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Professional paper

A PRELIMINARY ASSESSMENT OF THE RATIO BETWEEN URBAN GREENERY AND BUILT-UP AREAS AND AIR QUALITY IN THE CITY OF ELBASAN, ALBANIA

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Abstract: *The creation of cities is perhaps one of humanity's most ingenious "inventions" and solutions. Cities brought many benefits in terms of social services, but also a number of challenges, especially related to mobility and the urban environment. The demand for better living conditions increased, the pressure on natural resources intensified. On the other hand, a more overpopulated and urbanized world was emerging. Building surfaces began to dominate over natural ones and especially over greenery. Environmental components in many cases began to deteriorate, especially air. Elbasan, a city in central Albania, which also has a metallurgical plant with very outdated technology, exhibits very complex features in this sense, and is therefore included in our study. First, through semi-structured questionnaires, through a specific target group, about 16-20 people, the perception of citizens on the current construction-greening relations for the city of Elbasan and how they perceive it for the future was collected. The methodology used to select the stations where the measurements were taken was based on the use of satellite images, combined with consultations with urban greening specialists, as well as through preliminary field observations, selecting representative areas with a high construction ratio versus those with high greening ratios. Through a device with sensors, real measurements were made in Elbasan city for some air indicators. The main aim and purpose of this study is to highlight the role and importance of urban greenery and forestry in establishing and maintaining natural balances, as well as improving the livelihoods and well-being of communities in urbanized areas. A summary of some preliminary results of this data is presented in the following paper.*

Keywords: building–greenery ratio, Elbasan, air quality, urban forestry.

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1. INTRODUCTION

Buildings have increasingly begun to impact the natural environment, especially on the land surface and more specifically in greenery, as a result of the population's needs for better living conditions, mainly housing and services. But also, as a result of the pressure of construction businesses for higher profits. In this context, the city of Elbasan, Albania, also presents these characteristics. On the other hand, especially in recent decades, construction entities together with scientific circles are aiming not to neglect the components of urban greenery, therefore relevant studies are being carried out to optimize construction-greening ratios. Many scientific centers and universities are involved in this challenge. In this context, a group of researchers from the Metropolitan University of Tirana (UMT) applied to the National Agency for Scientific Research, Technology and Innovation (NASRTI) with a proposal focused on the relationship between construction and greening in urban environments. The project, funded modestly by NASRTI, entitled: "Optimizing the relationship between building infrastructures and green infrastructures as one of the main elements in improving the environment and the sustainable development of urban areas. A comparative observation of these issues in some cities/neighborhoods of our country (Case study: Elbasan & Tirana) realized during 2024-2025 years.

The main aim of this project is to evaluate urban environments with different construction-greening ratios, with particular emphasis on the presence, absence, or limited presence of urban greenery—especially trees and urban forests and to examine the correlations between these and the quality of life of communities in these urban areas. The project seeks to derive conclusions about the benefits brought by urban greenery in residential centers and to formulate recommendations for improving the construction-greening ratio in favor of greening in the near future.

A primary objective is to assess community perceptions of the importance of urban greening in relation to building infrastructure and its contribution to improving environmental components and quality of life. This objective is at the core of UMT's educational and research mission and is aligned with government strategies, where environmental problems have become increasingly significant at local, regional, and global levels (UMT, 2024).

Urban greening in cities and especially the presence of urban forestry elements such as trees and shrubs is essential for a healthy environment and for the well-being of human communities. Beatley (2012) emphasizes that we must better understand the processes by which green city innovations—and innovations in general—are embraced, adopted, and implemented. This is true for all urban centers worldwide, including those in Albania.

Various archaeological discoveries, dating back to the earliest times, in urban residential centers in Albania, have noted the presence of vegetation, trees, and shrubs (Haska, 2021; Haska, 2022).

The data collected through questionnaires and the results obtained from their processing will indicate the main directions in which future efforts should be focused, both in terms of research and in terms of policymaking and decision-making related to these pressing environmental issues. In what follows, we present several aspects of the project and some preliminary results for the city of Elbasan.

So, the aim of this paper is to highlight the construction-greening relationships in the city of Elbasan and undoubtedly the correlation between them, as well as to highlight the advantages of urban greening in the city of Elbasan in relation to air quality improvement and urban well-being

2. MATERIAL AND METHOD

2.1 Methodology and study area

All cities share similar physical structures (FAO, 2016), including: grey infrastructure: residential industrial buildings, roads, utilities, parking lots, etc.; blue infrastructure: rivers, lakes, ponds, canals, and other water bodies. Green infrastructure: trees, shrubs, grasslands, parks, forests, gardens, roadside greenery, and other vegetated areas. Optimizing interactions between these elements is essential for restructuring or building cities capable of responding to urban challenges. For the city of Elbasan, a very good and coordinated work was done in three main directions. First from the satellite image, as well as in cooperation with environmental specialists, staff of the municipality of Elbasan, forest specialists, several specific areas in the city of Elbasan were identified both on the map and in the field, about 12 of them, where 6 of them were selected with high construction coefficients and 6 with high greening coefficients. A questionnaire was drafted by the forest expert Prof. Haska and after being tested initially on 2-3 people, the final form was completed by a larger number of a specific target groups about 16-18. A completed copy of this questionnaire is attached below.

Urban forests can be defined as networks or systems that include all forests, tree groups, and individual trees located in urban and peri-urban areas. They include forests, street trees, trees in parks and gardens, and trees in abandoned or marginal spaces. Urban forests are the backbone of green infrastructure, forming a bridge between rural and urban areas and improving the urban environment. On the other hand, contemporary architecture should be guided by a vision that rethinks the relationship between construction and the environment, discovers new forms and content, and asserts that the art of building is entering a new phase that will fundamentally change the way we live, always in harmony with the “language” of nature (Haska et al., 2019).

The Study Areas for the UMT project (UMT, 2024) was the cities of Tirana and Elbasan, selected because they reflect characteristic conditions related to the project’s objectives and goals. In this paper, we present some preliminary findings for the city of Elbasan.

To make a preliminary assessment of several selected stations according to the methodology described above, i.e. based on construction–greening ratios, the project team, using a device purchased in France by project staff. Sensor apparatus with a satisfactory level of reliability, Temetop M2000, a Portable Monitor Air Quality which serves for the measurement of air quality indicators in motion, which serves for the measurement of air quality indicators in motion, with a dwell time at each station of at least 30 minutes and making real-time measurements for a duration of at least 10 minutes at the station, and at least twice a year in different seasons, carried out real field measurements of air-quality indicators in Elbasan city, which

is an added value for the project because initially it was planned to collect the perception of citizens only through questionnaires.

2.2 Data about geographic and climatic characteristics of Elbasan city, Albania

The city of Elbasan is located in the Elbasan plain, on the right bank of the middle course of the Shkumbin River. It is surrounded: to the east by Krasta e Madhe and Krasta e Vogël, to the north and northwest by olive-covered hills, to the west by the Zaranika stream and to the south by the Shkumbin River. On the western side of the city flows the Zaranika stream, and on the eastern side the Manazderia stream. Elbasan lies between latitudes 41°27' N and 40°10' N and longitudes 20°34' E and 19°03' E, at an average altitude of 125 m above sea level. The region has mild, rainy winters and hot, dry summers (Municipality of Elbasan, 2024). More detailed climate data include: Average annual temperature: 15.4°C, average January temperature: 6.5°C, average August temperature: 24.1°C, average annual precipitation: 1157 mm, maximum annual precipitation: 1500 mm, minimum annual precipitation: 620 mm, annual sunshine duration: 2488 hours, average heat value: 48.48 Kcal/cm², average annual humidity: 67%, wind speed: 30–35 m/s, main wind direction: east–west, altitude: 125 m.

2.3 Assessment of Environmental and Air Quality Indicators

Assessing environmental indicators, particularly air quality, involves evaluating multiple factors that influence both ecosystems and human health. In this project, we used an approach based on key air-quality indicators, where we can mention the main ones such as:

Particulate Matter (PM):

PM₁₀: particles with a diameter of 10 micrometers or less, which can be inhaled and cause respiratory problems.

PM_{2.5}: fine particles with a diameter of 2.5 micrometers or less, which can penetrate deep into the lungs and enter the bloodstream, leading to serious health problems such as cardiovascular disease, lung cancer, and aggravated asthma.

Ground-Level Ozone (O₃): Formed through reactions between VOCs and NO_x in the presence of sunlight. High levels cause respiratory problems and damage vegetation and crops.

Nitrogen Dioxide (NO₂): Emitted mainly from the combustion of fossil fuels in vehicles and power plants; contributes to acid rain and smog; prolonged exposure leads to respiratory issues.

Sulphur Dioxide (SO₂): Produced by burning fossil fuels (especially coal) and industrial processes; can irritate the respiratory system and contribute to acid rain. **Carbon Monoxide (CO):** Originates from incomplete combustion of fossil fuels, especially in vehicles and industrial settings; high concentrations can be lethal, and it contributes indirectly to ground-level ozone formation.

Volatile Organic Compounds (VOCs): Emitted from vehicles, industrial processes, solvents, and paints; contribute to ozone and smog formation.

Ammonia (NH₃): Primarily from agriculture (livestock and fertilizers); contributes to particulate formation and acidification of water bodies.

Air Quality Index (AQI): A composite index (0–500) used to communicate the overall level of air pollution to the public (US-EPA, 2025). (Air Now, 2025).

2.4 Some main factors that negatively affecting air quality in Elbasan city

- Overcrowding and human respiration (CO₂ emissions)
- Transport sector (old vehicles, low-quality fuel)
- Construction activities and site dust
- Urban solid waste (at home, in bins, in landfills)
- Inert waste (dust, fine particles)
- Use of refrigerants and air conditioners (greenhouse gases)
- Urban heat island effects
- Noise pollution
- Fires and combustion (smoke and toxic gases)
- Heating and cooking with CO₂-emitting fuels
- Emissions from factories and bakeries
- Decomposition of organic matter
- Intensive technologies in residential services
- Use of pesticides and herbicides
- Smoking in public and residential spaces
- Improper disposal of hospital waste
- Specific case: emissions of BVOCs (biogenic volatile organic compounds) from certain tree species at high temperatures

Poor air quality results in health impacts such as respiratory and cardiovascular diseases and premature mortality, as well as environmental impacts including vegetation damage, soil & water pollution, and contributions to climate change.

3. RESULTS AND DISCUSSIONS

In Albanian legislation, (Law nr. 162, 2014) in Annex No. 1 describes the 13 main air pollutants, including suspended solids PM_{2.5} and PM₁₀, and the data for the city of Elbasan, which we present below, are collected around them.

3.1 Characteristics of questionnaire respondents

The questionnaire regarding the construction-greening relations in the city of Elbasan was compiled in four sections: the first section dealt with introductory questions such as age, education and employment. The second section—introductory questions on the issue of greening and construction in the city of Elbasan, the third section dealt with construction-greening ratio in the city of Elbasan, and the fourth section dealt with suggestions and recommendations.

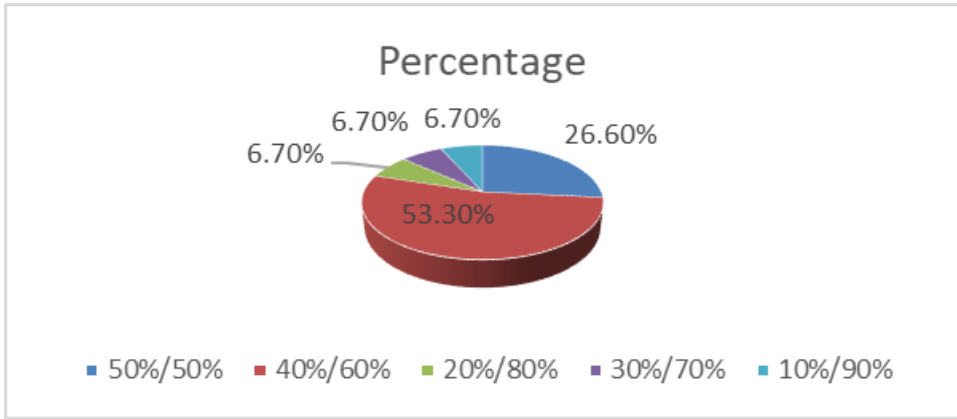
So, from the processing the data, it results: regarding education: 20% with primary education, 26.7 with secondary education and 53.3 with higher education, and age: 20% up to 40 years, 13.3% over 60 years and 66.7 between 40-60 years,

while employment: 6.7% self-employed, 20% pensioners, 33.3 employed in the public sector and 40% employed in the private sector (Haska et al., 2026).

Questionnaire with the focus construction-greenery ratio was drafted based in this methodology, it was initially tested in the city of Elbasan and then fulfilled completed by a considerable number of residents in this city. We are also presenting completed copies of this questionnaire above, and below we will present some relevant answer.

3.2 Public perception about ratio construction-greenery and air quality

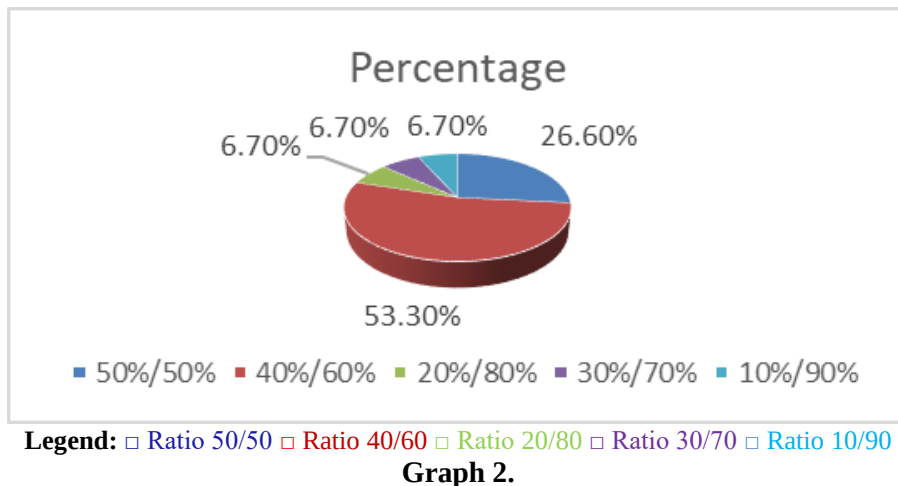
Based on the questionnaire data and a preliminary data processing, below we are graphically presenting them with answers about the construction-greening relationship as it is and as it should be according to the perceptions of the interviewees.



Legend: ■ Ratio 50/50 ■ Ratio 40/60 ■ Ratio 80/20 ■ Ratio 30/70 ■ Ratio 70/30

Graph 1.

From the above data processing Graph no. 1, it is noted that regarding the question: ***According to you, in the city of Elbasan or the region where you live or work, what is the ratio, what % is construction and what % is greening (in percentage)*** - about 55.3% of respondents answered that this construction/greening ratio is 50/50 percentage, whereas 26.6 % of respondents answered that this construction/greening ratio is 40/60 percentage, 6.7 % of respondents answered that this construction/greening ratio is 80/20 percentage, as well 6.7 % other of respondents answered that this construction/greening ratio is 30/70 percentage, as some people think and answered that this construction/greening ratio is 70/30 percentage, so an interesting variety of answers, but most of them are in the 50/50 ratio.



From the above data processing Graph. 2, it is noted that regarding the question: ***In your opinion, what should the construction-greening ratio be in the future?*** What percentage should be construction and what % greening? About 26.6% of respondents answered that this construction/greening ratio should be 50/50 percentage, whereas 53.3 % of respondents answered that this construction/greening ratio should be 40/60 percentage, 6.7 % of respondents answered that this construction/greening ratio should be 20/80 percentage, as well 6.7% other of respondents answered that this construction/greening ratio should be 30/70 percentage, as some people think and answered that this construction/greening ratio should be 10/90 percentage in the favor of greenery. In relation of questionnaire for air indicators, a large proportion of respondents indicated that city centers are the most polluted areas and identified transportation and local businesses as primary sources of pollution.

3.3 Field measurements of air-quality indicators

One of the most important aspects of this modest project is that real measurements of air components were carried out based on methodologies using contemporary instruments. While the city of Tirana has several permanent air-monitoring stations, the city of Elbasan does not.

Therefore, the project team - especially the architecture specialist - decided not only to rely on questionnaires, and the perceptions given there by the interviewees, but also to conduct direct field measurements the main air quality indicators in the Elbasan city.



Figure 1. During air measurements in terrain, Elbasan City

Table 1: Standards for pollutants $Pm_{2.5}$ and Pm_{10}

Nr	Pollutants	Albanian standards	World Health Organization standards	European Union Standards
1	$Pm_{2.5}$	25	5	10
2	Pm_{10}	40	15	20

(Source: NEA 2024, WHO 2021, Chathamparambath 2025)

From the Table 1 we can see the standards for some very important pollutants, and especially for $Pm_{2.5}$ and Pm_{10} , where Albanian standards have some more higher value for example for $Pm_{2.5}$ till 25 and for Pm_{10} till 40, while the standards are stricter from World Health Organization, respectively 5 for $Pm_{2.5}$ and 15 for Pm_{10} . In relation to this standard, direct field measurements in the Elbasan city were carried out in accordance with the relevant methodology explained in the above paragraphs. The measured values are presented in the following Table 2.

Table 2. Air Quality Measurements – Elbasan City
(12.10.2024-E. Kamberi, H.Haska)

Nr	Components Indicators	Stations							
		Station 1 (Gas station, Kastrati)	Station 2 (Globe)	Station 3 (Municip Elbasan)	Station 4 (Krasta Lower)	Station 5 (Crossing Librazhd)	Station 6 (Park Rinia)	Station 7 (Crossing Gramsh)	Station 8 (Crossing Gjinar)
1	Pm 2.5	9.2	9.6	11.2	12.4	10.1	6.4	17.3	9.2
2	Pm 10	13.4	18,8	19	21.1	18.2	10.4	29.6	16.6
3	Particles	1125	2250	1726	1847	1597	952	2659	1480
4	CO2	412	415	459	392	395	385	557	411
5	HCHO	0.115	0.050	0.039	0.034	0.031	0.029	0.027	0.028
6	Temp C°	25.1	28	27.5	27.7	27.4	27.3	27.8	26.9
7	Humidity %	55.5	44,2	50	50	50.7	51.6	49.6	53.4
8	Coordinate	N 41° 06' 01"	41° 06' 29"	41° 06' 40"	41° 07' 09"	41° 07' 17"	41° 07' 04"	41° 06' 16"	41° 05' 45"
		E 20° 01' 46"	20° 04' 17"	20° 04' 52"	20° 06' 08"	20° 06' 12"	20° 06' 12"	20° 04' 54"	20° 04' 59"
9	TIME	AM	AM	AM	AM	AM	AM	AM	AM

From Table 2, it is evident that: From the data, we note that the Albanian standard is not exceeded at all stations, neither for $PM_{2.5}$, nor for PM_{10} , but exceeded World Health Organization standards in all 8 stations for $PM_{2.5}$, and in 6 stations from 8 in total for PM_{10} , are also exceeded European Union Standards in 4 stations from 8 in total for $PM_{2.5}$, and in 2 stations from 8 in total for PM_{10} . We can underline that Station 7 (Crossing Gramsh) shows the worst values, especially for $PM_{2.5}$, PM_{10} , particle and CO_2 . This is due to very high traffic loads: vehicles of different sizes traveling from Tirana towards Qafë Thana and the Kapshticë border, and towards Korça, Cerrik, Belsh, and Gramsh. From the other side Station 6 (Rinia Park), located near a large urban green area with many trees and relatively few buildings, has the best air-quality indicators among the monitored stations. It is very interesting to underline that and a study realized from world Bank last years, published by World Bank report on six Western Balkan countries, “Western Balkans – Regular Economic Report No. 25 | Spring 2024 – Invigorating Growth” (World Bank, 2024), shows that Elbasan has comparatively good green-space coverage, with more than 16% of its area covered by greenery in 2020 year, a relatively satisfactory value compared to many other cities in Albania, but also in the region, which present relatively low values.

3.4 Activities to increase green spaces and community participation

To ensure that the project had a tangible positive impact not only on data and analysis but also on the ground, UMT, as the implementing institution, decided to donate and plant a number of decorative saplings symbolically in the municipality of Elbasan. This aimed to contribute to nature and, at the same time, raise community awareness about the importance of a green environment. The principle applied was: **“Do it together with the community, not for the community.”** Planting trees with community participation enhances project sustainability and promotes shared responsibility. Several field visits were carried out in Elbasan to identify suitable planting sites. Approximately **60–70 decorative** saplings were procured with funding from NASRIT and UMT. There were initial difficulties because many private nurseries did not have sufficient decorative red plum stocks. Ultimately, some seedlings were secured in Tirana and others in Lushnje, and transportation was supported by UMT and the Elbasan region. The dendrometric parameters and planting operations were based on contemporary literature on urban afforestation and on the **Afforestation Manual** of the National Forestry Agency (Tabaku & Starja, 2023). After selecting a planting site near the new Elbasan Municipality building, the planting process was carried out according to proper methodology-from pit opening through to final planting and initial watering. On the promotional planting day, participants included: The Mayor of Elbasan, **Mr. Gledian Llatja**, municipal staff, prof. Haska, urban forestry expert from UMT, other project staff and community members. This activity served as an important additional component of the project, contributing to community awareness and active participation in expanding green areas in the urban environment.



Figure 2. During promotional planting day, Municipality of Elbasan, Albania

4. CONCLUSIONS AND SUGGESTIONS

From the preliminary data, while more detailed statistical processing is ongoing, we can outline several conclusions:

- **In both Elbasan & Tirana, construction dominates over green infrastructure.** In future, efforts must be made to reduce this imbalance so that cities have green spaces in sufficient quantity and quality, with benefits for both the environment and society.
- **Areas dominated by greenery show better environmental indicators.** The monitoring results and in Elbasan city clearly show better air quality near large green spaces compared to high-construction zones.
- **Urban greening specialists should be integrated into planning teams.** Urban planners, architects, and policymakers should include urban forestry experts in studies and plans.
- **Dedicated green spaces must be planned for each city.** Green areas should be intentionally designed, not merely leftover or marginal spaces. Tree species must be selected carefully. Species choice should be based on scientific criteria (tolerance, environmental benefits, allergenic potential, maintenance needs). Maintenance and services for green spaces are essential. Air-quality indicators are good in some parts of the city and unsatisfactory in others.
- **Continuous air monitoring is needed.** Air quality is a crucial indicator for both environmental and human health. Monitoring pollutants such as PM_{2.5}, PM₁₀, ozone, and NO₂ is essential to assessing the severity and impacts of air pollution. Particularly in Elbasan, the absence of permanent monitoring stations is a serious gap. Citizen awareness is crucial for the maintenance of urban environments. Environmental education and public engagement should be strengthened.
- **Addressing air pollution requires** a combination of stricter regulations, technological improvements, and sustainable practices across sectors. Effective action can improve public health, protect the environment, and contribute to climate-change mitigation.

In conclusion, the implementation of this modest project from the UMT, supported financially by NASRIT and in collaboration with the Municipality and Region of Elbasan, Albania, has generated important insights into the correlations between built-up surfaces and green areas in urban centers, with the main aim so that in the future, a more substantial optimization of the construction-greening ratios in these residential centers can be aimed at.

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