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Projecting the air quality, toxic and health impacts of the Tuzla 7 and Banovići coal power projects

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Abstract

Bosnia and Herzegovina ('BiH') is among the countries in Europe most affected by pollution from coal-fired power plants. Yet, it's one of the few were new coal-fired units are still being planned, with the potential to affect air quality and public health for decades.

This study assessed the impacts of two proposed coal power projects, in Tuzla and Banovići. The emissions from these plants, if built and operated, would impose substantial harm on public health, including a projected 30 premature deaths per year (95% confidence interval: 20 to 47), as well as 7,600 days of sick leave, 470 asthma attacks in children and 25 hospitalizations per year, and 40 children suffering from bronchitis. If the plants operate for 30 years, the projected cumulative health impact would be 960 premature deaths.

The projects have substantial transboundary impacts, as 810 premature deaths out of the 960 attributed to the plants over their operating life take place outside BiH's borders, with Serbia, Italy, Romania, Hungary and Croatia most affected.

Results: air quality

The air quality impacts of emissions from the Tuzla 7 and Banovići coal power projects were modeled using the CALPUFF dispersion model, which uses detailed hourly data on wind and other atmospheric conditions to track the transport, chemical transformation and deposition of pollutants, and is widely used to assess the short and long range impacts of emissions from industrial point sources. The model predicts the increases in hourly, daily and annual pollutant concentrations caused by emissions from the studied source.

Emissions from the power plant contribute to ambient concentrations of PM2.5, NO2 and SO2 *(Figure 2),* causing increases in the risk of both acute and chronic diseases and symptoms. The impacts extend several hundreds of kilometers from the power plants, affecting air quality particularly in Croatia, Serbia, Montenegro, Albania, Slovenia and Italy.

Results: public health

The effects of these increases in pollutant concentrations on public health were quantified following the recommendations of WHO for health impact assessment of air pollution in Europe. The results indicate that, if built and operated as proposed, the plants would be responsible for approximately 30 premature deaths per year, along with 470 asthma attacks in children, 13 new cases of chronic bronchitis, 25 hospital admissions and 7,600 days of sick leave from work per year *(Table 1).*

As a result, if the plants were operated for a relatively short lifetime of 30 years, the health impacts would amount to a projected 960 premature deaths. The majority of the public health impact is transboundary, with 810 premature deaths per year projected to occur outside BiH *(Figure 1)*.

Table 1. Projected health impacts associated with the emissions from Tuzla 7 and Banovići coal power projects

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Effect	Pollutant	Value	Unit
premature deaths	PM2.5	26 (17 - 34)	cases per year
premature deaths	NO2	9 (5 - 13)	cases per year
premature deaths	Total	32 (20 - 47)	cases per year
asthmatic and bronchitis symptoms in children	PM10	469 (102 - 845)	cases per year
chronic bronchitis in adults	PM10	13 (5 - 20)	new cases per year
bronchitis in children	PM10	44 (-12 - 100)	cases
hospital admissions	NO2	7 (5 - 10)	cases per year
hospital admissions	PM2.5	18 (1 - 36)	cases per year
lost working days per year	PM2.5	7,579 (6,447 – 8,703)	cases per year

Figure 1. Projected premature deaths per year outside BiH by country, per decade.

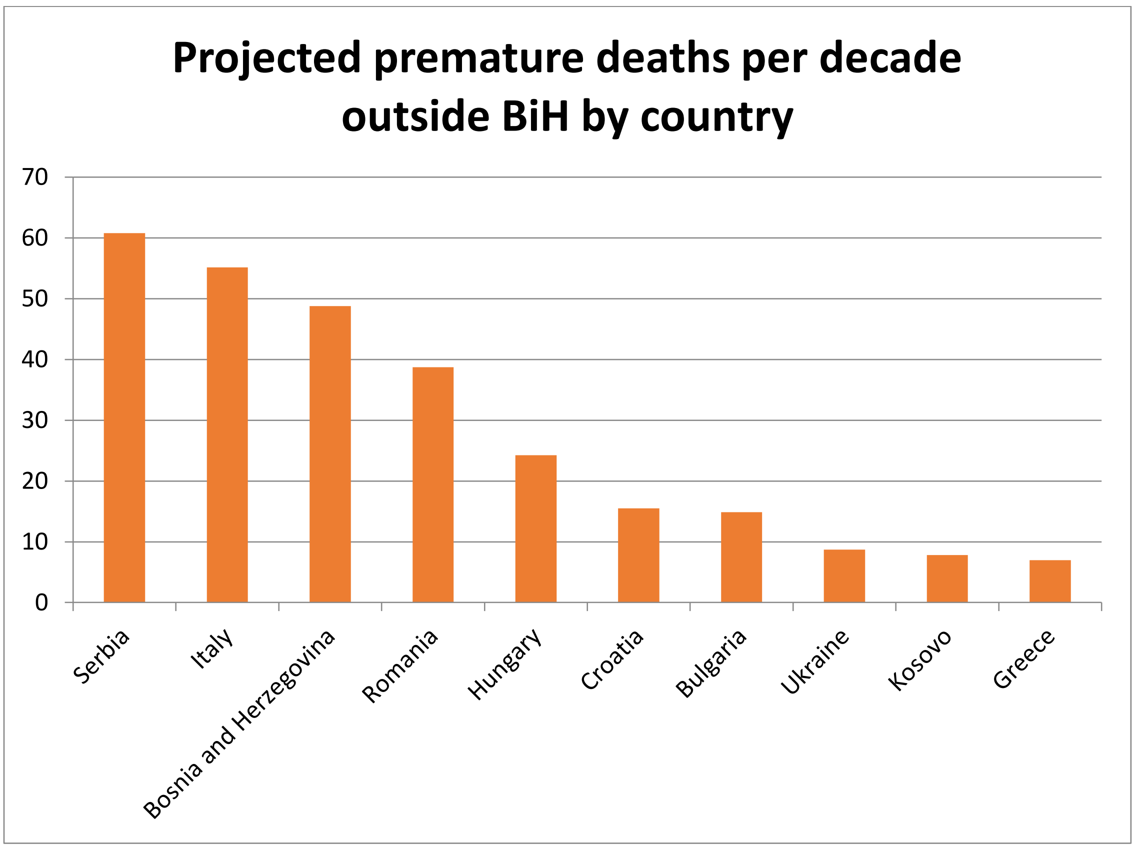

Table 2. Projected health impacts associated with the emissions from Tuzla 7 and Banovići coal power projects per decade, by country. Only central estimates are shown; relative error bounds are as in Table 1.

Effect and pollutant	Total	Serbia	Italy	BiH	Romania	Hungary	Croatia	Bulgaria	Others
long term mortality, all causes, PM2.5	259	49	41	41	34	20	13	12	49
long term mortality, all causes, NO2	89	18	21	12	7	7	4	4	17
total mortality	318	61	55	49	39	24	15	15	60
cardiovascular hospital admissions, PM2.5	91	18	14	15	10	8	4	3	18
respiratory hospital admissions, PM2.5	92	19	11	16	11	8	4	3	19
restricted activity days, PM2.5	374220	76501	65663	64895	43664	23267	17072	12664	70494
work days lost, PM2.5	75791	15751	13519	13361	6817	5061	4046	2607	14628
low birth weight, PM2.5	39	17	4	3	4	2	1	1	7
bronchitis in children, PM10	441	91	70	79	54	26	21	13	88
asthma symptoms in asthmatic children, PM10	4693	929	905	819	519	278	205	125	914
incidence of chronic bronchitis in adults, PM10	129	26	24	23	15	8	6	4	23
bronchitic symptoms in asthmatic children, NO2	16	2	5	3	1	1	0	0	4
respiratory hospital admissions, NO2	73	12	8	16	7	6	3	2	18

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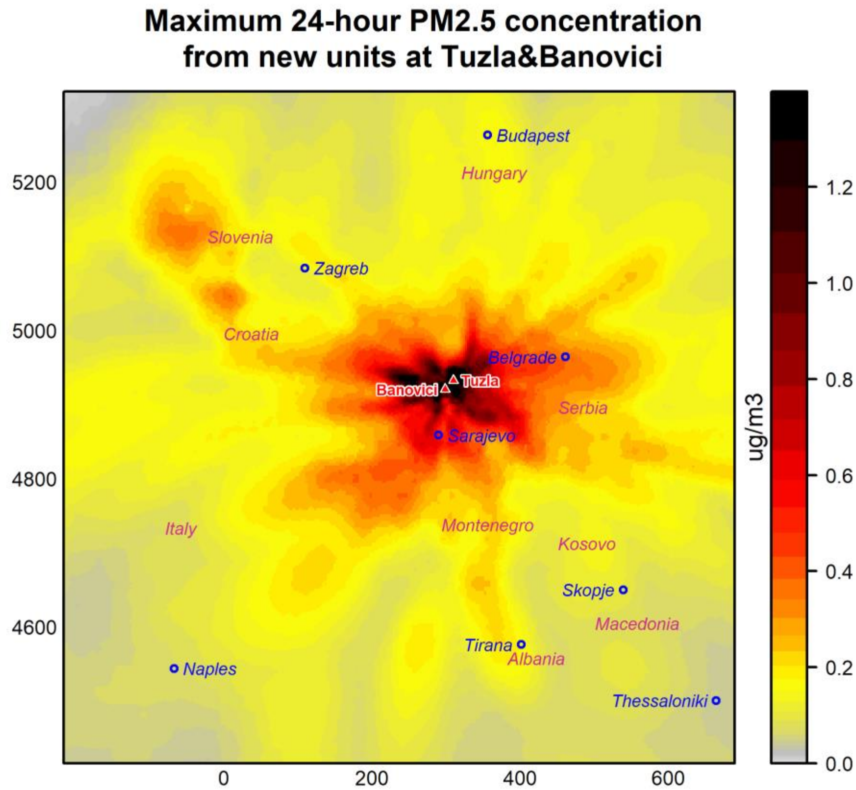
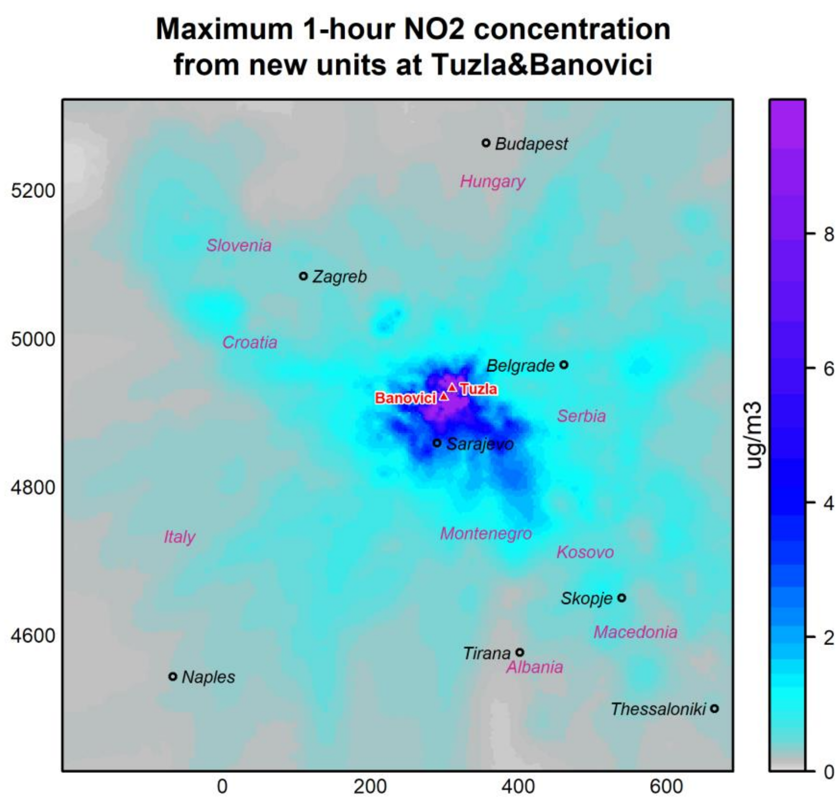
Figure 2. Projected contributions from the studied power plants to ambient air pollutant levels.





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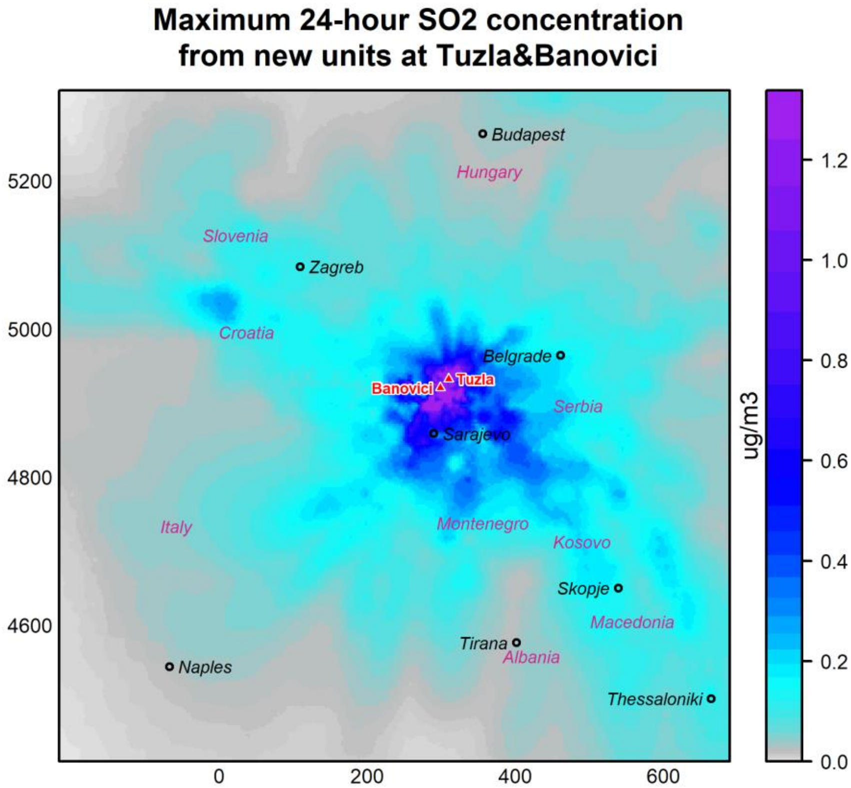


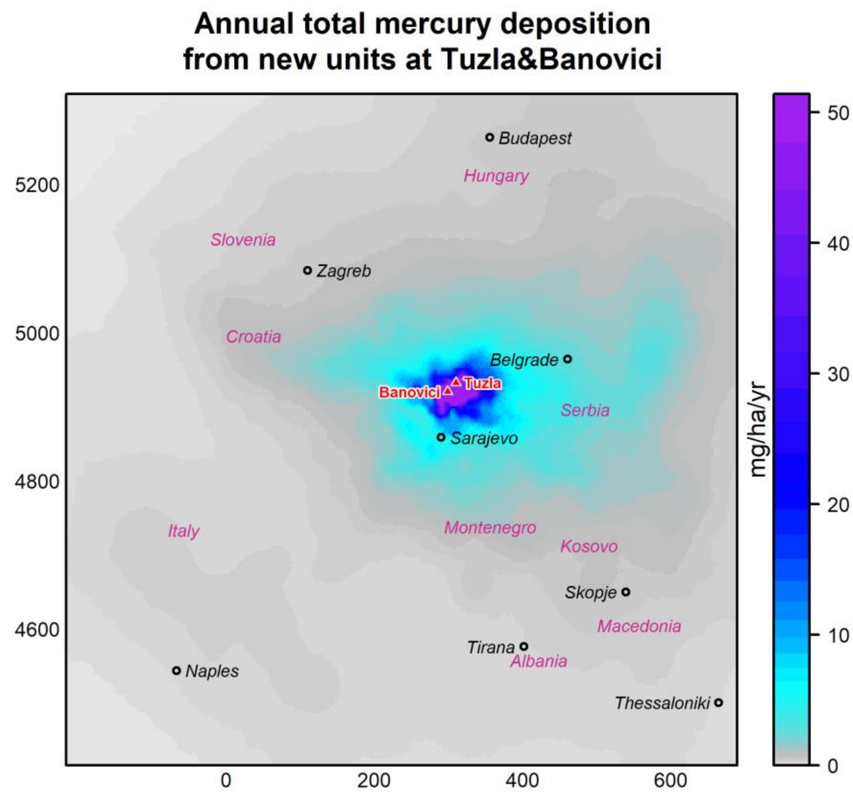
Maximum 24-hour SO2 concentration
from new units at Tuzla&Banovici
Budapest
Hungary
Slovenia
Zagreb
Croatia
Belgrade
Tuzla
Banovici
Serbia
Sarajevo
Italy
Montenegro
Kosovo
Skopje
Macedonia
Tirana
Albania
Naples
Thessaloniki
5200
5000
4800
4600
0
200
400
600
ug/m3
1.2
1.0
0.8
0.6
0.4
0.2
0.0

Results: mercury deposition

Due to the low quality coal burned, the mercury emissions from the power plants could be very large in relation to their capacity. While no precise data was available, using UNEP default emission factors, it was estimated that mercury emissions from the plants could be 270kg/year. Of this, approximately 90kg or 1/3 is estimated to be deposited into land and freshwater ecosystems. Mercury deposition rates as low as 125mg/ha/year can lead to accumulation of unsafe levels of mercury in fish (Swain et al 1992). The plants are estimated to cause mercury deposition above 125mg/ha/yr over an area of approximately 300km2, in the south and east of the plants, with a population of 60,000 people*Figure 3*). Approximately 60% of the projected deposition, or 50kg per year, takes place outside BiH.

While actual mercury uptake and biomagnification depends very strongly on local chemistry, hydrology and biology, the predicted mercury deposition rates are certainly a cause for concern and need to be addressed as a part of the permitting process.

Figure 3. Projected mercury deposition from the studied power plants.



Materials and methods

The hourly and annual emissions rates from the power plants were obtained from the project documentation, including the environmental permits and Environmental Impact Assessments ('EIA') for Banovići.[1] For Banovići, expected emissions rates were given in kilograms per hour, and expected annual utilization of 6500 hours was used to calculate annual emissions. For Tuzla, pollutant flue gas concentrations (FGC) in mg/Nm3 were given, and flue gas flow had to be estimated to obtain emission mass rates:

E = FGC * SFGV *CAP / EFF,

where CAP is the power generating capacity of the plant, EFF is the thermal efficiency of the plant, and SFGV is the specific normalized flue gas volume per fuel input (Nm3/GJ). SFGV was estimated based on the chemical analysis and net calorific value of lignite fired at the existing units of the Tuzla power station given in Smajevic et al (2012), using the stoichiometric flue gas volume formula in EN12952-15 (Formula 8.3-60, p. 42).

Cooling tower heights and diameters were found for both projects. Exhaust velocity of 3.4m/s was given for Banovići; a typical value of 4m/s was assumed for Tuzla. Typical exhaust temperature of 55oC was assumed.

Puzzlingly, there was no data on mercury emissions into the air from the proposed plants. Emissions were calculated based on annual coal consumption, an assumed mercury content of 0.11ppm and capture efficiency of 20% based on UNEP (2017) mercury toolkit. For Banovići, hourly coal consumption was available; for Tuzla, this was estimated based on coal calorific value and expected utilization.

Atmospheric dispersion modeling was carried out using version 7 (June 2015) of the CALPUFF modeling system. Meteorological and geophysical data for the simulations was generated with the TAPM model, developed by Australia's national science agency CSIRO. A set of nested grids with a 50x50 grid size and 30km, 10km, 3km and 1km horizontal resolutions and 12 vertical levels was used, centered on the power plant.

For emissions from main boilers of the power plants, 30% of emitted fly ash was assumed to be PM2.5, and 37.5% PM10, in line with the U.S. EPA AP-42 default value for electrostatic precipitators. Chemical transformation of sulphur and nitrogen species was modeled using the ISORROPIA II chemistry module within CALPUFF, and required data on ambient ozone levels was processed from measurements reported by the Romanian government to the European Environmental Agency. Other required atmospheric chemistry parameters (monthly average ammonia and H2O2 levels) for the modeling domain were imported into the model from baseline simulations using the MSC-W atmospheric model (Huscher et al 2017). The CALPUFF results were reprocessed using the POSTUTIL utility to repartition different nitrogen species (NO, NO2, NO3 and HNO3) based on background ammonia concentrations.

The health impacts resulting from the increase in PM2.5 concentrations were evaluated by assessing the resulting population exposure, based on high-resolution gridded population data for 2015 from CIESIN (2017), and then applying the health impact assessment recommendations of WHO HRAPIE (2013) as

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[1] The EIA for Tuzla 7 was carried out in 2009/2010, long before the engineering, procurement and construction contracts were signed in 2014 and 2016, so is not considered likely to be aligned with the actual project specifications.

implemented in Huescher et al (2017). Baseline incidence and prevalence data for Romania and neighboring countries were obtained from Global Burden of Disease results (IHME 2018).

Table 3. Emission source data for atmospheric modeling.

Parameter		Banovići Power Station	Tuzla 7 Power Plant	Unit
Location	Lon	18.47016	18.60611	degrees
	Lat	44.41007	44.52	degrees
Utilization		74%	76%	
Flue gas discharge	cooling tower height, m	125	135	m
	diameter	50.9	55	m
	exit temperature, K	328.15	328.15	K
	exit velocity, m/s	3.4	4	m/s
Emission rates	SO2	1221	1694	t/a
	NOx	1221	2259	t/a
	PM	659	113	t/a
	Hg	117	149	kg/a

References

Center for International Earth Science Information Network (CIESIN), Columbia University, 2017. Gridded Population of the World, Version 4 (GPWv4): Population Density, Revision 10. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). https://doi.org/10.7927/H4DZ068D.

European Environment Agency (EEA) 2008: Air pollution from electricity-generating large combustion plants. EEA Technical report No 4/2008. https://www.eea.europa.eu/publications/technical_report_2008_4

European Environment Agency (EEA) 2014: Costs of air pollution from European industrial facilities 2008–2012 — an updated assessment. EEA Technical report No 20/2014. https://www.eea.europa.eu/publications/costs-of-air-pollution-2008-2012

Huscher, Myllyvirta, Gierens 2017: Modellbasiertes Health Impact Assessment zu grenzüberschreitenden Auswirkungen von Luftschadstoffemissionen europäischer Kohlekraftwerke. Umweltmedizin - Hygiene - Arbeitsmedizin Band 22, Nr. 2 (2017) https://www.ecomed-umweltmedizin.de/leseproben/self/umweltmedizin--hygiene--arbeitsmedizin-band-22-nr-2-2017-.pdf

Institute for Health Metrics and Evaluation (IHME) 2018: Global Burden of Disease Study 2017 (GBD 2017) Results. Seattle, United States. http://ghdx.healthdata.org/gbd-results-tool.

Smajevic, I, et al., 2012. Co-Firing Bosnian Coals with Woody Biomass: Experimental Studies on a Laboratory-Scale Furnace and 110MWe Power Unit. Thermal Science 16(3): 789-804. https://doi.org/10.2298/TSCI120120122S

Swain EB et al, 1992. Increasing Rates of Atmospheric Mercury Deposition in Midcontinental North America. Science 257:784-787.

UNEP, 2017. Toolkit for Identification and Quantification of Mercury Releases. UN Environment Chemicals Branch, Geneva, Switzerland.

World Health Organization (WHO), 2013. Health risks of air pollution in Europe-HRAPIE project. http://www.euro.who.int/__data/assets/pdf_file/0006/238956/Health_risks_air_pollution_HRAPIE_project.pdf?ua=1