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THERMAL POWER PLANT "TUZLA" AS A FACTOR OF INDUSTRY DEVELOPMENT IN THE TUZLA BASIN

AUTHOR

Rahman Nurković
University of Sarajevo, Faculty of Science Department of Geography 71000 Sarajevo, Zmaja od Bosne 35, Bosnia and Herzegovina
e-mail: rahmannurkovic@hotmail.com

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ABSTRACT
Thermal power plant "Tuzla" as a factor of industry development in the Tuzla basin
The paper draws on a thorough theoretical and practical knowledge of spatial processes of industrialization and its manifestations in the Tuzla basin. Thermal power plant "Tuzla" is located in the center of the Tuzla basin near coal mines Kreka-Banovići, the largest in Bosnia and Herzegovina, with significant geological reserves of lignite and brown coal, which enable supply of coal for industries in the Tuzla basin. For such a complex development in the Tuzla basin, those elements of social, economic and physiognomic nature were taken, which were special and important for the transformation, i.e. for the change of space with its focus of spatial development of economic activities and social and technical infrastructure in the Tuzla basin.

KEY WORDS
thermal power plant "Tuzla", coal, energy, industry, the Tuzla basin

1. Introduction

The development of the thermal power station "Tuzla" was influenced by a number of natural-geographic factors, which besides its favorable geographical position, significant coal deposits and good supply of electricity from the thermal power plant "Tuzla", enable industrial development in the Tuzla basin. Industry is the most developed economic activity in the Tuzla basin, employing the largest number of workers and it influenced the regional development of the region the most. The following is a description of the development of thermal power station “Tuzla“ in the Tuzla basin.

For such a complex development in the Tuzla basin, those elements of social, economic and physiognomic nature were taken, which were special and important for the transformation, i.e. for the change of space with its focus of spatial development of economic activities and social and technical infrastructure. Intensive industrialization after the Second World War has fundamentally changed the economic situation of the region and especially in central towns in the Tuzla basin: Tuzla, Lukavac, Živinice, Banovići and Kalesija. The overall economic development of the Tuzla basin is closely linked to the production of coal and salt on which chemical industry was being developed as the leading branch of industry.

Thirty years of industrialization, despite the difficulties, significantly improved the living conditions of the population, not only in the Tuzla basin but also in Bosnia and Herzegovina. Mostly agricultural population of the Tuzla basin, after 1945, began to rapidly restructure. Industrialization of the Tuzla basin and its far-reaching consequences, were relatively little studied, hence there were created rare research papers on its social and economic development. This is surprising because it is the most vital region in Bosnia and Herzegovina.

The reason for this gap should be found in verbosity, intricacy and multiplicity of the phenomenon and implied necessities to clarify the issue from different scientific aspects. The purpose of this paper is to present geographical features of industry development of the Tuzla basin to a certain extent and thus at least partly complete the mentioned gaps in the study. Certainly, the theme is very extensive and complex, and it therefore in the future should be paid much more attention.

2. Methods of work and data sources

The methodological approach is imperativly adapted to the purpose of work, thus thermal power plant "Tuzla" and energy production have a strong impact on the local and rural development in the Tuzla basin and Bosnia and Herzegovina. Research has covered the local and rural development areas in

the Tuzla basin. In assessing the economic contribution of the development of thermal power plant "Tuzla" and energy production, quantitative methods ranging from stochastic to deterministic are almost exclusively used. Rating of direct contribution of the thermal power plant "Tuzla" had a significant impact on the development of industry and population in the Tuzla basin.

In the research of market potentials in Bosnia and Herzegovina were used analytical methods for determining the tendency and the interdependence of phenomena, conditions and opportunities i.e. limiting factors of market development. There were used standard desk research methods with the use of secondary data, including also the data of companies engaged in the production of energy in Bosnia and Herzegovina. There were used both the historical and normative methods, common for energy research. For the study of overall relations in the production and market of energy, there was used the balance sheet method, and for the assessment of further developments in the development of domestic energy, there was used an appropriate quantitative method. As a basic method of collecting primary data sources, there were used test methods, i.e. in-depth interview, where the main instrument were reminder polls.

3. Location factors rating in the deployment of thermal power plant "Tuzla"

In scientific research on locational factors influencing the development of the industry are given different opinions. It is believed that analysing of only the so-called classic locational factors (raw materials, energy, labor, market, transport links, etc.) is insufficient and that it should include other factors in such an analysis. In the modern industrial processes, industrial policy of the local or state authorities, connecting among industry, attracting industry to the so-called industrial agglomeration due to the many benefits they offer to industrial enterprises, transport, and customs policy are of a great importance. To avoid our analysis being too simplistic and depending only on the author's opinion, we performed evaluation of the main location factors in the deployment of each individual industrial enterprise by conducting a special survey for senior staff in the thermal power plant "Tuzla" and industrial enterprises of the Tuzla basin. (Vrišer, 1973)

In the analysis of industrialization of the Tuzla basin are applied listed locational factors. The thermal power plant "Tuzla" is a thermal power system with volume of 779 MW. It is located near the lignite mine "Kreka" in the settlement Bukinje, in the west of Tuzla, on the surface of 34 hectares. Another decisive location factor for the selected location of the thermal power plant "Tuzla" was the proximity of the river Jala from which the process water is

provided, that is required for the technological process of producing electricity. The third decisive location factor for the construction of the thermal power plant "Tuzla", were the microlocations for disposal of slag and ash from the thermal power plant in its immediate vicinity.

With the construction of the first stage of thermal power plant, the dump "Zasjeka" is open which was the main slag landfill until 1979. In addition to the landfill "Zasjeka", which could not accommodate all the slag from thermal power plant, there were open three more new landfills near the village Drežnik and Jezero I and II.

The total area of land on which slag and ash is deposited from the thermal power plant "Tuzla" is 180 ha. Until 1999, 28 million tons of slag and ash were disposed on all four landfills. The fourth location factor, which influenced the location of the thermal power plant is a connection to the power system of Bosnia and Herzegovina and the transport of electricity to consumers.

4. Periods of development of the thermal power plant "Tuzla"

The construction of the thermal power plant "Tuzla" was carried out in five stages. In the first stage, in 1963, there were built two blocks with the strength of 32 MW. In the second stage, in 1966, one block with the strength of 100 MW was put into operation. In the third stage, in 1971, a block with the strength of 200 MW was put into operation. In the fourth stage, in 1974, a block with the strength of 200 MW was built and in the fifth stage, in 1978, a block with the strength of 215 MW was built. (Miletic, 1999)

The blocks built in the first four stages were the strength of 564 MW. They were built for the production of electricity based on lignite from the coal mine "Kreka", whose calorific value is 8540 kJ / kg to 10 885 KJ / kg. The fifth phase of the block of 215 MW was built for the exploitation of brown coal from the coal mine "Đurđevik" with the heat content of 15,700 KJ / kg. When operating at full capacity, the thermal power plant "Tuzla" daily consumes about 17,500 tons of coal with the production of about 15 million kWh of electricity.

The thermal power plant “Tuzla“ was, by later reconstructions of blocks 1, 2 and 3, qualified for the combined production of electricity, heat steam of 125 t / h for industry and heat energy of 174 MWt / h for heating of the city of Tuzla. The thermal power plant spends 5 million tons of all kinds of coal, of which 3.5 million tons of lignite coal and 1.5 million tons of brown coal from the mine "Đurđevik" and "Banovići". With normal annual production, the thermal power plant "Tuzla" produces 4,200 GWh of electricity.

Coal is transported by railroad to the thermal power plant "Tuzla". In addition to the coal that is burnt in the process of energy production, for the technological process of the thermal power plant, it is spent about 30 million m3 of water annually. Water for the thermal power plant is being provided also from Modrac Lake. In addition to the primary product of electricity, the thermal power plant "Tuzla" produces and supplies: thermal heat, process steam for the chemical industry, fly ash for the cement plant in Lukavac and industrial water for the needs of industries in the Tuzla basin. Production and delivery of thermal energy for heating apartments in Tuzla started in 1983, after the reconstruction of condensing turbine in the block 3 into heating one and building of thermal stations.

Process steam production for the chemical industry in the Tuzla basin began in 1970 as a steam boiler reduced to the parameters of process steam and for the needs of the new Salt Factory Tuzla. Maximum production of process steam that was supplied to technological consumers was realized in 1987 amounting to 904 438 tonnes. Since 1974, blocks 5 and 6 are shipping solid residues (30.000 t/year) for the needs of Cement Factory in Lukavac.

From the system of chemical water process, the thermal power plant "Tuzla" distributed a certain amount of industrial water to Polihem and the detergent factory in Tuzla. Basic energy balance of the thermal power station "Tuzla" in the period 1959-2011 are presented in tables and graphs. (Figure 1)

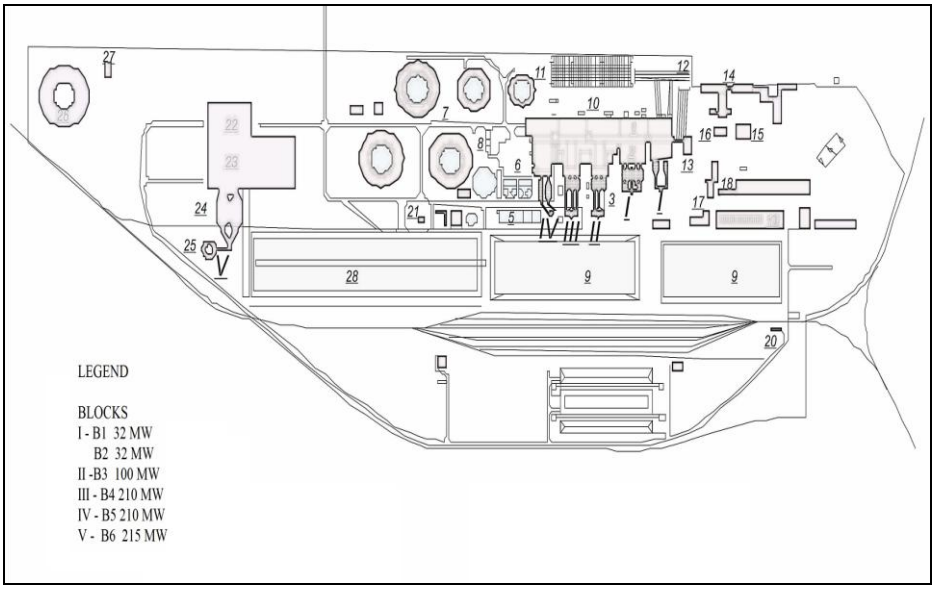

Figure 1: Layout of the thermal power plant "Tuzla", 1999
Source: Catalogue of the thermal power plant "Tuzla 800 MW", 1978

Analyzing the number of working hours of individual blocks for the production of electricity in the period 1959-1999, except for the time of the war in Bosnia and Herzegovina, it can be seen that the average annual number of working hours of each block individually amounted to 6000-7500 hours. This shows that the blocks were involved in covering the basic needs of electricity generation in the power system of Bosnia and Hercegovina. At the end of the 80s, due to the lower cost when compared to larger blocks, the reduced production of electricity on the block 2 is noticeable, which is not a characteristic for blocks 2 and 3, which due to the need of combined production of electricity and thermal energy (process steam), maintained a relatively high number of working hours per year.

In 1971, it was produced 210 MWh of electricity and it was sufficient to cover the electricity needs of the entire economy in the Tuzla basin. In relation to that, the consumption of coal grew (4-6 million tonnes a year) which was 85% of total annual production of coal mine "Kreka-Banovići". Electricity production was different. In 1971 it amounted to 1 million MWh; in 1984 4 million MWh; in 1991 3 million MWh; and in 1999 3 million MWh. However, for the entire period of plant's operation, there have been reported long delays of individual blocks and acquiring the status of cold reserve (suppression) and all because of favorable energy situation in the electric power system (1969 and 1974).

Electricity production from 1995 in the thermal power plant "Tuzla", for the purposes of the electric power system of Bosnia and Herzegovina, was relatively small when compared to the available installed power blocks. Produced process steam is supplied to consumers in Tuzla. Post-war production of process steam rose from 15,000 tons in 1995 to 180,000 tons in 1999. In the period 1983-1999, there was an increase in production of thermal energy for heating in the city of Tuzla. In 1983, it was produced 90 GWh of heat energy, also in 1999, production was increased to 210 GWh after 1995.

5. Utilization of coal in the thermal power plant “Tuzla“

The overall assessment of the used coal in the thermal power plant "Tuzla" is that lignite and brown coal mines in the Tuzla basin, in the period 1959-1999, delivered coal of appropriate quantity and quality. In the 40-year existence of the thermal power plant "Tuzla", it was burnt 100 million tons of coal and occasionally there were problems with the quality of brown coal for the purposes of block 6 in the period 1983-1986. New development period of industry in the Tuzla basin began in 1972 by building a chemical industry plant, which have used larger amounts of electricity.

Along with it grew the number of industrial workers where the power plant represents a major factor in the energy supply of industry and settlements in the Tuzla basin. Today, the thermal power plant employs about 1,900 workers. (R.Nurković, 2001)

We could not imagine industrial civilization without coal, because there are only few countries or regions which bypassed or skipped the coal period and achieved industrialization based on other energy sources. (Vrišer, 2000)

In the Tuzla basin, coal mining and energy production is one of the traditional industries. Coal mining is carried out since 1884, when the first pit mine of the pliocene lignite mine "Kreka" was opened in Tuzla. Coal from the mine "Kreka" was unveiled at a length of 250 m to the west and its quality puts it among better lignite. This type of coal has the following qualities: mostly contains carbon (46-48%), followed by humidity 21-27%, hydrogen 3-7%, ash 7.8-10.8%, sulfur from 0.2 to 0.9 %, and the heating value of 3877-4097 kilocalories. (Kovačević, 1985)

With the development of industry in the Tuzla basin also rose excavation of coal. Thus, in 1910, there was recorded 301,000 tonnes of excavation, 2 million tons in 1940 , 4 million in 1950, 5 million in 1961, 7 million in 1971, and the largest excavation of coal was in 1981 to 8 million tons. Since 1991 the excavation of coal in mines "Kreka" begins to decline. In 1993 there was the least excavation of coal of 761,000 tons. Since 1995, the excavation of coal in the Tuzla basin begins to grow again, and in 1999 it was 2,986 thousand tons. (Figure 2 and Figure 3)

In early April of 1992, due to the war in Bosnia and Herzegovina, there are the first major problems in electricity production in the thermal power plant "Tuzla". Production and consumption of electricity in the system was continuously decreasing so that it lost the ability to work for large blocks. At that time, "block 4" with the strength of 200 MW was switched off.

Bearing in mind that the war destruction caused tearing of a large part of system connections and jeopardized the operation of the production capacity in the single energy system of Bosnia and Herzegovina, in the thermal power plant "Tuzla", preparations have begun to test ability to work autonomously by starting blocks of less strength of 32 MW for local needs.

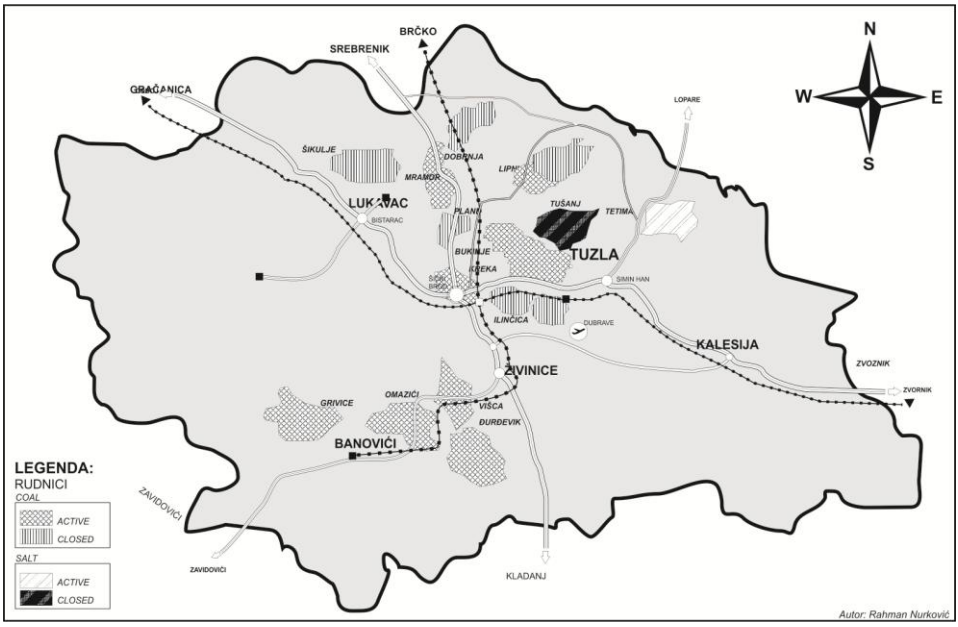

Figure 2. Coal and salt mines in Tuzla Valley.
Source: Nurković, R. 2001.

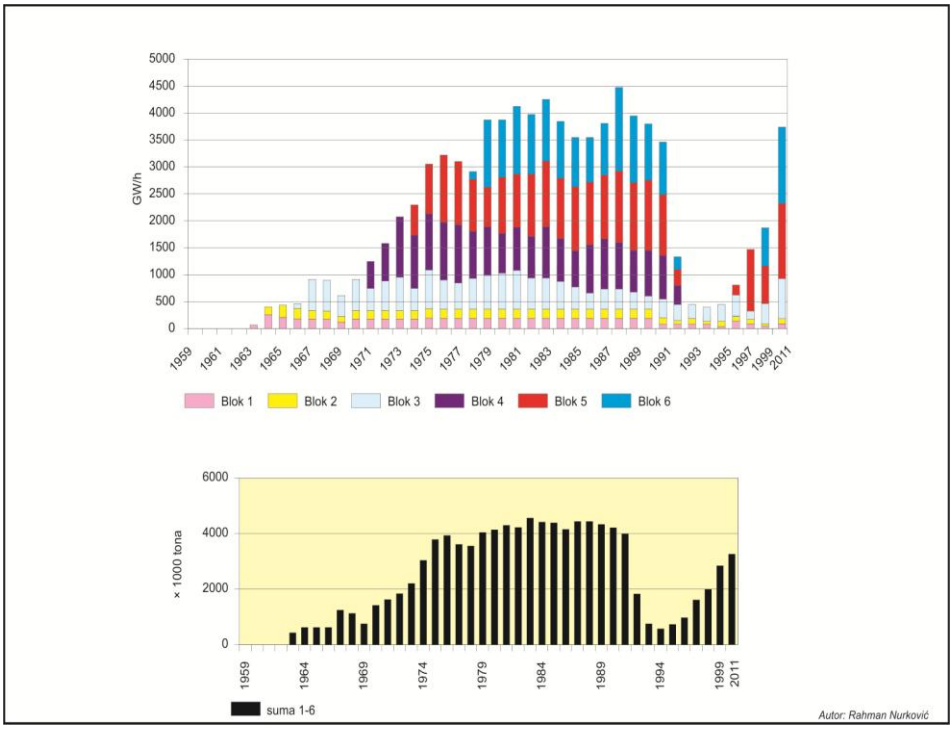

Figure 3. Production of electricity and consumption of coal in (TPP Tuzla,1959-2011).
Source: Adapted from Nurković, R., 2001.

6.Qualification structure of labor

Education is the so-called "human capital" and the most important characteristics of modern workforce. General knowlegde and expertise are the basic qualitative characteristics without which one cannot imagine a modern industrial production. It itself requires higher general education of workers which enables successful professional mobility and flexibility. This need is the result of industrial development, technological progress, the introduction of new technologies into the production and explosive expansion of knowledge. (Malačić, 1985)

For labor productivity, vocational education is significant which along with training in the workplace forms a qualification structure. Along with the overall economic development in the Tuzla basin, the education of workers in industrial enterprises also improved. New young workers were more educated than those who were already working. The qualification structure is improved at the expense of hiring new workers. In the industrial enterprises and plants of the Tuzla basin, we monitored the qualification structure of the industrial workforce at different levels.

We analyzed the qualification structure of employees in 1991 and 1999 in the thermoplant of the Tuzla basin. In 1991, there was the most workers with primary education, 1.796 or 4,9% of all employees. The following are highly skilled workers (339 or 18,9%), then qualified (384 or 21,4%), with secondary education (264 or 14,7%), semi-skilled (315 or 17,5%), with higher (32 or 1,8%) and with university education (29 or 1,6%). (Table 1, Figure 2)

Table 1. The qualification structure of employees in the electric industry of Tuzla Basin, 1991-1999

Qualification	1991		1999	
VSS	29	1,6	30	1,7
VŠS	32	1,8	39	2,2
SSS	264	14,7	286	16,1
NSS	225	12,5	276	15,5
VKV	339	18,9	342	19,2
KV	384	21,4	238	13,4
PKV	315	17,5	267	15,0
NKV	208	11,6	301	16,9
Total	1.796	4,9	1.779	6,6

Source: R.Nurković, 2001

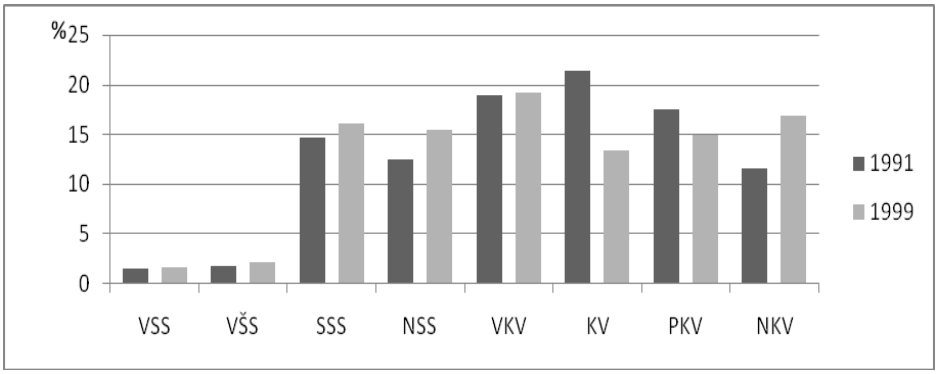

Figure 2.The qualification structure of employees in the electric industry of Tuzla Basin, 1991-1999.

Despite the best efforts of educational policy, which aimed at the formation of skilled labor by network of primary and secondary schools, though the thermoplant of the Tuzla basin still has an unfavorable qualification structure. The reason for this is primarily a relatively new industrialization adjoining the cheap and non-literate workforce. On the other hand, there is a consequence of specific branch structure with the prevalence of industry with a large proportion of unskilled labor (mines and chemical industry).

Finally we must not forget the social status of workers in the Tuzla basin. A large number of employees come from suburban areas, and besides working in the thermoplant they additionally work on their land. Due to the daily migration to work and cultivation of land, workers were overburdened showing no particular desire for additional education. Important differences also exist in the qualification structure of employees in the industry of the Tuzla basin. In 1999, in the thermoplant of the Tuzla basin there were 208 or 11,6% of unqualified employees. They are followed by persons with primary education (225 or 12,5%); 339, or 18.9% of high-skilled workers, 384 or 21,4% of skilled workers and 315 or 17,5% of semi-skilled workers. University and higher education had only 1.779 employees or 6,6%.

7. **Conclusion**

The development of the thermal power plant "Tuzla" was influenced by a number of natural-geographic factors, which besides its favorable geographical position, significant coal deposits and good supply of electricity from the thermal power plant "Tuzla", enable industrial development in the Tuzla basin. The development of industry in the Tuzla basin brought numerous changes in the development and structure of its population.

Industrialization in the Tuzla basin also affected the schedule of population and population development. Industrialization relied on agricultural population, the exploitation of cheap unskilled labor. Therefore, there is the question of development of other activities, not only industry. Finally, under the influence of industrialization in the Tuzla basin, there was an expansion of the central settlements, erasing boundaries between urban and rural areas, intensive development of the transport and electricity networks and improving of living conditions.

The achieved level of industrialization in the Tuzla basin has its negative consequences, too. Industry in the Tuzla basin became the largest polluter of the environment. Condition is getting worse from year to year and threatens to take on the elements of the general vulnerability of life especially in central neighborhoods Tuzla and Lukavac.

Today, large companies ("Polihem" and "Dita" in Tuzla) in the Tuzla basin ceased production. Thus, in the future, there will be many changes in the economic structure and regional development. In central settlements, spatial development will have to be planned taking into account the existing land use, environmental limitations of development and the market price of land. However, if you want to achieve the set parameters (for which it is already clear that it will be realized more slowly than it was desired by planners), one should take into account the readjustment of negativity in the implementation, which showed the current development of the industry. This primarily relates to spatial uneven development of the industry of the Tuzla basin which brought many economic and social problems in Tuzla and Lukavac.

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