Ostrovul Banului and Ostrovul Corbului (on the Romanian side) — also lack dates in that same time-range (figure 3).[3] These data suggest that many Mesolithic riverside settlements in the Iron Gates reach of the Danube were abandoned c 8250 cal BP, with some sites being re-occupied after c 7900 cal BP.

2 The 8200 cal BP global climatic oscillation

This period of site abandonment in the Iron Gates corresponds in timing with a distinct global climatic cooling phase, known as the '8200 BP event' (eg, Alley et al 1997; Johnsen et al 2001). The Holocene has been characterised by significant short-term climatic variability. Oxygen isotope and palaeotemperature records from Greenland ice cores show a number of centennial-scale cooling events, of which the '8200 BP event' is arguably the most pronounced. The $\delta^{18}O$ profile from the GISP2 ice-core shows this event to have had a duration of around 330 years, from c 8290–7960 cal BP (Nesje & Dahl 2001). The 8200 BP event appears to have been accompanied by an abrupt change in atmospheric and oceanic circulation patterns, which at the regional level was reflected in changes in weather and precipitation patterns (eg, Street-Perrott & Perrott 1990; Stager & Mayewski 1997).

The 8200 BP event is registered in a variety of climatic archives from Europe. For example, it has been recognised in oxygen isotope records from the Ammer Lake in southern Germany (von Grafenstein et al 1998) and from a speleothem in south-west Ireland (McDermott et al 2001). Lake sediment and palaeobotanical records from the Alpine region indicate cooler and wetter conditions at that time (Haas et al 1998).

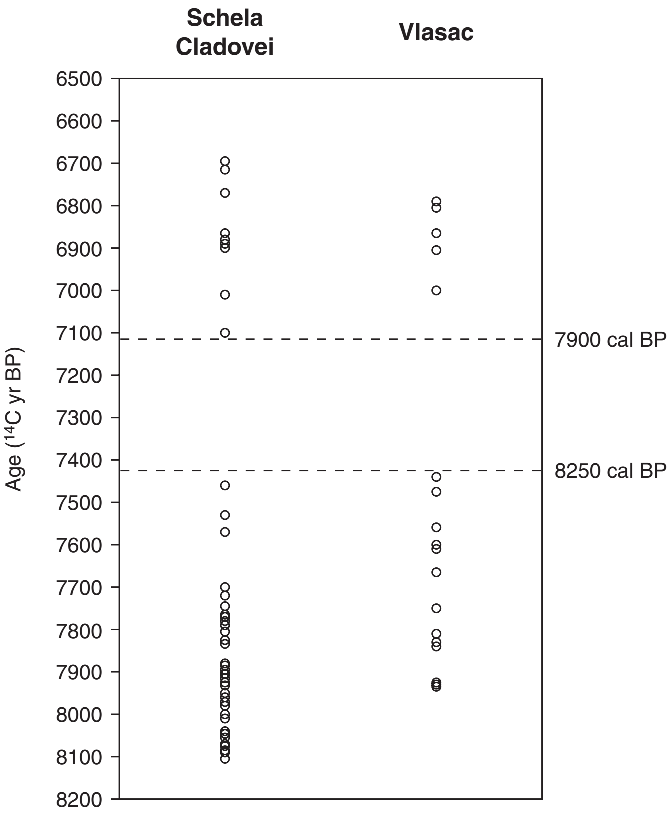
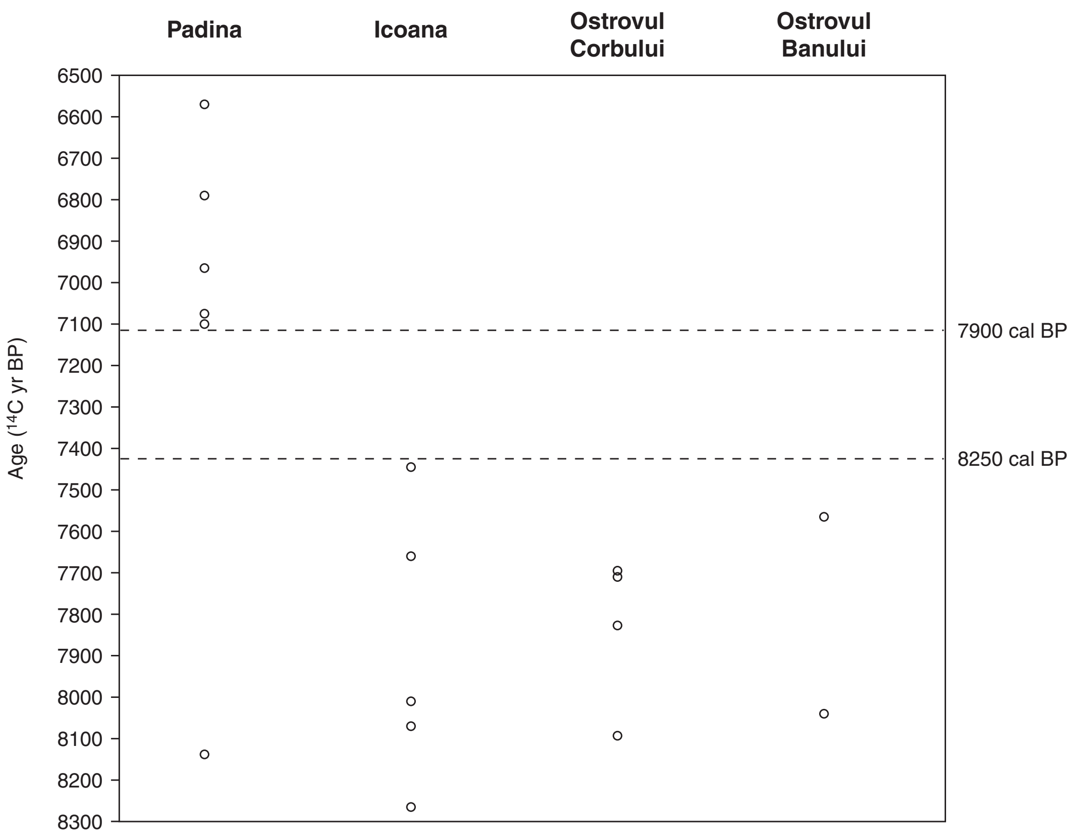


Figure 2 Radiocarbon mean ages for Schela Cladovei and Vlasac — see figure 1 for site locations. Data are from Srejović & Letica (1978), Bonsall et al (1997, 2000, and unpublished data) and Cook et al (2002). The ^{14}C ages on human bone have been corrected for the freshwater reservoir effect according to Method 1 of Cook et al (2002).

Figure 3 Radiocarbon mean ages for Padina, Icoana, Ostrovul Banului and Ostrovul Corbului — see Figure 1 for site locations. Data are from Radovanović (1996) and Boroneanţ (2000).



Importantly, in terms of human settlement of river valleys, a number of river systems across Europe experienced marked increases in the frequency and magnitude of floods broadly coincident with the 8200 BP event. There is evidence for a major period of flooding on several rivers in central Europe (Becker & Schirmer 1977; Leuschner et al 2000), Britain (Macklin & Lewin, in press) and the Danube delta where there was a major channel avulsion (Ghenea & Mihaelescu 1991). However, the clearest record of severe flooding at this time comes from the middle Durance valley in the French Alps where a period of substantial river aggradation is securely dated to between 8250 and 7950 cal BP (Miramont et al 2000).

3 Floods and settlement relocation in the Iron Gates

Typically, the Iron Gates sites are located close to the bank of the Danube, and archaeological remains survive between 5 and 13 metres above the average summer water level (prior to dam closures downstream in 1972 and 1995). It follows that they would have been vulnerable to major floods, which would have resulted in inundation of the lower parts of the sites. Moreover, many Stone Age settlements *within* the gorge (eg, Vlasac) were situated at the foot of steep slopes, which river erosion and undercutting could have destabilised, leading to landslides creating an additional hazard to human occupation. Therefore, it is likely that a sustained period of more frequent and, probably, larger floods between c 8250 and 7900 cal BP, would have caused people to abandon their existing settlements and move them to higher locations. It is not suggested that Stone Age people abandoned the Iron Gates reach of the Danube, since there is clear evidence to the contrary (Bonsall et al 1997, 2000).

A key question must be, is there any evidence for major flooding around 8000 cal BP in the Iron Gates, in the form of damage to archaeological structures and/or accelerated sedimentation of the valley floor? At present it is difficult to give a clear answer to this question, for a number of reasons. Evidence of major flooding may have been overlooked in earlier accounts of the Iron Gates sites (see below), and virtually all the known sites are currently inaccessible owing to artificial flooding following construction of the Iron Gates dams (figure 1). At least one site, Schela Cladovei, is still accessible. However, in floodplain sites of this age stratigraphic evidence of flooding often would not persist in the sedimentological record because of incorporation of any flood deposits into surface soil horizons by human activity and biotic processes of pedoturbation. Only in cases of deep burial by rapidly deposited river alluvium is the evidence of bedded flood deposits likely to survive in the subsoil. Where this occurs such deposits should theoretically overlie a buried A horizon marking the former topsoil, but this may have been eroded during the flood event. Generally, the thickness of flood sediments is unlikely to be very great in the more elevated parts of the floodplain away from the river channel, but could locally be thicker in depressions. At Schela Cladovei direct dating of the Holocene alluvial sediments has been attempted (Fuller et al 1994). An infra-red stimulated luminescence (IRSL) age of 8.2±1.3 ka was obtained (using a 'partial bleach' approach) for a sample collected from above a Mesolithic skeleton. Although this is a single age determination with a large error margin, it is at least consistent with a major phase of floodplain sedimentation between 8250 and 7900 cal BP.

4 Lepenski Vir — settlement or sacred place?

Another site that may show evidence of the effects of flooding during the period in question is Lepenski Vir, but the interpretation of this site is not straightforward.

Situated 2.5 km upriver from Vlasac on the right bank of the Danube in Serbia (Figure 1), Lepenski Vir has a number of features that set it apart from other Late Mesolithic/Early Neolithic sites in the Iron Gates. They include (i) buildings with mortared floors and elaborate stone fittings, (ii) burials that (apparently) were deliberately emplaced within or beneath some of the buildings, (iii) numerous carved sandstone boulders ('sculptures' and 'altars'), (iv) an unusually high frequency of other decorated ('symbolic') items, and (v) a location seemingly chosen to face an unusual and imposing landscape feature — the trapezoidal-shaped 'mountain' of Treskavac (figure 4).

Figure 4 The distinctive trapezoidal mountain of Treskavac on the Romanian bank of the Danube, opposite Lepenski Vir (photo: Clive Bonsall).

It is possible that Lepenski Vir originated as an ordinary settlement like Schela Cladovei or Vlasac, in the period before 8200 cal BP. But many authors have concluded that during the final Mesolithic and Early Neolithic it was treated as a 'sacred place', used primarily as a centre for burial and ritual. The trapezoidal-plan buildings have been variously interpreted as 'sanctuaries', 'shrines' or 'temples' (Srejović 1972; Gimbutas 1991; Chapman 2000). Interestingly, it is the only site in the Iron Gates which has ^{14}C dates whose mean ages fall within the period 8250–7900 cal BP (figure 5).

If the Stone Age people of the Iron Gates regarded Lepenski Vir as a sacred site — their 'spiritual home', perhaps — then transferring it to another location would not have been an option, and they are likely to have resorted to other measures to combat the threat from the river. Several previous authors have suggested that the carefully-prepared mortared floors and substantial stone fixtures of the buildings of 'Lepenski Vir I' were designed to resist flooding, although these authors have tended to view Lepenski Vir and the other Stone Age sites of the Iron Gates as *seasonal* encampments subject to annual floods throughout their existence (Gimbutas 1991:285; Chapman 2000:195). The present authors would accept the first part of this scenario, but not the second.

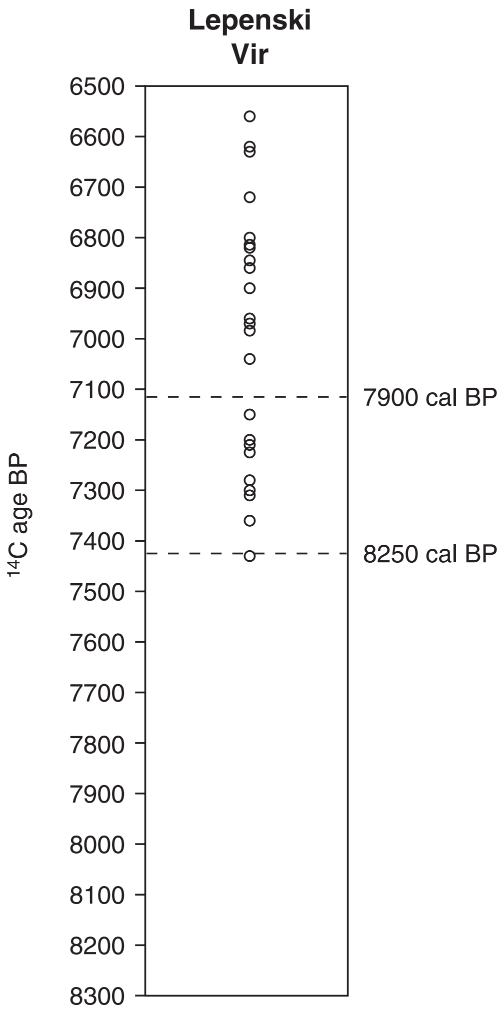


Figure 5 Radiocarbon mean ages for Lepenski Vir. Data are from Quitta (1972) and Bonsall et al (1997, 2000). The ^{14}C ages on human bone have been corrected for the freshwater reservoir effect according to Method 1 of Cook et al (2002).

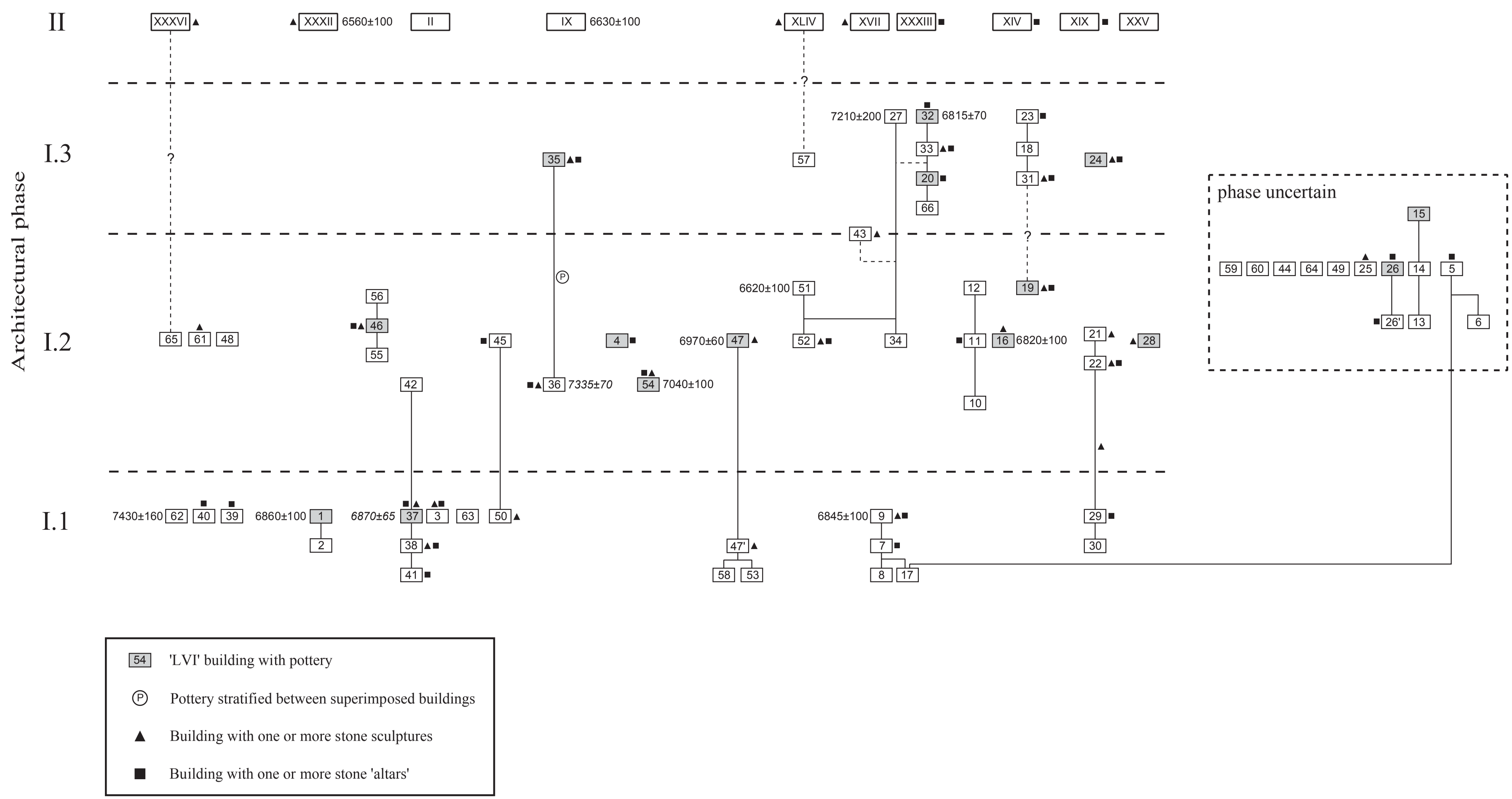


Figure 6 Stratigraphic relationships of the Lepenski Vir 'shrines', organised according to Ivana Radovanović's (1996) architectural phases. Associated finds of Starčevo pottery and carved boulders ('altars' and sculptures) are shown. Designed primarily as a test of Radovanović's relative chronology of the site, the chart highlights the fact that sculptures are found in buildings that have radiocarbon ages as old as 7335±71 BP (c 8150 cal BP). Furthermore, three superimposed buildings with associated sculptures and 'altars' (21, 22, 29 — bottom right of the chart) are stratigraphically *older than* a human burial, which on evidence of dietary tracing using stable isotopes probably pre-dates 7900 cal BP and the appearance of pottery at Lepenski Vir — for details, see Bonsall et al (2000:128–130). *Notes*: 1 Information on superpositioning of buildings is from Srejović (1972) and Radovanović (1996). 2 The occurrence of stone sculptures and 'altars' is based on the catalogue by Srejović & Babović (1983), which has several discrepancies with Srejović's (1972) list. 3 Only a selection of the 'LVII' buildings identified by Srejović have been included in the chart; stratigraphic relationships with 'LVI' buildings are poorly documented, and not entirely convincing. 4 ^{14}C dates in italics are weighted means of two or more age measurements on the same sample.

There has been much speculation about the significance of the stone sculptures. It seems generally agreed that they were not just works of art, but intimately associated with the religious beliefs of the community. Some authors have argued that the figural sculptures — with carved faces that are often described as 'fish-like' or 'half-fish, half-human' — depict ancestors or 'river gods' (eg, Srejović 1972, 1989; Srejović & Babović 1983; Handsman 1991; Gimbutas 1991). Radovanović and Voytek (1997:28–29) interpreted their appearance and proliferation at Lepenski Vir as part of a process of intensive 'ideological integration' among a Mesolithic forager population, which was under increasing territorial and economic pressure from farming societies that were becoming established in the surrounding areas. The weakness of this interpretation is that sculptures occur in some of the earliest-dated houses of Lepenski Vir (figure 6), which probably pre-date the earliest known Neolithic sites on the Hungarian or Wallachian Plains by several centuries.

The carved boulders appear to have been intimately associated with the architecture of Lepenski Vir, and were often found inserted into sockets in the mortared floors. In some houses that lacked carved boulders, holes in the mortared floors have been interpreted as the sockets for sculptures that were subsequently removed (Srejović 1972:81). Significantly, neither the sculptures nor the mortar-floored buildings can be traced back before c 8200 cal BP, and it is possible that both phenomena appeared around that time. This raises the intriguing possibility that the ideological integration referred to by Radovanović and Voytek was *not* a response to the threat from neighbouring farmers, but to increased flooding along the Danube. For the inhabitants of the Iron Gates between 8250–7900 cal BP the Danube was still the principal source of food (Bonsall et al 1997, 2000) and the main artery of communication and social interaction; but it had become more prone to extreme and unpredictable floods. The cause of such dramatic events would likely have seemed mysterious. The source of major flooding in the Iron Gates reach would have been geographically remote, generated by excessive rainfall and/or snowmelt many hundreds of kilometres upriver in the Alps, Carpathians and other mountainous areas that form the headwater catchments of the Danube. Therefore, an equally, if not more valid interpretation of the Lepenski Vir sculptures is that they were apotropaic, intended to appease or achieve dominance over the unseen powers responsible for unpredictable and potentially devastating floods, which became much more frequent (and possibly of greater magnitude and duration) between 8250 and 7900 cal BP.[4]

5 Floods and 'Proto-Lepenski Vir'

Srejović believed that the first settlement at Lepenski Vir had been confined to a narrow strip of land along the riverbank. This 'Proto-Lepenski Vir settlement' comprised the remains of some eight structures, represented essentially only by remnants of stone-bordered hearths; no other traces of the floors or walls of the original structures survived. These were located in a zone about 12 metres wide that was apparently separated from the Danube by a narrow floodplain some 15 metres wide (Srejović 1972:45–46).

There is no radiocarbon or (convincing) stratigraphic evidence to support Srejović's assertion that the Proto-Lepenski Vir structures are *older* than the mortar-floored buildings of his main Lepenski Vir I phase. Located in the lowest part of the site, they would have been at most risk from higher-than-normal floods, and the simplest explanation is that they are the remains of mortar-floored buildings, contemporaneous with those of Lepenski Vir I higher up the slope, which were severely damaged by extreme flood events between 8250 and 7900 cal BP.

6 Wider implications

6.1 Archaeological potential of the Iron Gates

The construction of two dams across the Danube — Iron Gates 1 between 1964 and 1972 and Iron Gates 2 between 1977 and 1995 — led to artificial

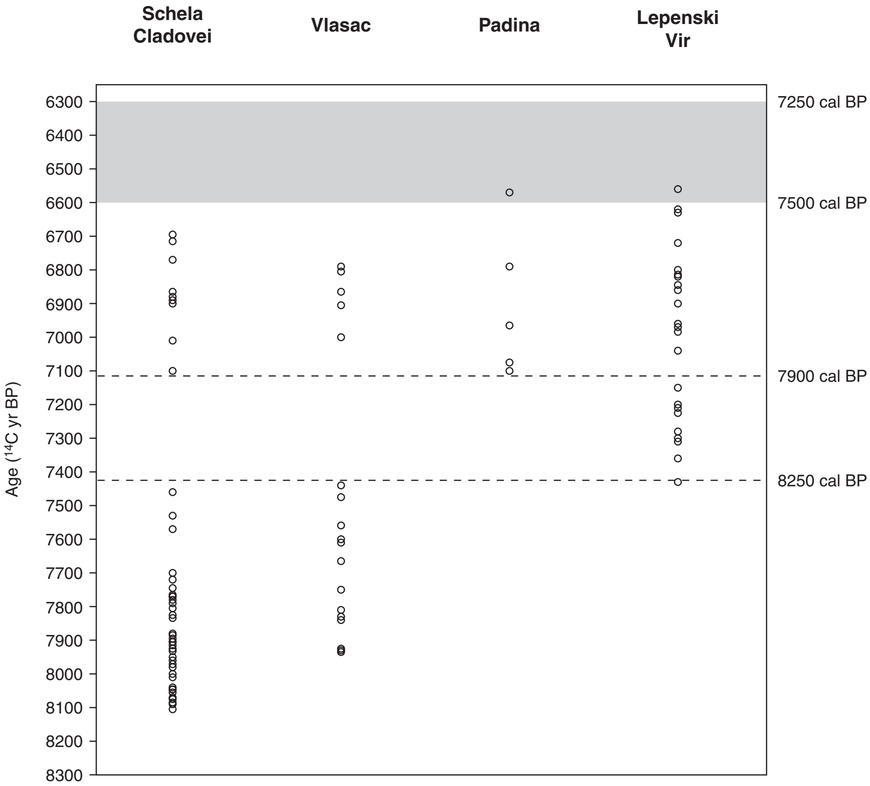


Figure 7 Radiocarbon mean ages for Lepenski Vir, Padina, Schela Cladovei and Vlasac plotted against the 7500–7250 cal BP flood episode.

flooding of the majority of the known Mesolithic and Early Neolithic sites. As a result, archaeologists have tended to assume that all of the archaeologically interesting areas are now submerged, and no further excavation is possible.

However, if during the period c 8250–7900 cal BP settlements were transferred to higher positions relative to the river, then some of those sites can be expected to have survived. It is worth emphasising that riverbank erosion has been the principal mechanism leading to exposure and subsequent discovery of Stone Age settlements in the Iron Gates. This, and the fact that survey work was focused on valley floor areas that were to be flooded following dam closure, has determined the present archaeological distribution pattern. Hitherto, except in caves (Boroneanţ 2000), very little archaeological prospection has been undertaken in more elevated areas where there are fewer natural exposures.

If the above interpretation is correct, it follows that there is significant scope for further research in the Iron Gates, focusing on a crucial period in the prehistory of the region — that during or immediately prior to which pottery and farming made their appearance in the region.

6.2 Beyond the Iron Gates: the spread of farming into the Danube Basin

The period from 8250 to 7900 cal BP was when Neolithic farming spread through much of southeast Europe. During that time the agricultural frontier moved from northern Greece to the Hungarian Plain. River valleys and their generally fertile, stoneless soils developed from river alluvium appear to have been the primary conduits for agricultural expansion, the first Starčevo–Körös settlements being established along the Danube and its major tributaries in northern Serbia and southeast Hungary c 7900 cal BP. In other words, it took 300–400 years for the agricultural expansion to cover a straight-line distance of c 600 km. Yet some later agricultural expansions over considerably greater distances apparently were accomplished more rapidly. For example, the Linearbandkeramik (LBK) expansion from the Hungarian Plain to the Netherlands and the spread of farming through the British Isles, both extending over c 1000 km, occurred in less than two centuries.

In southeast Europe, it can be shown that farming reached the middle Morava Valley (150 km from the Danube) by c 8100 cal BP (Whittle et al, in press). However, it appears to have been another 150–200 years before farming villages appeared on the Hungarian Plain. Did increased flooding between c 8250 and 7900 cal BP *delay* the spread of agriculture onto the valley floors of the Danube and northern tributaries such as the Tisza, Maros and Körös? Or were the first farming settlements established in the Danube Basin before 7900 cal BP, but subsequently buried by accelerated river alluviation during the ‘8200 BP event’?

We incline toward the former interpretation. Starčevo–Körös sites typically are located on upstanding alluvial landforms such as levees, islands and low terraces that would have been extremely vulnerable to large floods (Gimbutas 1991; Manson 1995; Whittle 1996). Even more vulnerable to flooding would have been the associated fields, crops and livestock, probably often located in lower-lying parts of the valley floors.

6.3 Later flooding episodes and Neolithic settlement of the Hungarian Plain

The major period of flooding between c 8250 and 7900 cal BP was not the only such episode registered in the Danube catchment during the early–middle Holocene. A significant increase in flood frequency and magnitude has been documented in many European river systems between c 7500 and 7250 cal BP (Becker & Schirmer 1977; Leuschner et al 2000; Macklin & Lewin, in press).

Judging by the distribution of ^{14}C dates from Lepenski Vir, Padina, Schela Cladovei and Vlasac, *intensive* use of the principal riverside settlements of the Iron Gates came to an end during this period (figure 7). Only sporadic use of the sites is recorded thereafter, until the Eneolithic and in many cases the pre-Roman Iron Age. This raises the possibility that a further period of major flooding forced the long-term abandonment of these riverside locations. Since by that time agriculture had supplanted aquatic resources as the basis of the Stone Age economy, there was perhaps little incentive for people to return to their former settlements.

6.4 Starčevo, Vinča and LBK

Not long after the Iron Gates sites were abandoned, many Starčevo–Körös settlements in the Middle Danube Basin ceased to be occupied. A recent study by Whittle et al (in press), which produced nearly seventy AMS ^{14}C dates for early Neolithic sites on the Hungarian Plain, shows that few, if any, Starčevo culture occupations are later than 7400 cal BP. Coincidentally, this is also the approximate date of the emergence of the LBK culture on loessial soils of the higher areas of the Hungarian Plain.

Are these cultural events linked, and are they related to the period of increased flooding recorded across Europe at c 7500–7250 cal BP? Did more frequent and/or longer-lasting overbank flooding force early farmers to move away from low-lying alluvial areas, and explore the agricultural potential of other environments? And was this the catalyst for the LBK expansion across the loess belt of central Europe?

As noted above, early agricultural expansion through the Balkan Peninsula and onto the Hungarian Plain tended to follow river valleys. Explanations for this have generally stressed soil fertility and better availability of water (Sherratt 1980; Roberts 1998). Whilst it is true that young, often naturally fertile, well-drained, stoneless soils occur on river alluvium, it must be recognised that soils of alluvial valleys form a mosaic, with substantial areas of more sandy and more clayey, often poorly-drained soils. This mosaic was of variable suitability for agriculture but also provided a range of exploitable natural resources and habitats, including wetlands. Conversely, in much of the Balkan Peninsula shallow calcareous soils (Rendzinas)

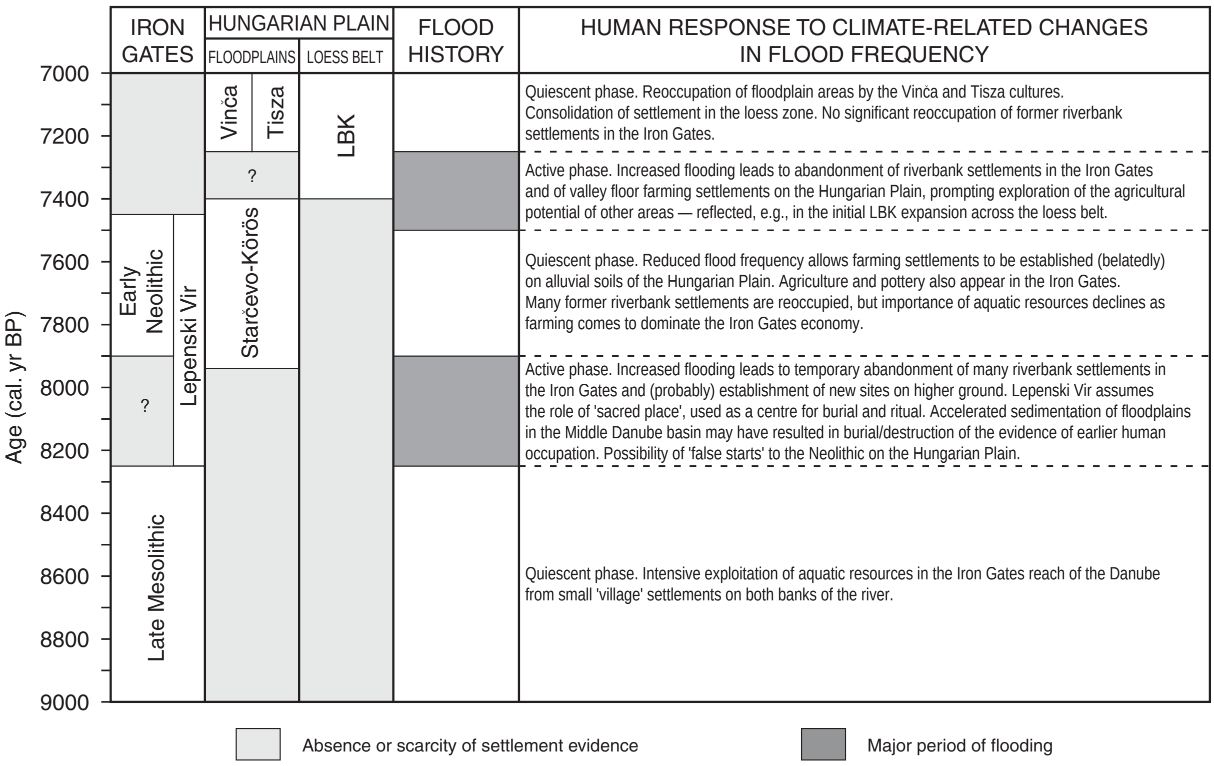


Figure 8 Cultural chronology of the Middle Danube basin from 9000 to 7000 cal BP and human response to changes in flood frequency.

that dominate the limestone uplands would have been much less attractive to early farmers; likewise the drought-prone soils of the grassland areas of the Hungarian Plain (Chernozems) would have been less suitable for early Neolithic agriculture.

The mosaic of soils on river levees and backswamps would have been variably affected by increased flooding. Low-lying parts of the floodplain with clayey soils would have experienced deeper, more extensive and more prolonged inundation leading to a periodic expansion of wetlands. Well-drained loamy or silty soils on the higher lying areas closer to the river channels, which were favoured for settlement and agriculture, would have been subject to more frequent bank erosion and deposition of coarse-textured alluvial sediments that locally would have buried cropland or grazing areas.

The aeolian loess belt that stretches from the steppes of Russia to the Paris Basin supports a variety of soils (FAO 1974–81; CEC 1985; Bronger 1991). Although these are all stoneless and silty in texture, they display a range of contrasting chemical and hydrological properties that may favour or constrain agricultural land use. The predominantly northwestward (LBK) expansion of agriculture in the period beginning c 7400 cal BP started along the axis of the deciduous forest–sub-humid grassland transition within the loess belt of the Hungarian Plain. We would argue that the attraction of these areas can be attributed to a favourable combination of climate, soil conditions and the presence of open areas initially precluding the need for woodland clearance. Under the climatic conditions and natural vegetation communities of woodland and grassland that prevailed during the middle Holocene, Luvisols (Brown soils) and Chernozems form fertile soil resources with stable structure, good organic matter levels and good water storage capacity.[5] Rainfall in this zone is non-limiting for cereals and the land resource base would have provided an attractive ‘niche’ for agricultural expansion at a time when the river valleys of the Hungarian Plain had become less suitable for farming because of increased flooding. Because of their stoneless character, texture and fertility, making them easy to till, the soils encountered would have had many properties in common with some of the soil resources previously exploited in alluvial valleys. The more acid loessial Brown soils (Luvisols) of the deciduous woodland zone further to the northwest also provided valuable agricultural land, assuming adequate manuring.

Following the 7500–7250 cal BP flood phase, the river valleys of southeast Europe would rapidly have returned to their former state, allowing farming settlements to be re-established on soils now often enriched by recent additions of alluvium. This may have been a critical factor in the appearance and proliferation of Vinča and Tisza culture settlements in river valleys of the central and northern Balkans from c 7250 cal BP (Gimbutas 1991).[6]

7 Conclusions

Until just over a decade ago, it was assumed by many archaeologists that the Holocene in Europe was characterised by relatively limited climatic variability. Recent studies of ice cores, lake and cave sediments have overturned this traditional view. At the same time geomorphological studies of river systems have shown them to be particularly sensitive to small-scale changes in climate in both the prehistoric and historic periods that are not registered in the palynological record of vegetation change. This has major implications for the understanding of the European archaeological record, since some of the largest concentrations of ancient human populations and settlements occurred in river valleys.

What we have shown in this paper, with examples drawn from a single major river basin in central and southeastern Europe, is how climate-related flooding impacted on human settlement and use of riverine environments, and may even have been an important stimulus of culture change (figure 8).

We believe that this poses new challenges, and suggests a possible future direction, for archaeological research in which greater emphasis is placed upon the dynamic relationship between human behaviour and river environments. There is an urgent need for more research into the long-term flood histories of European rivers to achieve better chronological and spatial control of individual flood episodes. This should be conducted in parallel with systematic archaeological and pedological investigations of river environments where cultural remains are stratified within fluvial sediments and afford opportunities for high resolution dating.

Acknowledgements

We thank László Bartosiewicz, Gordon Cook, Dimitri Tsintjilonis, Barbara Voytek and Ann Wintle for their comments on the first draft of the paper, and Alasdair Whittle for sight of a prepublication copy of a forthcoming article. The 1992–1996 excavations at Schela Cladovei were funded by the British Academy, the Carnegie Trust for the Universities of Scotland, and the Munro Lectureship Fund and the Hayter Fund of The University of Edinburgh. The radiocarbon dates were provided by the Oxford Radiocarbon Accelerator Unit and paid for by the UK Natural Environment Research Council.

[1] The chronological evidence discussed in this paper is based on a combination of archaeological and non-archaeological ^{14}C, dendrochronological, luminescence and ice-core ages. For the sake of consistency, we quote all ages in calibrated years BP (before present).

[2] Two radiometric ^{14}C dates on charcoal from Vlasac (Z-268 and Z-264 – Srejović & Letica 1978:129) have been omitted from Figures 2 and 7, for taphonomic reasons. These samples appear to be from grave fills. If so, the charcoal is likely to be redeposited and could comprise material of differing ages.

[3] A number of radiocarbon dates from Padina on bones of humans and animals that may have ingested significant amounts of freshwater fish have been omitted from figures 3 and 7. They comprise five radiometric ^{14}C ages on human bones (Burleigh & Živanović 1980) and three AMS ^{14}C ages on dog bones (Whittle et al, in press). For the humans there are no associated $\delta^{15}N$ measurements, which would allow a correction for the freshwater reservoir effect to be applied, and for the dogs there is insufficient information on the dietary end members to perform a reservoir correction.

[4] The possibility that some of the sculptures were 'apotropaic' is discussed by Srejović (1972:111), and the idea is implicit in the writings of some later authors. However, none of these authors has linked the sculptures to increased flooding along the Danube, as suggested in this paper.

[5] Evidence from buried soils developed in loess from various parts of Europe, models of soil evolution and established rates of soil-forming processes indicates that the major soil categories of the loessial Hungarian Plain (Chernozems, Luvisols, etc) had sufficient time to develop by the end of the Mesolithic and would have had broadly similar properties to soils under sub-humid grasslands and deciduous forest today. However, the forested Luvisols would have been less acid than modern equivalents that have remained under forest, as decalcification and leaching would have

been less advanced. Loess and silty alluvium are normally well supplied with easily weatherable silicate minerals and provide initially base-rich parent materials that are stoneless and have good water-holding capacity. Hence they would have formed relatively fertile and desirable soils for agricultural use under the climatic conditions and vegetation communities that prevailed in central Europe during the middle Holocene. Such parent materials continue to provide land with high agricultural capability in those parts of Europe today. Under early agriculture natural soil fertility would have declined more rapidly in the formerly forested Luvisols than in the Chernozems, once the forest nutrient cycle had been broken.

[6] Careful scrutiny of radiocarbon dates from sites on the Hungarian Plain suggests there is a hiatus in the settlement record at the transition from Early to Middle Neolithic. Reliable ^{14}C ages for Starčevo occupations are invariably older than c 6450 BP (7400 cal BP) while ^{14}C ages for Vinča or Tisza culture occupations are invariably younger than c 6300 BP (7250 cal BP).