

ROLE OF HYDROELECTRIC POWER PLANT IN DEVELOPMENT OF UZICE AND BAJINA BASTA SETTLEMENTS

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Abstract

This paper demonstrates the link between the construction of hydroelectric power plant and the development of settlements in the surrounding area. The influence of electrification and industrialization in urban restructuring is viewed through different social conditions in the socio - political system, which determines the nature and engagement of investments, and the degree of technological development, which conditions the possibility of electric energy use. In this way, the distinctiveness in the economic, spatial and social development of settlements was observed relative to the stimulus of hydroelectric plant in different socio- economic and technical and technological conditions and it may serve as the foundation for defining the set of guidelines in the planning of restructuring and developing settlements.

Keywords: Electrification, industrialization, hydroelectric power plant, settlement

1. Introduction

The development of manufacturing technology and transmission of electric energy and the expansion of possibilities of its use made a huge impact in all areas of social life and action, primarily as an incentive for industrialization as the basis for economic growth, closely related to the creation of new urban structure and functions and changes in the quality and way of life. The process of electrification denotes the construction of power plant facility, which, as a system of specific function, influences the transformation of its close surroundings. The subject of this paper is the research of the impact hydroelectric power plants had on the growth of local environment within the framework of hydroelectric plant case studies "Pod Gradom" (Uzice, 1900.) and "BajinaBasta" (Bajina Basta, 1966.). The research entails multidisciplinary approach through plans of relations of social processes in different social conditions. The impact of electrification and mechanisms used to accomplish it are examined through the relation between planned and achieved changes in the settlements, regarding the economic, spatial and social aspect. The main objective of this paper is to establish a

connection between the development of settlements and the construction of hydroelectric power plant through the role of electrification and industrialization in the processes of urban restructuring, discerning the general and specific occurrences in the process of settlement development. Main material of the research is the technical documentation of hydroelectric plants (plant's draft projects, studies of accumulation influence on the coastal area, plans for regulating the settlements affected by the construction), general documentation (workers' council meeting transcripts), technical documentation of investments put into the development of local environment (regional and local spatial plans, architectural projects of individual objects), sources for the settlement development (primary sources: plans and statistics, secondary: studies and monographs) and historic and sociological studies of observed periods in Serbia.

Electrification beginnings in Serbia

The initial period of electrification in Serbia took place within the framework of personal initiative, directed toward stimulating the economy as the basis of settlement development. At the end of the 19th century Serbian economy was backward and predominately agriculturally-oriented with almost the whole population working in agriculture, /1/. Engaging in supra-regional markets and diffusion of monetary economy changed the existing ways of entrepreneurial and social life by the beginning of the 20th century, but the contours of modern industrial society could have been only vaguely recognized. Not until the electrification developed and the electric power was used as a driving force, could the industrial production reach new heights. At the beginning of the 20th century electric power became the main prerequisite for economic and social advancement, therefore the idea of electrification in Serbia was the attempt in direction of overcoming the arrested economic development by adopting modern technologies. The first power stations produced direct current which could not be transmitted over long distances; therefore its usage was limited mostly to poorly developed industry and had no significant role in households. The expansion of possible usage began by producing

alternating current, and the first power plant of this type in Serbia was the hydroelectric plant "Pod Gradom" in the town of Uzice.

Uzice: a small town transformation into an industrial centre

Despite the district town status, at the end of the 19th century Uzice was the back of beyond. Land and town development was carried out by plan, but the urban equipment was very modest. The streets were either of beaten earth or gravel, only the occasional one covered in cobblestone. There existed no water supply system nor the wastewater disposal system, and the public lighting implied sixty lanterns placed in front of taverns and hospitals. According to the 1898 census, Uzice had approximately one thousand family homes, and even though they were built from solid material, they had very poor housing conditions. There were a few public institutions; a gymnasium, primary school, church and military barracks. The economy was underdeveloped and based on leather processing and fabric manufacturing in small craft shops. The elementary impediment to the industrial development was the poor railway interconnectedness to the rest of the country and the foreign market. The main source of income was the export of cattle to Austro-Hungary, which, overtime, started to grow and provided the means for the development of other industries. At the outset, the textile manufacturing was launched because it had already had a tradition in the area. In the year 1898, The Shareholding Weaver Workshop was founded which marked the beginning of industrial development in Uzice. Firstly, the construction of textile factory was planned, which had to contribute not only to the economical and social growth of the town, but also to the development of national economy, since it would reduce the import of foreign textile merchandise and thus enabling the domestic production to come to the fore.

During the construction planning, an idea arose of powering the facility with hydropower, which had already been done in the industrial production. Building a factory in such immediate vicinity to the river would, however, raise the cost of manufacturing and minimize the competitiveness of the final product price. That obstacle was overcome by the suggestion Djordje Stanojevic made, a man credited for the electrification of Belgrade, that the power used for putting the loom into motion should not be the mechanical energy of water turbines, but electric energy. Driving power obtained in this way would have been extremely cheap; the factory would have been built in the location best suited for the transport of goods and raw materials, while the rest of the electric energy would have been directed towards the electrification of the town. In 1899, the manage-

ment of The Weaver Workshop made a decision to build a hydroelectric power plant on the river Djetinja, with the intention of increasing the capital investment for the textile factory construction with the profit from electric energy sales.

The financial support for the construction of hydroelectric plant and the power supply network was largely gathered from the private or local sources rather than governmental. Citizens would invest into the plant by shareholding and in return they would gain profit. Hydroelectric plant was first put into regular operation in 1900. The plant was built in with two 50 hp turbines and three-phase electric power generators, and only four years later, the plant had three generators, 130 hp turbines and a dynamo of 90 kW and 28,3 A, /2/.

After only three or four months the produced electricity was sold out. Two distributing networks were established: street lighting with 120 light bulbs of 16 candles and 9 flame lamps of 10 A and a private lighting. By keeping the low prices and installation free of charge, the management of Weaver Workshop wanted for electric power to become available even to the poorest working man and not only for the lighting, but also for every "domestic, economic or agricultural business...". That way the electric energy "will enter into homes, factories and fields", /3/. Although modest in light strength, the newly placed light sources were far better in comparison to the kindling wood, tallow candles and lanterns which were used up to then, and with much better hygienic conditions and considerably lower risk of fires. Electric light affected the daily routine and family life, since the part of household chores was left for the evening. In this way the use of electric energy surpassed the framework of manufacturing facilities and became a part of daily activities changing the quality and the way of life in the households. The number of light bulbs in private houses, however, grew very slowly, which indicated low economic viability and adherence to the tradition of frugality.

Although the electrification influenced the traditional way of life of the local population rather unassumingly, it had largely contributed to the expansion of local economy and the development of Uzice from a small town into an industrial centre. During the following few years industrial activity expanded and included a sawmill, still room, brick and tile factory, electric mill and chalk mine. Since the weavers' workshop production capacities had expanded, new facilities were built in the vicinity of the factory and the electric switchboard and network were upgraded, thus in the year 1904, it counted 1554 light bulbs and two 8A "Bogen" lamps for private and public use, /4/. Jobs for dozens of trained weavers from "The Weaver School" were provided and the manufacturing of textile raw materials was started, which contributed to the income increase in rural households. During

this period the development of settlements was carried out by private investments which were directed primarily into the economy development, consequently the urban structure and function development was neglected. Except for the construction of business facilities, nothing major changed in town renovation.

Socialist modernization

The period of socialist modernization in Yugoslavia after the World War II relied upon the electrification as the basis for industrialization, which was viewed not only as the method for structural change of economy, but also as a strategic preference of a complex process of overall socio- economic transformation, seeking support in accelerated development and by its means the radical conversion of the inherited structure was accomplished. One of the objectives in economy plans was the establishing of electric power system based on the large-scale production facilities, which would replace the existing local production and create the conditions to satisfy the growing needs of increasing number of consumers, both in industry and households alike. The structural changes in economy coupled with intense industry development contributed to the rapid growth of Yugoslavia electric power. Production of the electric power from 1953 to 1980 had significantly increased, achieving the average annual growth rate of 11.7, while the consumption in households per capita increased from 16 kWh in 1951 to 729 kWh in 1981, /5/.

The process of rapid industrialization was followed by the transformation of backward urban surroundings and social changes. During the first period of post-war restoration the investments were primarily directed toward the industrial development ("forced growth"), hence there was not any particular strategy for urban development, but the growth of settlements followed the growth of industries. Changes in production, trade and commerce and overall way of life and the use of spare time contributed to the change in lifestyle, both in the city and countryside alike; in places where the people were employed by the industry changes were noticed in the style of construction, interior decorating and daily routines and habits. In the late sixties, a phase of "intense socialistic urbanization" commenced and the investments were redirected from the industry to the structural urban development, utility and traffic network and enhancement of housing conditions, which represented one of the fundamental aspects of city modernization.

Even in the late fifties the increase in personal consumption was noticed, especially in the purchasing of home appliances for the "modern household", which greatly improved housing hygiene and nutrition. Owing to the radio and

television broadcast, the outside world became a part of private life, along with the new media habits which brought a new way of organizing spare time. That marked the beginning of considerable increase in the consumption of electric power, since it was a characteristic of new, higher standard. Social practices, by the late sixties, indicated that Yugoslavia had become an industrial society. The process of socialist modernization accomplished the transformation of social relations in all spheres of life: the social and professional structures had changed, same as the geographic image of settlements and architecture.

BajinaBasta: settlement as a part of socialist modernization project

In post-war period, BajinaBasta municipality was considered as one of the highly undeveloped settlements. The economy barely existed, and the urban equipment, infrastructure coverage and electric power supply were under-represented. The attempt to resolve the backward status of that area was attributed to the construction of hydroelectric plant on Drina River. According to the development plans of Yugoslavia electric power industry that facility was planned as the first in the line of strong power plants which would enable further economic and social progress. The construction was financed by loans from The Investment Bank of Yugoslavia, Commercial bank and International Bank for Reconstruction and Development, and the plant was first put into operation in 1966. Average annual production of 1625 GWh made up for 10% of electric power production in Yugoslavia, which was equal to the overall annual production in 1939. Apart from the production volume, the availability of electric power also increased due to the average price reduction from 13.26 to 11.68 dinars per kWh, /6/.

In order to provide necessary conditions for the power plant construction, numerous works were initiated in the immediate surroundings, primarily in the area of infrastructure. Until the power plant commissioning, a new road and power supply network had been built, utility and water management network had been upgraded, as well as the postal services, which created conditions for economy development in the municipality. Regarding the remodeling of physical structure, urban design and environmental plan for the power plant area and Perucac settlement, planned to build, in 1959 and 1960, a housing colony with outbuildings i.e. a shop, canteen, bathroom and infirmary.

The works also continued for the needs of reversible hydropower plant, which had been set in operation in 1982. The existing roads were reconstructed and the road network was expanded to 40 km and connected the main facilities with the sources of supply. At that time, municipality of

BajinaBasta had the most developed and the highest quality road network in the region. The construction of traffic network was of multiple significance, for the settlement as a whole and for every individual resident. The conditions were created for commerce development, more efficient and faster health services as well as other activities which contributed to the improvement of social standards. Electrical and telecommunication networks were expanded and the remote rural areas were electrified. Water supply system in BajinaBasta was reconstructed and the regional water system was constructed in the mountain of Tara which was more than 50 km in length and its capacity represented a lasting solution for the economy, especially tourism, and for the people living in the area. The construction of water management facilities was carried out, as well as the regulation of watercourses, forestation and beautification of the beach and coastal area of the lake in Perucac, just next to the dam, giving extraordinary options for development of sports and recreation tourism. A hotel was also built with the capacity of 118 beds and an annex of 50 beds for professional and technical staff, which is still being used today. In the town of Perucac two temporary settlements were erected with the accommodation capacity of 2500 people for the workers at the construction site and their families, with the utility and service outbuildings, which are, in part, still used today. The professional staff, that was supposed to stay after the construction was finished, had their permanent settlement built in the town of BajinaBasta, which is today a central area of residence.

Since the beginning of the construction of hydroelectric plant in 1961, the territory of BajinaBasta had been significantly expanded. The change of investment type and socio-economic system in previous decades as well as the plant construction, which was considered as the part of public works, contributed to the demographic imbalance, which was, in the terms of town construction, amortized by the insufficient financial strength of possible investors. Conversely, already in the early seventies, due to the favorable economic situation in the country, began a period of extremely intense construction. During the following twenty years immeasurably more area of municipality was urbanized than in the previous hundred years. Since in this period the development of settlement was an accompanying circumstance of large development projects in economic and social transformation, therefore the town of BajinaBasta was also taken care of in all aspects of development, starting with the infrastructure, construction of new housing fund to

the content of supporting functions of culture and entertainment.

The engagement of hydroelectric power plant "BajinaBasta" in solving the issues which did not directly refer to the income, but represented conditions for normal economic activity, exempted the economy of Yugoslavia from some investments, and as a result it could pay more attention to the production and possibilities of its own development. The significance hydroelectric plant construction had on the town of BajinaBasta was represented in the idiosyncrasy of economic development, which relied upon dynamic industry growth in the plan period. In the year 1989, in the economic structure of BajinaBasta, the industry had the largest partake in the forming of income, /7/. Thus, it was the industrial development which represented the basis for further urbanization, which was in most part connected to the needs of hydroelectric plant.

Structural integrity as a prerequisite for the proper functioning of hydroelectric power plant

In order to keep a hydroelectric power plant working smoothly, especially bearing in mind the scope of impact it has on its immediate surroundings, it is essential to make an evaluation of consequences for possible unforeseen circumstances and the way to prevent any possible negative impact. Hydroelectric plants, as large systems of complex equipment and large quantities of water in their accumulations, represent a potential danger, threatening not only the immediate environment but also the wider area. Therefore, it is the matter of special importance to pay attention to proper maintenance of all technical systems in the facility, because any malfunction endangers, not only the facility, but also all locations set downstream. The greatest degree of risk comes from the dam, inlet – outlet pipeline with their water and safety organs, as well as evacuation organs: spillway floodgates and bottom outlets (Fig. 1-2). Breaking of pipelines in the reversible hydroelectric plant "BajinaBasta" would cause water occurring at the water hub, at the slopes and foot of the mountain Tara, mudflow occurrences and the collapsing of facilities and communications. To reduce the risk of malfunction, constant evaluation of working life and structural integrity of aforementioned equipment is conducted, as well as the rest of the equipment intended for the use in electric power production, whether it is in the working condition or not. The checking of equipment and facility status entails a periodic trial run, visual inspection and non – destructive testing, and consulting with specialized institutions.

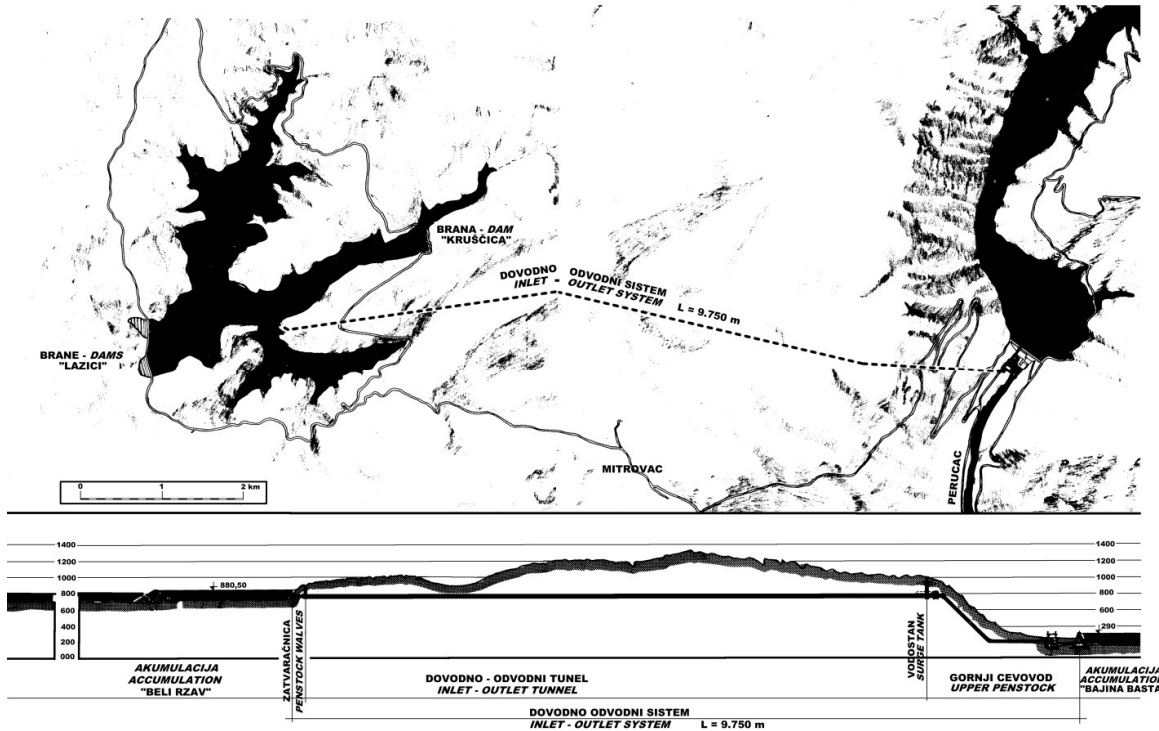


Figure 1. Upper and lower accumulation and inlet-outlet system of hydroelectrical power plant "Bajina Bašta".

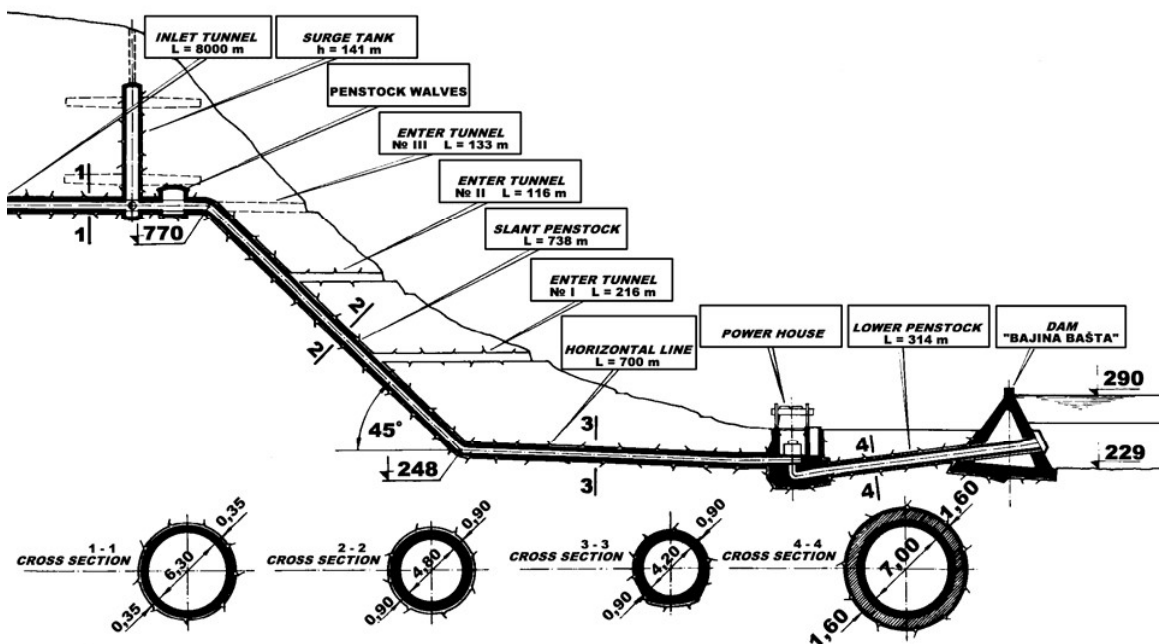


Figure 2. Disposition of penstock (upper and lower pipeline) "Bajina Bašta".

2. Conclusion

The contribution of hydroelectric power plant construction to the urban restoration within the framework of local environment development viewed from the stance of history, architecture and

urbanism, sociology and technology, gives an insight into the connectedness of technological innovations with the improvement in the way and quality of life. The construction of hydroelectric plant contributes to the economic, spatial and social development of local environment. As an incentive for industrialization, it is the effect of

change it has on the production method and volume, which results in the urban development and the forming of new urban structure and functions which follow the new economic activities, and social changes which entail demographic changes, new division of labor and leisure time, conditions of labor and housing and organization of everyday life. This influence is conditioned by ideological framework of socio – political system, which determines the nature of development initiative, the way and scope of investing, and by the degree of technological development, on which the possibilities of electric power use in different areas depend. In the firstly observed period, private initiative and investments were directed primarily towards the development of local economy, while the urban structure and function development was neglected. During the period of socialist construction, the development of local environment was an accompanying circumstance of large development projects, where all aspects of

development were considered, starting from the infrastructure equipment and construction of new housing fund to the content of accompanying functions.

3. References

- [1] Čalić, M., Istorija Jugoslavije u 20. veku, Clio, Beograd, 2013.
- [2] Ivanković, R., Vek elektrike 1893 – 1993., Elektroprivreda Srbije, Beograd, 1993.
- [3] Stanojević, Dj., Električna industrija u Srbiji, Privredni glasnik, Beograd, 1901.
- [4] Spasojević, A., Gluščević, M., Vek elektrifikacije Užica, Elektrodistribucija Užice, Užice, 2008.
- [5] Vukčević, R., Industrijalizacija i deagrarizacija u Jugoslaviji, Birografika, Subotica, 1983.
- [6] Ostojić, J., Hidroelektrane „Bajina Bašta“, Vesti, Užice, 1982.
- [7] Nacrt plana generalne regulacije Perućca, Arhitektonski fakultet, Beograd, 2009.