Endangered Cultural Heritage along the Major Rivers and Adjacent Wetlands in Croatia

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Abstract. The areas subjected to flooding in 2010 on the territory of Croatia were the lowlands along the major rivers of the Sava, Drava, Danube and Neretva. These are agricultural zones, the most fertile and the most densely populated regions in the north and south of Croatia. During the months of January and December 2010 there were major floods in the lower course of the Neretva and its delta, located in the region of Dalmatia, from 42°57’ to 43°06’ and from 17°25’ to 17°45’.

The flooded areas contain sites of cultural and natural heritage: prehistoric settlements, the pre-Roman and Roman urban center of Narona, Roman villas, as well as the ornithological sanctuary in the delta marshes. During the months of May and June 2010 the flooding occurred in the northern Croatia, in the region of Slavonia (also called Pannonia), between the rivers Drava, Sava and Danube, the north latitude from 45°03’ to 45°43’ and the east longitude from 16°50’ to 19°01’.

Then again, in the month of September, following the major floods in Slovenia, the north-central part of Croatia was inundated down-stream of the capital city of Zagreb, from 45°25’ to 45°47’ and from 16°05’ to 16°30’. The city was not affected, but the dikes down-stream were breached and the Sava flooded the area between Zagreb and Sisak, where two major Roman urban centers, Andautonia and Siscia were located. In the Sisak area, floodwaters were drained into the Lonjsko Basin, what prevented more flooding further down-stream of Sisak. Other areas in the north-central Croatia suffered flooding, as well as the region of Istria, in locations at the north latitude from 45°25’ to 46°05’ and the east longitude from 13°30’ to 15°46’.

Keywords. Cultural heritage, flooding, wetlands, Croatia, 2010

Introduction

The territory of Croatia, from a cultural heritage viewpoint, is one of the richest areas of Europe, particularly in its diversity. Major migrations passed through this territory from the prehistoric period onwards and highest achievements of European civilizations left their imprints here. Diverse peoples and cultures settled along the major rivers of Sava, Drava, Danube and Neretva, and also along the Adriatic coast and islands, the maritime route into Europe (Durman, 2007, 5). These areas have been continuously inhabited from prehistoric, classical and medieval times till today.
Navigable rivers have always been major communication arteries, connecting nucleated or dispersed settlements and entire regions. During the Roman Empire arterial roads were first built in river basins and consequently population centers grew in size. The Roman imperial exploitation of the countryside extended into the adjacent wetlands, previously having sustainable population. Such land was systematically drained and used for cash crops, what intensified the building of towns and of rural villas. In the present time, the population pressure is even more extensive and settlements are built on or extended to unsustainable locations. Within the framework of the research project “Roman archaeological topography of Croatia” we investigated by using aerial photographs such riverine and wetland areas, which were flooded in the months of January, May, June, September and December of 2010.

The state territory of Croatia today is divided into twenty-one administrative units – counties (županije, in Croatian). We present the archaeological heritage in the areas subjected to flooding in 2010 by counties, which are situated along the major rivers of the Sava, Drava, Danube and Neretva. These are agricultural zones, the most fertile and the most densely populated regions in the north and south of Croatia. One evident example of endangered cultural heritage is the Roman city of Cibalae (today Vinkovci) in eastern Croatia, in the area of the Danube’s tributaries Vučica, Vuka and Bosut, which sustained great floods in May and June 2010. The land-reclamation of this area was done in the third century AD during Emperor Probus. The summer floods along the Sava, downstream from Zagreb also affected ancient sites and the remains of the arterial Roman road located between Ščitarjevo and Sisak (the Roman Andautonia and Siscia). The delta of the Neretva River in southern Croatia sustained catastrophic floods in January and December 2010.
These wetlands are home to cultural heritage of the highest category: the Roman city of Narona with numerous suburban and rural villas, while other sites are in the present-day towns of Metković, Opuzen and Kula norinska. All these heritage sites are now in danger of further degradation from the consequences of the floods, such as pollution from raw sewage. Any viable protection against and avoidance of catastrophic damages, as well as the identification of natural and human factors (eg. power plants and dams on the Neretva) require an integrated approach to disaster management and the systematic use of remote sensing for the monitoring and conservation.

1. General Events

1.1. Bjelovar- Bilogora County, Požega-Slavonija County, Brod-Posavina County, Osijek-Baranja County, Vukovar-Srijem County

After heavy rains in the month of May 2010, the rivers and creeks overflowed their banks in the region of Slavonia. About 200 liters of rain fell per square meter, what was three times above the average rainfall for May. There was widespread flood damage and destruction in five counties of Slavonia from May 30 to June 10. Floodwaters of the small rivers Orljava, Vuka, Bid, Bosut and Karašica, which are tributaries of the Sava, Drava and Danube Rivers, caused the most problems because of their inability to flow into those major rivers. In the county bridges and roads were under water; wells were contaminated and there was no drinking water.

Bjelovar- Bilogora County is located in northwestern Croatia. Its characteristic geomorphological features are the Lonja-Ilova rivers basin and the flood plain of the Česma River. The county’s main transportation routes from north to south and east to west are reasons for the continuous habitation of this area since the Neolithic. From the Roman period there are many sites with the evidence of Roman roads, military camps and villae rusticae. The termal bath in Daruvar (Roman Aquae Ballisae) is known from the prehistory till today.
In Požega-Slavonija County the area of Oriovac was flooded after 21.5 liters of rain fell per square meter in 24 hours. Flooded were also the towns of Pleternica and Ivandvor, where 50 houses and businesses were under water. The river crested at 5.29 m at the village of Frkljevac. In the area of Pleternica, the villages of Brodski Drenovac, Bučje, Komorica, Koprivnica and Suljkovci were threatened and many homes and farmland were inundated. In the Požega valley the oldest traces of human presence come from the Upper Paleolithic and the Mesolithic. The Roman town of Incerum was documented in the vicinity of the village Tekić on the basis of a late-antique graveyard discovered on the site Gradina near Požega. Roman villae rusticae are located at the sites of Sloboština (with a bath complex), Draga and Imrijevci. The Romanesque church of St. Michael is at Rudina.

In Brod-Posavina County the river Berava flooded the town of Babina Greda and a number of villages in the area: Bošnjaci, Štitar, Rokovci, Cerna, Ivankovo and Mikanovci; all cattle was evacuated. The settlements of Slobodnica and Vrpolje in the Sibinje municipality were inundated. The city of Slavonski Brod was surrounded by floodwater and there were mudslides. Endangered archaeological sites were those of Roman Marsonia on the site of today Slavonski Brod and Servitium, at the village of Pivare near Nova Gradiška. Both are mentioned on the Peutinger’s Map, a 16th copy of a 4th century original.

In Virovitica-Podravina County the drainage of the overflow of floodwaters and their collection were inadequate; melioration canals were not maintained properly. The municipality of Crnac was flooded. There is cultural heritage from the Neolithic to the modern age. A cemetery of the Celtic–La Tène Culture was discovered at Veliko Polje near the village of Žvonimirovo. From the Roman period there were remains of road stations - mansiones and mutationes, such as mansio Bolentium, and of numerous villae rusticae. At the location of Sühopolj Borova there were Avar finds and a Slav settlement was found in the surrounding of village Čadavica.

Osijek-Baranja County had 7,000 km of the canal network, which did not succeed in preventing flooding. The Danube River reached 6 meters above the flood stage at the beginning of June 2010. The Nature Park Kopački Rit, located in this county, in the lowlands between the rivers Drava and Danube, was flooded.

In the angle formed by the confluence of the Drava and Danube River there is an extensive swampy area that stretches further toward the north, which has arisen as a result of the Danube’s course shifting gradually eastward. Today’s Kopački Swamps is what remains of a once much larger wetland. East of Osijek, between Nemetin and Aljmaš, the swamp also takes in the right bank of the lowest course of the Drava River. Aside from the Danube and the Drava, other rivers in that area are the Vuka and the Karašica. An extensive swampy area intersected by alluvial ridges, alongated rises that remained dry even at times of the highest water level, existed in the relatively recent past south and southeast of Osijek. Its origin was due to shallow underground waters, whose level mostly depended on the change in the water level of the Danube and Vuka. Such topographic conditions made possible habitation of this area and the rise and development of settlements from the Early Neolithic, through all the prehistory, and to a large extent in historic times as well. This area was open to the most diverse cultural influences and immigrations. From the very beginning of human habitation, the places most favorable for building settlements were the high river terraces and edges of swamps. During the Roman Empire, the border on the Danube (Danubian limes) and good communications played the decisive role in the development of settlements. The regional center in Roman times was the city Mursa, today Osijek on the Drava River. Major military border camps were Teutoburgium, today Dalj, and Ad militare, today Batina, on the Danube. There are same very important monuments from the Great Migrations period and the Middle Ages.

In Vukovar-Srijem County the high rainfall of 125 liters per square meter in 48 hours caused widespread flooding of the rivers in the easternmost area of Slavonia. The river Bosut, normally
small and shallow, reached the record level on June 6, 2010 and breached the dikes in the city center of Vinkovci; homes and yards were under water.

![Figure 3: The flooding in Vinkovci](image1)

![Figure 4: Vinkovci flooding map made on the base of aerial photo](image2)
Another breach of the dikes occurred in the suburb of Krnjaš and at a motel in the woodlands of Kunjevci along the road Vinkovci - Županja. The Bosut’s level rose from the high waters of its tributary Bīd flowing from the Đakovo area, while floodwaters along the Bosut could not flow into the rising waters of the Sava River. Drinking water was closely monitored for contamination. Yards and basements were flooded in the area around the city of Županja. Farmland was inundated around the city of Vukovar when the Danube and the Vuka River crested. The losses in agricultural yields were estimated to reach around one billion Kunas. This entire region is agriculturally the most important part of Croatia.

Vukovar-Srijem County is in the easternmost part of Croatia. It is located between the Danube and the Sava Rivers in the regions of eastern Slavonia and western Srijem. The northern part of the county is on the slopes of Fruška Mountain, which descends to the Vukovar plateau, and on the slopes of Dilj, which turns into the Vinkovci-Dakovo plateau, while the lowest parts are along the river Sava. (Durman 2007, 63) Thanks to its topographic features, natural riches and good transportation routes this area has been inhabited since the Neolithic. The whole county is filled with numerous archeological sites. In the Chalcolithic period, the most significant center was at Vučedol, with the first mass production of metal objects in the region; it arose on an autochthonous base as a result of the arrival of the Indo-Europeans. Large settlements were discovered at Vučedol, Stari Mišanovci and Vinkovci, where a vessel with the oldest calendar was found. During the Late Iron Age the area was in the sphere of influence of the Celtic-La Tène Culture. The most important settlements were located on the territory of Vinkovci, Privalaka, Oriolik, Lipovac, Vukovar and Sotin. The Roman city of Cibalae, today Vinkovci, was a commercial and manufacturing center. It was located at the intersection of roads that linked it with the main Roman routes. At today Sotin there was the military border camp Cornacum, further east at Ilok was the Roman Cuccium, and near Županja the Roman Ad Basantae, where the crossing over the Sava River and connection with the Bosut River was located. There are numerous pre-Romanesque sacral buildings and Gothic and Baroque cultural monuments.

The floods in May and June 2010 endangered those numerous sites of cultural heritage, but also one site of natural heritage - the Nature Park Kopački rit in Osijek-Baranja County, mostly in the wetlands between the rivers Drava and Danube. It extends northwards from the river Drava to the river mouth of Drava into the Danube, and upstream of the Danube River on its left and right bank to the former quay Kazuk. Kopački rit covers the area of 17.730 hectares. Kopački rit is a marshy area made by the activity of two large rivers, Danube and Drava. The narrower reserve area of 7.220 hectares has the status of a Special zoological reserve and the wide area of 10.510 hectares the status of Nature Park. Kopački rit is on the list of the Important Bird Areas program (IBA).

2. Major disaster charter activation

2.1. Dubrovnik-Neretva County

The town of Metković on the Neretva River suffered two catastrophic floods in one year – the first one in January 2010 and the second one in December 2010. In January the Neretva crested at 3.83 m and 700 structures were flooded. On the 2nd of December the crest of 4.05 m was the highest in the last 50 years. The main street in Metković was 40 cm under the water.
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Figure 5: The flooding in Metković in the Neretva delta

Figure 6: Metković and beyond map made on the base of aerial photo
In the delta area, towns and villages of Komin (60 structures), Opuzen, Kravac, Ploče and Kula Norinska were flooded. The state highway D9 and the local roads Metković – Vid and Rogočin – Kula Norinska were under water and closed, as well as the border crossing into the Bosnia and Herzegovina. Drinking water was contaminated and there was a fear of infectious diseases. The flooding was partially caused by opening the spillway on the dam at the Jablanica power plant upstream in the state of Bosnia and Herzegovina. There are three power plants upstream on the Neretva. All three released the pressure of the swollen river, which aggravated flooding caused by sudden snowmelt.

The events at the beginning and at the end of 2010 played out the most pessimistic predictions of the World Climate conference in Copenhagen, held only one month earlier (7-18 December 2009). The Neretva delta and the estuary were extensively flooded. This area is only one meter above the sea level, what in the extreme conditions under the storm-causing south wind does not prevent the sea from flooding the shallow delta. The disastrous flood was however caused by torrential rains and snowmelt in the mountains, both abnormal conditions in the winter season. The low-lying parts of the ancient site of Narona were affected, including the church of St. Vid, the forum, and the suburban villa with an early Christian basilica at the site of Erešove Bare. An added problem could have been the shrinking of the coastal wetlands in the Neretva delta due to intensive agriculture and development. When wetlands disappear, storm surge (sea flood) advances, as the disaster of New Orleans showed when the hurricane Katrina hit the region.

The area of the Lower Neretva River with the associated coastal area is the region of a mountain river and marshlands in the Neretva delta. The area has been inhabited since the Neolithic, the period of the great migrations of the Indo-European peoples. The migration process lasted from the Neolithic to the Chalcolithic period and took place in several waves. In the 4th century BC Greek sources mention a trade settlement (emporium) Naron, later the site of Roman Narona (today Vid near Metković). Remains of the forum in Narona with the imperial cult center and statuary (the Augusteum) are famous (2007, 76-77). There are late-antique findings at Erešove Bare, Njiva and the church of St. Vitus. Early Christian churches and pre-Romanesque churches add to the rich corpus in this area of the monuments of Gothic, Renaissance and Baroque cultural heritage. The floods in January and December 2010 also seriously endangered the natural heritage of the Neretva delta. The marshes are an ornithologically important area due to their natural characteristics and as the reservation for the population of European bird species. The Neretva delta is on the List of Ornithologically important areas (IBA).

In September and November of 2010 the historic city of Dubrovnik, one of the World Heritage Sites, was subjected to torrential rains and storm surges. On September 27 the streets in the city center were under 50 cm of water. Then again on the 23rd of November, 160 liters of rain fell per square meter in only three hours. The central street Stradum and the Sponza Palace, with the century-old archives, were inundated. The city lost electricity and drinking water. Sinkholes opened on roads and there were torrents and mudslides. High winds and storm surge caused further damage and destruction. Earlier in November, the coastal city of Split was also hit by high winds and storm surge. The waterfront was inundated and the basement rooms of Diocletian’s palace were flooded.
3. Recent natural disasters in the northwestern counties

3.1. Zagreb County, Sisak-Moslavina County, Krapina-Zagorje County, Karlovac County, Primorje-Gorski Kotar County, Istria County

Heavy rains fell in the first half of September 2010 both in Slovenia and Croatia. Flooding started in the northern Croatia on September 18 along the swollen rivers of Sava, Kupa, Dobra and Sutla. The situation was worst along the Sava in the area between Velika Gorica and Sisak, downstream of Zagreb, in the period from September 18 – 27. Persistent, heavy rains through 48 hours brought more than 200 mm of water per square meter.

Figure 7: Flooding of River Sava near Zagreb

Figure 8: Zagreb and beyond map made on the base of aerial photo
The Sava River kept rising 3-5 cm per hour and on September 17th it rose a full 5 metres. Inhabitants were rescued by boats from their rooftops. Strong currents carried houses and there were widespread mudslides. Sections of the major and local roads were closed. The Roman town of Andaustria, located at the present-day Šćitarjevo, and a Roman villa at Čička Poljana were flooded.

In Sisak-Moslavina County floodwaters along the Sava River affected heavily populated villages of Rugvica, Lijevi Dubrovčak, Desni Dubrovčak and Željezno Desno.

People and animals had to be rescued. Dikes were breached upstream of Strmec Bukevski and Sop Bukevski, while mudslides occurred at the villages of Orle, Vrbovo, Drnek and Stružec. Dikes were also breached at Trstenik-Abesinija, Resnik, Donje Šćitarjevo, Željezno Desno, Bukevje-Drnek, Stružec Posavski, Strmec Bukevski-Tunj, Lekneno and Drenje Šćitarjevsko. The Sava topped the dikes in the villages of Desno Trebarjevo, Desno Željezno and Desna Martinska Ves. All-time record levels were recorded at many flood gauges along the Sava. Floodwater destroyed a bridge on the state highway Sisak – Popovača. The city of Sisak and the places downstream of Sisak were saved by opening some dikes and diverting water from the main channel into the Lonjsko Basin (Lonjsko polje).

The wetlands in the central part of the county are connected primarily with the Sava River. From its source in the Slovenian Alps to Zagreb the Sava is a river with a steep gradient, almost a mountain river. In its subsequent course the gradient is suddenly reduced by half and the huge quantities of sand that it carries suddenly begin to be deposited in its bed. Here the riverbed is elevated five meters above the surroundings, and the streams coming from the right and left banks flow below its level. On the left bank of the Sava a whole series of smaller rivers that cannot get through to its bed begin to flow in parallel. Flowing into one another and overflowing they occasionally form a lake more than 150 km long. Nowadays the area is partly regulated by numerous canals; the Struž River is of particular importance, for it finally carries all those waters into the Sava. Those wetlands in the past hindered transportation and made east-west travel difficult.

Sisak-Moslavina County is rich in prehistoric cultural heritage, from the time of the developed Neolithic and throughout the Bronze and Iron Age. The most important Hallstatt settlement and then a Celtic strategic center for the Pannonian region was Segestica. The Roman colony Siscia, the provincial center of Pannonia Savia, was founded on its site. Siscia owed its importance to the transportation route running from Pannonia to the Adriatic Coast. It became a center for iron indus-
try and a Roman mint site; ten iron bars were found in excavations there. The network of Roman roads, which opened downstream along the Sava and Kupa rivers, were attested by the findings of Roman milestones and numerous Roman *villae rusticae* in this region. From *Siscia* toward Turopolje and to the other important Roman city *Andautonia* (today Štitarjevo) traces of the road have been located west of the villages of Dužica and Lekenik. In the Middle Ages, *Siscia* was the center of Christianity and the seat of famous Ljudevit Posavski until 822. A great number of important civil and ecclesiastic buildings were built during the Romanesque, Gothic and Baroque stylistic periods in this region. Traditional rural sites – villages with wooden houses and churches of specific construction and unique cultural identity are the most endangered.

The flooding of the Lonjsko Basin endangered bird sanctuaries, similar to those in the Neretva Delta. The Nature Park Lonjsko polje, with two ornithological reserves Krapje Dol and Rakita, is located in the Sisak-Moslavina County, north of the Sava. It covers an area of 50,650 hectares, including meadows, pastures and forests. The nature park is well known also for its valuable cultural heritage, especially very specific, traditional wooden architecture, folklore, crafts and folk art. The park has high importance for the population of European bird species due to its natural characteristics; there are 239 species of birds living in this area with more than 130 nesting birds. The Nature Park Lonjsko polje is entered into the List of Ornithologically important areas (IBA). The International Union for Conservation of Nature listed Lonjsko polje under 7 examples of planning the environmental protection in rural areas of Central and Eastern Europe (Space, Heritage @ Future 2010, 84).

In the counties of Krapina-Zagorje, Karlovac, Primorje-Gorski Kotar and Istria heavy rains (70-100 litres per square meter in Rijeka) and inflated rivers caused flash floods in towns and flooded major and local roads, which had to be closed for traffic. Since Karlovac and its surroundings are the place where the southwesternmost extremity of the Pannonian Plain comes closest to the Mediterranean, from the very earliest times this area has been a great crossroads for different cultures and influences. From the north to the south of the county the low-lying, partly swampy Pannonian area gives way west and south of Karlovac to a hilly, mainly karst area and to the southern mountainous part. The most attractive areas for longterm habitation in most cultural periods were the fertile alluvial terraces – the valleys of the Kupa, Korana, Mrežnica and Dobra rivers and offered possibilities of an easy flow of trade and transportation through ther territories. Caves with archaeological finds are quite numerous (Durman, 2007, 15).

The EU Joint Fund gave Croatia a significant aid for dealing with the consequences of the floods in 2010. The amount of 1.17 millions Euros was received for rebuilding from the flood damages and losses in September alone.

4. Conclusion

Floods are no longer only seasonal (early spring, late fall), but are unpredictable and are connected with cyclones that bring unusually heavy rains, sometimes lasting an extended period of time. High winds are another common occurrence now. There are also unusual and rapid temperature fluctuations during winter months, even of 15 to 20 degrees Celsius within a 24-hour period, which can cause sudden snowmelts. On December 20, 2010 the temperature in the northern Croatian city of Čakovec was -21°C, while on December 21st it climbed to 0°C. In that same period there were wild temperature fluctuations in the central Croatian region of Gorski Kotar. On December 7th it was -17°C, on December 22nd it was +16°C, while on the 26th it fell to -10°C. Natural catastrophes are related to weather. Following heavy rains or sudden snowmelt in winter months, the rivers swell
with flood tides. On December 7, 2010 the Sava River reached 7.23 meters above its normal level at Slavonski Broad and 9.01 meters at Županja. The Kupa River was recorded at 5.99 meters above normal at Karlovac on December 13, 2010. Sudden snowmelts in December and January are normally unexpected, but have been recurring lately. The snowmelt in Germany and Austria in the middle of January 2011 caused sudden rise of the Danube of 50 cm per day or 2 cm per hour. In a few days the Danube reached the level of 5.6 meters above its normal level on the territory of Croatia. Large rivers cannot absorb small rivers and tributaries because of their own high levels and cause floodwaters to spill into vast areas. A network of canals can no longer control those floodwaters. The recent floods were reminiscent of the ancient annual flooding of the Nile. The Greek historian Herodotus (484-424 BC) described the Nile valley during a high flood and observed that settlements looked like small islands in the sea.

The past settlement patterns and the location of ancient settlements along the major rivers give us an insight into past climates and the interaction between people and the environment. The research of the prehistoric period settlements in the basins of the Sava, Drava and Danube has shown that a climate similar to the present climate probably existed during the Neolithic Period (8000-3000 BC). The Neolithic settlements were located on higher grounds, while wide law lands along the rivers (probably flooded regularly) seem to have been uninhabited. We may conclude that the flood plains were much larger than in modern times. The present climate change seems to tend again toward establishing wide flood plains. Could these patterns suggest a return of some known historical diseases? The stagnant water elevated for several weeks increases the number of mosquitoes and the danger of infections.

When floodwater is one to two meters deep in settled areas, people and domestic animals are evacuated, but it is not possible to save wild animals and birds’ nesting grounds, and they face natural forces. Farmland has to be replanted after flood, but if the growing season is cut short, crops fail and famine and diseases occur.

Climate change is occurring and the year-to-year aberrations are becoming the rule. The causes are mostly human activities but some are due to natural cycles. Hydropower plants located on rivers release extra water from dammed reservoirs, contribute to catastrophic floods. However, the warming climate and the warming seas, and consequently a higher evaporation cause heavier rains. Cyclones cause stormy weather and storm surges. Floods have both benefits and costs. Sediment brought by flooding helps build up arable land, but sediment and chemicals from human activities negatively affect environment. It is a precarious balance in which a wide range of human and natural systems must survive. Disaster management and the systematic use of remote sensing for the monitoring and conservation of cultural heritage are necessary for their survival.

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