THE PM10 EXPOSURE DURING POOL CONSTRUCTION IN NOVI SAD, SERBIA

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Abstract

The local impacts of construction site activity should be taken into account in order to properly address the risks to human health, particularly within vulnerable and sensitive urban areas. The paper presents a particulate matter (PM10) exposure assessment during a construction project in a mixed-use area including medical center, an elementary school, sports centers, and residential houses. The average PM10 concentration modeled was 171.25 μg/m³, using the EMEP/EEA Tier 1 methodology. Risk assessment was based on dose-response functions and Time-Weighted Average (TWA), Occupational Exposure Limits (OEL) and the Air Quality Index (AQI) value. Risk elements are highly expressed, especially for certain groups: children, patients, and residents. The research revealed rapid need for application of effective dust control measures that will avert the PM10 emission impact on workers carrying out the project and people in the vicinity of the construction site.

Introduction

Air pollution, including particulate matter suspended in the air, has currently emerged as both an important environmental and public health issue in urban areas across the world. Among the various kinds of pollutants Particulate Matter (PM) smaller than 10 micrometers, referred to as PM10, poses a major threat to health because of the way these particles can enter the respiratory system and travel down to the lungs. Several research studies prove that exposure for a long time to high levels of PM10 is very dangerous and may result in a variety of health problems such as respiratory and cardiovascular diseases and ultimately may lead to high mortality rates [1–4]. That is why urban transformation activities need to be clearly marked as crucial sources of PM10 emissions, especially in densely populated regions where they can seriously degrade air quality and affect public health [5, 6].

Earth excavation, material handling, demolition, and use of heavy machinery are among the major dust and particulate matter sources in construction activities [7]. Without effective dust control, emitted particulate matter can stay airborne for a long time and travel long distances, resulting in increased concentrations of PM10 [8, 9]. The associated health risks are extended by the exposure of children, the elderly, and persons with existing respiratory health problems [10].

The paper observes a construction project of pool center within a mixed-use area. The construction site urban characteristics are important for detailed assessment of PM10 emissions. Proximity to hospitals increases the population's risk of being sensibly exposed to high levels of PM10, which has the effect of compounding or inducing cardiovascular or respiratory conditions [11]. The sports centers and residential areas are also at a greater risk because during

the period of construction, active individuals as well as residents would be exposed to harmful air.

The World Health Organization (WHO) and the European Environment Agency (EEA) have laid down guidelines to limit concentrations of particulate matter to safeguard human health. WHO specifies that particulate matter concentration by mass should not exceed on average 20 μg/m³ annually and 50 μg/m³ in 24 hours [1, 2].In many urban construction sites across the globe, the levels of PM10 are high above these limit values [12–14]. The main concern is the long-term health impact it may have on the workers. While developed countries are under strict air quality monitoring, the developing countries such is Serbia still lack legislation.

Material and methods

Location

The construction project is in an urban area surrounded by critical infrastructures; these include a medical center, an elementary school, several sports centers, and residential housing. These facilities are within a 500-m radius which classifies the area as very sensitive to air quality changes. Construction activities involve earth excavation and building development over 12 months. The proximity of sensitive receptors, such as patients at the hospital, and children at the school or playground, as well as elderly residents in surrounding houses, requires special attention to PM10 exposure.

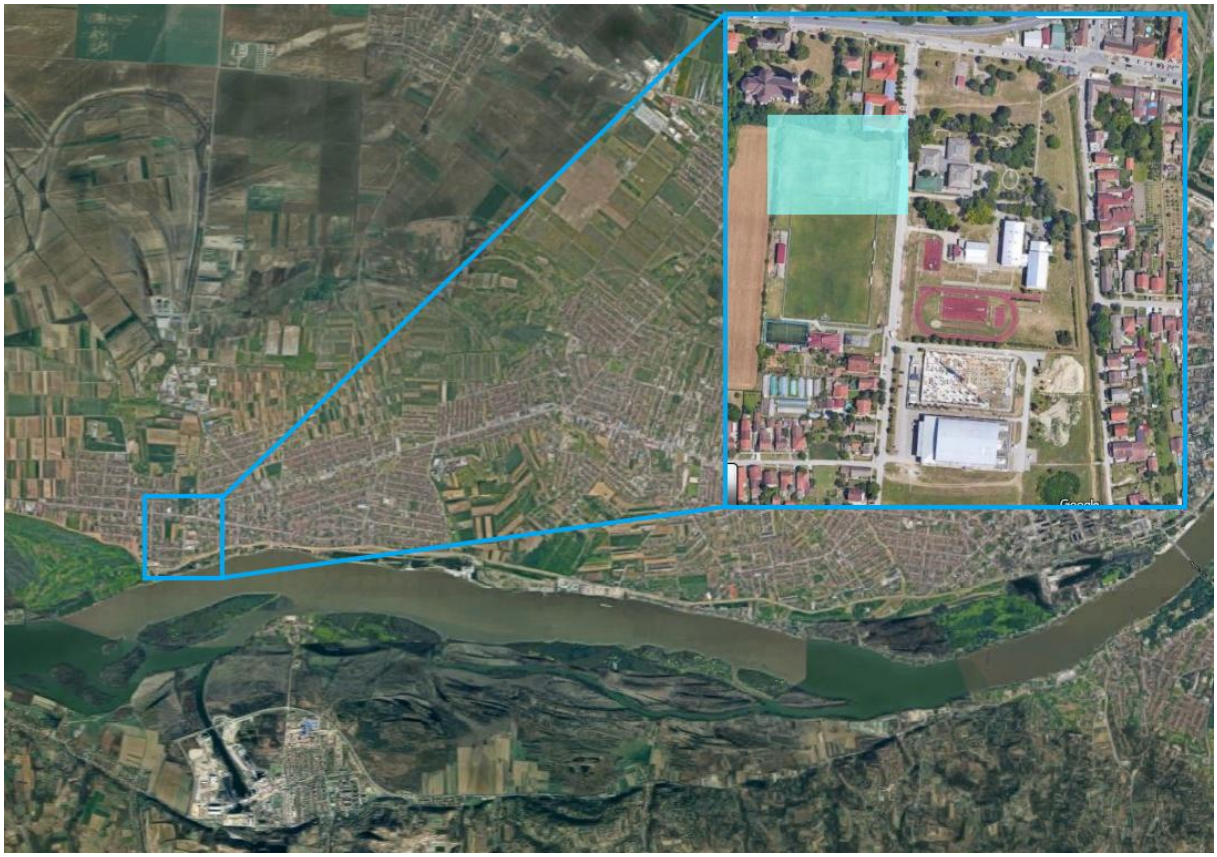

Figure 3. Pool construction in Novi Sad, Serbia

PM10 emission modeling

The EMEP/EEA Tier 1 methodology model was applied in modeling average PM10 concentrations [15]. The method uses emission factors and activity data for estimating levels of PM10 on selected location. Key input parameters include a silt content of 35.4% [16]. The modeled average concentration of PM10 for pool construction project is 171.25 μg/m³. Since the site is close to different receptors, such a concentration is of great concern to public health.

Dose - response calculation

The dose-response function is used to calculate the relative risk (RR) of respiratory diseases due to PM10 exposure. With the concentration of PM10 increasing per 10 μg/m³, the risk of respiratory diseases RR increase by 0.6%. At an average PM10 concentration of 171.25 μg/m³ with a baseline reference level of 20 μg/m³, the relative risk (RR) at this site is 1.9075. This means that the likelihood of respiratory complications increases by 90.75%.

Occupational exposure limit (OEL)

For modeled PM10, the Time-Weighted Average (TWA) concentration for worker exposure is given as TWA = C × T / Ttotal, where C is the concentration, 171.25 μg/m³, T is the duration of the work shift, 8 hours, and Ttotal is the total shift length, 8 hours. The TWA was 171.25 μg/m³ for this project, 3.425 times the Occupational Exposure Limit (OEL) of 50 μg/m³. This indicates very major risks to the occupational health of workers.

Air quality index (AQI)

From the average modeled PM10 concentration, the AQI was calculated to 115, putting the air quality into the “Unhealthy for Sensitive Groups” category. This indicates that under prolonged exposure, members of sensitive populations (children, patients, elderly) may experience effects that are unhealthy, and members of the general population may be lightly affected.

Results and discussion

At 171.25 μg/m³, the modeled concentration significantly exceeds the WHO's 24-hour recommended limit of 50 μg/m³ [2]. The high level of PM10 is very risky, especially for sensitive populations around the construction site. For instance, patients in the medical center are already at risk of developing a disease associated with PM pollution, which is primarily linked to heart or respiratory conditions. Onsite school-going children are more susceptible to developing asthma and other related respiratory issues due to their developing lungs. Equally, athletes involved in different sports and who frequently attend training sessions may note a reduction in their lung capacity as well as feeling exacerbated signs during high-level physical activities in a polluted environment.

Table 1. *Research results*

Applied model	Average PM10	Dose-response	OEL	AQI
Results	171.25 μg/m³	1.9075	3.425	115

TWA calculation indicates that workers are exposed to PM10 levels that are 3.425 times the OEL. Continued exposure to such high levels increases the likelihood of an individual developing chronic respiratory conditions. The conditions may manifest as bronchitis or lung dysfunction. The different conditions further call for strict workplace safety measures, which include personal protective equipment (PPE) and dust suppression systems. Use of PPE reduces the level at which workers may be exposed to risky conditions.
With an AQI value of 115, this location is slightly within the "Unhealthy for Sensitive Groups" category. Because it is close to the medical center and elementary school, immediate mitigations are very important: water spraying for dust control, covering exposed soil, and also scheduling high-dust activities so that they take place during off-peak hours when the surrounding areas are less occupied.

Conclusion

On the pool construction site, PM10 emissions are discovered to be tightly connected with health risks. The recently allowed average PM10 concentration in this atmosphere is surpassed by 171.25 μg/m³, an issue of great concern related to public health. Vulnerable populations that is located in the vicinity of the construction site present a much higher risk of contracting respiratory diseases. In addition, workers are exposed to levels close to four times the recommended OEL, which therefore calls for dust control and personal protection strategies to ensure worker safety. The most effective ways the risks associated with such exposure occur only during working hours and would need complete dust control and personal protection strategies to be put in place.

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