BACKGROUND KNOWLEDGE

April 2021

www.facebook.com/BalkansUnitedforCleanAir

BALKANS UNITED FOR CLEAN AIR

1. AIR POLLUTION IN THE WESTERN BALKAN REGION (CAUSES AND CONSEQUENCES)
2. AIR POLLUTION AND ITS CONSEQUENCES ON MORTALITY RATES AND THE HEALTH OF WESTERN BALKANS CITIZENS
3. AIR POLLUTION AND COVID-19 IN THE WESTERN BALKANS
4. AIR POLLUTION AND INFERTILITY IN THE WESTERN BALKANS
5. AIR POLLUTION, INDUSTRY AND LARGE POLLUTERS
6. AIR QUALITY MONITORING IN THE WESTERN BALKANS

The “Balkans United for Clean Air” campaign aimed to inform Western Balkan citizens on the causes and consequences of air pollution, and possible solutions which would improve air quality. Only an informed person is motivated and prepared to engage in a common and solidary struggle for clean air in their street, neighborhood, village, and city. The campaign was open, with all materials made available to any citizen of the Western Balkan who wanted to join a solidarity-based struggle for clean air.

Between January and April 2021, we have tackled six topics: air pollution in the region, its links to Covid-19, relations between mortality and air pollution, connections between infertility and air pollution, big polluters in the region, and monitoring and informing citizens about air pollution. Topics were simultaneously promoted every two weeks by all local partners on social networks and through traditional media.

The “Balkans United for Clean Air” campaign was initiated by the European Fund for the Balkans, in partnership with the Right to the City (Belgrade, Serbia), Renewables and Environmental Regulatory Institute (Belgrade, Serbia), Belgrade Open School (Belgrade, Serbia), Environmental and Territorial Management Institute (Tirana, Albania), Ekoforum (Zenica, Bosnia and Herzegovina), Centre for Ecology and Energy (Tuzla, Bosnia and Herzegovina), Sbunker (Pristina, Kosovo), Air Care (Skopje, North Macedonia) and OZON (Podgorica, Montenegro). We were joined by more than 435 individuals and organisations from the Western Balkan and beyond.

AIR POLLUTION IN THE WESTERN BALKAN REGION (CAUSES AND CONSEQUENCES)

AUTHOR

Srđan Kukolj, activist with two decades of professional experience managing international projects in the field of public health. He is experienced in developing and implementing HIV/AIDS/Tuberculosis surveillance and environmental health impact assessment. The bulk of his career has been dedicated to creating strategies and policies, advocating the right to equal access to healthcare, establishing national bodies to manage healthcare projects, eliminating discrimination of vulnerable populations, legal analysis, and creating tools for improving the implementation of national and international legal obligations. In his spare time, he is an environmentalist, and advocates children's and animal rights.

CAUSES OF THE PROBLEM

Air pollution is a decades-old problem in the Western Balkan countries and represents, by definition, the emission of air pollutants which harm the health of humans and other living beings, jeopardize the environment including vegetation, water and soil, causing the emergence of climate change and negative economic effects in the region's countries. The total emission of air pollutants should be viewed as a sum of anthropogenic and natural matters in the liquid, solid or gaseous state, along with the presence of physical and meteorological factors determining the distribution of air pollutants.

On the world map, Western Balkans is marked as a region with continuous excessive air pollution caused by various sources of pollutants – from thermal power plants, heating plants, large and small industrial facilities running on fossil fuels, oil processing, transportation and household heating appliances, to construction, agriculture and landfills. The main pollutants, whose effects on health is documented in numerous scientific research papers, include solid particles, ozone, nitrogen oxides, sulfur dioxide, carbon dioxide and heavy metals. Also, research indicates that solid particles (mainly classified as PM2.5 and PM10), compared with the other aforementioned pollutants, have the biggest impact on the onset of acute and chronic diseases, as well as premature deaths. The United Nations report "Air Pollution and Human Health: The Case of the Western Balkans" shows that the annual concentrations of particles (PM2.5) in select Western Balkan cities (Banja Luka, Brod, Prijedor, Tuzla, Zenica, Bar, Nikšić, Pljevlja, Podgorica, Tivat, Bitola, Skopje, Tetovo, Belgrade, Pančevo, Užice, Valjevo) exceed 10 mg/m3 (WHO, 2005) as defined in the World Health Organization's Air Quality Guidelines. The majority of those cities (almost 75 per cent) exceed even the European Union's less strict limit values of 25 mg/m3 (Air Quality Standards, op.cit.). An indicator of average exposure measured by the European Environment Agency (EEA, 2018) shows that out of 37 European countries issuing their reports, only eight (five of which being countries in the Western Balkans region) exceed the recommended level of PM2.5 exposure concentrations, set at 20 mg/m3. The daily limit value of PM10 was exceeded on 120-180 days per year in the Western Balkan cities, despite the fact that national and European Union legislation limits this number to 35 days per year.

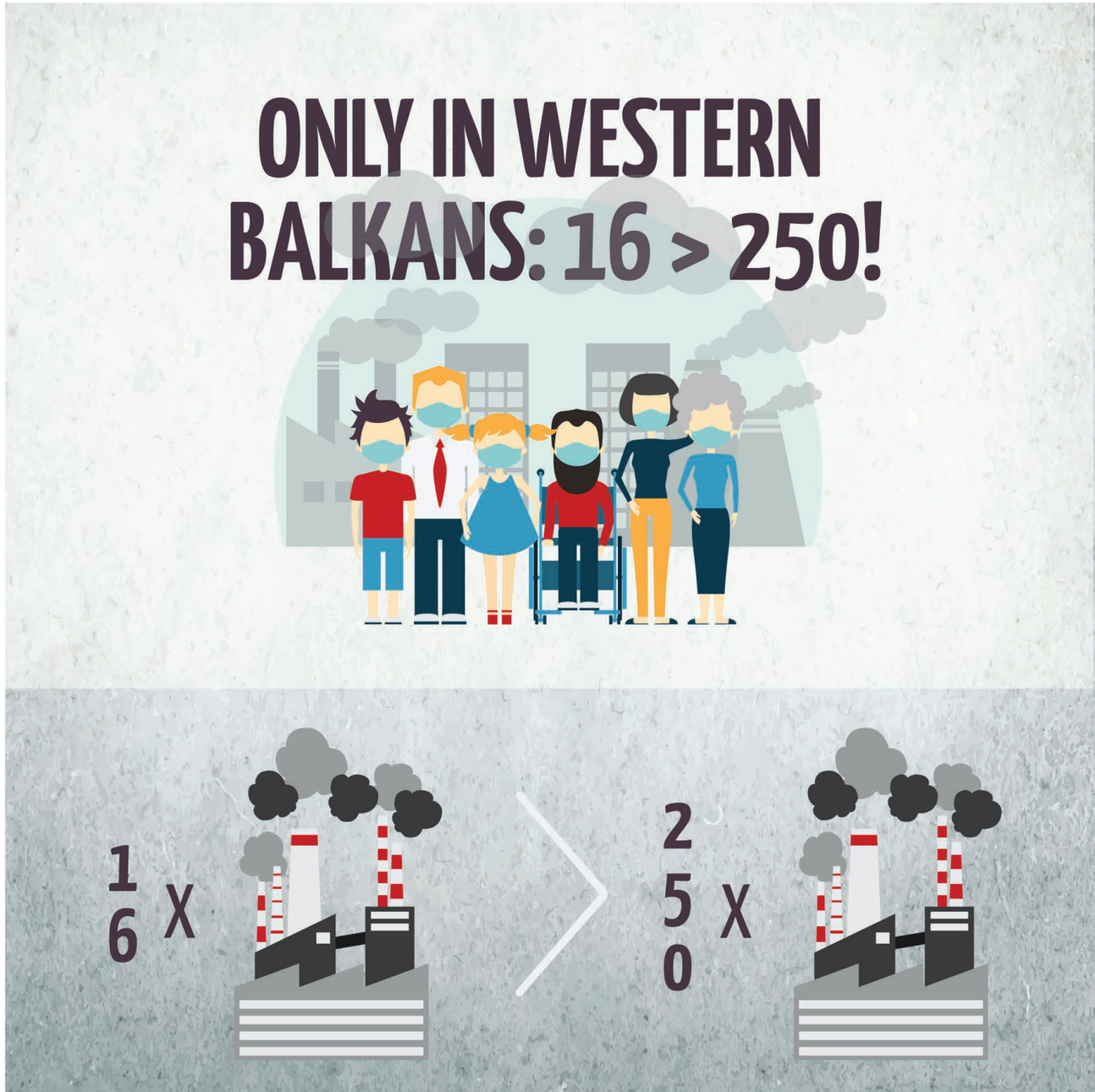
The European Union's Joint Research Centre points out that Western Balkan countries find themselves in different stages of dealing with the issue of air pollution, with regard to national strategies, policy developments, financing, monitoring and reporting. Moreover, progress in the field of climate change is slower compared to the one made with regard to air pollution. Despite the progress made, the implementation of the Ambient Air Quality Directive is not completely efficient in all countries of the Western Balkans, and the networks for air quality monitoring, the data networking process and the procedures of insurance and quality control are at different stages of development. Reporting on air pollution in the Western Balkan region often fails to meet all the criteria, and the number and share of reporting units, time references and data coverage remain rather variable. Concentrations of solid particles (PM2.5 and PM10), ozone, nitrogen oxide, and sulfur dioxide are frequently above the annual average, daily maximum and maximum hourly limits. Despite the trend of decreased emissions of air pollutants recorded in some of the countries, the emissions remain critical in almost all of them, and the hourly concentrations of nitrogen oxide and sulfur dioxide are excessive in most of the region. Air pollution in the Western Balkans is also influenced by weather conditions, mainly air temperature and humidity. For instance, ozone and solid particle episodes in the Balkan region in 2017 have coincided with higher air temperatures. The Joint Research Centre also points out the fact that there are ca. 520 measuring stations in Western Balkan countries, for the purpose of monitoring ambient air quality including sulfur dioxide, ozone, nitrogen oxide, solid particles (PM2.5 and PM10), carbon dioxide and benzene.

Coal power plants, the industry, household heating appliances, transportation, agriculture and the uncontrolled combustion of waste are the main sources of PM10 emissions in the Western Balkan region. Despite the trend of decreased average annual PM10 pollution, concentrations remain above the limit. In 2018, the average annual concentrations of solid particles (PM2.5) – an indication of health impact – have been up to six times higher than the values defined by the World Health Organization's Air Quality Guidelines (10 μ/m3). Coal power plants and the industry are among the main sources of sulfur dioxide emissions in the Western Balkan region, while the emissions of nitrogen oxide have been predominantly caused by coal power plants and the transportation sector. In most of the countries, emissions from large combustion plants exceed the limit values determined by the existing national plans for the reduction of sulfur dioxide, nitrogen oxide and solid particle emissions.

Daily maximum concentrations of PM10 and the maximum daily and hourly SO2 concentrations are among the air quality indicators which most frequently exceed the legal limits in the Western Balkans. These pollutants have reached increased and steady levels, particularly in Bosnia and Herzegovina (SO2, PM10), North Macedonia (PM10) and Serbia (PM10), with high population exposure. In addition, NO2 and O3 levels have exceeded hourly limits or the maximum daily eight-hour mean in several areas (Serbia, Bosnia and Herzegovina, North Macedonia, Albania).

PUBLIC OPINION

The Balkan Barometer 2019 (www.rcc.in), a public opinion survey conducted among 6.120 citizens and 1.271 companies in late 2018 throughout the region, shows that 59% of Western Balkan citizens were prepared to pay more for environmentally acceptable products, 35% have reported a decreased usage of consumables, 34% have purchased locally produced food, 32% have recycled, 20% have considered environmental factors when purchasing household appliances, whereas 19% have taken no measures to lessen their impact on the environment. On the other hand, 23% of Western Balkan companies have reported taking major steps towards decreasing their environmental impact, 34% have failed



to take any action to reduce environmental impact, and 41% have taken some steps.

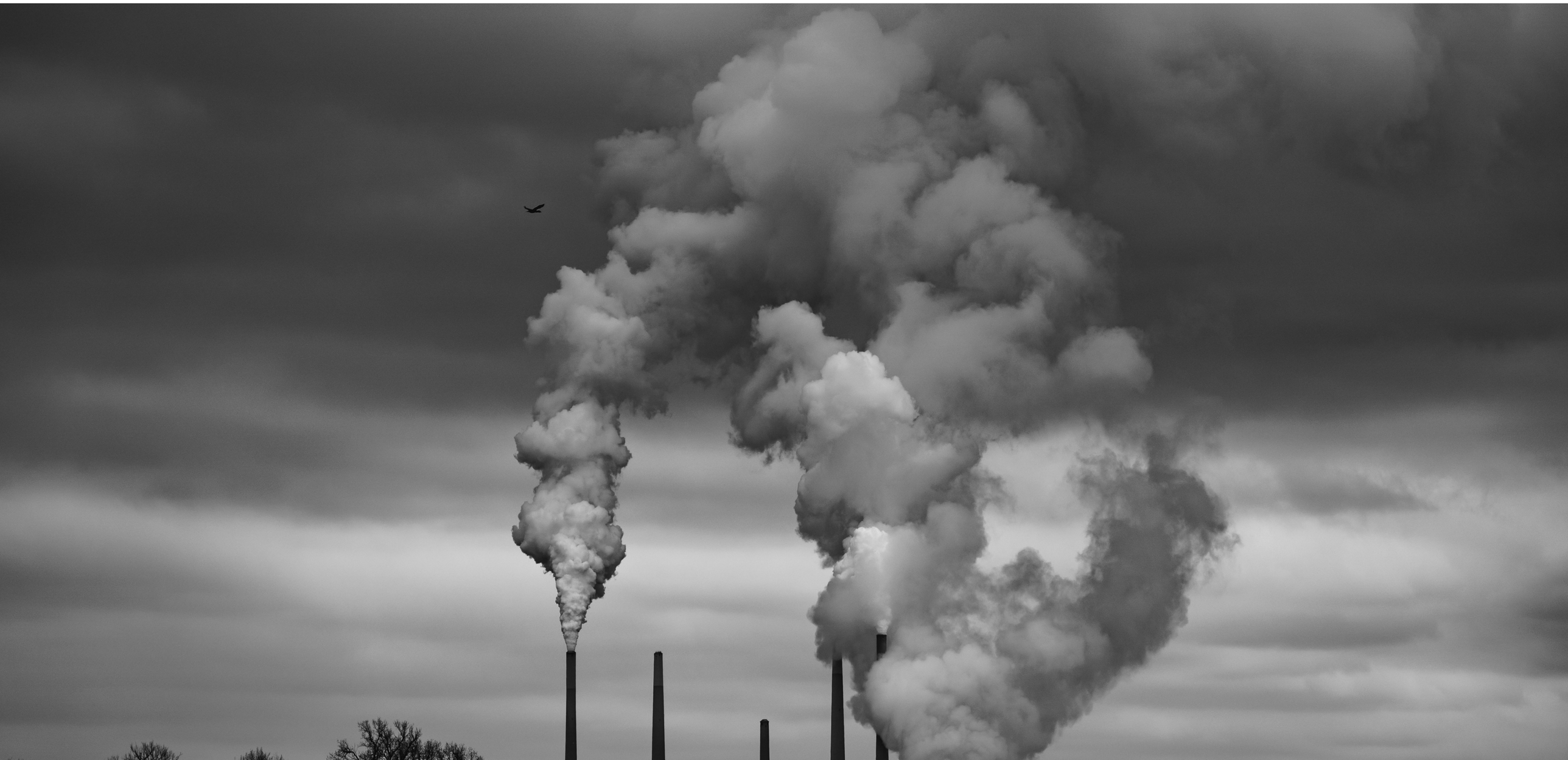
PROBLEM'S CONSEQUENCES FOR THE CITIZENS

We know that globally 4.2 million people die every year due to exposure to ambient air pollution, and 3.8 million deaths occur as a result of air pollution emitted by households – 20% have died as consequence of chronic obstructive pulmonary disease and acute lower respiratory infections, 8% of lung cancer, 27% of pneumonia, 18% of stroke and 27% of coronary heart disease. In addition to this, 91% of the world's population live in places where air quality levels exceeds WHO limits. Air pollution may increase the risk of pneumonia which causes the deaths of almost one million children under the age of five every year, making it the number one child killer worldwide. This phenomenon is most obvious in the case of infants and children. Out of all deaths which can be attributed to air pollution in 2016, 8% were children under the age of five, as compared to 1% of children between the ages of 5 and 15.

Airborne pollutants are inhaled into a human or animal body, they are present in the environment, in places where food is being produced, or in water, which directly or indirectly causes reduced vital organ functioning and leads to premature death. At the same time, air pollution jeopardizes the economy in various ways – it increases the number of premature deaths, reduces people's ability to work or contribute to their households, generates a financial cost for the rehabilitation and treatment of people whose health it affects, influences vital food production and water sources, and diminishes an ecosystem's ability to perform its basic functions.

With regard to human health, air pollution may cause preeclampsia, premature delivery, low birth weight in children or attention deficit hyperactivity disorder; it has a negative effect on semen quality; it may cause new asthma cases; it increases the incidence of respiratory illnesses, causes the onset or advancement of chronic diseases such as chronic obstructive pulmonary disease, damages lung alveoli, causes lung cancer; it may alter heart function, cause the onset of coronary heart disease and angina pectoris, high blood pressure and oxidative stress, and atherosclerosis. Most frequently, long-term exposure to polluted air causes the occurrence of cardiovascular and respiratory diseases. One of the problems we as a community face on a daily basis are vulnerable populations whose health is significantly jeopardized by air pollution, which should be prioritized in terms of receiving proper care and timely information on air quality. Categories of the population which are most vulnerable and most prone to negative health effects of polluted air, resulting in the highest incidence of disease and premature death, include persons with lung diseases, such as asthma, chronic bronchitis, emphysema and chronic obstructive pulmonary disease, infants and small children, people who work or exercise outdoors, persons over the age of 65, people with cardiovascular diseases, poor people, people lacking access to healthcare, people who smoke or who are exposed to tobacco smoke, people working in sectors with high exposures to polluted air and those who spend a lot of time near high traffic volume roads, industrial facilities, construction sites, thermal power plants and coal mines.

The Forum of International Respiratory Societies' Environmental Committee point out that air pollution is a contributor to a whole range of negative effects, from diabetes and dementia to infertility and leukemia in children. Inhalation of soot or smoke containing solid particles – often referred to in micrometers, PM10, PM2.5 and PM1 – leads to cardiovascular and respiratory problems such as



chronic obstructive pulmonary disease, lower respiratory tract infection, asthma and lung cancer. The smaller the particle is, the deeper it can penetrate the body, thus posing a greater health risk. Inhalation of solid particles is a frequent cause of stroke and leads to premature death; it also contributes to slower development in children and causes obesity and Alzheimer's disease. Sulfur dioxide is toxic to humans when inhaled, causing nose and throat irritation; high concentrations cause life-threatening excess fluid in the lungs (pulmonary edema) with symptoms that include cough, shortness of breath and tightness in one's chest. Just one exposure to a high concentration can cause a longstanding asthma-like condition. Sulfur dioxide can react with other compounds in the atmosphere and form small particles (PM), called "secondary PM". Nitrogen oxide gases cause respiratory infections; they are oxidants – causing oxidative stress, which, in turn, disrupts cellular mechanisms and damages tissue, decreasing an organism's immunological capabilities.

Apart from being a risk factor for the environment, air pollution is a major contributor to mortality rates and incapacity to work in the Western Balkans. It is estimated that due to exposure to air pollution in the form of PM2.5 particles, 3.300 people die prematurely in Bosnia and Herzegovina every year; 250 in Montenegro; 1.600 in North Macedonia; 760 in Kosovo and 3.585 in Serbia. Between 80 and 90% of those deaths are caused by cardiovascular disease (stroke and heart disease). Most of the deceased, between 50 and 70%, whose deaths can be attributed to air quality, are people of working age. Annual economic expenses caused by health issues linked with air pollution in Bosnia and Herzegovina, Kosovo and North Macedonia, three Western Balkan countries for which the model was created, range from 3.6 to 8.2% of the respective GDP; on average, this amount in 2016 ranged from $240 million to $1.38 billion.

Data on air quality show that the biggest polluters in the Western Balkans are coal power plants which are old, inefficient and function below the standards of environmental protection. In 2016, 16 thermal power plants with a total capacity of 8 GW emitted more sulfur dioxide pollution than all European coal thermal power plants combined (250, with a total capacity of 156 GW), as well as equally concerning levels of particles and nitrogen oxides. This pollution causes 3.000 premature deaths every year, 8.000 cases of bronchitis in children, and other chronic diseases which generate a total cost of €6.1-11.5 billion for the healthcare systems and the economies. The greatest burden of healthcare expenses is carried by the European Union, amounting to €3.1-5.8 billion. At the same time, the annual economic burden for Western Balkan countries is estimated at €1.9-3.6 billion.

The onset of the pandemic caused by the type 2 coronavirus has urged many members of the scientific community to conduct studies on the air pollution's impact on increased COVID-19 mortality rates, in order to examine whether ambient air pollution has a role in the spreading and the effects of the coronavirus pandemic. Western Balkan countries are particularly vulnerable, given that many of them are affected by air pollution, especially in the winter when extremely high levels of pollutants are emitted. The arrival of winter and increased air pollution could trigger an outbreak of coronavirus infections in the Western Balkans and cause high incidence rates. Households affected by economic difficulties due to direct or indirect income loss might replace cleaner fuels with cheaper ones, which could lead to increased air pollution. Long-term exposure to harmful emissions is a risk factor for developing acute and chronic diseases, mostly those of the respiratory system which, due to the organs' reduced functioning, becomes more prone to virus infections, such as the one caused by the coronavirus (SARS-CoV-2), i.e. severe acute respiratory syndrome. Scientific studies indicate that fine particulate matter PM2.5 and nitrogen oxides are much more closely linked with the occurrence of the coronavirus than PM10, because particles with a diameter larger than 5 mm are less likely to reach the lung alveoli's epithelium, i.e. alveolar type II cells, which is where the receptor for SARS-CoV-2's entry into the cell is located.

RECOMMENDATIONS ON PROBLEM SOLUTIONS

Countries with high air pollution levels should implement valid regulations and introduce measures to improve air quality so as to decrease health consequences for the population and negative effects on the environment. Western Balkan countries have national laws, strategies, action plans and regulations directed at the protection of the environment and citizens' health, air quality control, as well as sanctions imposed for exceeding the limit of air pollutant emission. However, in practical terms, the implementation of those measures is lagging which is why it is necessary to strengthen capacities within institutions in charge of the population's health and the environment. Furthermore, it is necessary to increase the number of automatic stations in national networks for monitoring and recording air quality, in order to secure greater geographical coverage and availability of information, as well as inform the public on the current status of air quality via public broadcasters – institutions must strengthen the monitoring of air quality data and use the obtained data for the purpose of issuing recommendations for decreasing the emission of air pollutants.

All countries in the Western Balkan region need to introduce a standard for the implementation of a comprehensive impact assessment regarding polluted air and citizens' health, which covers the full, life cycle-spanning health risk, and to take the gathered data into account while making future decisions. Such approach will decrease health consequences caused by thermal power plants, heating plants, large and small industrial facilities using fossil fuels, oil processing, transportation, household heating appliances, construction, agriculture and landfills, and lead to selecting options which have the least cumulative negative health impact, both long- and short-term.

The priority should be assigned to the development of clean energy storing technologies and decentralized production of energy from renewable sources, rather than building new electrical utility networks. In creating a healthy energy future, we should simultaneously aspire towards increasing access to renewable energy, reducing inequality in health and environment protection, and dealing with and reducing energy poverty. Workers in the fossil fuel industry should receive support in terms of requalification and reemployment during a phase-out period, while fossil fuel industry subsidies must be abolished as soon as possible.

Medical and healthcare workers can make an important contribution to the transition of all sectors contributing to air pollution, by exchanging knowledge on the links between various pollution sources and health issues and risks posed by climate change, by taking part in decision- and policy-making processes, developing health impact assessments and becoming involved in educational and field activities.

Heads of states in the Western Balkan countries should advocate for the improvement of air quality standards so that they are in full compliance with the recommendations and the latest scientific findings of the World Health Organization; they should implement the zero pollution principle in all policies, develop plans on air quality control for all cities in the region, adopt an intersectoral approach and involve the civil society in creating decisions of significance to health and environment protection, accelerate the harmonization process with the European Union's acquis on air quality and climate change, and develop more ambitious comprehensive strategies for air quality and climate change.

CLIMATE CHANGE AND THE GREEN AGENDA

In this part, Prof. Vladimir Đurđević has summarized the problem, its consequences and proposals of a solution, with regard to the topic of the brief, from the standpoint of climate change and the green agenda, and through a lens of solidarity in the Western Balkans

In this part, Prof. Vladimir Đurđević will summarize the problem, its consequences and proposals of a solution, with regard to the topic of the brief, from the standpoint of climate change and the green agenda, and through a lens of solidarity in the Western Balkans. This part should not exceed 1 page.

The unreasonably high dependence on coal as the main energy-generating product in countries of the Western Balkans clearly puts them in a very disadvantageous position both in terms of air quality and climate change. It is more than likely that the biggest part of gas and particle emissions which affect air quality comes from the process of fossil fuel combustion, in the case of both large plants and individual sources. The process of fossil fuel combustion emits, apart from pollutants, carbon dioxide (whose concentration in the atmosphere has risen by 50% since the industrial revolution), thus causing a series of changes in the climate system. Although when viewed in absolute figures, these countries are not significant contributors to global annual emissions of carbon dioxide, the value of their emissions, calculated on the basis of their respective gross domestic product, ranks them among the biggest global polluters. This clearly shows that these countries are featured by extremely inefficient use of energy which comes as no surprise since the majority of thermal power plants are decades old, mostly without adequate investments in their maintenance and improvement. In addition, the facilities' obsolescence and inefficiency cause emissions of pollutants, such as sulfur and nitrogen oxides, which are significantly higher than what is considered standard values.

The global process of phasing out coal as the main source for the production of electricity has been ongoing for almost two decades. It was mainly initiated by a need to reduce carbon dioxide emissions and halt further climate change on Earth. This process was initially steered by additional financial support from the states, in form of transformation towards renewable energy sources such as solar and wind. In recent years, due to technological advancements in the field of renewable energy sources, in many countries in the world, coal has also become economically unsustainable compared with clean energy sources, which was likely one of the reasons behind many countries' raised ambitions to completely phase out fossil fuel in general, not only coal. In 2020, EU, Japan and South Korea have pledged to go carbon-neutral by 2050, China set this benchmark for 2060, while the American president-elect has announced the US would join this wave by rejoining the Paris Agreement, with the goal of America, too, abandoning fossil fuel until 2050. When it comes to the Western Balkan countries, the EU plans are certainly most relevant, especially in light of the recently signed Sofia Declaration, which entails their commitment to follow the EU in this field – this implies the adoption of adequate policies, harmonized with EU objectives.

Such a development clearly shows that if Western Balkan countries do not quickly abandon their tradition of very rigid policies on phasing out coal, the gap between them and the EU could only deepen, and distance them even from the declaratively set accession goals. From the aspect of air quality, a shift away from fossil fuel and the transition to green energy is a superior solution to any other particular measure which can only somewhat reduce the scope of this problem. On the other hand, given that solar and wind energy production depends on current weather conditions, the process of a U-turn towards renewable sources also requires better energy system networking, as well as a decentralization and democratization of energy production. In that regard, Western Balkan countries could view the process of energy transition as an opportunity for solidifying mutual ties and better cooperation in the region. In short, energy transition can bring about multiple benefits for those countries – from significantly improved air quality, increased energy efficiency and economic competitiveness, development and implementation of new technologies, to improved cooperation and mutual connectedness. That way, energy transition can be viewed as the best possible choice currently at the countries' disposal. The most certain way of assuming this course is for all the countries to consider the ratified Sofia Declaration as the lower benchmark of possible national objectives and policies.

SRĐAN KUKOLJ

AIR POLLUTION AND COVID-19 IN THE WESTERN BALKANS

AUTHOR

Prim Dr sci med Tatjana Radosavljević, medical doctor specialized in lung disease and tuberculosis.

Specific fields of interest: air pollution, treating the consequences of COVID-19. A practicing pulmonologist for over 30 years. Master's degree in healthcare management, doctor of medical science.

AIR POLLUTION AND COVID-19

Much has been written on the harmful effects of air pollution in the previous decades. However, the onset of the COVID-19 pandemic has highlighted one of its very dangerous aspects.

At the outbreak of the COVID-19 pandemic in Europe, it was determined that 78% of infected persons came from 5 of 66 regional centers, those with highest levels of air pollution. Similar data were obtained in Spain and Germany. The rapid spreading of COVID-19 in Italy was very much linked with air pollution.

Later research in China, Engleske, USA, Germany, the Netherlands and Italy has shown that increased air pollution can result in higher numbers of infected persons, as well as higher COVID-19 mortality rates.

It has been long known that a link between the level of air pollution and increased mortality existed as far back as 1918, at the time of the Spanish flu pandemic.

Air pollution increases COVID-19 mortality rates by 15% globally, by 27% in East Asia, 19% in Europe, and 19% in North America.

An increase of particulate matter concentration of 1 microgram per cubic meter also increases COVID-19 mortality rates by 11%.

Research in Germany has indicated that an increase in PM10 levels also increases mortality rates in COVID-19 patients aged over 80, namely by 30% in men and 35% in women.

In the Czech Republic, research shows that air pollution increases COVID-19 mortality by 29%, whereas in the case of Poland and Paraguay, mortality rates go up by 28% and 15%, respectively.

Furthermore, in the Netherlands, it has been proven that an increase in PM2.5 by 1 microgram per cubic meter causes 9.4 times more COVID-19 infections, up to three times more hospitalizations, and an increase in mortality rate by 2.3 times.

MECHANISMS OF THE CONNECTION BETWEENAIR POLLUTION AND COVID-19 INFECTION

There are several possible mechanisms, and they are still being researched.

Long-term exposure to air pollution may lead to lung, heart and brain disease, such as chronic obstructive pulmonary disease, coronary heart disease, and stroke. These chronic diseases entail a higher risk of more severe COVID-19 cases and increased mortality rates. This is an effect of prolonged air pollution, especially particulate matter (PM), as well as ozone.

Particulate matter reaches the smallest segments of lung tissue, alveoli, causing damage to blood vessels, and a local immune response disorder. When SARS-CoV-2 enters the lungs in the same manner, it is spread easier, leading to more severe inflammations and the creation of small blood clots.

Particulate matter and SARS-CoV-2 have the same target cells and cell components, which is why persons exposed to air pollution experience more volatile responses to the presence of SARS-CoV-2, and thus more severe forms of COVID-19, cytokine storms, and higher mortality rates.

It is known that particulate matter can be a carrier, of sorts, of certain microorganisms, bacteria, parasites, as well as viruses such as SARS or smallpox.

As for SARS-CoV-2, it is spread via droplet transmission; however, airborne transmission, from aerosol dispersion, is possible, too.

It is hypothesized that it can be spread by airborne transmission, with particulate matter as carriers, of sorts, which can transport it further than droplets can. However, this theory could not have been proven, hence one cannot state that air pollution increases the number of persons who become infected with COVID-19. Populations exposed to air pollution are more sensitive and less resistant to COVID-19.

Long-term exposure to air pollution is linked with the development of chronic diseases, and in the short term, it can lead to harmful inflammatory reactions and reduced immune response to the emerging infection, as well as worsening of COVID-19 symptoms.
When assessing the harmful effects of air pollution on the number of infected and diseased persons from COVID-19, the following factors must also be taken into account:

- economic situation in the country
- population density
- population distribution
- use of public transportation
- age structure of the population
- quality of the healthcare system
- human resources in the healthcare sector
- availability of hospital beds
- number of beds in intensive care units
- available equipment at intensive care units (number of ventilators)

A high level of air pollution can aggravate an existing infection, increase the number of cases with symptoms, and the total number of confirmed cases.

AIR POLLUTION AND COVID-19 – WESTERN BALKANS

Western Balkans countries are seriously affected by air pollution, from all sources. The distribution of measuring stations is disproportionate and unfavorable, and in some of the countries, such as Serbia, the levels of permitted particle concentrations is being administratively increased.

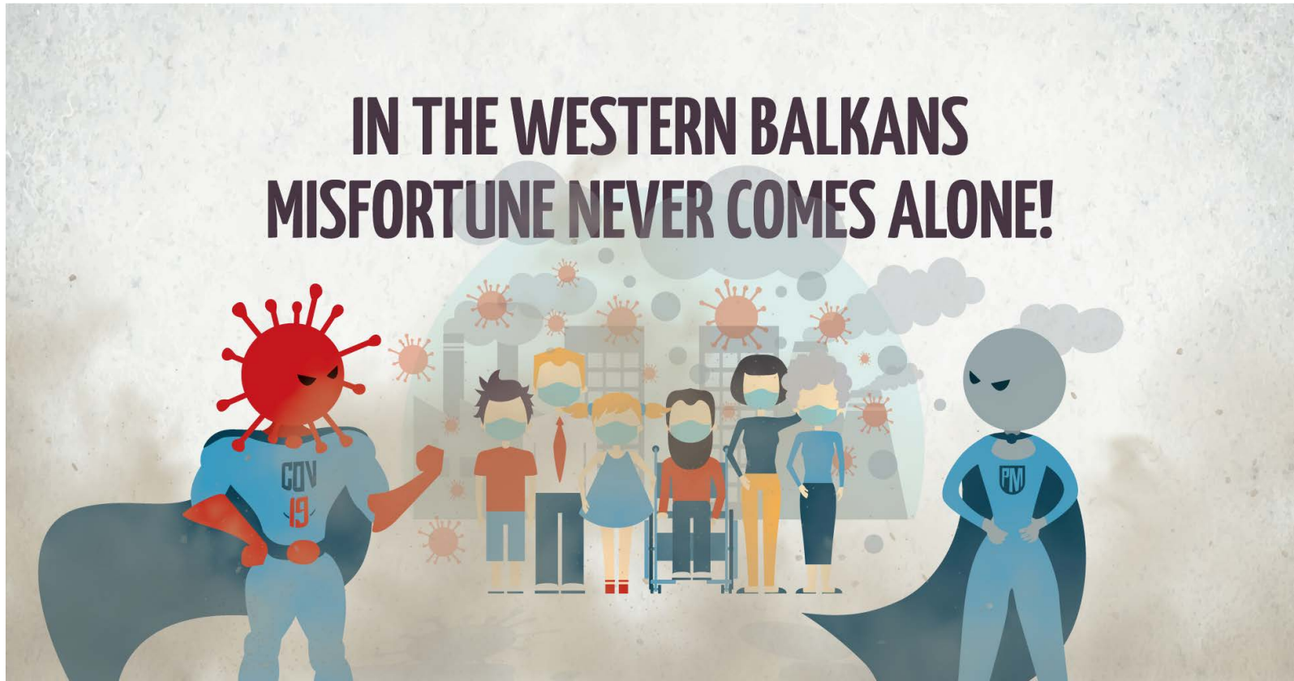
On the other hand, a large number of people live in poverty, in densely populated areas, and the age structure is not favorable (elderly population).
Healthcare systems in the Western Balkans are not highly developed, there is a pronounced trend of medical professionals' migration, the number of available hospital beds is not adequate, nor is the number of beds in intensive care units and the number of available ventilators. Also, there is a lack of trained healthcare professionals working in intensive care units.

The reported number of infections and deaths in Western Balkan countries can be subject of doubt (definition of an infection case, pitanja da li je pacijent umro od Covida ili zbog kovida i sl)

All of this means that potential research on the environmental and epidemiological correlation between air pollution and COVID-19 in the Western Balkans must be very precisely planned and implemented, so that adequate conclusions and recommendations can be adopted.

It is necessary to provide the right answer to the question whether reducing air pollution in Western Balkan countries will be effective and improve the prognosis of COVID-19 patients.

PRIM DR SCI MED TATJANA RADOSAVLJEVIĆ



AIR POLLUTION AND ITS CONSEQUENCES ON MORTALITY RATES AND THE HEALTH OF WESTERN BALKANS CITIZENS

AUTHOR

Srđan Kukolj, activist with two decades of professional experience managing international projects in the field of public health. He is experienced in developing and implementing HIV/AIDS/Tuberculosis surveillance and environmental health impact assessment. The bulk of his career has been dedicated to creating strategies and policies, advocating the right to equal access to healthcare, establishing national bodies to manage healthcare projects, eliminating discrimination of vulnerable populations, legal analysis, and creating tools for improving the implementation of national and international legal obligations. In his spare time, he is an environmentalist, and advocates children's and animal rights.

CAUSES OF THE PROBLEM

The scientific community has been warning the public for decades about the harmful effects of air pollution on public health, primarily pointing out the onset of neurological, cardiovascular and respiratory diseases, which often lead to premature death. Particulate matter (PM2.5 and PM10), ozone, nitrogen oxides, sulfur dioxide, carbon dioxide and heavy metals are globally responsible for millions of premature deaths every year.

Risks of air pollution are usually quantified as ambient air pollution, household air pollution and tropospheric ozone pollution. The main sources of ambient air pollution include solid fuel combustion in residential and commercial facilities, coal combustion for energy production, industrial emissions, stubble burning, waste combustion, agricultural and construction activities, brick kilns, transport vehicles, and diesel generators. Household air pollution is mainly caused by the use of solid fuels, such as wood, waste, agricultural residues and coal, for cooking and heating. Tropospheric ozone, combined with nitrogen oxide, hydrocarbon, sulfur dioxide and formaldehyde gases emitted by automobiles and the industry, is an aggressive mixture of harmful gases, dangerous for public health.

In most cases, the combined harmful effects of ambient and household air pollution result in increased mortality caused by stroke, heart disease, chronic obstructive pulmonary disease, lung cancer and acute respiratory infections. Effects of exposure to air pollution vary – they range from clinical effects, such as lower respiratory tract infection, to premature death. They also depend on an individual's general state of health, length of exposure to polluted air and the amount of harmful emissions.

Mortality due to exposure to polluted air is assessed using the terms "premature death" and "years of life lost". Premature deaths are those that occur before a person reaches an expected age. This age is usually the life expectancy in the country inhabited by the individual. Premature deaths can be prevented if their cause is removed. Years of life lost are defined as potential years of life, lost due to premature death. It is an estimate of the age that would be reached by people within a population if premature death had not occurred. This estimate takes into consideration the age at which death occurs – hence, the contribution to the total sum is larger for each death occurring at a younger age, and smaller for each one that occurs at an older age.

The European Environment Agency estimates that air pollution in Western Balkans countries leads to a large number of premature deaths, specifically[1]:

IN ALBANIA
2,200 deaths due to excessive fine particulate matter (PM2.5) pollution,
140 deaths due to excessive ozone (O3) pollution, and
270 deaths due to excessive nitrogen dioxide (NO2) pollution

IN BOSNIA AND HERZEGOVINA
3,500 deaths due to excessive fine particulate matter (PM2.5) pollution,
200 deaths due to excessive ozone (O3) pollution, and
70 deaths due to excessive nitrogen dioxide (NO2) pollution

IN NORTH MACEDONIA
3,000 deaths due to excessive fine particulate matter (PM2.5) pollution,
130 deaths due to excessive ozone (O3) pollution, and
210 deaths due to excessive nitrogen dioxide (NO2) pollution

IN SERBIA (WITH KOSOVO)2
13,400 deaths due to excessive fine particulate matter (PM2.5) pollution,
550 deaths due to excessive ozone (O3) pollution, and
1,100 deaths due to excessive nitrogen dioxide (NO2) pollution

IN MONTENEGRO
570 deaths due to excessive fine particulate matter (PM2.5) pollution,
40 deaths due to excessive ozone (O3) pollution, and
20 deaths due to excessive nitrogen dioxide (NO2) pollution

PROBLEM'S CONSEQUENCES FOR THE CITIZENS

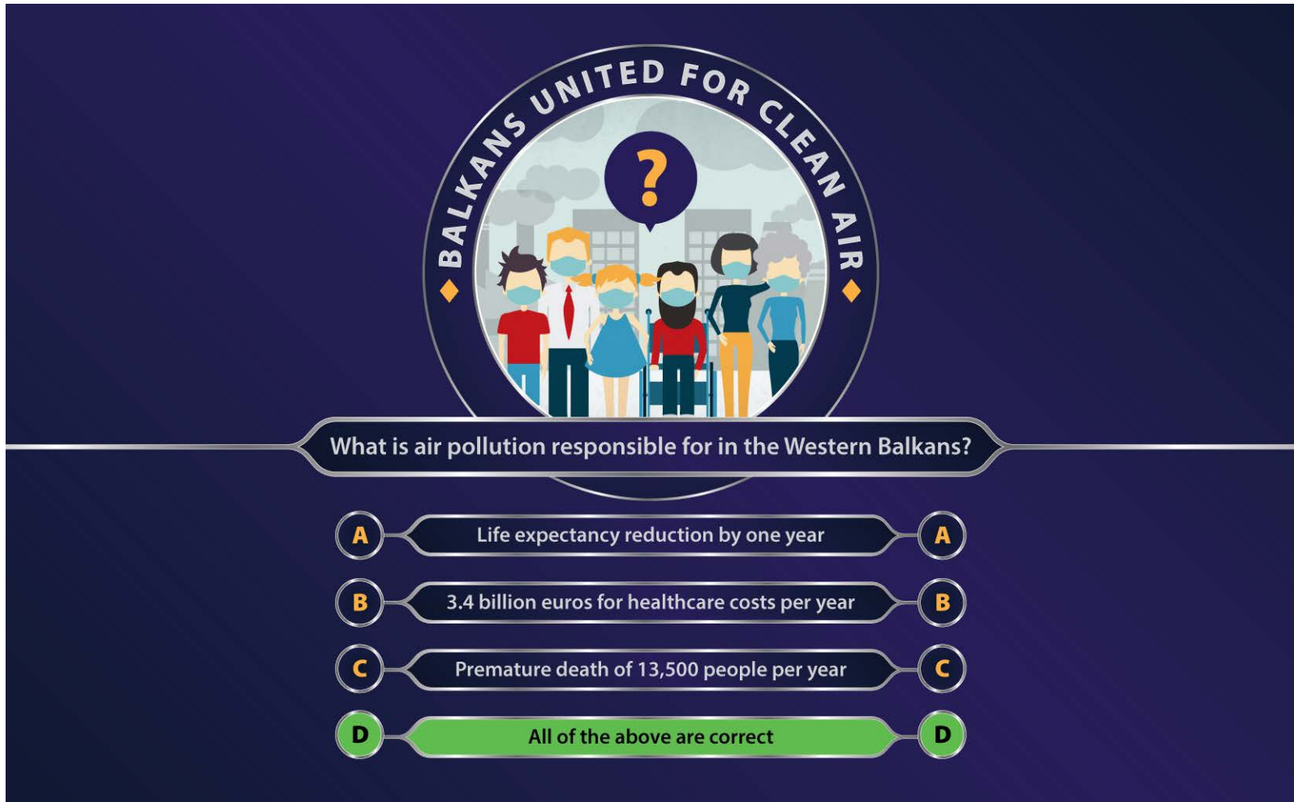
During the past 40 years, a large number of epidemiological studies examined the links between air pollution exposure and premature death. Exposure to polluted air eventually results in more obvious health effects that require hospitalization or cause premature death. On a global level, around 75% deaths attributable to air pollution occur in people above the age of 60. Only in 2015, global air pollution has caused an additional 8.8 million premature deaths. On a global level, around 75% deaths attributable to air pollution occur in people above the age of 60. Only in 2015, global air pollution has caused an additional 8.8 million premature deaths. This amounts to an average shortening of life expectancy by almost three years for all persons around the world. In comparison, tobacco smoking shortens life expectancy by an average of 2.2 years (7.2 million deaths), HIV/AIDS by 0.7 years (1 million deaths), diseases like malaria carried by parasites or insects such as mosquitos, ticks and fleas by 0.6 years (600,000 deaths), and all forms of violence (including wartime deaths) by 0.3 years (530,000 deaths).

Looking at the effects of air pollution on six categories of diseases: lower respiratory tract infections, chronic obstructive pulmonary disease, lung cancer, heart disease, cerebrovascular disease leading to stroke, and other noncommunicable diseases – it is estimated that cardiovascular diseases (heart disease and cerebrovascular disease combined) cause the majority of premature deaths attributable to air pollution: 43% of the loss in life expectancy on a global level. Air pollution has a bigger effect on shorter life expectancy of elderly persons and children under the age of five in low-income countries. On a global level, around 75% of deaths attributable to air pollution occur in people aged over 60.

Although the factors which potentially increase health risks differ depending on the type of pollutant, it has been determined that age (especially with regard to children and adults aged over 65), as well as underlying heart and lung disease, generally contribute to an increased risk. The ratio between length of exposure to air pollution and the emergence of health risks varies depending on the individual's general state of health, as persons with underlying chronic health problems are more prone to premature death.

Air pollution is defined as any airborne substance that can harm people, animals, vegetation or materials. Pollutants come from various sources and each can possess different characteristics depending on composition, source and the conditions of their manufacturing. Common gases include sulfur oxides (mainly sulfur dioxide [SO2]), nitrogen oxides (mainly nitrogen oxide and nitrogen dioxide [NO2]), reactive hydrocarbons (frequently called volatile organic compounds) and carbon monoxide (CO). They are emitted directly into the atmosphere, usually from industrial or transport-related sources, and are called "primary pollutants". Polluting gases and particles can also form in the atmosphere, mainly from primary pollutants, and they are called "secondary pollutants".

Human tissue damage by airborne pollutants depends on their water solubility, concentration, the tissue's oxidative capacity and the person's general state of health. SO2 is highly soluble in water and to a large extent damages the upper respiratory tract and the skin, while NO2 and O3 are less soluble and thus able to penetrate deeper into the lungs. CO is highly soluble, non-irritating and easily passes into the bloodstream, its toxicity mainly the result of successful competing with oxygen in binding with hemoglobin, which results in decreased levels of oxygen in cells and tissue. Its effects are acute: a two-day increase in mid



CO levels by 1 mg/m3 is linked with an increase in total deaths by 1.2%, as shown by scientific studies

Particulate matter is usually classified according to its size or aerodynamic diameter; PM10 stands for particles of a diameter <10 mm; PM2.5 for <2,5 mm; PM0.1 for <0,1 mm. All PM2.5 and PM0.1 are included in PM10. Hence, harmful effects attributed to PM10 can be caused by smaller particles. The term "solid particles" is used to label particles sized between PM10 and PM2.5. Unlike large particles, which can be visible as dust or mist in adequate lighting, small particles are invisible. Large particles can affect the mucous membrane and the upper respiratory tract, causing cough and tearing. Fine particles (PM2.5) easily reach the lung alveoli, whereas ultrafine particulate matter (PM0.1) passes through the alveolar-capillary membrane, easily absorbed by cells and released into the bloodstream. Therefore, smaller particles have a higher systemic toxicity.

SOLID PARTICLES

Inhaling solid particles can affect both the lungs and the heart. Numerous scientific studies have linked exposure to solid particles with various problems, including: premature death in persons with heart or lung diseases, nonfatal heart attacks, irregular heartbeat, asthma, impaired lung function, aggravated respiratory symptoms – airways irritation, cough or difficulty breathing. Exposure to particle pollution mostly affects people with heart or lungs diseases, children and the elderly.

SULFUR DIOXIDE

Short-term exposure to increased concentrations of sulfur dioxide in the community can cause health problems. People with asthma or chronic obstructive pulmonary disease are at higher risk, and that includes children and the elderly. Symptoms may include constriction or tightening of the airways in the lungs, coughing, wheezing and difficulties breathing, as well as nasal cavity, throat and eye irritation. If one is sensitive to sulfur dioxide, exposure may increase the number of emergency room visits and hospitalizations due to respiratory problems.

Long-term exposure to particles created through the reaction of sulfur dioxide with other airborne compounds can also affect one's health. These particles penetrate the lungs deeply. This may cause irritation and inflammations, which can damage lung mucosa and affect other parts of the body. Particles may aggravate underlying heart and respiratory diseases, including emphysema and bronchitis. Due to this, children living in areas with high levels of sulfur dioxide may develop increased breathing problems as they get older.

NITROGEN OXIDES

Nitrogen oxides cause a series of harmful effects to the lungs, including a rise in respiratory infections cases, aggravated cough and wheezing, impaired lung function, increased asthma attacks and a higher probability of emergency room visits and hospitalization. The scientific community warns that NO2 is a probable cause of asthma in children. Long-term exposure to these pollutants is linked with a series of negative health outcomes, including disability and years of life lost due to stroke, coronary artery disease, chronic obstructive pulmonary disease and lung cancer – especially in sensitive populations, such as the elderly who are at greater risk of chronic diseases.

OZONE

Inhaling ozone may shorten one's life. Researchers have repeatedly pointed out that the risk of premature death increases with higher levels of ozone. New research has also confirmed that ozone increases the risk of premature death. Immediate problems – apart from the increased risk of premature death – include: difficulty breathing, wheezing and coughing, asthma attacks, higher risk of respiratory infection, sensitivity to inflammation in the lungs, as well as a higher need for medical care and hospitalization of people with lung diseases such as asthma or chronic obstructive pulmonary disease. Ozone pollution represents a serious health threat: it causes damage to the airways (e.g. aggravation of asthma or chronic obstructive pulmonary disease), cardiovascular problems (e.g. heart attack, stroke, heart disease, congestive heart failure). It can also damage the central nervous system and may cause reproductive and developmental damage.

Both external and internal factors determine the vulnerability to the negative health effects of air pollution exposure. The most important one is the level of exposure. People of a low socioeconomic status are often more exposed to air pollution because they live in areas of higher-intensity traffic and close to pollution sources such as power plants and industrial facilities. Other external factors contributing to vulnerability include poor housing, lack of healthy food markets (e.g. fruits and vegetables that contain antioxidants), segregation, lack of green areas and poor access to healthcare. In most cases, "dirty" jobs are operated by poor people who are thus professionally exposed to fumes, solid particles, gases and heavy metals. The factors which increase vulnerability to air pollution also include age (the very young and the very old), underlying conditions, pregnancy, genetic and epigenetic variations, smoking and obesity. That is why reducing the impact of air pollution on public health should be done by means of a cumulative risk concept which combines the external and internal factors, in an attempt to estimate an individual's or a population's vulnerability to the negative effects of air pollution.

Air pollution is one of the leading causes of premature death in many small countries with low and middle income, where the mortality rates per 100,000 inhabitants are much higher than those in larger populated high-income countries, and 91% of the total number of premature deaths occurring in the former.

RECOMMENDATIONS ON PROBLEM SOLUTIONS

Air pollution reduction is a public health measure that directly influences better quality of life and citizens' health, while indirectly helping reduce the rate of premature deaths caused by short- and long-term exposure to airborne pollutant emissions. Air pollution increases the number of health problems, and causes the onset of acute and chronic diseases, shortens life expectancy and causes premature death.

A range of accessible technologies, investment strategies and political options are available for the reduction of air pollution from its biggest sources – including transport, industry, agriculture and fuel combustion for cooking and heating purposes. Potential steps for governments, such as the adequate use of land and spatial planning, clean transport and energy production, energy efficient buildings and waste management – these will also lower emissions, while simultaneously supporting a cleaner way of life and sustainable urban development.

The most fundamental solution for air pollution is to phase out fossil fuels and replace them with alternatives such as solar, wind and geothermal energy. The production of clean energy is crucial. However, an equally important step is to reduce energy consumption by adopting responsible habits and using devices that are more efficient. A shift to electric and hydrogen vehicles and promoting shared mobility (shared and public transportation) could also reduce air pollution. From the planning stages to deconstruction, green building aspires to create environmentally responsible and resource-efficient structures, so as to reduce their carbon footprint.

1. Define the reduction of air pollution as a national and international priority, and integrate it in state and city development planning processes.
2. Increase the national pollution control budget and set priorities dedicated to decreasing the influence of pollutants on the population and the environment.
3. Establish systems to monitor pollution and its effects on public health.
4. Build multisectoral partnerships for better oversight of polluters.
5. Integrate the prevention of noncommunicable diseases into the priorities of environmental policies.

CLIMATE CHANGE AND THE GREEN AGENDA

In this part, Prof. Vladimir Đurđević has summarized the problem, its consequences and proposals of a solution, with regard to the topic of the brief, from the standpoint of climate change and the green agenda, and through a lens of solidarity in the Western Balkans.

CLIMATE CHANGE AND HEALTH

Health effects of climate change can be observed through both direct and indirect consequences. When it comes to health effects of climate change, usually the most emphasized problem is the negative influence of heat waves, periods of abnormally hot weather, when air temperatures significantly differ from expected values for the observed part of the year. During heat waves, high temperatures can have a destructive influence on people, especially vulnerable groups such as the elderly and persons with chronic conditions. For instance, during a heat wave in Europe in 2003, 70,000 persons have lost their life, while the Moscow heat wave in 2010 claimed around 15,000 lives. Although a significant rise in the number of heat waves has been recorded in recent decades in the Western Balkans, having approximately doubled compared to the mid-20th century period, there still lacks adequate research and analyses that would clearly quantify their influence on public health. One of the few available studies is dedicated to the July 2007 heat wave. During its course, the mortality rate of persons older than 75 in Belgrade has increased by 76%[3]. The highest mortality rate, in percentage terms, was recorded in diabetics, and in terms of absolute numbers, in persons with cardiovascular diseases. The situation was likely similar in other Western Balkan cities, since this heat wave – one of the 10 worst recorded in Europe in the past two decades – affected the entire region. Floods, which due to climate change also show a trend of increased frequency, clearly demonstrate the disastrous influence of extreme weather, in terms of loss of human life. The 2014 floods in Bosnia and Herzegovina and Serbia resulted in a total of 81 direct victims, while the August 2016 floods in Macedonia claimed at least 21 lives. Apart from their direct effects, devastating atmospheric and hydrological extremes such as heavy rainfall and floods can have a serious indirect impact. This is manifested by a potential disruption in the normal functioning of the healthcare system. Thus, additional victims may occur either due to healthcare institutions' closures, or the patients' inability to move because of the devastated infrastructure. This indirect influence is often underestimated even though some cases have indicated that it might be dominant. A relevant example is Hurricane Maria – after it hit Puerto Rico, the number of direct victims was 60. However, later estimates showed that the number of indirect victims, due to inadequate functioning of the healthcare system and collapsed infrastructure, was almost 3,000. After the 2014 floods, a large number of health centers also temporarily ceased to operate normally; however, a potential impact of that situation on the population in areas affected by the floods has never been analyzed. Climate change can also be linked with air quality, given that warmer weather conditions suit the formation of ozone, one of the main pollutants during the warmer part of the year. In addition, it has been indicated that warmer weather and larger CO2 concentrations in the atmosphere contribute to a longer growing and pollination season. This contributes to a larger concentration of pollen in the air, which could have negative effects on persons with allergies and asthma patients. Finally, warmer climate and the shift of climate zones to the north, enables the migration of certain vectors, primarily mosquitoes, towards areas in which they had previously been uncommon. Thus, the population will be more exposed to corresponding diseases transmitted by them, such as the West Nile fever whose presence in all Western Balkan countries in recent years has grown.

AUTHOR

Miodrag Stojković received his doctorate and habil degrees from the Ludwig Maximilian University of Munich, in 1998 and 2002, respectively. His research focuses on early embryology, stem

[3]Bogdanović DC, Milosević ZG, Lazarević KK, Dolićanin ZC, Randelović DM, Bogdanović SD. The impact of the July 2007 heat wave on daily mortality in Belgrade, Serbia. Cent Eur J Public Health. 2013 Sep;21(3):140-5. doi: 10.21101/cejph.a3840. PMID: 24344537

AIR POLLUTION AND INFERTILITY IN THE WESTERN BALKANS

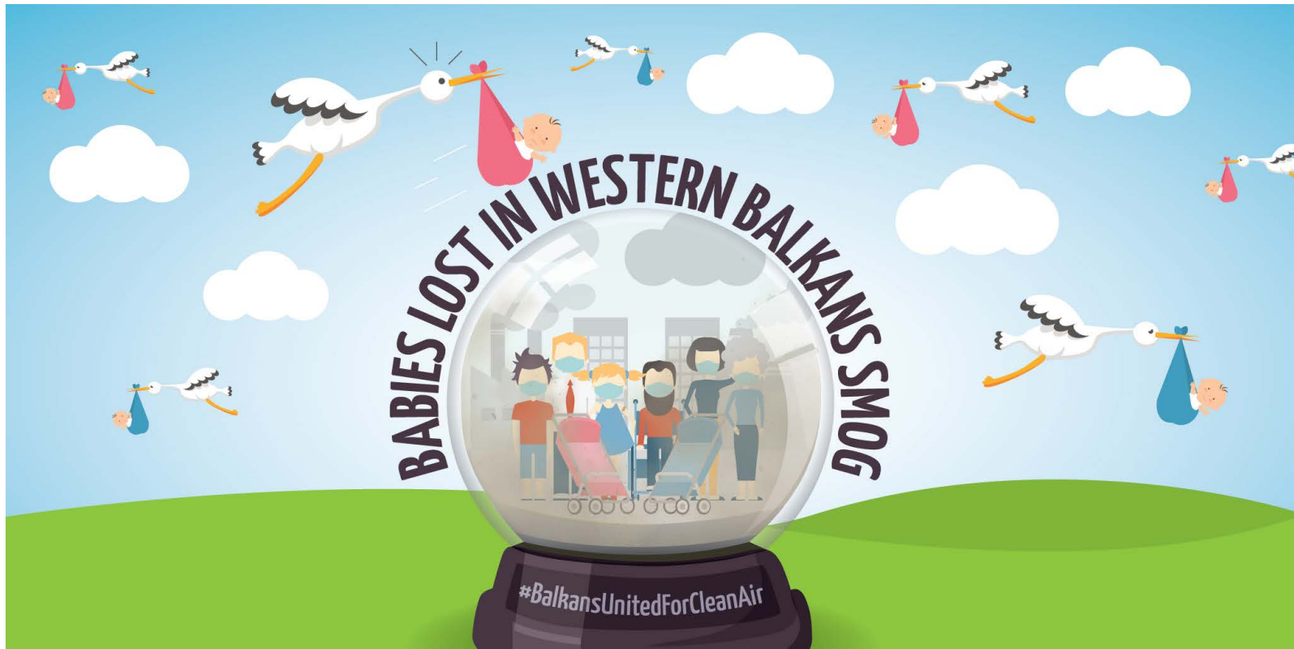
cells and epigenetics. In 2002, he joined the team at the Medical School of the University of Newcastle, where in 2005 he was appointed as Chair in Embryology and Stem Cell Biology and Deputy Director of the Centre for Stem Cell Biology and Developmental Genetics. In 2006, he joined the Prince Felipe Research Centre in Valencia, where he worked as Head of Cellular Reprogramming Laboratory. In 2007, he was appointed Professor of Human Genetics at the Medical School, University of Kragujevac. In his hometown of Leskovac, in 2008 he founded SPEBO Medical, a special hospital for fertility treatment. He was Editor of the scientific journal STEM CELLS (Durham, North Carolina, USA) until 2012. Until September 2020, he was a research fellow at the Harvard Medical School, Boston, MA. He authored and co-authored numerous scientific publications (H-index: 67) and served as an academic reviewer for more than 30 grant/regulation bodies and scientific journals. He has been a member of Academia Europea since 2012.

CAUSES OF THE PROBLEM

On a daily basis, the human organism is exposed to harmful effects by a mixture of airborne particles and chemicals. This applies both for the inhabitants of developed countries, and those of developing countries. The situation in the latter is extremely dramatic, as they lack sufficient funds and modern technology to prevent air pollution. Anthropogenic activities – traffic, industrial facilities and fossil fuel combustion, which are particularly intensive in large cities, are the main source of health-linked air pollution in the Western Balkans. Uncontrolled urbanization and migrations from rural areas to large cities are additional factors burdening developing countries, given that urban population growth also intensifies people's socioeconomic activities. A major increase in urbanization and migration to urban centers also causes a higher level of air pollution, as well as its potential health implications. The list of hazardous materials entering the digestive and respiratory tracts includes particles of various diameters (2.5–10 μm; PM2.5 and 10), ground-level ozone (03), benzo[a]pyrene (main marker of the presence of polycyclic aromatic hydrocarbons), polychlorinated biphenyl, sulfur dioxide (S02), nitrogen dioxide (N02), carbon monoxide (C0), heavy metals (lead and copper), different organic compounds (organic solvents and dioxins) and the increasingly present micro- (diameter less than 1 mm) and nanoplastics (diameter less than 100 nm). They are abundant in air, water and food. Air pollution caused by plastic is constantly growing, because so does the production of plastic – trailing only the production rates of steel and cement. Air pollution contributes to additional contamination of fertile land, plants, animals – namely, the food chain – and thus increases the impact of harmful matter on human health. It is a known fact that obsolete technology, lack of filtering and environmental pollution caused by waste particularly lead to premature deaths, increase the risk of cancer, high blood pressure, rheumatism, spondylosis, diabetes, respiratory disorders, including a higher incidence of infectious diseases such as the flu and COVID-19. Additionally, many scientific studies performed in a laboratory and in vivo prove that the said pollutants act as endocrine/hormonal disruptors, induce oxidative stress in cells and have a genotoxic effect, namely a harmful effect to DNA itself. Moreover, the secretion of harmful matter from the organism is slow, leading to its accumulation in the blood, bones and soft tissue, which affects the primary functions of the kidneys, liver, nervous system and other important organs. This is why long-term exposure to air pollution is also linked with neuroinflammations, altered congenital immunological response, On a daily basis, the human organism is exposed to harmful effects by a mixture of airborne particles and chemicals. This applies both for the inhabitants of developed countries, and those of developing countries. The situation in the latter is extremely dramatic, as they lack sufficient funds and modern technology to prevent air pollution. Anthropogenic activities – traffic, industrial facilities and fossil fuel combustion, which are particularly intensive in large cities, are the main source of health-linked air pollution in the Western Balkans. Uncontrolled urbanization and migrations from rural areas to large cities are additional factors burdening developing countries, given that urban population growth also intensifies people's socioeconomic activities. A major increase in urbanization and migration to urban centers also causes a higher level of air pollution, as well as its potential health implications. The list of hazardous materials entering the digestive and respiratory tracts includes particles of various diameters (2.5–10 μm; PM2.5 and 10), ground-level ozone (03), benzo[a]pyrene (main marker of the presence of polycyclic aromatic hydrocarbons), polychlorinated biphenyl, sulfur dioxide (S02), nitrogen dioxide (N02), carbon monoxide (C0), heavy metals (lead and copper), different organic compounds (organic solvents and dioxins) and the increasingly present micro- (diameter less than 1 mm) and nanoplastics (diameter less than 100 nm). They are abundant in air, water and food. Air pollution caused by plastic is constantly growing, because so does the production of plastic – trailing only the production rates of steel and cement. Air pollution contributes to additional contamination of fertile land, plants, animals – namely, the food chain – and thus increases the impact of harmful matter on human health. It is a known fact that obsolete technology, lack of filtering and environmental pollution caused by waste particularly lead to premature deaths, increase the risk of cancer, high blood pressure, rheumatism, spondylosis, diabetes, blood-brain barrier disruption, accumulation of ultrafine particles in cell organelles causing cell death, organ dysfunction and diseases. All those effects, individually or combined, produce a catastrophic influence on the reproductive system and gametes, as well as on conception rates and ongoing pregnancies. They also affect offspring health and increase infertility rates in both women and men. In 2019, one in six couples in Serbia experienced difficulties conceiving which explains the number of patients seeking medical assistance and increasingly undergoing the process of in vitro fertilization (IVF) (report by the European Society of Human Reproduction and Embryology, https://www.eshre.eu/Press-Room/Press-releases-2020/ART-in-Europe and Calhaz-Jorge et al., 2020). If we observe infertility through a time lens, it is constantly growing and is one of the major factors in Western Balkans countries' population decline. Due to turbulent sociopolitical developments, there has been a population decline between 1991 and early 21st century, in Albania, Bosnia and Herzegovina, Croatia, Macedonia and Serbia. Due to migration and other factors, the number of inhabitants of Bosnia and Herzegovina has decreased the most, twice as much in comparison with Croatia, Albania and Serbia. While the youth keeps leaving Western Balkans countries, the remaining population is getting older, and fertility rates remain low. Therefore, it comes as no surprise that, apart from other socioeconomic factors, the right to a clean environment (health) is becoming an increasingly important one, too – with regard to the increased youth migration, the vicious cycle of high infertility rates, and the depopulation in Western Balkan countries.

PROBLEM'S CONSEQUENCES FOR THE CITIZENS

Air pollution and female infertility. Several international studies have linked air pollution with infertility, childbirth complications, increased rates of congenital abnormalities in offspring and stillbirths. Fertility rates statistically decline with higher levels of air pollution levels attributable to traffic, especially with the presence of harmful matter's coarse fractions. Certain air pollutants, namely lead, copper and diesel exhaust, perform an endocrine function which negatively affects female reproduction. Moreover, these endocrine disorders have estrogenic, antiestrogenic and antiandrogenic effects, and some of them can cause thyroid disruption and metabolic disorders, such as insulin resistance and obesity, which are closely linked with infertility. A rise in female infertility is occurring in parallel with toxic emissions, suggesting that the influence of air pollution on human health will only increase in the years to come. These air polluters disrupt human gametogenesis, namely the creation of reproductive cells. The main mechanisms of their impact on the ovaries are not only linked with changes in the endocrine system, they also entail an increase in inflammations and activation of certain genetic mechanisms that can stimulate the onset of infertility. The key question that comes to mind: how does the inevitable exposure of women to pollutants pre- and post-conception cause abnormalities in the egg cells, the embryo and/or fetus, and disrupt the safe birth of a child and its overall health? Several studies prove that women living in polluted areas have a smaller number of vital egg cells due to a significant decrease in antral follicles count, as well as lower fertility rates and higher rates of unsuccessful embryo implantation, when compared with women who are not exposed to air pollution. Particulate matter PM 2.5 decreases egg cell quality, reducing fertility by 2% per 10 μg/m3 (Conforti et al., 2018; Xue & Zhang, 2018). This negative impact was confirmed by studies from California and Harvard, which show that air pollution accelerates reproductive aging, causing an ovarian reserve decline. The relation between higher air pollution levels and lower fertility rates is determined by measuring the serum Anti-Müllerian hormone (AMH) levels. This hormone is released by somatic cells of the ovaries and it is used as an ovarian reserve marker, indicating the number of vital egg cells that can be produced by the ovaries. After measuring the daily PM2.5–10 and NO2 levels in the area surrounding the city of Modena, Italy, a significant drop in AMH levels was detected in women inhabiting polluted areas. Moreover, when compared with the control group, women who had been exposed to high PM10 levels, even for a short period, have experienced early miscarriage more frequently as the polluted air affects the placenta's functional morphology and causes reduced fetal weight. A 2010 study (Mohorovic et al., 2010) has shown that the rate of miscarriage and stillbirths in the town of Labin, Croatia, was significantly higher during periods of exposure to polluted air from the nearby coal-fired power plant, compared to a



period without such exposure. While sulfate compounds significantly increase the risk of pregnancy loss, by up to 13%, exposure to PM2.5 and PM2.5–10 causes a conception rate decline. The presence of SO2, O3, CO and NO2 has multiple negative effects: it causes not only miscarriages, but also a higher incidence of stillbirths and jeopardized newborn health. For that reason, US scientists have recently proposed a plan for reproductive endocrinologists and gynecologists to promote healthy pregnancy by educating women on adopting a safe lifestyle in the pre-conception period. This implies the use of highly efficient particulate air filtering indoors and avoiding outdoor activities during periods of poor air quality. This recommendation is very important when it comes to special institutions that provide infertility treatment. By following it, they would create optimal conditions for patients during the process of in vitro fertilization and reduce the negative impact of laboratory air pollution on highly sensitive egg cells and embryos.

Air pollution and male infertility. The effect of pollutants on semen quality has meanwhile been tested on both humans and laboratory animals. Even prenatal exposure to diesel exhaust is linked with a significant drop in daily semen production and endocrine changes in the male offspring in animal models. Particulates, namely microscopic solid or liquid matter suspended in the atmosphere, can carry various trace elements such as polycyclic aromatic hydrocarbon, which directly impairs the production of male reproductive cells – sperm. Several studies (Lafuente et al., 2016; Carre et al., 2017; Zhou et al., 2019) have shown that PM10 and PM2.5 can be found in the testicles and cause increased mitochondrial dysfunction, DNA fragmentation and programmed cell death. Testicular function and sperm development can also be affected by exposure to isoflavones, heavy metals, and by-products of disinfection with chlorine and organic solvents. It is indicated that electromagnetic waves emitted by mobile phones and stations can also reduce sperm quality – therefore, their negative influence cannot be objectively assessed, independently from the other environmental and air pollutants (Gye & Park., 2012; Kesari et al., 2018). As for sperm quality, which includes the criterion of motility, a Czech study has shown that air pollution is in correlation with decreased progressive sperm motility, a parameter necessary for natural fertilization. A recent prospective cohort study (Jurewicz et al., 2018) from Poland has confirmed a significant correlation between PM10 and PM2.5 and sperm chromosomal abnormalities, which means that such abnormalities can be passed on to the offspring.

Air pollution and artificial insemination (AI). Recently there has been a growing need to analyze data from literature on the most common polluters' effects on gametes, particularly in embryos, which are exposed to laboratory conditions during the AI process. Despite the fact that some studies feature a broad heterogeneity of respondents, results indicate that laboratory air pollution poses an additional hurdle in the struggle against infertility, since it diminishes the vitality of the egg cells, sperms and embryo, thus lowering AI success rates. For instance, in case of a malfunctioning air filtering system for over 6 months, the rate of pregnancy following AI drops significantly. After the installation of new filters, the success rates return to normal values. If, however, patients are constantly exposed to contaminated air, problems pertaining to infertility and pregnancy loss may persist, regardless of modern laboratory technology. A 2010 study from Brazil (Perin et al., 2010) has shown that women exposed to high PM10 levels (>56.72 mg/m3) experience a higher incidence of miscarriages, despite undergoing AI. That means that the quality of laboratory air can very much be influenced, but the infertility issue caused by an accumulation of harmful matter from ambient air cannot be resolved even by the AI process.

Plastic air pollution as a cause of infertility. Air pollution caused by plastic is becoming a global problem because plastic particles are spread by rain and wind, after the decomposition or combustion of plastic waste. This problem is particularly affecting developing countries, which includes those in the Western Balkans. One of the most harmful types of plastic is bisphenol A (BPA), a synthetic organic compound mainly used in the production of polycarbonate plastics and epoxy resins. Due to its wide industrial use, the presence of BPA can be detected in various bodily fluids such as urine, saliva, blood, breast milk and amniotic fluid, and on the skin. The most harmful effect of BPA is due to its hormonal, namely estrogen and antiestrogen features, which lead to pathological changes in the differentiation of spermatogenic cells, as well as through functional modification of DNA. Our recent results have clearly shown that polystyrene, a type of plastic, which in its micro and nano form can be found in food, water and air, affects the genetic profile of early human embryos and their capacity to be implanted and develop properly. Later on, this can cause an abnormal development and premature birth (Bojic et al., 2020). According to a World Health Organization report, preterm births in 2005 have cost the US economy more than $26 billion. Unfortunately, there is a lack of data on the incidence of preterm births at the global level and for Western Balkan countries, respectively. Data on premature birth rates are available in certain developed countries, such as Great Britain, United States and Scandinavian countries, and they indicate a dramatic growth during the past 20 years, with global environmental pollution cited as one of the causes. This data shows that Western Balkan countries, too, are headed towards an influx of patients who will be treated for infertility and undergo AI, which will place a larger burden to budgets – both individuals' and state.

Influence of air pollution on migrations in the region. Air pollution is most certainly a contributing factor to major changes in the population's immigration and emigration, a problem very elegantly presented in a study from China. Air pollution that occurred there in the period of industrialization, particularly between 1996 and 2010, has caused a population decline due to emigration – by 5% in a county heavily affected by air pollution. Since it is mainly the young and the well educated at the beginning of their professional careers who leave such regions, this causes major changes in the sociodemographic characteristics of the population. The study shows that women will more likely initiate family relocations or migration in response to air pollution, so as to protect the children or future generations. Since the European Environment Agency's report for Western Balkan countries (https://www.eea.europa.eu/publications/western-balkans/file) clearly indicates that total regional air emissions rates have not changed much in recent years, national migration trends of young people, who had recently created a family or are about to do so, will remain high.

RECOMMENDATIONS ON PROBLEM SOLUTIONS

In the past decades, the start of heating season in the Western Balkans has always been accompanied by higher rates of air pollution. Unfortunately, in 2020, cities of the region were once again featured on the lists of those with the highest rates of pollution. The majority of air pollution sources is within reach of individual and state influence and calls for joint action. In order to resolve the issue of air pollution in the Western Balkan countries, the states should constantly educate their populations, define standards and regulatory norms, and also develop green economy. For instance, apart from the policy of reducing exhaust gas emissions and promoting electric vehicles, in Germany, as of January 1, 2021, stoves that cause excessive levels of dust and CO emissions, built between 1985 and 1994, must be replaced or modernized by installing fine particle filters. By doing so, almost 11 million systems in Germany will emit significantly less harmful particles in the air. Western Balkan countries' government agencies will have to create cleaner transportation methods, reduce plastic and other forms of waste and organize its better management, introduce better energy production methods and technology to lower emissions. The policy of reducing emissions from industrial chimneys should be continued, as should investments in renewable energy sources, and prioritizing fast and communal transit. Ensuring healthy air in urban areas should be a priority both at national and city level. A way to reduce the harmful effects of air pollution is to reduce the use of disposable plastic, especially non-recyclable packaging, as well as using natural fiber as substitute for synthetic. This would aim towards reducing emissions and ingestion of micro- and nanoplastics, given that just one washing machine cycle with synthetic laundry releases more than 700,000 fibers; this number is 3.5 times higher in the case of laundry dryers (Napper & Thompson, 2016). Improvement of air quality will help the struggle for climate, environmental and health protection, and lessen the impact of harmful particles on fertility. Additional measures include transparent and available air quality monitoring, training and interaction between air quality specialists, and medical and laboratory staff. Apart from dealing with result analysis and public health measures, they would assist the production of modern programs and applications so as to make all relevant data available to a broader public. A new mobile phone application was launched in Bosnia and Herzegovina, to help citizens of Sarajevo avoid additional exposure to harmful airborne matter. Namely, the application calculates the least polluted route between any two locations in the city by assessing PM10, PM2.5, NO2 and O3 pollution levels. Access to such data and apps is important for experts and patients struggling against infertility, since its analysis can lead them to valuable results, particularly in cases in which high air pollution levels coincide with infertility issues, miscarriage or preterm birth. In addition, the capacities of diagnostic centers need to be raised, and there is a need for joint studies that use monitoring and measuring data from Western Balkan countries. Creating joint interactive charts and mathematical models would summarize short- and long-term exposure to harmful airborne particles, with particular emphasis on their effects on infertility, preterm birth, onset of disease and neonatal death rates. Developed countries (USA, Canada, Sweden, Germany, the Netherlands) have long been using modern technology and genotoxicity testing which measures the scope of damage inflicted by polluted air at the cellular and subcellular levels. Genotoxic lesions can be easily discovered in cellular organelles (changes in cell membrane, lysosome vitality), genomes, immune system, biomolecules, etc. Cytotoxicity tests such as chromosome damage measurement are also common and useful as a tool to determine long-term effects of polluted air. Diagnostic centers should also measure (qualitatively and quantitatively) biochemical changes caused by air pollution, using methods that include the analysis of chlorophyll, protein and changes in enzyme activity. Particular emphasis is due in the case of patients who experience sterility issues or frequent pregnancy loss, since their medical history can reveal their everyday exposure to toxic airborne agents, and the vicinity of industrial facilities and major roads. This would save diagnostic time, funds and, when couples need to proceed with AI for medical reasons, such special institutions should undertake comprehensive cleaning of laboratory air and supply air, and create laboratories with clean rooms. Such conditions not only increase success rates, they also prevent laboratory air from being affected by harmful matter including volatile organic compounds, which can prevent early embryo development. Meanwhile, 7 out of 10 top laboratories in the USA operate in clean rooms, which is an example that, along with an overall reduction of ambient air pollution, should be followed by Western Balkan countries, too.

MIODRAG STOJKOVIĆ

AIR POLLUTION, INDUSTRY AND LARGE POLLUTERS

AUTHORS

Mirko Popović, civil society activist, policy analyst and programme director with the Renewables and Environmental Regulatory Institute (RERI). Focused on the application of EU and international environmental and human rights standards in Serbia and Western Balkans countries, he has been involved in numerous advocacy campaigns aiming to foster energy transition and to protect local communities endangered by harmful hydro power and industrial projects. Author of several policy analyses on energy policy, environmental impact assessment and the adverse effects of small hydro plant construction.

Denis Žiško is the Energy and Climate Change program coordinator with the Center for Ecology and Energy. Since 2013, he has been coordinating activities of the "Stop Dirty Energy - The Future is Renewable" campaign in Bosnia and Herzegovina. The campaign was initiated by a group of BiH NGOs in reaction to irresponsible and unsustainable management and planning with regard to the energy sector, by decision-makers in a country largely relying on a dirty energy source – coal.

Samir Lemeš, professor at the University of Zenica and environmental activist. For more than decade, he has led the campaign against industrial air pollution, but is also active on other environmental protection topics, such as the Aarhus Convention, environmental justice and corporate responsibility. Author of 19 books and 90+ scientific papers. His latest book is the "Handbook for Advocacy Campaigns towards Companies".

CAUSES OF THE PROBLEM

The Western Balkans region is facing significant difficulties in aligning with EU environmental standards and long-term climate and energy policy goals. Despite the fact that the region has been on its EU accession pathway for more than a decade, with a large portion of the EU environmental acquis already adopted, Western Balkans countries (WB6) are suffering from overwhelming air pollution, inefficient electricity consumption and carbon emissions from power generation which are high relative to the total generation. Moving away from fossil-fuel electricity production and achieving climate neutrality by 2050 is certainly a challenging task for the WB6, although these goals have been adopted within the 2020 Sofia Declaration on the Green Agenda for the Western Balkans.

The main sources of air pollution in WB6 include the power sector, individual households (considered responsible for the largest portion of particular matter emissions (PM)) and energy-intensive industry, but there is no relevant information available to estimate the ratio between these sources. The power sector is a significant emitter of sulphur dioxide (SO2), PMs and heavy metals, while energy-intensive industry creates pollution hot spots in several cities and areas across the region. Air pollution causes health problems, degradation of the environment and economic backwardness of the Western Balkans countries. However, air pollution is not a problem in and of itself, but a consequence of long-term neglect of adopted EU rules, violations of the Treaty Establishing the Energy Community and the lack of accountability and law enforcement mechanisms. Such circumstances create an environment enabling the favorable status of state-owned power companies and private investors, which are allowed to maintain their businesses despite clearly violating air protection standards and exceeding emission ceilings.

Even though releases of air pollutants caused by European industry have generally decreased during the last two decades as a result of strict environmental regulation and improved pollutant abatement technology, the industry is still a major source of air pollution1. In the Western Balkans, industrial activities are modest, but their contribution to air pollution is significant.

Industry refers to the production of goods within an economy. Its activities include the energy supply industry, extractive industry, ferrous and non-ferrous metal production, non-metallic minerals production, chemical industry, the rest of the manufacturing industry, and the waste industry (including wastewater treatment). The energy used for transport related to these industrial activities and the associated emissions are not included. Industrial pollutant releases to air include greenhouse gases such as carbon dioxide (CO2) and acidifying pollutants such as sulphur oxides (SOx). There are also pollutants that can have adverse impacts on human health and environment, such as nitrogen oxides (NOx), particulate matter (PM10; PM2.5), non-methane volatile organic compounds (NMVOCs) and heavy metals including, in particular, arsenic (As), cadmium (Cd), lead (Pb) and mercury (Hg).

Industrial CO2 emissions are subject to Greenhouse Gas Monitoring Mechanism Reporting (GHG MMR) and they have decreased in the EU between 2007 and 2017. Large industrial facilities report releases of air pollutants to the European Pollutant Release and Transfer Register (E-PRTR; this dataset only covers releases from larger facilities involved solely in certain activities and data; therefore, it contains the majority of industrial releases, but not all of them). E-PRTR releases have also declined in the case of all major air pollutants between 2007 and 2017.

[1]Source: European Environment Agency. https://www.eea.europa.eu/data-and-maps/indicators/industrial-pollution-in-europe-3/assessment

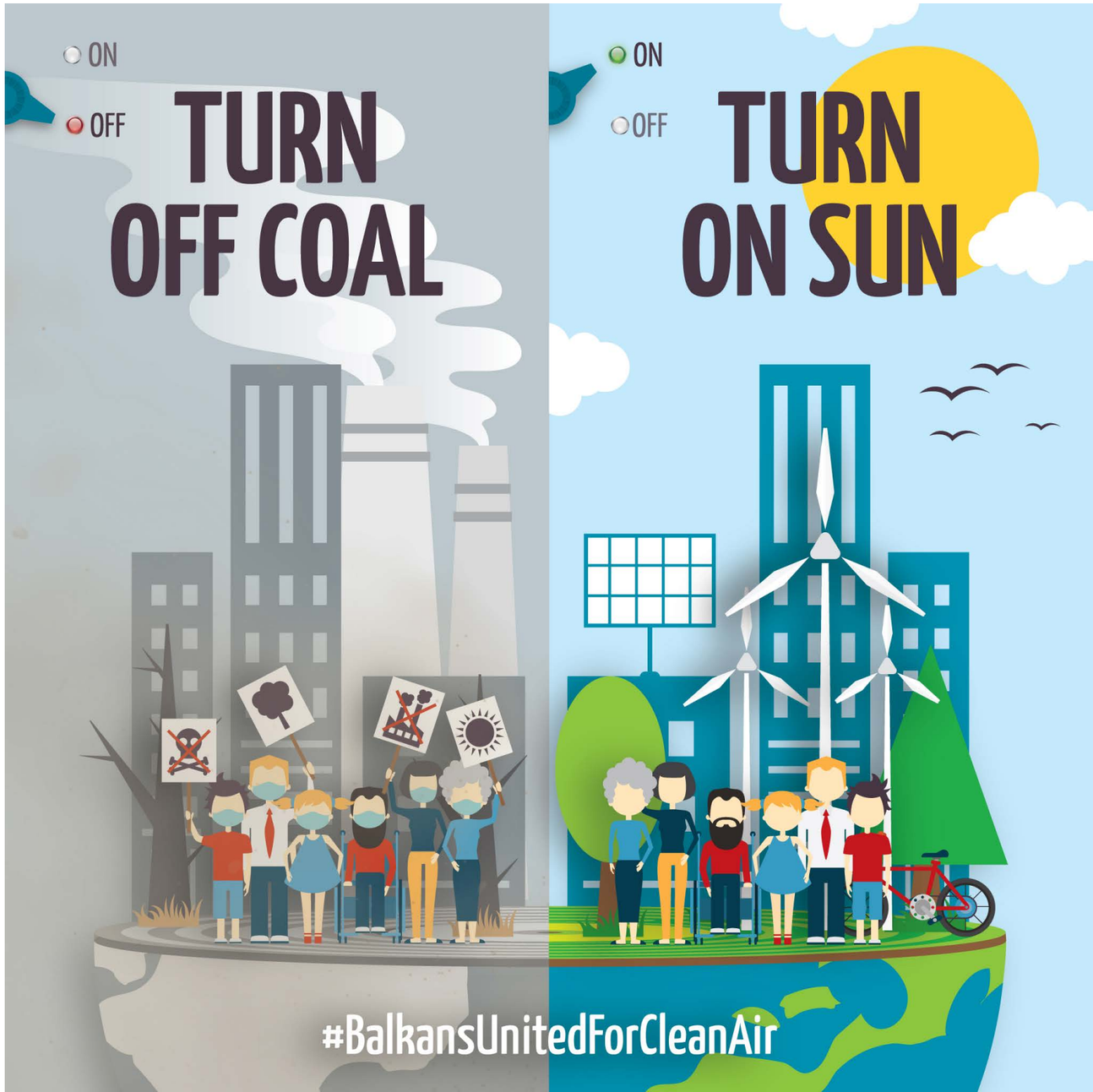
When it comes to emissions of carbon dioxide in the Western Balkans, electricity and heat production are the main culprits with 56.5 million tons of CO2 in 2019 (1% increase compared with 2018), electricity production being a key contributor to CO2 emissions. The generated carbon emissions relative to the final electricity demand exceed the EU-27 average by 3 times. The WB6 emits on average ten times more CO2 than EU-27, to create the same amount of gross domestic product.[2]

Overall, industrial releases of SOx and PM10 decreased in the EU by almost 80% and more than 60%, respectively, during this period. Other emissions decreased to a lesser extent: CO2 (-12 %), NMVOCs (-40 %), NOx (-49 %) and aggregated heavy metals (Cd, Hg and Pb) (-47 %).

[2]WB6 Energy Transition Tracker, Energy Community Secretariat, February 2021, p. 5

In 2017, the industry was responsible for more than half of all anthropogenic emissions to air of CO2, SOx, NMVOC and the heavy metals Cd, Hg and Pb, across the EU. It further contributed to emissions of NOx and PM10, albeit to a lesser extent.

The European Pollutant Release and Transfer Register (E-PRTR) is the Europe-wide register that provides easily accessible key environmental data from industrial facilities in 27 EU member states, as well as Iceland, Liechtenstein, Norway, Serbia, Switzerland and the United Kingdom. The register contains data reported annually by more than 30,000 industrial facilities covering 65 economic activities across Europe. For each facility, information



is provided concerning the amounts of pollutant releases to air, water and land, as well as off-site transfers of waste and pollutants in wastewater, from a list of 91 key pollutants that includes heavy metals, pesticides, greenhouse gases and dioxins for years 2007 onwards.[3]

Regulation (EC) No 166/2006 of the European Parliament and of the Council of January 18 2006 established a European Pollutant Release and Transfer Register, in order to implement the UNECE Protocol on Pollutant Release and Transfer Registers (PRTR), derived from the Aarhus Convention. The PRTR protocol was ratified by Albania, Montenegro, North Macedonia and Serbia, while Bosnia and Herzegovina and Kosovo are still in the process of ratification.

There are public PRTR databases in Albania[4], North Macedonia[5] and Serbia[6]. There is no public register in Kosovo. The register in Montenegro[7] contains no data about the emissions, and the two separate registers in Bosnia and Herzegovina are not functional, containing only partial annual emission reports for the Federation B&H[8] and Republika Srpska, respectively[9].

The Industrial Emissions Directive (IED) (EC, 2010) is a key regulatory instrument used by the EU to achieve emission reductions in the industrial sector. It superseded the Industrial Pollution Prevention and Control Directive (IPPCD) by harmonizing it with several other relevant regulations and directives such as the Large Combustion Plant Directive (LCPD). According to the IED, around 50,000 industrial installations are required to operate under a permit (which itself is granted by authorities at the member state level). Importantly, in the context of this indicator, permit conditions, including emission limit values, must be based on the Best Available Techniques (BAT). BAT refers to the most effective and economically and technically viable methods of operation that reduce emissions and the impact on the environment.

Western Balkans countries, as signatories of the Treaty Establishing the Energy Community, have been obligated to implement LCPD since January 1 2018, and to gradually align their policies with stricter IED-defined emission limits from large combustion plants until 2027. However, Bosnia and Herzegovina, Kosovo, North Macedonia and Serbia do not comply with the SO2 emission ceiling under the National Emission Reduction Plans (NERPs), which is required under the LCPD. Sulphur dioxide emissions from coal plants that were included in the NERPs of Bosnia and Herzegovina, Kosovo, North Macedonia and Serbia, totaled exceeded the 2018 ceilings set in the plans by six times, while dust emissions amounted to 1.6 times as much as the ceilings.[10] According to the Energy Community Secretariat reports, NOx emissions are below the ceilings, but Bosnia and Herzegovina, Kosovo and North Macedonia have dust emissions which exceed those values, while Serbia narrowly meets the limit.[11]

The biggest polluters in Bosnia and Herzegovina are its thermal power plants (Tuzla, Kakanj, Ugljevik, Stanari, Gacko). In absolute terms, Ugljevik TPP was the highest-emitting unit of SO2 in the region in 2019, with 88,302 tons, or 9.7 times as much as its ceiling. A desulphurization unit became operational in December 2019; however, technical problems were reported in early 2020. Finally, it was shut down for lack of a use permit.[12]

Serbian thermal power plants (TPPs) are among the main European contributors to SO2 pollution, emitting around 300,000 tons of SO2 per year in 2018 and 2019, which is almost a half of the total SO2 emissions (expressed in tones per year) in the entire EU. Serbian TPPs are state-owned, governed by the Public Electricity Company Serbia (EPS). Even though they are aligned with PM emissions defined by the Serbian NERP, environmental inspection has identified that emission limits for PMs in TPP Nikola Tesla have been exceeded in 2017 and 2018. Similar to TPP Ugljevik, a desulphurization unit was installed in the Serbian TPP Kostolac, too, in 2017. However, after the trial period, the unit was shut down due to the lack of a use permit.[13] Serbia did not adopt its NERP due on time, it did so in January 2020, as a public policy document without concrete enforcement measures deployed.

Kosovo's NERP covers all five existing lignite TPPs and the plan inot being implemented in practice (for nitrogen oxide and PMs).[14] The biggest problem is caused by the PM emissions. Kosovo has failed to submit its NERP in accordance with the deadline and even made an attempt to postpone the begin of NERP implementation from 2018 to 2022. On March 16 2020, the Energy Community Ministerial Council took a decision via written procedure on the failure by Kosovo to comply with Article 16 of the Treaty Establishing the Energy Community, due to the lack of implementation of LCPD.[15]

Although energy-intensive industry is not considered a key contributor to air pollution on national levels in WB6, there are worrisome trends related to alignment with environmental legislation.

According to the report published by a coalition of civil society organizations in 2016 the biggest industrial polluters in Bosnia and Herzegovina included the steel factory in Zenica (ArcelorMittal Zenica), cement factory in Kakanj, coke plant and chemical factory Şişecam Soda in Lukavac, and the oil refinery in Brod.16 All of those industrial facilities have been privatized during the transition period and are owned by foreign investors.

Serbian heavy industry complexes in Bor and Smederevo, both privatized by Chinese investors, represent a specific case. The Chinese company "ZIJIN MINING GROUP CO., LTD" owns a substantial share in "Serbia Zijin Copper Bor" (copper mining and smelting complex) based on the Agreement on Strategic Partnership. The company is responsible for air pollution emissions of heavy metals (arsenic, cadmium and nickel) and high emissions of SO2. During 2019, concentrations of sulphur dioxide dangerous for human health were reached 13 times, and the concentration of arsenic at one station was almost 100 times higher than the target value.17 "HBIS GROUP Serbia Iron &Steel d.o.o. Beograd" (parent company - Chinese company HBIS Group Co.) owns the steel factory and a trade port on the Danube River in Smederevo, which is causing significant air pollution and emissions of dust. The automatic air quality monitoring station near the steel factory (Radinac village), in operation for only 15 days in December 2019 - January 2020, measured excessive PM emissions. According to the city's Air Quality Plan, the steel factory is the largest air polluter of Smederevo.18

The emission limits are prescribed by national regulations, which should be aligned with the European directives and BATs. The environmental permit, issued for each industrial facility, can allow less strict emission ceilings for a limited period of time, in order to enable operators to implement the emission reduction measures. The typical adjustment period is 5 years, but it usually lasts longer than that. In some cases, when technology cannot be adjusted to obey the emission ceilings, the operating period is limited.

PROBLEM'S CONSEQUENCES FOR THE CITIZENS

Large industrial polluters are important for the society, as they employ thousands, contribute to GDP, pay taxes and other incentives. Aware of that, they often use their position to delay the implementation of environmental projects. For example, the steelwork in Zenica was obligated to install filters until 2011, and ten years on, only half of the factory's facilities have the necessary emission reduction equipment. The only desulfurization plant in Bosnia and Herzegovina, worth €80 million , was installed at the Ugljevik thermal power plant, but it went out of service soon. The higher costs of desulfurization were used as an excuse to increase the price of electricity by 15%. The Kostolac B TPP desulfurization facility was an investment worth $130 million, but has been out of function for more than three years. Even if desulfurization facilities were to be in place, this would increase costs of electricity production and CO2 emissions.

Filters that reduce dust emissions, flue-gas desulphurization units, or catalytic converters that reduce NOx emissions – these all require electricity to operate, hence they increase the on-site use of fossil fuels, also causing a rise in a plant's CO2 emissions by a small percentage. These investments also increase the value of fossil fuel assets, making them too expensive to be retired early.[19]
High sulphur emission levels from thermal power plants and industrial facilities such as the smelting complex in Bor contribute to the acidification of soil and have a negative impact on agriculture.

Negative health impacts are not limited to WB6 citizens only. HEAL estimated that more than a half of premature deaths in 2016 caused by emissions from Western Balkan coal power plants occurred in the EU: 2,013 of the total 3,906 premature deaths afflicted the EU population, while 1,239 occurred within the Western Balkans, and 654 elsewhere. As for the Western Balkans, Serbia suffered the greatest health impact due to the region's coal pollution. Coal plants in the WB6 also contributed to the onset of disease and ill health: their emissions caused a total of 8,516 cases of bronchitis in children and 2,023 cases in adults. Chronic coal pollution in the Western Balkans also harmed European productivity with an estimated total of 3,047 hospital admissions and over 1.16 million working days lost in the EU and Western Balkan countries during 2016. In the EU alone, the total amounted to 1,418 hospital admissions and over 600,000 working days lost.[20]

When it comes to the economic burden caused by air pollution, the World Bank assessed the annual cost associated with the health damage from ambient air pollution in the three Western Balkan countries (Bosnia and Herzegovina, Kosovo and North Macedonia) as significant: between 3.6 and 8.2% of the gross domestic product (GDP) or between $240 million and $1.38 billion, on average, in 2016.[21] However, this assessment covers air pollution from different sources: households, the power and heating sector, industry and transport. According to the World Bank, the most significant source of air pollution is the residential sector.

Potential public health hazards caused by industrial pollution include industrial contamination i.e. creation of contaminated sites. Contaminated sites mean "areas hosting or having hosted human activities which have produced or might produce environmental contamination of soil, surface- or groundwater, air, and the food chain, resulting or being able to result in human health impacts." Air pollution contributes to the levels of As and Cd in ambient air PM10 which are close to industrially contaminated sites. Concentrations of As in PM10, extremely above the limit value, were identified in Bor and Lazarevac, with Cd values slightly increased in Bor.[22]

Air pollution is the consequence, while the real problem lies in the lack of accountability towards accepted obligations and commitments by governments and decision-makers. Recommendations are focusing on the improvement of accountability, transparency and stronger public engagement, which should create an enabling environment for the implementation of EU environmental acquis and adopted standards, aimed at air pollution reduction. Zero tolerance towards violations of national and Energy Community legislation is crucial. In that regard, accountability and transparency mechanisms must be strengthened and public authorities need to be subject of social and legal responsibility. Such an approach requires strong and resolute engagement of the EU and the international community.

ACCOUNTABILITY DOES MATTER:

Key deficiencies in applying EU and Energy Community acquis, also disabling the solution of air pollution problems, include the lack of accountability and the weakness of legal enforcement

[3] https://prtr.eea.europa.eu/#/home
[4] http://prtr.akm.gov.al/main/pollutantSearch.jsf
[5] https://prtr.moepp.gov.mk/npgsql.aspx
[6] http://www.sepa.gov.rs/PRTR/pretraga.html?lang=en
[7] https://eis.epa.gov.me/#/PublicModules/PublicReports/2?_k=xfs022
[8] https://www.fmoit.gov.ba/bs/okolisne-dozvole/registri-i-izvjesivanje
[9] https://rhmzrs.com/zivotna-sredina/registar-postrojenja-i-zagadivaca/izvjestaji/
[10] Comply or Close, How Western Balkan coal plants breach air pollution laws and what governments must do about it, CEE Bankwatch Network, June 2020, p. 6
[11] WB6 Energy Transition Tracker, Energy Community Secretariat, February 2021, p. 7
[12] RITE Ugljevik will not start the 165 million plant by the end of 2021? https://www.en24news.com/e/2021/02/rite-ugljevik-will-not-start-the-165-million-plant-by-the-end-of-2021.html
[13] Data for Serbian TPPs are from RERI documentary archive.
[14] Energy Community Secretariat Annual Implementation Report, 1 November 2020, p. 93
[15] Comply or Close, How Western Balkan coal plants breach air pollution laws and what governments must do about it, CEE Bankwatch Network, June 2020, p. 17
[16] Biggest polluters of Bosnia and Herzegovina: ArcelorMittal steelworks and Elektroprivreda power stations: https://english.arnika.org/press-releases/biggest-polluters-of-bosnia-and-herzegovina-arcelormittal-steelworks-and-elektroprivreda-power-stations
[17] Source: RERI documentary archive.
[18] Source: RERI documentary archive.
[19] World Bank Regional Note on Air Quality Management in the Western Balkans: Bosnia and Herzegovina, Kosovo, and North Macedonia, March 2020
[20] Chronic coal pollution - EU action on the Western Balkans will improve health and economies across Europe, HEAL, CAN Europe, Sandbag, CEE Bankwatch Network and Europe Beyond Coal, 2019, p. 8
[21] World Bank Regional Note on Air Quality Management in the Western Balkans: Bosnia and Herzegovina, Kosovo, and North Macedonia, March 2020
[22] Branislava Matić et al, Industrially Contaminated Areas in Serbia as a Potential Public Health Threat to the Exposed Population, TEHNIKA – KVALITET IMS, STANDARDIZACIJA I METROLOGIJA 17, 2017

mechanisms. Hence, holding governments accountable is of the essence. The improvement of government accountability requires an independent judiciary and strong legal action by the civil society. Public authorities and industrial facility operators should be exposed to social and legal responsibility when breaching environmental laws and ratified international agreements. In order to do so, civil society organizations should strengthen their capacities for launching court cases and submitting complaints to international organizations in charge of the implementation of ratified international agreements and conventions. More frequent interference with the courts on the national level will improve their practice and pose a challenge to the judiciary's low levels of interest and knowledge on violations of environmental laws and procedures. Legal intervention should be followed by persuasive public awareness-raising campaigns. In order to strengthen their legal approach, civil society organizations should work to increase media attention and gain public support. Since we are dealing with more or less similar problems in all Western Balkans countries, regional and partnership-driven approaches should be applied. This implies that joint actions towards the EU, the Energy Community and international organizations will be more efficient than individual claims. The exchange of knowledge and experience with regard to strategic national-level litigation will improve the quality of civil society legal interventions.

International organizations will not achieve their objectives if the enforcement suffers from lack of effectiveness or neutrality. This is the conclusion by Mr. Dirk Buschle, Deputy Director and Head of Legal at the Energy Community Secretariat, regarding the enforcement of European energy law outside the European Union.23 The common conclusion, summarized in the Energy Community High Reflection Group Report, is that weak enforcement mechanisms constitute one of the major obstacles to the implementation of the acquis communautaire in the Contracting Parties.24 The lack of neutrality, due to the composition and the role of key decision-making bodies within the Energy Community, is the most obvious flaw of the current dispute settlement procedure, since the Treaty seems to grant the Ministerial Council wide discretionary powers as to whether or not take a decision on an infringement.25

Bearing in mind the necessity of strengthening enforcement mechanisms of the Energy Community by exploring the possibility of an independent court body as its integral part, as well as introducing financial fines for Contracting parties failing to align with the Treaty's requirements, such a reform requires support from the EU level, strong advocacy efforts by the civil society and commitment of the Energy Community bodies.

RELIABLE AND UP-TO-DATE DATA MATTERS:

The online emissions register is a widely recognized tool, used to assess pollution trends and evaluate the effectiveness of environmental legislation. PRTR data is also used in studies to assess the effectiveness of environmental policies addressing industrial pollution, such as the EU Industrial Emissions Directive.

These registers support public participation in environmental decision-making, as they reveal the hot spots, and help citizens identify the largest polluters. They can also be used to alert the authorities, or to help them plan new installations. An accurate pollutant register is essential in determining pollution sources, helping authorities to prioritize their pollution reduction actions. Even the polluters themselves can use this data to assess the effectiveness of their environmental investments or to identify their production facilities' pollution leaks or malfunctions . If the industry can communicate its environmental policies, the measures taken and their effects with local residents, this can help build trust and confidence.

STRONGER COMMITMENT OF INTERNATIONAL FINANCIAL INSTITUTIONS TO HIGH ENVIRONMENTAL AND SUSTAINABILITY STANDARDS:

Major financial institutions – private banks, investment funds or international banks such as EBRD, World Bank, and the International Monetary Fund, all have policies in place with regard to social responsibility, sustainability and the environment. Given the fact that owners of large industrial polluters are often more powerful than the governments of countries in which they operate, the only more powerful actor that could influence their operation are the said financial institutions. They can condition their loans with environmental protection measures, requiring the industry to ensure environmental protection prior to granting a loan. Some of these institutions even have complaint mechanisms that citizens or civil society organizations can use to raise an issue when they suspect violations of environmental rules. Supporting energy transition and decarbonization, zero tolerance to air pollution and violations of the right to clean air – these should be the base-line standards for financial support in the energy and industrial sectors.

COMMUNITY ENGAGEMENT, MULTI-PERSPECTIVE APPROACH AND RESPONSIBLE EXPERTS' COMMITMENT:

The scope of actions available to citizens, when it comes to large industrial polluters, is limited. All they can do is alert the authorities, run media campaigns, or engage in decision-making in environmental permitting processes. The Aarhus Convention grants citizens the right to participate and to be consulted when authorities decide on the operation of polluters. The voice of communities, particularly those directly affected by air pollution, has proven to be a trigger for government reactions. These communities need support both from international institutions and experienced environmental civil society organizations.

Air pollution is a multi-dimensional problem that requires a multi-perspective approach and a dialogue based on facts and evidence. A framework for such a dialogue should be provided through strong engagement by experts, particularly those from the public health sector. Health impacts need to be included in decision-making processes, with specific health impact indicators for envisioned policies and projects.

[23] European Energy Journal, Volume 6, Issue 1, March 2016: Dirk Buschle, The enforcement of European energy law outside the European Union: Does the Energy Community live up to the expectations? P. 26

[24] An Energy Community for the Future, Report by the High Level Reflection Group of the Energy Community, May 2014, p. 19

[25] Dirk Buschle, The enforcement of European energy law outside the European Union: Does the Energy Community live up to the expectations? Pp. 31-33

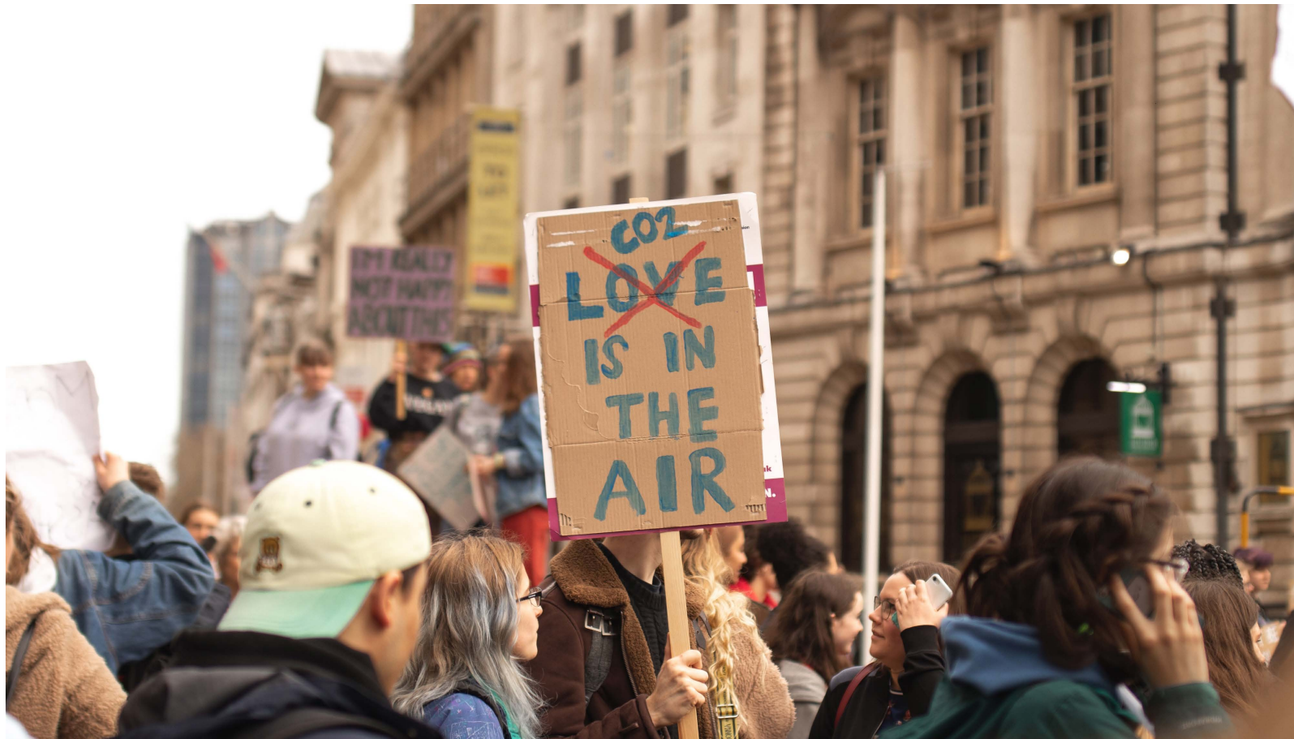
CLIMATE CHANGE AND THE GREEN AGENDA

The lack of strong enforcement mechanisms, transposition of EU and Energy Community aquis without proper implementation and the lack of accountability, create an environment in which air pollution becomes an unsolvable problem. In such circumstances, WB6 governments have committed to working towards the 2050 target of a carbon-neutral continent, together with the EU, through mainstreaming a strict climate policy and reforming the energy and transport sectors. This is the essence of the Sofia Declaration on the Green Agenda for the Western Balkans, signed in November 2020. If taking into account the fact that the EU climate policy relies on an emissions trading system, it is worth mentioning that a business-as-usual scenario in the WB6 is quite far from a desirable trajectory. Cutting CO2 emissions is unviable without a coal phase-out and a resolute decarbonization strategy, which is not very high on the practical policy agenda. As of now, only North Macedonia has pledged to an ambitious goal of speeding up energy transition in order to increase the share of renewables in the installed electricity production capacity to 50% by 2024. On the other hand, all countries of the WB6, including North Macedonia, are responsible for breaching the Treaty Establishing the Energy Community and failure to comply with LCPD requirements. If considered jointly with the lack of legal enforcement, which should enable effective control over key polluters, the loopholes in air pollution monitoring and data collection, and protective governmental attitude towards environmentally harmful foreign investment projects, this indeed represents an emergency call for the EU, Energy Community, civil society, experts' community, and the citizens themselves to unite their efforts in solving the air pollution problems. Perceiving the governments as likely partners would mean that Western Balkans societies have failed to learn lessons from the recent past, as well as those from the present time. Accountability first – exposing the responsible authorities and investors to legal and social responsibility is an inevitable task for Western Balkans societies. Resolving accountability issues will open a space for an inclusive public dialogue on a sustainable future.

Western Balkans still struggle with industrial emissions which have been already solved in the EU. As the Industrial Emissions Directive drastically reduced the industrial emissions of SO2 and PM10 in the European Union, current efforts are directed towards the reduction of Greenhouse gases. On the other hand, the industry in the Western Balkans is yet to install desulfurization and dedusting filters in order to retrofit outdated thermal power plants. Even the necessary improvements for abatement of air pollution, such as desulfurization facilities, will not enable the WB6 power sector to play a significant role in the EU energy market. Isn't it rather sobering that the Council of the EU called for a global phase-out of environmentally harmful fossil-fuel subsidies, a resolute and just worldwide transformation towards climate neutrality, including a phasing out of unabated coal in energy production?[26] Could a picture be any clearer than this? Fragile and fragmented WB6 energy markets can find their place in the EU only through partnerships and a solidary approach to resolving air pollution problems. At the end, air pollution does not care about borders. Do we?

MIRKO POPOVIĆ | DENIS ŽIŠKO | SAMIR LEMEŠ

[26] Council of the European Union, Council conclusions on Climate and Energy Diplomacy - Delivering on the external dimension of the European Green Deal, Brussels, 25 January 2021: https://www.consilium.europa.eu/media/48057/st05263-en21.pdf



AIR QUALITY MONITORING IN THE WESTERN BALKANS

AUTHORS

Ognjan Pantić is a Project Coordinator of the Energy, Climate, and Environment program in Belgrade Open School. His work includes developing project ideas and drafting project proposals, as well as overview and coordination of project implementation. He graduated from the Faculty of Political Sciences in Belgrade, Department of International Politics. He is currently studying for a Master's degree at the same faculty, majoring in Environmental Policy.

CAUSES OF THE PROBLEM

Challenges in the field of air quality monitoring in the Western Balkans are related to the territorial span of the monitoring networks, insufficient monitoring of PM 2.5 concentrations, network maintenance and data validity, as well as transparency and availability of the data. Air quality monitoring networks in Western Balkan countries have been recently established (during the previous decade) and are still being expanded in order for the air quality monitoring systems to meet the standards transposed from the EU air quality legislation into the local legislation of WB6 countries. At the same time, a limited amount of historical data prevents a more detailed analysis.

The data on ambient air pollution, along with reports on the state of air quality at a national level, is shared with the European Environment Agency (EEA) and presented through the European Environment Information and Observation Network (EIONET). Out of the 134 air quality monitoring stations in the region, only a limited number provides data to the EEA and EIONET, North Macedonia being the country with the highest number of stations reporting to these institutions (JRC, 2020, p. 17). The validity of the data, as well as the issue of PM2.5 concentrations monitoring, stand out as some of the main challenges.

The main criterion for the validity of the data is the availability of valid hourly values. Air quality monitoring standards adopted by the region's countries require at least 90% of the available data throughout the year. However, the reports also include data from stations which only achieved the 75% mark. Both national reports and the data provided to the EEA show significant fluctuations in data validity, Albania being the country with the lowest data validity rate in the region – its air quality monitoring network has not achieved required data validity for any of the major pollutants encompassed by the reports issued to the EEA and EIONET (JRC, 2020, p. 15). Fluctuations in data validity are also evident in the air quality monitoring network of Serbia, where 94% of the stations worked in compliance with the standards in 2011 when the network was established. This was followed by a downward trend – the lowest point concerning data validity was reached in 2017 (23%), which was then followed by a notable improvement (SEPA, 2020). In Bosnia and Herzegovina, for example, it has been reported that over the last 6 years, a rate of approximately 75% of valid measurements has been achieved, with 80% in 2019 (FBIH, 2020). The lack of maintenance has reportedly jeopardized the quality of data in Kosovo, whose air quality monitoring network achieved its full operational capacity as late as 2018 (INDEP, 2019, p. 22).

Financial resources, staff capacities at different levels of authority, and institutions that monitor the environment (mainly environmental agencies founded by the ministries in charge) – these stand out as the main challenges for ensuring a robust and functional air quality monitoring system in the countries of the Western Balkans. Human and financial resources ensuring reliable operation and maintenance of monitoring stations have been recognized as a need in North Macedonia (World Bank, NM, 2019, p. 6). In Bosnia and Herzegovina, insufficient financial resources are perceived as the most common reason behind an unsufficient rate of valid measurements (FBIH, 2020, p. 13). A lack of human and technical resources results in a limited number of qualified staff with required technical expertise (World Bank, Kosovo, 2019, p. 10).

In addition to limited resources, decisions and procedures at different levels of governance have also been recognized as having a negative effect on air quality monitoring. Poorly timed or slow public procurement procedures with regard to air quality monitoring have been noted in Bosnia and Herzegovina, as well as in Serbia. This can be illustrated with an example from BIH in which a technical malfunction of the data collection system could not be removed in a timely manner due to public procurement procedures at the Tuzla Canton stations, resulting in the loss of half of the air quality data collected in this area in 2016. (Report on the state of air quality in the Federation of BIH for 2019, 2020, p. 13). For years, there has been a trend of untimely tendering procedures and contracts between local self-government units and local public health institutes in Serbia, on conducting air quality monitoring in a given territory. This has caused frequent difficulties in conducting a valid air quality analysis in certain territories (BATUT, 2020, p. 56).

The scope of PM2.5 monitoring is one of the main challenges concerning air quality monitoring in the Western Balkans. The available monitoring data for PM2.5 is incomplete as the monitoring stations are either not measuring the concentrations of this pollutant, or fail to do so consistently. Only 11 stations from the entire region report the concentrations of PM2.5 to the EEA and EIONET. Furthermore, all of them are located in two countries of the region– North Macedonia and Bosnia and Herzegovina. The focus of air quality monitoring in the entire region is primarily directed at the less harmful PM10 particles.

An additional challenge with regard to particulate matter pollution monitoring is the lack of chemical analysis of this pollutant. PM concentrations include primary particles emitted from combustion sources directly into the atmosphere and secondary particles formed by chemical reactions in air. The lack of analysis of the secondary particulate matter and its origin results in imprecise air pollution inventories.

Finally, transparency and availability of air quality data has been recognized as an important factor, shown by various practices of reporting it to the public . The monitoring and reporting on the concentrations of particulate matter pollution has been recognized as a central challenge, especially taking into account the fact that the equipment for automatic measurement of particulate matter pollution is rather costly.

PROBLEM'S CONSEQUENCES FOR THE CITIZENS

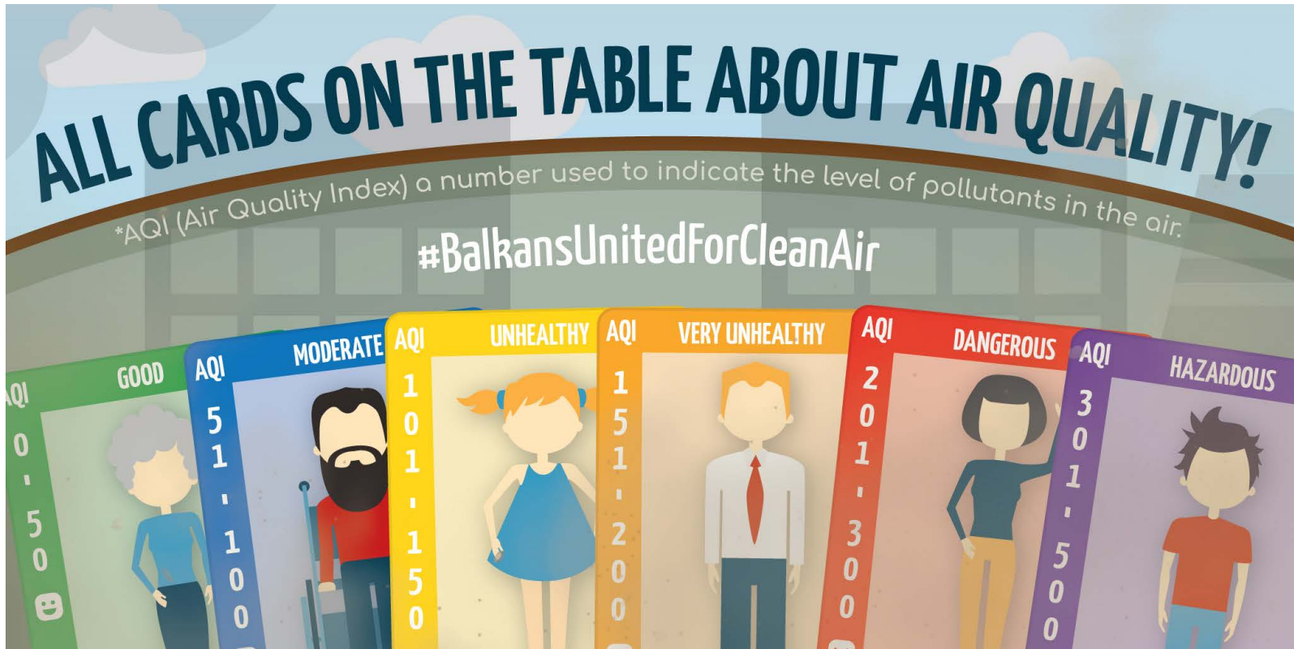
The consequences for citizens caused by the shortcomings of air quality monitoring in the Western Balkans, can be summed up in the following way:

- Citizens in major urban areas lack real-time information on air quality;
- Without official and detailed monitoring, there is no foundation for the implementation of measures by competent authorities;
- Without continuous monitoring, public health institutions are not able to monitor and research the impact of air pollution on public health.

Due to the limited scope of the automatic monitoring of particulate matter pollution, even in certain large urban areas, citizens are left without accurate and complete real-time information on the quality of air in their communities , since the air quality index is not calculated and reported based on the concentrations of all relevant pollutants. This is important given that the concentration of PM10 and PM2.5 particles is recognized as the main challenge in the entire region. Without the real-time information on these pollutants' concentrations, the air quality index (a system used for reporting the daily air quality and associated health effects) is inaccurate and misleading.

In addition, the official data on air quality is often scattered across various information sources. In the case of Bosnia and Herzegovina, for example, federal units are in charge of air quality monitoring, with regional and municipal authorities also having a role in its implementation. The manner in which the data is presented in official documents is not understandable enough to the citizens. Furthermore, some of the official documents are being developed with significant delays. In the case of Serbia, the annual air quality assessment for 2019 was published in September 2020, despite legal provisions which specify that the annual air quality report for each year is to be presented within the first two months of the following year.

Citizens believe that the authorities' efforts on informing the public on air pollution is inadequate. A poll in Montenegro has shown that 47% of the respondents were dissatisfied with the authorities' efforts in informing the public on the state of air pollution (Ozon, 2014). In Serbia, that percentage is as high as 84% (National Geographic Serbia, 2021). The citizens dominantly rely on the media, social media platforms and the internet for information on the topic of air pollution: 60% of respondents in Serbia rely on the mainstream media and social media platforms (National Geographic Serbia, 2021) and 65% in



Montenegro rely on the media (Ozon, 2014) for staying informed on this topic.

Citizens of the region have largely turned to alternative methods for obtaining information on the state of air quality, with various mobile applications such as AirCare and Air Visual, and websites such as WAQI (World Air Quality Index) and Sensor Community becoming increasingly popular with both the citizens and the media in their efforts to get information on air quality in real time, as well as comparisons between different cities and countries. The fact that those tools are utilized by the citizens and the media in the region has led to various reactions from the authorities, mostly improvements in the transparency and the manner in which the official monitoring networks report on air quality – through development and improvement of websites and mobile apps for air quality reporting. All of the national environmental agencies, with the exception of Albania's, have developed websites which present the data on the state of air quality, obtained from the official monitoring networks.

Most of the countries in the region still lack accurate emission inventories; these would provide the data on the extent to which various sectors contribute to air pollution. Efforts on determining various sectors' accurate contributions to ambient air pollution are rare in the region of the Western Balkans (JRC, 2020, p. 3). In some of the countries, such as North Macedonia and Serbia, such inventories have been developed. The inventory of pollutants in North Macedonia is considered to be detailed, but it lacks additional data for areas such as the transport and residential sectors (World Bank, NM, 2019, p. 5). Various uncertainties with regard to the data on fuel use, waste management and vehicles hamper the efforts towards an accurate emission inventory in Bosnia and Herzegovina (World Bank, BIH, 2019, p. 7). Furthermore, there also lack local inventories which would present detailed data in the local context. Incomplete data from the local level lead to an incomplete picture with regard to air pollution at the national level. In Kosovo, it has been noted that local governments often fail to comply with their obligations to report to the national government on air quality (World Bank, Kosovo, 2019, p. 39). In the case of Serbia, the annual assessment of air quality at the national level was carried out with the contributions by only 8 public health institutes, along with the data from the national air quality monitoring network.

The lack of precise air pollution inventories at the national and local level further prevents the development of air quality management. If air pollution rates are high and the measures hitherto taken have failed to reduce them, if certain areas are affected by constant air pollution, then the competent authority is obliged to adopt an Air Quality Plan in order to achieve the appropriate limit or target values. However, without sufficient air quality monitoring there is no foundation for the implementation of air quality improvement measures, neither is there sufficient data for public health institutions to be able to examine the effects of air pollution on public health.

As a consequence of insufficient monitoring, there is a lack of policy instruments for air quality improvement, particularly at the local level. In Bosnia and Herzegovina, there is a need for scaling up the adoption of local air quality plans, given that only two cantons have developed their plans as of now (World Bank BIH, 2019, p. 9). In Serbia, only 29 local self-governments reported to the ministry in charge that they would be implementing local air quality monitoring programs in 2020. Consequently, only six local self-governments have adopted Air Quality Plans approved by the Ministry of Environment. In North Macedonia, air quality improvement plans have not been developed for all zones in which the levels of pollutants exceed the limit values (World Bank, NM, 2019, p. 58).

RECOMMENDATIONS ON PROBLEM SOLUTIONS

The first step in overcoming the challenges of air quality monitoring in the Western Balkans should include sufficient investments in robust systems for air quality monitoring networks, data analysis and management ;

Development of detailed air pollution inventories, both at the national and local level, is a prerequisite to understanding different sources' share in the local air pollution;

Strengthening inventories at the local level should be carried out in order to provide additional statistical data on energy consumption in the residential sector (data on fuelwood and combustion technologies used in households);

The geographic coverage of air quality monitoring networks should be increased, with a particular focus on expanding the scope of PM2.5 particles monitoring; Additional efforts and funds for ensuring real-time monitoring of particulate matter pollution in all major urban areas are also required;

Monitoring of particulate matter pollution should be expanded so as to encompass the measurement of chemical species and components of particulate matter;

It is necessary to ensure strengthening and further capacity building of the staff in charge of the monitoring stations' operation and maintenance;

It is necessary to improve the cooperation and coordination between various authorities at the local, regional and national level, in order to ensure air quality monitoring implementation at all levels, as well as information exchange between different institutions;

Further work on improving the transparency of air quality data and its presentation to the citizens should be undertaken by the competent authorities operating the air quality monitoring networks.

CLIMATE CHANGE AND THE GREEN AGENDA

The importance of improving air quality monitoring is underlined within the Green Agenda for the Western Balkans. Some of the main findings of the Green Agenda with regard to air pollution in the Western Balkans include the following:

It is necessary to reduce the fragmentation of air quality monitoring and reporting between national and local authorities; the complete set of air quality indicators stipulated by the legislation should be the subject of monitoring.

Moreover, integrated environmental monitoring systems that provide access to both real-time and processed online data should be developed in order to provide timely and comprehensive air quality analyses. The development of complete and accurate emission inventories should be a priority in the WB area.

Assessing the atmospheric transport processes and the formation of secondary pollutants is a prerequisite for quantifying the impact of their sources on air quality. Source apportionment is a necessary step for the development of effective abatement strategies and air quality plans.

Development of reliable emission inventories will also contribute to improved monitoring of the emission of gases crucial to international mitigation efforts, as a central part of combating climate change. Various international mechanisms that were developed in the past decades as a policy framework to reduce the emission of different gases, presuppose the existence of detailed and robust emission inventories.

SOURCES:

https://eur-lex.europa.eu/legal-content/ENTXT/?uri=CELEX-%3A52020SC0223

https://ec.europa.eu/jrc/en/science-update/eu-support-decarbonising-western-balkans

LITERATURE:

Agjencija Kombetare e Mjedisit: "Raporti i Gjendjes Ne Mjedis", 2019 http://www.akm.gov.al/assets/rgjm-2019.pdf

Agencija za zaštitu prirode i životne sredine Crne Gore: "Informacija o stanju životne sredine za 2019. godinu", 2020. https://epa.org.me/wp-content/uploads/2020/10/Informacija%20o%20stanju%20zivotne%20sredine%20za%202019.%20godinu.pdf

Agencija za zaštitu životne sredine R.Srbije: "Godišnji izveštaj o stanju kvaliteta vazduha u R. Srbiji za 2019. godinu", 2020 http://www.sepa.gov.rs/download/izv/Vazduh_2019.pdf

Ekološki pokret "Ozon": "Ispitivanje javnog mnjenja o nivou informisanosti građana o uticaju aerozagađenja na zdravlje ljudi i kvalitet životne sredine u opštinama Pljevlja, Nikšić i Podgorica", 2014.

European Commission: "JRC Science for Policy Report: Status of air pollutants and greenhouse gases in the Western Balkans", 2020 https://publications.jrc.ec.europa.eu/repository/bitstream/JRC118679/air_qualityghg_western_balkans_online.pdf

INDEP: "Air quality in Kosovo – Towards European standards", 2019 https://indep.info/wp-content/uploads/2019/08/INDEP_June-2019_Air-Quality-in-Kosovo.pdf

Institut za javno zdravlje Srbije "Milan Jovanović Batut": "Zagađenost urbanog vazduha na teritoriji Republike Srbije merena u mreži institucija javnog zdravlja u 2019. godini", 2020 http://www.batut.org.rs/download/izvestaji/higijena/GodisnjiIzvestajVazduh%202019.pdf

Nenad Spasojević: "Šta građani Srbije misle o kvalitetu vazduha", 2021; Published in the National Geographic Serbia: https://www.nationalgeographic.rs/vesti/16133-zagadjen-vazduh-istrazivanje-sta-gradjani-srbije-misle.html

The World Bank: "Western Balkans Reqional AQM – Bosnia and Herzegovina", 2019 http://documents1.worldbank.org/curated/en/117281576515111584/pdf/Air-Quality-Management-in-Bosnia-and-Herzegovina.pdf

The World Bank: "Western Balkans Regional AQM – Kosovo", 2019 https://openknowledge.worldbank.org/bitstream/handle/10986/33041/Air-Pollution-Management-in-Kosovo.pdf?sequence=1&isAllowed=y#page=64&zoom=100,92,813

The World Bank: "Western Balkans Regional AQM – North Macedonia", 2019 http://documents1.worldbank.org/curated/en/116521576516981237/pdf/Air-Quality-Management-in-North-Macedonia.pdf

OGNJAN PANTIĆ

BALKANS UNITED FOR CLEAN AIR

UJEDINJEN BALKAN
ZA ČIST ZRAK

BALLKANI I BASHKUAR
PËR AJËR TË PASTËR

ОБЕДИНЕТ БАЛКАН
ЗА ЧИСТ ВОЗДУХ

UJEDINJEN BALKAN
ZA ČIST VAZDUH