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INCREASING THE VISIBILITY AND KNOWLEDGE BASE ON AIR QUALITY WITH BIG DATA AND ITS IMPACT ON THE POPULATION HEALTH

Erasmus+ KA220 Cooperation Partnerships

AIR POLLUTION SOURCES - POWER PLANTS

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1 INTRODUCTION

The global ecological crisis, which is becoming more intense every year, is linked to the quality of life and the development of regions. Population growth, urbanization, the development of economic sectors (mining, energy, industry, transport) creates several environmental problems, but can also affect the quality of life of the public, by influencing air quality (Alloway 1995). Kampa and Castanas in (2008) stated, that the main sources of particulate air pollution are factories, power plants, waste incinerators, motor vehicles, construction activity, fires and natural wind-blown dust. That´s why reducing air pollution is a crucial element in promoting sustainable development.

2 BACKGROUND

One of the global and local challenges is air pollution, which is mainly caused by energy production and use. Over time, it continuously contributes to global warming. In today's world, energy is essential in all aspects of existence. It is critical for industrial production, fuel for transportation, and energy generation in thermal power plants. Electricity is also widely known as a key tool for nearly all human activities (Hannun, R. M., and Razzaq, A. H. A. (2022). One of the many sources of air pollution are different types of power plants. Emissions from coal-fired power plants are among one of the largest air pollutants and also significantly affect both air and water quality (Duncan et al., 2016, Chai et al., 2018; Uddin and Czajkowski, 2022), human health (Li and Gibson, 2014, Gao et al., 2018, Wu et al., 2019), and economies (Ye et al., 2019) of many countries. Most importantly for human health, coal combustion causes emissions of particulate matter ($PM_{2.5}$ and PM_{10}), ozone (O_3), nitrogen oxides (NO_X), and carbon dioxide (CO_2), sulphur dioxide (SO_2), methane (CH_4), volatile organic compounds (VOCs) and more than 80 hazardous air pollutants such as mercury, lead, arsenic and benzene (Shahzad Baig and Yousaf, 2017). Inhaling air with high concentrations of these pollutants can irritate the respiratory system, particularly during short-term intense exposure. The most significant pollutants in the atmosphere are CO2, SO2, NOx and primarily PM (Schneider, D. R., & Bogdan, Ž., 2007). Particulate matter (PM) is small particles with an aerodynamic diameter less than or equal to 10 micrometres that are produced by the combustion of fossil fuels in coal-fired power stations (Contini, D., et al., 2016). Due to their small size, they can enter the respiratory tract deep in the lungs, where they can settle and cause health problems (Shin, D., et al., 2020). Prolonged exposure may contribute to asthma development and increase susceptibility to respiratory infections (Eguiluz-Gracia et al., 2020). These pollutants significantly affect acid deposition (Lu and Streets, 2012; Yim et al., 2019), smog formation (Jacobson et al., 2004; Lu et al., 2013), visibility (Singh et al., 2017), and radiative forcing (Peng et al., 2016). Sulphate and nitrate aerosols also impact the climate by reflecting solar radiation and cooling the atmosphere (Lyamani et al., 2008), while serving as cloud condensation nuclei (CCN), which modify cloud properties (Novak et al., 2021). Sulphate’s can persist and travel long distances, making sulphated pollution a regional and global issue (Lee et al., 2011). The

impact of power plants on the environment is a central topic of discussion for many scientists. Recent studies on emissions from coal-fired power plants, especially those without modern control techniques, have raised the issue of controlling several hazardous pollutants, including gaseous emissions and heavy metals (Campbell 2020; Chen et al., 2020). The combustion of coal in thermal power plants generate huge amounts of ash, which is a source of inorganic pollutants from both air and damp in the area surrounding of the plant (Adriano et al., 2002; Dragovic et al., 2013). This form of pollution caused year worldwide many health problems (Finkelman et al., 2021**).** Therefore, the need to improve air quality associated with coal-fired power plants is also stated in combination with technological progress (Wilczyńska-Michalik et al., 2020). Hazardous fly ash, which is released from the air when coal is burned as residual unburnt particles, causes respiratory and lung diseases. Heavy metals such as mercury cause neurological diseases in both humans and animals (Deng et al., 2019). One of the most serious environmental problems in developing countries is gas flaring. Its combustion pollutes the air in the area where the oil is processed, thus emitting various pollutants into the environment, including NOx, CO, CO2, SOx and hydrocarbons (Kahforoshan et al., 2018). Based on Howard et al., (2019) in 2015, it was estimated that 4.2 million people worldwide died because of exposure to ambient particles due to the environmental impact of thermal power plants. Power plants that are using a modern pollution control systems are able to capture more than 99% of the dust particles produced. However, emissions from power plants which combustion fossil fuels such as (coal, oil, and natural gas) or those that have outdated infrastructure, as well as those that have been exempted from the obligation to implement pollution control systems to reduce air emissions, contributing to a range of health problems and an estimated number of one million premature deaths per year globally; 800 000 of those deaths were in Asian countries (McDuffie et al., 2021). In December 2021, the global amount of CO2 was recorded at nearly 417.41 parts per million (ppm), it was the highest on record despite the economic strike due to the COVID-19 pandemic (Lindsey 2024). Coal accounted for up to 27% of global primary energy supply in 2021, which was largely used for electricity generation. However, this coal combustion contributed to 15 billion tonnes CO2 per year globally (Buonocore et al. 2021), however China is considered the world's largest consumer of coal and has a capacity of 1.1 billion kW of installed coal-fired power plants in 2019, followed by India, the US, Germany, Russia and Japan (Wang 2020). The report 'Coal Kills' by researchers (Goenka and Guttikunda, 2013) states that coal contributes to 80,000 to 115,000 premature deaths annually in India. In Europe, coal causes up to 23,300 deaths annually. The medical costs that arise from coal combustion are estimated to be around USD 70 billion per year. These statistics represent estimates related to the impact of coal dust and emissions from coal-fired power plants on public health (Finkelman et al., 2021). Costs that cannot be directly quantified are largely invisible because they are related to environmental degradation of ecosystems and deteriorating living conditions. Over a long period of time, these costs can rise high to cut down countries' budgets and slow economic growth (Landrigan et. al., 2018).

The importance of clean energy derived from nuclear power in the field of environmental pollution has recently received tremendous attention from scientists. Based on research, the authors argue that clean energy sources help mitigate CO2 emissions (Paramati et al., 2017; Bélaid, F., and Youssef, M., 2017; Dong et al., 2018). Opinions are quite divided on this issue, with some scientists agreeing that clean energy sources contribute to pollution and few others argue that the impact of renewables has an insignificant effect on CO2 production (Bulut 2017; Bento, J. P. C. and Moutinho, 2016). Lee el. al., (2017) confirms through his research that the energy obtained from nuclear fuel has a positive effect on CO2 production, which means that nuclear mitigates the level of CO2 emissions. Another research group presents that nuclear power produces less CO2 emissions than coal power, even when used with technologies that help capture carbon storage (Xu, et al., 1018). Another group of researchers reports the opposite findings. Authors Jin and Kim (2018) examined the relationship between CO2 emissions and energy produced from nuclear fuel in 30 countries over the time span 1990-2014. The results of the research showed that nuclear power had no effect on reducing CO2 emissions. Based on Saidi and Mbarek (2016) who investigated the relationship between nuclear power consumption and CO2 emissions in nine developed countries between 1990 and 2013 have found, that the impact of nuclear power on CO2 emissions is negligible. Based on Jaforullah (2015) research, he presents that nuclear power consumption increases CO2 emissions, while Baek (2016) talks about the negative impact of nuclear power and carbon emissions. According to Ishida (2018) nuclear power consumption increases CO2 emissions in Japan, but Iwata et al., (2010) writes that nuclear power reduces carbon emissions in France. Research on the impact of nuclear power plant operations in South Africa has shown that nuclear power promotes pollution (Sarkodie and Adams 2018).

3 CONCLUSION

Nuclear power plays an important role in reducing carbon emissions however, the operation and management of a nuclear power plant always involves some risks (Nur et. al., 2024). There is strong evidence that air pollutants pose serious health risks to the global population. The World Health Organisation (WHO 2014) estimates that around seven million people die each year worldwide because of air pollution. Both short- and long-term inhalation of fine particles found in the air can cause increased health risks such as respiratory infections, coronary heart disease, stroke, lung cancer and infant mortality. Other research, in turn, also reports the impact of air pollution on fetal and infant health (Currie et al., 2015). In addition to effects on the human cardiovascular system, the effects of coal dust/emissions have been associated with negative increased susceptibility to viral and bacterial infections, low birth weight in newborns, neurological effects, and reduced life expectancy (Lockwood, et al., 2009; Burt et. al., 2013). Javidkia et. al., (2011) says that the new generations of nuclear power plants are much safer, and this energy is the cleanest, safest and most environmentally friendly source of energy among other energy sources.

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