ENVIRONMENTAL CHANGES FROM COAL SURFACE MINING IN KOSOVO

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Abstract
Fossil fuels (petroleum, gas, coal) are leaders in global level in energy production. The use of these resources have consequences for the environment where they are. Kosovo is well known for energy resources (coal-lignite, 10-14 billion tone) which are found in central part of Kosovo Plain. The huge amount of lignite makes that economic development of Kosovo to be dependent from this nonrenewable resource.
The use of coal-lignite for energy production began in 50s of XX century. For energy production, in these area are open pit mines from which is extracted coal-lignite for power plants with a capacity of 7.8 million tons per year (2009). From that time, existing mines are extended, new pit mines are opened, wastelands and ash landfills are created, water, air and soils are polluted, thermal effects near power plants are made, etc. Holes created by the exploitation of lignite occupy an area about 1600 ha, overburden dumps courses covering another 1500 ha.
The aim of this paper is to analyze the use of energy resources and geo-environmental changes that came due of this usage. The results achieved in this paper will be addressed to policy makers of governmental level, while the disturbance created by use of coal are affecting citizens in different aspects.
In order to achieve satisfactory results, in this paper will be used analytical methods, comparative method (GIS and RS techniques, maps and aerial image of different year), field survey, etc.

Key words: *energy resources, energy production, surface exploration, environmental degradation, pollution, anthropogenic landscape.*

JEL Classification: *F64, K32, O13, P28*

I. INTRODUCTION

Based on energy resource research, Kosovo has considerable amounts of lignite coal, which is found in several localities, with low water potential that can be used for hydropower, low geothermal resources, and small potential for natural gas. Kosovo is known for the large reserves of energy resources (coal type lignite, 10-14 billion metric tons) (Table 1) which lie in three main basins: Kosovo, Dukagjini and Drenica (Fig.1), as well as in some smaller parts such as: Malishevë, Babushi i Muhaxherëve, Rahovec, Gjonaj, etc. (Abazi, 2000)

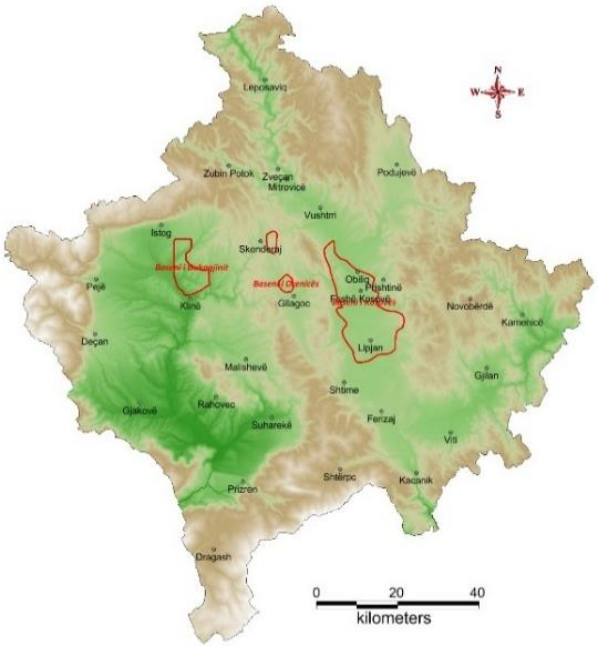

Fig. 1. Coal basins in Kosovo

Lignite utilization in Kosovo's basins has come up to the environmental changes that are reflected on nature with new forms of anthropogenic landforms, such as the creation of pit holes from the expansion of existing mines and the opening of new mines, ash hills; thermal effects in the environment, pollution of water, air, soil, etc.

Table 1. Lignite reserves according to location

Basin	**Area** (km^2)	**Reserves** (million metric tons)	
		Researched	**Usable**
Kosovo	274	**10,091**	**8,772**
Dukagjini	49	2,244.8	2,047.7
Drenicë - Skenderaj	5.1	106.6	73.2
Total		**12,442.4**	**10,892.9**

Source: Energy strategy of Kosovo 2009-2018, Pristina, 2009)

Kosovo coal basin is most important with a surface of 274 square kilometers which lies in the center part of Kosovo Plain (Fig. 2). It has an extension of 30 km long (north-south) and an average width of 10 km. The lignite basin extends along Sitnica River where differences in altitude don't exceed 80 meters. The soils in this basin are mainly used for agriculture, with small parts of forests. This basin includes 20% of the entire area of Kosovo Plain (1,400 km2).

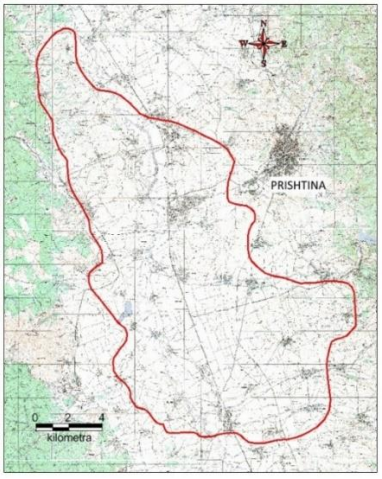

Fig.2. Lignite coal basin in Kosovo

Kosovo's coal is of the lignite type, with Pliocene age, low quality with thermal effects from 6.28-9.21 MJ/kg, with an average 7.8 MJ/kg. On average it contains 40-45% moisture, ash content is 15% (in some cases up to 25%), about 1% sulfur. Lignite has low sulfur content and a relatively good concentration of calcium oxide which absorbs part of the sulfur during combustion. The ratio between overburden materials and coal is 1:1 m3/t, which indicates that this ratio is very favorable, and makes these coal surface mines competitive and attractive for exploitation (Dushi, 2008).

The extraction of coal in Kosovo has begun during 1920s, with an average volume from 2,000 metric tons per year. The mine began in Hade (Obiliq municipality). In 1948 the volume of extracted coal reached 250,000 metric tons per year. During the year 1962-1984 near of Pristina, the capital city of Kosovo, two power plant were built “Kosovo A” with operating capacity of 800 MW and “Kosovo B” with operating capacity of 678 MW. (Dushi, 2012).

II. MATERIALS AND METHODS

Several data were used in order to achieve the goals of this study. Data from different reports from government institutions measurement were compared according to the normal values of pollution allowed. Aerial images of different year were used to compare the changes in physical environment, especially in extension of coal surface mining and overburden material disposal. All the data were generated in GIS software to analyze more in details.

III. RESULTS AND DISCUSSIONS

The first coal mine extraction in Kosovo Plain was Mirashi mine. At its beginnings, from Mirashi mine were extracted 1 million tons/year. Based on extraction capacities, two years later the construction of "Kosovo A" power plant started. With the increase of electricity use and good conditions for coal extraction, it has been possible to expand the mine and increase the capacity for 2,200,000 tons/year (Dushi, 2012). Thus, the coal mining capacity in this mine was increased to 3.2 million tons/year. The coal mining field at the Bardh mine is located in the northern part of Kosovo Plain basin, near the village of Bardh i Madh, and Pristina-Peja railway, in the aluvial Plain of Drenica River. The surface area of the mine is 2.45 km2 and the average thickness of the coal layer is 58m (Pllana, 2008).

Out of the amount of coal exploited, approximately 90% are used for electricity generation, 7% for chemical processing and about 3% for industry and households. In the period 1958-1996, a total of 208,222,306 tons of coal and 29,158,083 m3 of overburden materials were produced in two surface mines. During this period, 1.81% of Kosovo's total exploitable reserves or 2.12% of coal reserves in Kosovo were exploited. (Abazi, 2000)

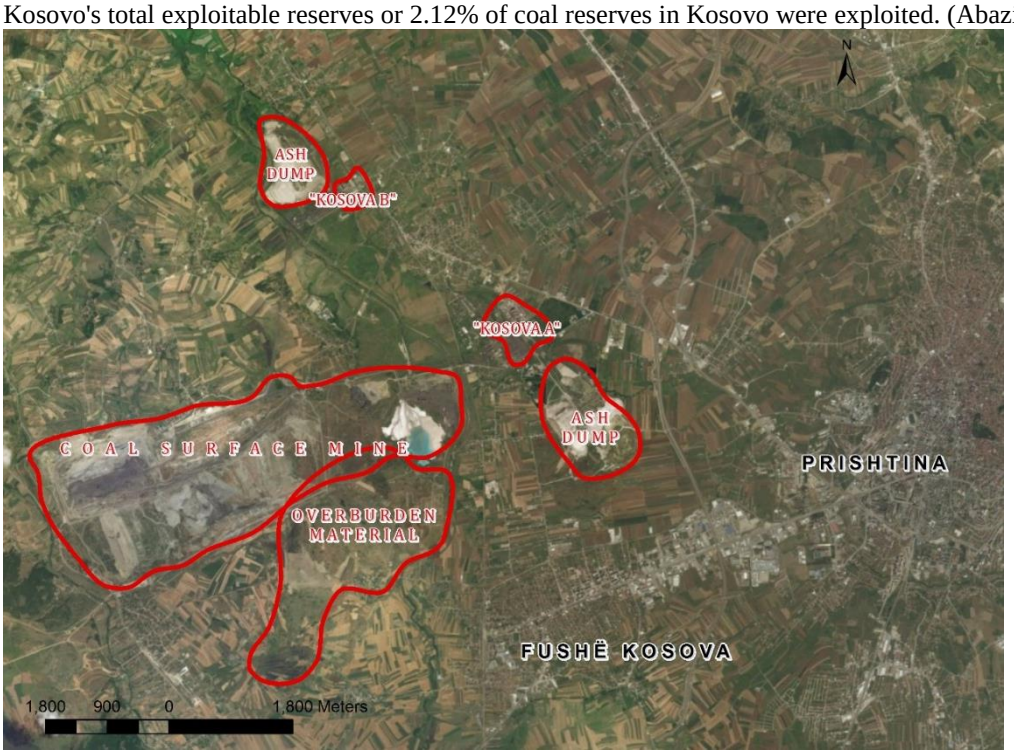

Fig. 3. Power plants, existing mines and distance from urban centers (image source: Kosovo Cadastral Agency)

According to other data (Ministry of Energy and Mines, 2009), it is said that the existing two mines of Bardh and Mirash have spent the total coal reserves of 300 million tons. While, in 2012, Mirash and Bardh mines were merged and on this occasion the coal mines were exhausted. With existing mines exhausted, the works on coal Power plants will continue towards the north, where the new mine "New Mining Field" will be opened. Finally, during the 5th century of lignite exploitation, with an average production of 5.5 million tons, 400 million m3 of overburden material and 54 million m3 of coal ash has been dislodged (Fig.3 and 4)

Fig. 4. Hade, a settlement that should displaced for coal mining (Source: MMPH)

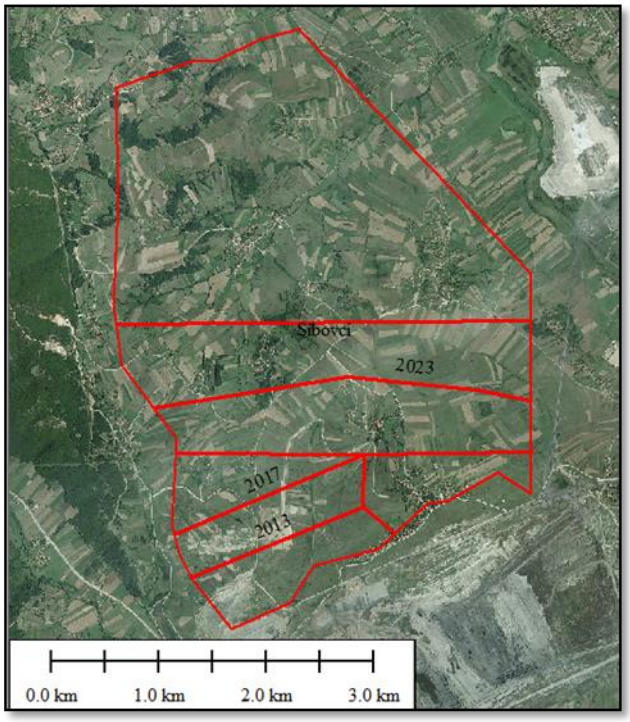

Fig. 5. The planned extension of Sibovci mine to supply the Powerplants with lignite coal.

Land use is of great importance and implies the destination of certain areas in the "New Mining Field" (Fig.5). Based on the measurements from aerial images of recent years, it is noted that in this area dominates agricultural land and forest areas (71%) which can directly affect the economic activities of the inhabitants of the extended mining area. Although a large number of inhabitants of this area are employed in the coal exploitation industry, agricultural land is another option to develop agriculture in these areas. Settlements are affected by the "New Mining Field". Settlements within this area occupy 11% of the total area. With the commencement of "New Mining Field" works, 4 settlements are obliged to undergo a total displacement process (Hade, Leshkovic, Shipitullë, Sibovc with a surface of 17.2 km2 and 6,320 inhabitants). In addition, 3 other settlements (Krusheci, Caravadica, Graboc i Poshtëm) with a surface of 13.7km2 and 3,360 inhabitants prefer to be subject to the resettlement process. While 21 other settlements are expected to be affected by the expected developments, with only the nearest settlements having more than 15,000 inhabitants.

Within the "New Mining Field" about 16% of area are covered by forests. Forests, in such energy-producing environments, are of particular importance, especially in the absorption of carbon dioxide. Therefore, by cutting them, the situation on the field would be even worse.

Surface coal mining operations require large areas of land to be temporarily disturbed creating a number of environmental challenges, including soil erosion, dust, noise, water pollution, and impacts on local biodiversity (Mamurekli, 2010). Environmental changes from the use of coal resources are caused by: overpopulation, exploitation and depletion of natural resources, uncontrolled waste disposal, overburden of agricultural land, air and water pollution, and land cover change. The negative environmental impacts result in the high degree of ecological pressure of the area with human activities. Ecological pressure means the degree of territorial saturation with concrete anthropogenic objects and is expressed by the formula (Pllana, 2008):

$$D = \frac{N}{S}$$

(D – Density, N – number of object, S – area).

Fig.6. Ash dumps of Power plant "Kosovo B" along Sitnica River

In Kosovo lignite coal basin are 44 settlements (16 settlements per 100 km2), population density is quite high (average >200 b/km2), large infrastructure density (roads, railways, airports), coal exploitation facilities and industrial facilities for their finalization.

With the exploitation of lignite in the coal surface mines, with overburden material and ash, existing physical structures in large area have been broken, and creating anthropogenic landforms. Altitude differences of anthropogenic landforms reach 200 meters in height. Pit in the mines have depths of up to 150 meters, and ash hills have a height of 20-50 meters (Fig. 6). With the current processes which are developed in the areas around Power plants, the fertile soil layer disappear as overburden material, the changes in topography, groundwater and surface waters are seen, the microclimate of the region changes, and faster winds transfer dust, the loss of biodiversity, and the health of the population is generally jeopardized.

Released dust emissions are measured only at the power plant "Kosovo B". The annual average for the measured dust emissions during 2008 was: for the B1 unit: 272.22 tons/month, while for B2 unit: 254.49 tons/month (Table 2). The following table presents the emissions of KEK (Kosovo Electro Corporation) Power plants, and the limits under European Union Directive 2001/80/EC. As can be seen from the table, the dust emissions, compared to the limits on the request of the Athens Memorandum, are very high, especially from Power plant "Kosovo A". Also, the NOx emission according to the calculations is above the allowed levels. SO2 emissions, although calculated lower than the limits of the Directive, are required to be verified through continuous measurements.

Table 2. Actual emissions and limits of Athens Memorandum

The pollution	"Kosovo A"	"Kosovo B"	Limit	To be reached
Ash	902.32	156.35	50	31.XII.2017
SO_2	251.42	208.55	400	31 XII.2017
NO_x	705.75	835.08	500	31.XII.2017

Source: State of environment in Kosovo 2008-2010 (report)

Whereas, CO2 emissions calculated from the total lignite used are estimated to be over 5 million tons/year (Table 3). By installing new filters against air pollution, the release of emissions from Power plant may be reduced. "Kosovo A" which is the largest pollutant in the energy production area, is expected to leave its function in 2016 (in fact it didn't happen). The new Power plant will be built with the highest environmental standards, so it will have less impact on the pollution of the environment.

Table 3. CO2 Emissions from "Kosovo A" and "TC Kosovo B"

Power Plant	Unit	CO_2 Emissions (t/y)
Kosovo A	A1, A3, A5	1.532.930
Kosovo B	B1, B2	3.608.876

Source: State of environment in Kosovo 2008-2010 (report)

IV. CONCLUSIONS

Lignite coal is used for energy production and is the main resource in Kosovo. Being a low quality coal, besides exploitation, along with positive economic effects, the use of lignite has caused environmental changes to a very high degree in a wider area, with serious consequences for public health.

The production of electricity from coal and agriculture which is based on a high quality soil fund, represent the main segments in which Kosovo's economic development is based. The development so far has not respected the sustainability criteria since coal extraction, waste, chaotic growth of settlements on the one hand, and agricultural lands on the other hand have created a duality which is manifested negatively both in terms of economic, social and environmental development.

As a result of the use of energy resources in Kosovo, environmental changes have been inevitable, such as: Creation of pit holes, ash dumps, loss of agricultural land from coal mining and overburden material, thermal effects in the surroundings, water, air, and soil pollution, noise, sliding near of mine, relocation of settlements, etc.

Pit holes and surface mining have made an area from 1.600 hectares, and overburden material another 1,500 hectares. These 3,000 hectares are of high quality soils in Kosovo Plain. Until now, no further steps have been made to the restoration or cultivation of degraded area. In addition of losing of agricultural land, another 160 hectares are covered by ash dumps.

Based on the Kosovo Energy Strategy, from 2016, "Kosovo A" will not work, while from the same year "Kosovo B" will begin to reduce generation capacities. In order to achieve high environmental standards, some measures should be made during construction of new Power plant with consideration of ecological criteria, overburden material to be restored in order to use later for agriculture, and restoration with cultivation to be made in order to reduce the pollution. In the future, Kosovo should be more oriented toward use of alternative energy sources such as: hydropower, wind and solar capacities, and to invest more in energy efficiency.

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