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UNITED NATIONS DEVELOPMENT PROGRAMME

DEVELOPMENT FUTURES SERIES

SEPTEMBER 2021

UNDP Global Policy Network Brief

Air quality monitoring data for analysis of the pace and intensity of the coronavirus (COVID-19) spread in Central and Eastern Europe and the Balkans

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The correlation between ambient air quality and heightened transmission rates/case severity of COVID-19 has been recognized in previous studies. The initial results have shown that an increase of only 1 μg/m3 in PM2.5 is associated with an 11 percent increase in the COVID-19 death rate.[2] Nevertheless, there is very limited data available on air quality and its correlation with COVID-19. The lack of necessary data affects policy preparation and the development of national strategies that would focus on reducing air pollution with a view to combatting the ongoing pandemic and other health issues. Air pollution is a major public health threat[3] and one of the main environmental problems in developing countries. Capturing the combined impact of both threats is a challenge that the entire international community faces.

The United Nations Sustainable Development Goals (SDGs)[4] mention air pollution under two targets: SDG 3.9 (substantial reduction of health impacts from hazardous substances) and SDG 11.6 (reduction of adverse impacts of cities on people). However, there are also indirect links to other SDGs (such as clean water, conservation or industry innovation).[5] The United Nations Development Programme Istanbul Regional Hub and its country offices have joined the discussion, capturing links between air pollution and COVID-19 on both the global and local scales—Ukraine, Serbia and Moldova are just examples.[6]

The obstacles that need to be overcome include how to deliver air quality data without delay for government policymaking and response and how to facilitate data interpretation by citizens. There are diverse forms of pollution in terms of type and concentration, and pollution information is presented in concentrations of different pollutants, which makes it difficult for the public to understand. A graphic presentation of the air quality index makes it easier to understand for general users and policymakers. The 'hyper-local approach' allows identification of the sources of air pollution, alerts about its threats, and the delivery of data for decision-making processes, justifying actions for air pollution prevention and improving resource management.

This paper aims to raise awareness of the need for a coordinated/cross-sectoral approach to air quality management and health sector planning.

I. Method of air quality data collection and processing

For the purpose of air quality data collection, Airly PM+THP+GAS sensors were used. They measure the concentration of suspended particulates PM1, PM2.5 and PM10; two gases, NO2 and O3; and air temperature, humidity, and pressure. Measuring suspended particulate matter is based on light scattering analysis (Mie scattering) of dust particles in a measurement chain—and the laser method enables the analysis of individual dust particles. The measurement data pertaining to air quality and weather parameters are averaged and sent in regular intervals to the data collection platform.

The accuracy of the devices, described as the correlation rate against reference instruments, is > 0.8, which indicates the data is reliable for drawing conclusions. Information on the current quality of air is also conveyed by built-in LED diodes. Airly sensors use global system for mobiles (GSM) networks not only to transmit data but also for remote updates and diagnostic purposes. A built-in SIM card enables unattended usage of the sensor. The Airly sensor is powered by an included USB power adapter.

II. Data analysis and insights

Based on our data analysis on the relationship between the rates of COVID-19 cases/deaths, and air pollution in Poland, we were able to repeat this analysis for a set of countries. The first group of countries was in Central and Eastern Europe: Poland, Belarus, and Ukraine. The second group was three Balkan countries: Serbia, Macedonia, and Bosnia and Herzegovina. To serve as a reference for the above-mentioned countries, we also added two high-income countries: Norway and Denmark, which are known for their good air quality.

Air quality data was acquired from the Airly network of sensors. We used a period from November 2020 to the end of March 2021. This period is the winter season in most of those countries, and therefore the season with the worst air quality given the emissions from heating.

As supported in earlier studies, air pollution can catalyse the spread of the virus—small air particles, such as PM2.5 and PM10, can carry the virus on their surfaces, thus increasing exposure to the risk of infection, particularly in high-population density areas. The pollution tends to be worse in poor communities, hence making it more difficult for vulnerable groups to protect against future pandemics.

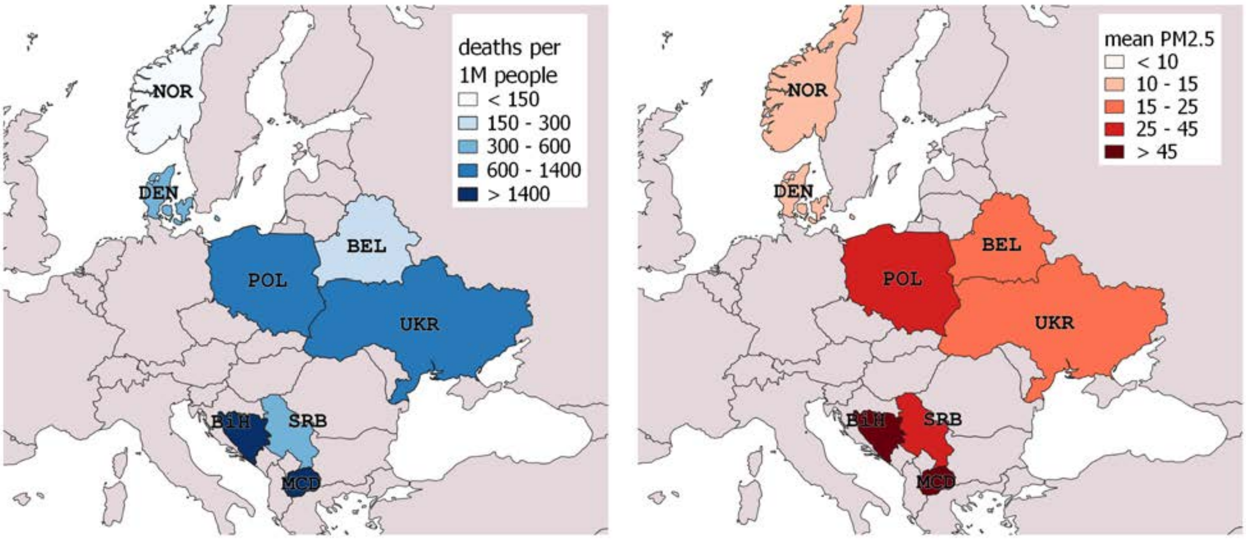
PM2.5 is acknowledged as a greater threat to health than PM10, considering that smaller particles are more likely to be deposited deep in the lungs and throughout the body.

Individual and district heating as well as fossil fuel–based power generation are important contributors to the PM2.5 concentrations, which are less than 2.5 micrometers in diameter and can penetrate deeply into the lung, irritate the alveolar wall and impair lung function. This can leave the body and early immune response more vulnerable to various infections and diseases, such as COVID-19.[7]

Children and women are even more at risk than before, depending on the hours spent indoors, which are very likely to be long hours considering COVID-19 related restrictions/lifestyles.

The COVID-19 data on confirmed case and death rates were acquired from the worldmeters.com website, which provides data from multiple national and official sources.

Figure 1: Number of COVID-19 deaths through the end of March 2021 and mean PM2.5 concentration from November 2020 to 21 March 2021



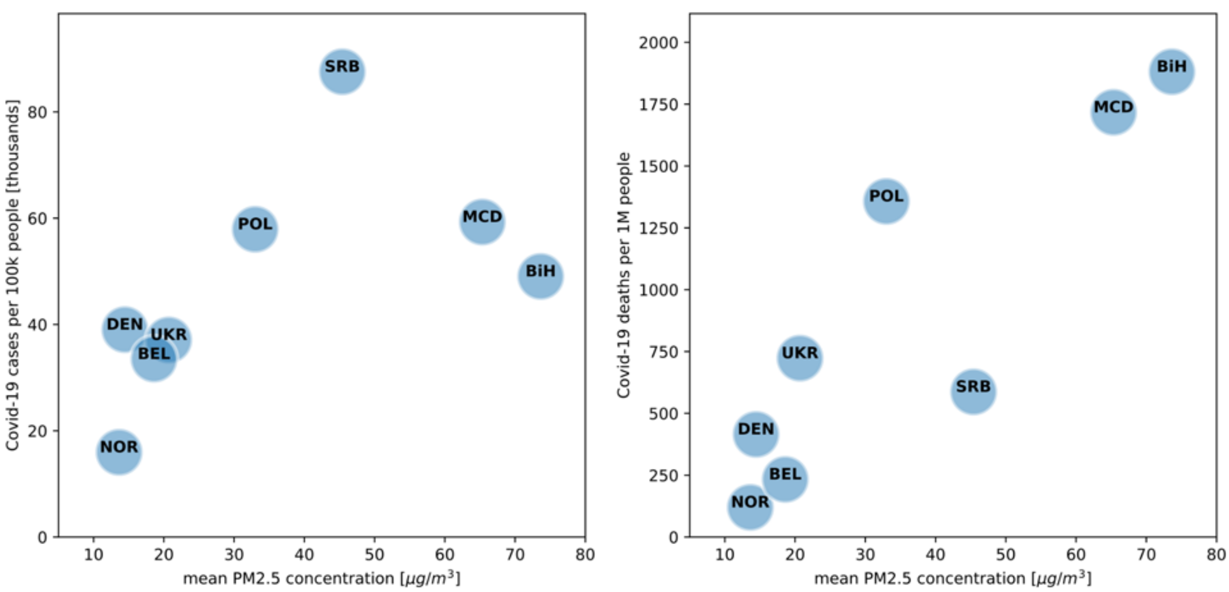
The depiction and use of boundaries, geographic names and related data shown on the map do not imply official endorsement or acceptance by the United Nations, including UNDP, or UN Member States.

Source: Airly, European Environment Agency, Worldmeters.org

We compared the mean PM2.5 concentration [µg/m^3] for each country for the period of November 2020–March 2021, with the number of confirmed COVID-19 cases and the number of confirmed COVID-19 deaths from the beginning of the pandemic for the four consecutive months.

Correlation between COVID-19 mortality/morbidity rates and air pollution (PM2.5) concentration have been calculated based on the Pearson correlation coefficient, measuring dependency between the studied variables.

Figure 2: Correlation between COVID-19 mortality/morbidity rates and air pollution (PM2.5 mean concentration from November 2020 to March 2021)



Source: Airly, European Environment Agency, Worldmeters.org

Table 1: Data about air pollution, COVID-19 mortality/morbidity rates and population of analysed countries

Country	Country abbreviation	Population	Mean concentration of PM 2.5 [μg/m^3]	Covid-19 deaths per 1M	Covid-19 cases per 1M
Bosnia and Herzegovina	BiH	3.3 M	73.6	1881	49,000
N.Macedonia	MCD	2.07 M	65.3	1717	59,300
Serbia	SRB	6.94 M	45.4	587	87,500
Poland	POL	37.9 M	33.0	1357	57,900
Ukraine	UKR	43.5 M	20.7	723	37,000
Belarus	BEL	9.4 M	18.6	233	33,500
Denmark	DEN	5.8 M	14.4	415	39,000
Norway	NOR	5.3 M	13.6	120	15,900

Source: Airly, European Environment Agency, Worldmeters.org

For both phenomena, we witness a correlation between air pollution and COVID-19 outcomes: 0.88 for the number of deaths and 0.58 for the number of cases, respectively.

The finding does not imply direct causality, as the number of cases and deaths is the outcome of many factors. These include population density, healthcare quality and capacity, age of the population and implemented restrictions (lockdowns) as well as differing testing and reporting policies among countries.

However, given the results of the detailed regional analysis in Poland, where many other factors were taken into consideration, air pollution was found to be the most responsible for COVID-19 outcomes. These results are alarming, and more research is needed on this topic, given the lack of data on the relationship between COVID-19 and air pollution.

It is, therefore, likely that bad air quality, especially in the Balkans, is contributing to facilitating COVID-19 pandemic outcomes as well as being responsible for many other diseases and health problems. It also emphasizes the role of up-to-date, local data on air pollution, as both air pollution and COVID-19 outcomes are locally diverse within Poland.

Very interesting is the relationship between air pollution and cases in Serbia, where the number of cases is the highest among the selected countries and the number of deaths is the lowest of the Balkan countries. Air pollution in Serbia remains on a moderate level. However, compared to the national averages, we notice higher levels of pollution in Serbia's major cities, where data for air quality is collected. The presented relationship requires the analysis of more factors to draw conclusions. Our results indicate that air pollution level is the contributing factor in the context of enabling COVID-19 case-load increase.

III. Alignments to the Development Debate and Possible Steps in the Future

Real-time measurements for November 2020–March 2021 reveal that the combustion of fossil fuels is the main source of pollution in Central and Eastern Europe (except Belarus) and the Balkans. The concentrations of PM2.5 and PM10 rise significantly with drops in temperature and the increased domestic activity of residents, which points to the use of solid fuels and biomass for house heating. There are multiple regions where homes are equipped with central heating systems and still use coal or wood. Clean energy solutions are still not well recognized in the region and are relatively expensive. According to the Center of Research and Energy and Clean Air, the economic and health costs of air pollution from burning fossil fuels totaled US$2.9 trillion in 2018. This is calculated in the form of work absences, years of life lost and premature deaths. The cost represents 3.3 percent of global GDP, which is about US$8 billion per day. A similar cost calculation for 2020–

2021 is still ongoing. However, considering the extent of the pandemic and the number of deaths, this figure is likely to increase.

Using air quality data combined with the current number of inhabitants in a given region and medical statistics might provide important insights for planning governmental responses. This calculation seems simple and, if used in decision-making processes, will allow for the allocation of medical, financial and other resources in advance of the need to use them. Provision of an optimal level of human resources and equipment can also be used in other regions to better manage costs. The use of air quality data could significantly affect the time and quality of medical services provided in a region, which is crucial in treating COVID-19. It will also bring an economic benefit in the form of cost reduction. From a logistical perspective, it may be interesting to use air quality data to determine the order of vaccinations and other services for the poorest people, who tend to live in areas with a high risk of air pollution.[8]

The correlation between air pollution and health risk is proven not just with regards to droplet-borne diseases and virus spread. According to the World Health Organization,[9] long-term exposure to air pollution (PM2.5) leads to a wide range of diseases. Multiple types of air pollution have an impact on the central nervous system and can cause headaches and anxiety (SO2, PM), eye irritation, breathing problems in the nose and throat (NO2, PM, O3), asthma and reduced lung functions (NO2), lung cancer (PM) and cardiovascular diseases (SO2, PM, O3) and can impact the liver, spleen and blood (NO2) and the reproductive system (PM). Taking actions similar to those described above for COVID-19 can reduce the number of premature deaths, improve cost management processes in healthcare and reduce economic losses arising to easily interpreted regional data about air quality. This should be supported with the development and use of affordable alternatives to fossil fuels in heating systems. This data should be available on the Internet for access from desktop devices and mobile applications as well as on paper in the form of reports by the local council or leaflets available in schools and offices. Introducing online classes on the formation of air pollution will also help educate younger generations that can influence elder ones.

Create awareness among governments that there are feasible alternatives to fossil-based systems and practices, based on calculations of the economic and health burdens of air pollution with return-on-investment scenarios. Overviews such as this allow governments to take action based on concrete calculations. Therefore, improvements in the following sectors, among many others, will be critical:

- Green transport: Upgrading vehicle emission and fuel quality standards, developing retrofitting programmes for heavy-duty vehicles, and promoting shared mobility as well as clean transport technologies like electric vehicles.
- Efficient heating: Promoting clean and efficient heating systems (compared with existing coal stoves) while implementing mandatory building codes for energy efficiency and energy saving and improving building insulation.
- Cleaner waste: Providing incentives for circular economies, developing integrated waste management strategies (with improvements in waste prevention, segregation, collection, recycling, treatment and disposal facilities) and banning open burning of accumulated waste.

2. **Develop the infrastructure for air quality measurements with better data and monitoring systems**, as existing infrastructure allows only