RR 2004
3rd European Conference on River Restoration
RIVER RESTORATION 2004
Zagreb, Croatia, 17-21 May 2004

The revitalisation of kultural hereditary buildings in water streams

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ABSTRACT: The paper will analyze the specific aspect of revitalization of water streams – the revitalization of previously constructed buildings in water streams that have cultural hereditary characteristics. That means reconstruction of mill cascades, but also bridges, mills, rafts and other similar abandoned and forgotten hydrotechnic buildings in water streams that have monumental value. Their presence (especially mill cascades) represents the element of possible revitalization of wider river basins and in river water paths they enable the survival of specific ecological societies. The paper will consider their role in the context of providing ecologically acceptable water flow e.g. ecologically acceptable water level.

The questions regarding the interrelation between the possible concept of water streams revitalization as totally natural environment and the revitalization in a wider context that includes the elements of cultural and historical heritage was considered in this paper on the example of river Kupa catchment. This is the river and the water streams it's catchment on which mills and mill cascades were integral parts of life of rivers, of inhabitants and represented the value of their cultural landscape even less than fifty years ago.

This work suggests that the problem of revitalization should be considered in a wider context that includes also the analysis of possibilities of reconstruction of cultural buildings that is essential for repopulation of these areas and their contents.

KEYWORDS: revitalization, cultural hereditary, mill, ecology, Kupa

1 Introduction

The concept of water streams revitalization that is present for several years in both modern theories of water system management and in practical implementation of this approach on certain water streams is mainly connected to eco-remediation principles of water streams regeneration close to its natural statement. From several examples throughout the world it can be concluded that such approach is adequate and desirable and that it represents a good model of getting back natural values to the water streams that was subjected to the negative anthropogenic influence on the river morphology and water quality. The mode of successfulness measurement of such revitalization projects is the degree of adjustment of solutions to the natural look, content and water quality of the stream.

But, on certain water streams and their localities, during earlier historical periods some buildings were constructed mainly assigned for exploitation of water energy for putting in motion water-mills, saw-mills, blacksmith's workshops etc. These contents are abandoned and ruined today, so previously mentioned approach maybe is not sufficient. It is questionable weather revitalization of water streams should be performed to the degree of natural flow morphology or, in such cases, revitalization means reconstruction of these contents as well. In second case the goal is to protect surrounding values and

cultural heredities of such buildings and their water thresholds in the water stream that direct water to their running wheels.

It is, of course, impossible to give the general answer to this question. The arguments in favour or against depend on present water stream and buildings conditions and on wider spatial and social context of relation between water and population in certain area. Another important component is also the possible development of tourist and recreational contents connected with water and buildings on water streams. Water thresholds have the important impact on water dynamics during small waters when their upstream gulfs represent sometimes the only shelter for certain fish species. Therefore, before making the final decisions regarding revitalization it is necessary to analyze all of these components. Returning to the nature doesn't necessarily means only returning to the original water stream morphology. The definition can also comprise the historical buildings reconstructed in accordance with the nature without the disturbance of surrounding and ecological characteristics of some water area.

One of the identity foundations of every nation is material cultural inheritance [3], that is, because of the dynamic water influence during the time, especially endangered on water streams. The buildings besides the water stream such as water-mills, saw-mills etc. have the characteristics of ethnological cultural monuments – monuments of the reshaped nature. Therefore they should be preserved in original shape for ourselves and future generations as an "eminent story of human's culture and civilization" [12].

One of such stories is connected for the upper part of river Kupa stream, located in mountain area. Together with its affluent Čabranka, river Kupa represents the state's border between Croatia and Slovenia in length of about 130 km (Fig. 1). In the past, on that area, upstream from the entrance of Kupa river to the Croatian territory there were as much as 192 wheels propelled by water [9], while in present time only few of them remained active.

Figure 1: Analyzed area

Thresholds on Kupa river that gave necessary declination and directed water towards water wheels where hidrotechnically adjusted to the dynamics of Kupa water stream and haven't represent the obstacle to water flow of high waters because of relatively small heights that were very good adjusted into the longitudinal decline of the water bed.

Mutual agreement between water management professionals from Croatia and Slovenia in the mid 90-s of the past century, several thresholds were reconstructed as a presumption for the reconstruction of some plant buildings and for keeping water face upstream from them during small waters durations. The reconstruction of these buildings represents the element of possible revitalization of wider river areas and their tourist valorisation. Besides that the reconstruction ensures the maintaining of once established ecological communities in gulfs upstream the thresholds in the riverbed of the Kupa river.

2 Thresholds and buildings connected with them in the upstream part of the Kupa river

A very detailed review of the distribution of water wheels (water-mills, saw-mills etc.) on the Kupa river and its affluents concluded with the year 1984, and a historical overview of their gradual abandoning was described in [9]. According to [9] in the last 100 years in the upstream part of the Kupa river basin, 192 water wheels were in function. Sixty seven of them were located on the Kupa river, 36 on Čabranka and 22 on Lahinja river and its affluents.

Remaining were located on other water streams. On the left Slovenian bank during the last 100 years 115 (59,9%) were located and on the right Croat side 77 (40,1%). Water-mills were predominant (147 or 76,6%), there were 39 saw-mills while water wheels for another purpose were 6. The buildings powered by water wheels went ruined because of the influence of several socio-economic changes, such as change in traditional economy, change in agricultural policy and very pronounced negative demographic changes on the analyzed area. The emigration that started in the second half of 19th century and has lasted until World War II has resulted in abandoning of the majority of water-mills and saw-mills. The most of saw-mills stopped working during the last twenty years of 19th century and between two World Wars. In the year 1984 only 24 water wheels were in function (12,5%); 12 saw-mills, 11 water-mills and one blacksmith workshop on Čabranka river.

The present situation, after the formation of independent Croatian and Slovenian states at the beginning of 1990s can be overlooked from water management principles, e.g. their substrates. According to the substrates for composition of Water management principle of Croatia [4], on the area of the Kupa river basin that is shared between Croatia and Slovenia there are only two active water wheels left, there are two mini power plants while few of the past saw-mills accepted electrical motive power. In Slovenian Water management principle of the Kupa river catchment area [14] the detailed description of thresholds on the river was shown. According to that document there are approximately 6 water-mills and saw-mills still active, one blacksmith workshop (Bilpa) and five small power plants on Slovenian affluent of rivers Kupa and Čabranka. According to that document, on the part of Kupa between borders, from former 64 thresholds in the water bed there are still 58 of them, mostly in condition requiring reconstruction.

The prerequisite condition for better tourist valorisation of ambient characteristics of the Kupa river and its affluent is reconstruction of partially demolished thresholds.

Such reconstruction has also the wider water management significance because with such reconstructed thresholds the water bed and water flow are stabilized also, the erosion of water bed and its bottom is diminished, the alluvium is retained and the ecological water characteristics are improved. The Slovenian part has begun the reconstruction since the middle of the last decade and after the formation of joint Croatian-Slovenian water management commission in 1999. the Croatian side started as well. Until now about 10 thresholds was repaired according to the agreement that for reconstruction is responsible the state on whose side the water wheel and its building is or was located. According to that agreement on the border part of the Kupa river there are 38 thresholds belonging to Slovenian side and 20 belonging to Croatian side. Two of the mentioned thresholds are directing the water on both sides. Just for illustration of the spatial distribution of thresholds on the border part of the Kupa river, Fig. 2 shows the area managed by Water management department (WMD) of Croatian waters from Rijeka on which 32 thresholds are located (the numeration in figure was adopted from [14]).

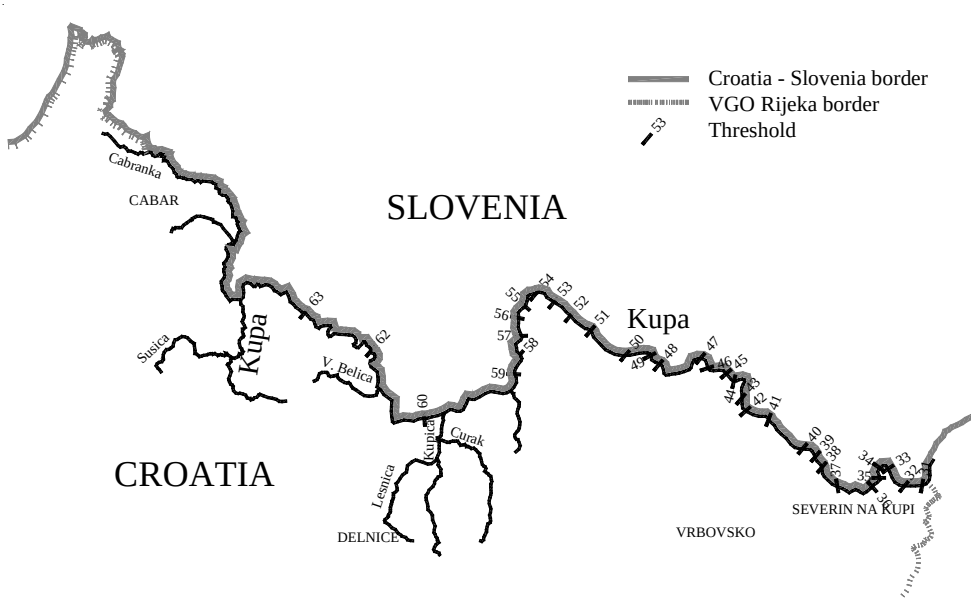

Figure 2: Threshold distribution on the border part of the Kupa river within the area managed by Water management department of Croatian waters from Rijeka

The thresholds heights on the Kupa river are in average between 0,40 and maximally 2 m. Because of relatively low height they are usually flooded by 2-years water with the exception of only few highest thresholds covered by 20-years water flow [14]. Fig. 3 shows on the example of threshold Klanac that was reconstructed during 2002 the principles of their reconstruction. Threshold Klanac is about 170 m long and mildly directed towards Croatian side where the water-mill was located in the past and whose crown was lowered by approximately 60 cm.

The reconstruction project [5] considered the possible water-mill reconstruction as well as the needs for the functioning of kayak path during the Kupa's course. Therefore, the part of

derivation toward water-mill was formed as the part of that path. In case of the appearances of minimal runoffs, the guaranteed water stream height is 20 cm. It was planned that the reconstruction will be conducted in two phases. The second phase (the waterproof obtaining by mini piles built in and the construction of waterproof material based on rammed piles) will be performed after the subsiding of repaired construction made from stone blocks.

The reconstruction was performed by rocks pelt for better adjustment of the object into the surroundings. Stone blocks with the diameter between 0,50 and 0,80 m, e.g. with the mass between 300 and 700 kg. For the obtaining of hydrodynamic stability of the threshold, the width of the crown constructed is 4 m and the upstream part of the threshold was conducted with the inclination of 1:1 and downstream part with the inclination of 1:3. Behind the slope the protective pillow was put. The machine technology of reconstruction was used (posting the stones) but with the use of autochthonous material – stone. Such technology should guarantee the stability of the construction in the contrast with traditional manual way of building of smaller stone blocks that requires reconstructions almost after every high water appearance. Considerable wideness of the threshold enables the use of machines for future maintenance of the threshold. The mentioned model is not the only model of construction and reconstruction of thresholds. In previously mentioned document [14] there are seven types of such objects listed. The idea was that repaired thresholds should resemble the original shape and that after observing the efficacy of proposed solutions on the site, the most proper shapes should be selected for implementation of further activities in reconstructions and revitalization of the Kupa river.

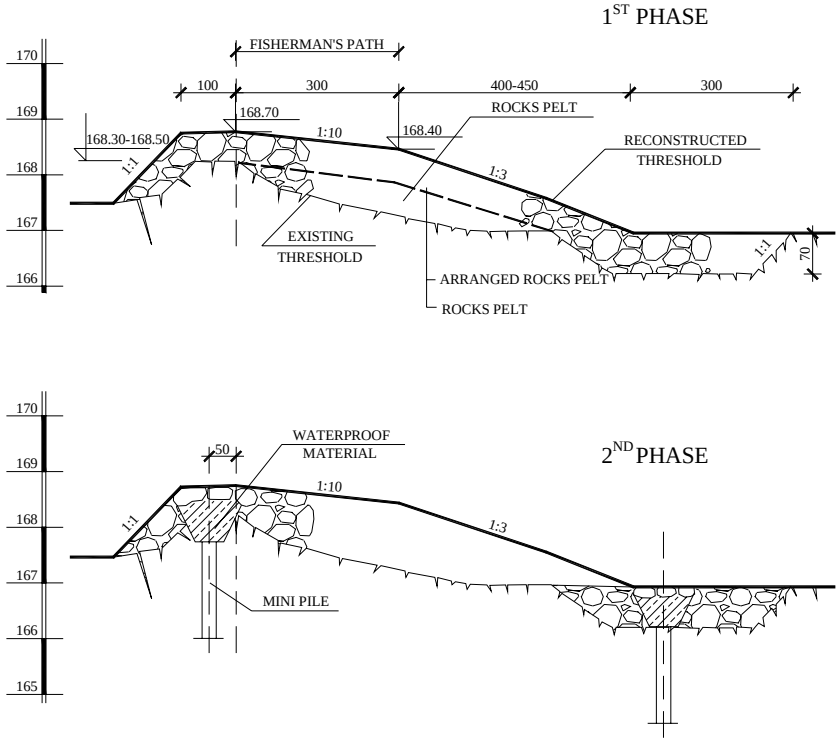

Figure 3: The repair of the threshold Klanac

The appearance of repaired threshold near Klanac is presented on Fig. 4 and 5.

Croatia repaired thresholds in Klanac (35) and Gusti Laz (60), and Slovenija - Gornji Radenci (42), Kot (45) and Vrt (50).

3 Hydrotechnical buildings in water streams and their ecological significance

Besides the cultural significance of thresholds on the Kupa river what is the reason why in Slovenia they have the status of cultural inheritance, they have ecological significance as well, especially in case of small waters. Upstream formed gulfs in such conditions increase the water levels and the spreading and the area of permanent water face in water bed of Kupa river and consequently wetness of the water bed and the conditions for preservation and the development of larger number of different water habitat along its water bed. The thresholds in water bed and such formed gulfs also retain one part of the alluvium, keep the level of underground waters in valley parts and increase the self-purification characteristics of water stream. On the other hand the decreasing of water bed descending augments enrichment of water with oxygen.

That, all together has very pronounced significance for the increasing of recipient self-capability of the Kupa river especially during extremely dry periods for which, according to the analysis of small waters, evaluation of recipient capacity was performed [11]. In the addition, the significance of thresholds in the Kupa river water bed can be stressed in the context of the fact that minimal annual runoffs, on almost all analyzed hydrological measurement stations in the Kupa river catchment area, have the descending trend so the extreme conditions are continuously more pronounced [6]. Such significantly extreme, in regards of small waters appearance was also the year 2003 [7].

Modern methods of biological minimum determination, e.g. the ecologically acceptable runoff, take into account the water level as the limiting parameter of small waters. According to Doupe and Pettit, that were cited by Bonacci [1] during ecologically acceptable runoff determination it is necessary to find the equilibrium between needs for water

Figure 4: The sight on the threshold near Klanac

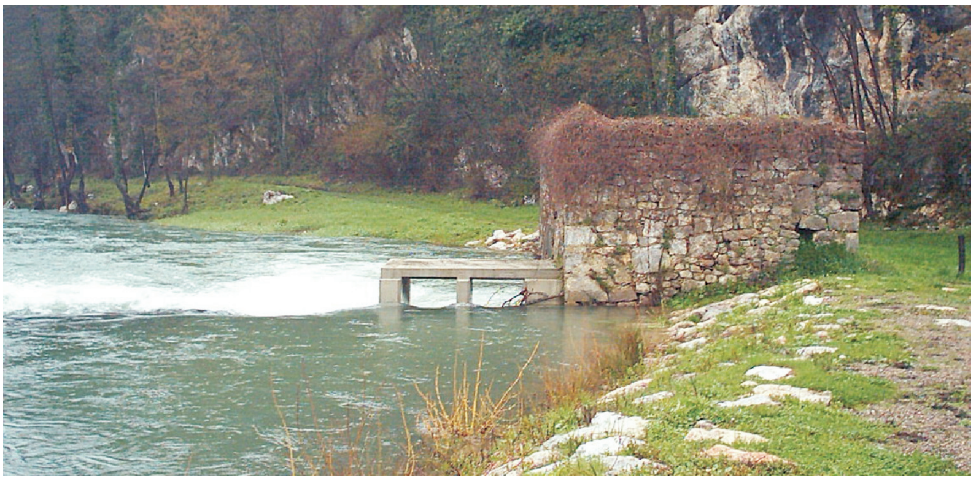

Figure 5: The sight on abandoned mill near the threshold near Klanac

of the ecosystem and socio-economic surroundings that necessarily leads to the integral or comprehensive approach of surface water streams resources management. The problem of defining the ecologically acceptable runoff is therefore complex and, in fact, there is no simple solution. During that process it should always take into account different hydrological and ecological components and the methods used by them.

According to [8] it was proposed that, because of insufficient fundamental bio-ecological researches of water streams and their surroundings on Croatian territory, until the conditions will be achieved to apply the complex methods and/or models of biological response, during defining ecologically acceptable runoff e.g. the sufficiency of retained inflows for the protection of autochthonous flora and fauna of basic water stream, the evaluation should be performed in a way that such sufficiency is valued according to proceeding of basic life conditions of some indicator species. Characteristic fish species have been proposed to be very good indicators. Table 1 shows the basic ecological demands of two most important inhabitants of the upstream part of Kupa river, trout and graylings [10], [8].

It can be seen that different developmental stages of mentioned indicator species demands different conditions of water flow, water speed, water depth etc. In the conditions of extremely small water they would be very difficult to be obtained if thresholds wouldn't exist. Therefore because of ecological reasons their maintenance and reconstruction are necessary for reaching the ecological stability. Similar results could be obtained with the use of some other biological indicators such as algal flora that was proposed in [13]. They are the most important primary producers in small water streams that are located on the very beginning of food chain and react very quickly on the changes in the environment. Their composition and biomass are influenced by the distribution of gulfs in the river bed.

One of hydrological elements for determination of ecologically acceptable runoff is based on the use of wetted surface method that was applied in [2] exactly on this particular part of the Kupa river. The more detailed presentation of different approaches to determination of ecologically acceptable runoff was given in works [1] and [8]. Their application under certain conditions would almost certainly give a quantified proof of positive influence of thresholds on the ecology of Kupa river small waters.

Table 1: Basic ecological demands of chosen indicator fish species, trout and grayling – adopted from Mišetić and Pavlin (2004)

Biogeog. area	Life cycle stages	Water depth (cm)	Water speed (m/s)	Water temperature (^oC)	Oxygen (mg/l)
Trout	Spawning	More than body length 20-65	Less than 2^L 30-80	1-12 (9)	Over 6
	Larva	Oko 30	0,003	4-19 (13)	Over 9
	Fly	Oko 30	15-70	4-19 (13)	Over 9
	Adults	More than body length	30-80	3,5-19 (14)	Over 9
Grayling	Spawning	More than body length 20-40	Less than 2^L 30-55	4-17 (12)	Over 6
	Larva	Do 30	6-20	4-18 (17)	Over 9
	Fly	Do 30	6-20	4-18 (17)	Over 9
	Adults	More than body length 20-60	30-70	4-18 (17)	Over 9

4 Conclusions

The discussion presented in this paper regarding the revitalization of thresholds in water beds in function of cultural – historical heritage revitalization and the improvement of ecological characteristics of water stream during some critical periods of small waters suggests the need of constructing the positive attitude towards the implementation of such activities on water streams where such constructs have been coordinated with the stream morphology and natural conditions. One of such streams is the Kupa river that served as a good example for the elaboration and analysis of such revitalizing interventions. Because of the broader influence of thresholds reconstruction on the environment, on buildings along the water stream and local socio-economic surrounding, such interventions demand very detailed preparation activities. Their implementation demands cooperation of water management specialists, ecologists, hydrologists, ethnologists, geographers and other experts connected with the analyzed area.

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