# ZAGREB AND THE SAVA RIVER, ASPECTS AND DILEMMAS

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## 1. INTRODUCTION

The City of Zagreb has developed on the southern side of Medvednica mountain. Further to the south of the old city flows Sava, a river with relatively low water level and a wide inundation area.

The river changes its character in the Zagreb area, turning from a relatively fast and narrow mountain river into a relatively slow and meandering lowland river. Modern high-rise housing are situated south of the river. The city expansion omitted the land along the river, leaving wide areas free for parks and natural reserves. Zagreb is a city that has not developed on the river, but on the contrary, it has fled from its inundations. Its sothern border up until mid nineteenth century, a street stretching in the east-west direction, runs along the edge of flooding area. Frequent floodings of Sava river, and especially the heavy flood of 1964 which endangered large parts of the city, resulted in levee building as a means of protecting the city. The river is not navigable within the city area. Instead of making it a part of itself, the city has to defend itself from the river.

Today the river still presents an obstruction in the city image, yet its green surroundings represent an enormous asset for the city's existence. Most gravel pits still have to be revitalized, but one of them, lake Jarun has become a leisure centre with rowing tracks.

The key elements for planning of regulation and utilization of Sava river are:

- flood prevention
- water distribution
- use of hydroelectric potential

*Figura 1. Sava river*

## 2. METHODOLOGY AND ANALYSIS

Water management plan of Zagreb contains analyses and proposes possible scenarios for use of hydroelectric potential of Sava river. Originally there were two different solutions. The first proposed five power plants. The second proposed three power plants and five concrete dams instead of two power plants in the inner city area. These dams would ensure waterbed stability and even water levels, so the river does not dry out in the city area. Finally, the amendment to the Water management plan of Zagreb included the accepted solution with four power plants.

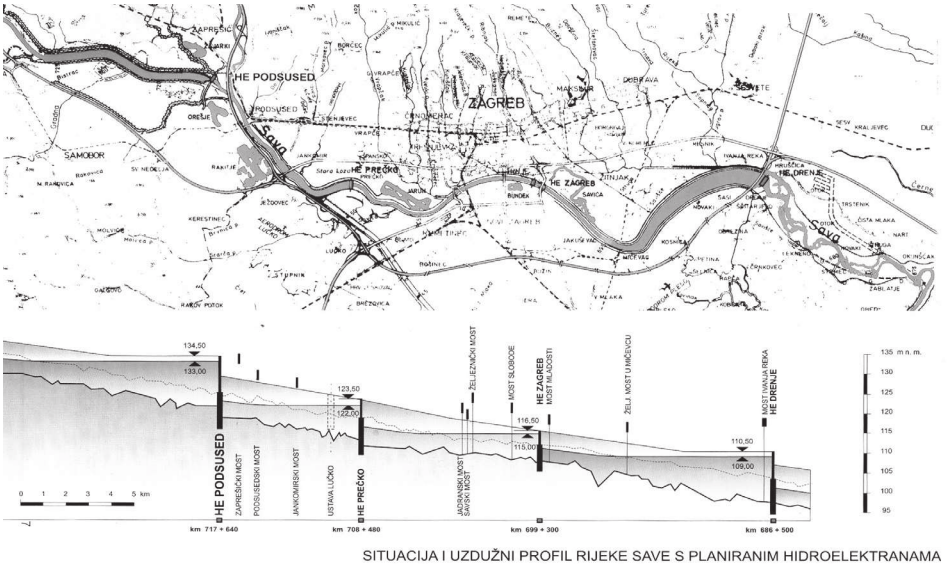


*Figura 2. Layout and cross section of solution with four power plants*

Basic characteristics and indicators of Sava power plants

| | | Podsused | Prečko | Zagreb | Drenje |
|---|---|---|---|---|---|
| installed flow | $m^3/s$ | 500,00 | 500,00 | 500,00 | 500,00 |
| regime | | flow | flow | flow | flow |
| deceleration | meters above sea level | 133,00 | 122,00 | 115,00 | 109,00 |
| required altitude | meters above sea level | 122,95 | 116,40 | 110,45 | 100,62 |
| altitude difference | m | 9,72 | 5,30 | 4,25 | 8,02 |
| power | MW | 41,00 | 23,08 | 19,00 | 37,00 |
| average annual production | GWh/ann. | 202,40 | 121,40 | 97,60 | 189,10 |

Sixty percent of the Odra canal is built. The canal, located upstream from the city, receives excess water of the river. By digging the canal floor two meters deeper, its capacity can be enhanced by 1000 $m^3/s$. So in case of high waters of 4780 $m^3/s$ the canal can bear 2500 $m^3/s$, and 2280 $m^3/s$ will flow through the city. The decrease in the flow through the city can lead to two scenarios. One is that existing levees can be lowered for 95 cm, which would facilitate access to the river and render the adjoining land more attractive. Another is the possibility of narrowing of the inundation area by 140 meters, which would leave a strip of land along the levee.

*Figura 3. The levee area*

## 3. RESULTS

Sava is Zagreb's source of drinking water, so the water-bearing area must be carefully protected. Zagreb lies mostly on alluvial ground, which purifies water from the river, rendering it clean and potable. Still waters in the Sava surroundings are either gravel pits or backwater. Placement of certain polluters is inapropriate, like the heating plant situated next to the ornithological preserve, or the city dump across the river from the protected water reservoir. The city sewer is released into the river southeast from the city, which does not endanger the city but does pollute its southeastern stream. The hydro-electric power plants are a questionable solution, as their impact on the water resources and the image of the city has not been studied enough.

In order to obtain ideas for utilization and protection of the river and its surroundings in 2001. the City Bureau for Development Planning and Environmental Protection has issued a competition for development of Sava area within Zagreb. Three equivalent prizes and five honourable mentions were awarded. The majority of projects dealt with regulating the riverbed, either with or without the hydro-electric power plants. Protection of drinking water reserves and natural surroundings have also been emphasized.

*Figura 4. Heating plant and ornithological preserve*

*Figura 5. Lake Bundek*