Thesis Abstract

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THESIS TITLE:
Air Pollution Cavity Areas, the effect of Urban Form on air pollution dispersal.
Case study, Tirana – January – March 2023

Curriculum: Urban Planning

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Abstract:

This research reflects upon the promotion of a sustainable solutions for the next generation of urban planning systems addressing the decreasing ecosystem services in urban areas vis a vis the natural dispersal of air pollution and further depollute the cities as one of the main objective of 2050 Green Ageda (European Commision, 2020).

Currently, 73% of Europe's population live in cities and this is projected to increase up to 82% by 2050, resulting in over 36 million new urban citizens. **Cities are a dynamic and diverse habitat**, not only for people, but also for plants, animals and various natural cycles that interlink by offering a fertile and in the same time fragile nexus. With the ever-expanding urban area, there are **less suitable conditions for nature fulfilling its cycles and providing services** that could ease climate related events. Crafting a resilient future for urban areas that should be able in the same time to host and nurture qualitative and healthy life, **nature should be included in the design of new developments and regenerative programs** (United Nations, 2017)**.**

This research is occurring with regard to Western Balkans climatic region as well as its urban characteristics. Last decade environment related occurrences in Western Balkans have undoubtedly proved that the Intergovernmental Panel on Climate Change predictions on the escalation of extreme climate events shall affect our societies and economies. The extent is such that today's required actions/measurers will soon turn into imposed norms. When adding the effects of the COVID-19 global pandemic and the recent energy crisis to this already complex algorithm of the climate emergency, it becomes evident that what is missing is resilience with regard to environment and climate change. Third National communication of Albania indicates that recent climate change scenarios predict a rise in mean temperature and change in precipitation patterns leading in seasonal increasing temperatures and decrease of precipitation.

In addition to climate change, the **urban environment quality represents one of the main concerns globally with regard to the public health status**. There is a scientific consensus that the warming of the climate system is unequivocal while the situation is aggravated by human activities, such as continued pollution in urban areas, poorly managed urbanization or careless land use, all these contributing in environment degradation and biodiversity loss.

Migration in main urban areas affected land use, accommodating needs for residential, commercial and infrastructure developments decreased permeability and overall urban green areas, thus impacting the resilience towards climate change effects and quality of life.

The highest concentration and consequently the largest health impacts are observed in central and eastern European countries, more specifically Balkan peninsula (EEA, 2021).

Despite the growing knowledge on air pollution, with recent technological and practical monitoring systems being implemented from ground level to satellites, numerous studies and research linking air pollution with urban health, other gaps appear to require further research: 1) ways in which urban form can influence a range of outcomes, including air pollution, public health, and social equity. 2) how designing in line with nature ecosystem services, in this case harvesting the power of wind to naturally disperse air pollution from urban areas. 3) can we actually enable such services to be naturally harvested by communities for their well-being.

This research is developed around the central question if urban form (at a rather small scale / neighbourhood level) can affect the natural dispersion of air pollutants and even create areas where pollution is captured crating thus unintended hot-spot. Taking into consideration that odd phenomena during monitoring at ground level indicate that certain areas within the cities appear to have higher concentration of air pollution eventhood they appear far from emitting sources or even protected from them.

Methodologically, the geographical area of this research is the capital city of Albania, Tirana. Whereas the exact locations, selected through a scrupulous approach based into their urban form, proximity with emission sources, orientation and morphology. These 4 areas are the following: KIKA complex, MAGENT complex, Delijorgji complex (all constructed between 2010-2020) and prefabricated complex behind “Ish-Ekspozita” (constructed during the 70s).

Besides developing a critical and discussion on Urban Air Pollution and its linkage with Urban Form, the research includes field works through: daily monitoring the concentration *(in ppm and µg/m^3)* of the gaseous Nitrogen Dioxide (NO_2), Particular Matters $PM_{2.5}$ and PM_{10}, daily monitoring of wind direction and speed, humidity, meteorological conditions. Monitoring conducted from 1st January to 31st March 2023. Daily site monitoring sheets were filled and digitalized into excel database and further in GIS, whereas mapping of pollution dispersal and

the effect of meteorological conditions indicated and visualized the temporal effect that urban form had on the phenomena of “Air Pollution Cavity Areas”. The existences of such phenomena is reflected in the results of these daily monitoring of 9 monitoring points per each of the study areas.

The utilization of the Statistical Correlation Coefficient, denoted as “r”, is pivotal in quantitatively assessing the magnitude and orientation of a linear correlation between observed variables, such as pollutant concentration levels and wind velocity. This metric, a seminal contribution by Karl Pearson—a distinguished British mathematician and biometrician—during the transition from the 19th to the 20th century, serves as a foundational statistical tool in elucidating the dynamics between environmental variables. Pearson's introduction of correlation factor, facilitates a nuanced understanding of the interdependencies within environmental systems, particularly in the context of urban air quality management.

This study leverages the Correlation Coefficient as a cornerstone in constructing a sophisticated analytical framework aimed at an in-depth investigation of urban air pollution dynamics and their natural dispersion mechanisms in relation to urban form. Further the logical framework of this research could be expanded and include Computational Fluid Dynamics (CFD), fostering to simulate and analyse the intricate flow patterns of air pollutants within urban environments, offering insights into the mechanisms driving their dispersion. The integration of micro-climate observations furthers the comprehension of localized atmospheric conditions, could lead future researchers to enriching the analysis of pollutant dispersal phenomena.

Finally, the incorporation of sustainable urban planning practices within this analytical framework underscores a proactive approach to mitigating the adverse spatial and temporal impacts of Air Pollution Cavity Areas on public health. By synthesizing years of site-monitoring and detailed literature, combined with empirical climatic data and forward-thinking urban design principles, the research candidate delineates a path towards reducing the environmental and health ramifications of urban air pollution. Through such a multidisciplinary methodology, the study not only contributes to the academic discourse on environmental science and urban planning but also proposes actionable strategies to enhance urban air quality and, by extension, public health outcomes.