A thesis submitted to the Department of Environmental Sciences and Policy of Central European University in part fulfillment of the Degree of Master of Science

Pollution in Tirana, Albania: A look into a post-communist nation's transportation pollution rates and an assessment of their public transportation usability

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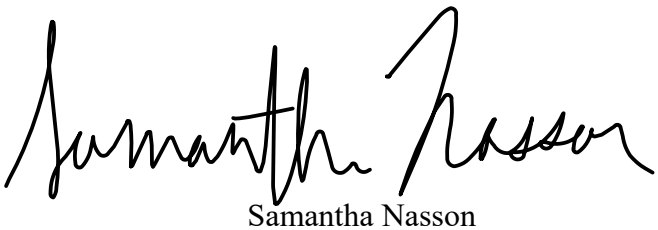

Samantha Nasson

Abstract

Abstract of the dissertation submitted by Samantha Nasson
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In the growing age of technology, green alternatives regarding *public transportation* are starting to spread around the world. Unfortunately, sustainable transport is not always affordable for some developing countries, such as *Albania*, causing *privately owned cars* to dominate the roads leaving significant *pollution*. This thesis will analyze Albania's pollution crisis as an issue that has been on the forefront since the fall of communism in the 1990s. In the capital of Albania, *Tirana*, older *diesel* cars are the norm for transportation for many as well as *petrol* cars and motorcycles. *PM10 and PM2.5 emissions* in the city of Tirana are poorly and infrequently checked. These emissions frequently go over the standard set by the European Union (EU), World Health Organization (WHO), and the Albanian Government. The lack of environmental regulations in the country poses the issue of how to reduce emissions. Outdated cars with little *maintenance* supervision cause an increase of pollution, as cars do not have to meet a specific standard to be on the road. Corruption may overpower laws and cause harm not only to the people, but the environment as well. Albania needs to become a member of the European Union (EU) to help combat climate change. With increased funding and baseline regulations for car emissions, Albania could change their future and decrease their car pollution, one day becoming a member of the European Union.

Keywords: public transportation, Albania, privately owned cars, pollution, Tirana, PM10 and PM2.5, maintenance

Dedication

This thesis is dedicated to my grandfather, Anesti (Nick) Nasson, who never got the opportunity to return to his home country of Albania but knew of my travel plans before his passing in December of 2022. Thank you for being one of my biggest supporters and always encouraging me to follow my dreams. I love you, Papa.

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List of Abbreviations

EU	European Union
WHO	World Health Organization
USA	United States of America
MIE	Albanian Ministry of Infrastructure of Energy in Tirana
UK	United Kingdom
PM	Particulate Matter
$\mu g/m^3$	Microgram per cubic meter, unit of measure for air pollutants
AQI	Air Quality Index
PM10	Particulate Matter 10 micrometers or less in diameter
PM2.5	Particulate Matter 2.5 micrometers or less in diameter
DPM	Diesel Particulate Matter
EPA	Environmental Protection Agency
NGO	Non-Governmental Organization

Introduction

Climate change issues are majorly influenced by humanity (Karl and Trenberth 2003). As the population of Earth is continuously growing, private cars are in higher demand as public transportation fails to keep up with the demand in most developing countries. Car emissions are a large contributor to the air pollution crisis, where "gasoline and diesel fueled vehicles are the world's dominant mode of rural and urban transport [16]. These vehicles generate approximately one-sixth [20] to one-fifth [13] of the world's greenhouse gas emissions and are a major contributor of local air pollutants" (Briggs et al. 2008). Unfortunately, countries that are underdeveloped or newly established have limitations on what they can spend on reducing emissions, as most of the focus is on improving day to day life instead of concentrating on long-term environmental concerns.

In many walks of life, owning a car is a form of a 'rite of passage' for several youths symbolizing the transition from childhood to adulthood with a new sense of independence. Teens save up to buy older, used cars as a primary form of transportation. From that moment on, having a "nicer" car is seen as a status symbol in many cultures. For example, "a car is one of the few status symbols that historically is widely accepted in Germany and has always been embedded in conspicuous consumption" (Veblen 1899), which individuals engage in to publicly display their economic power, prestige, and status" (Biehl 2021). Public perception often states that the better, more expensive car, the higher up in society the person who owns that car is in. The cyclical cycle of car buying is never-ending for most. Unfortunately, the car industries dominate the transportation market, and this sense of status is what contributes to the increase of emissions.

This thesis will highlight the issues with emissions in the capital city of Tirana, Albania in hopes that it will lead to a conclusion about the current state of the city in the eyes of the European Union. The three main research questions are:

1. What are the PM10 and PM2.5 emissions at selected locations in Tirana and how do they compare to the Euro 6 standard of emissions?
2. What is public transportation like in Tirana and how does it contribute to the city's emissions? How can it be changed/fixed?
3. What are the main factors holding progress back? Does this stem from Albania's communist past?

This thesis will be important to the academic community due to the research gap that is present for the topic. Few studies have been done on emission statistics in Tirana, especially those pertaining to PM10 and PM2.5 emissions. Of these studies, few compare emission statistics to the growing public transportation issue in the country. Therefore, this thesis will contribute greatly to the academic understanding of emissions levels and public transportation's influence within Tirana, Albania.

The scope of the research will aim to address the issues that diesel engine emissions have on the environment of Tirana. The hypothesis is that due to the presence of older, diesel engine private cars in Tirana, emissions will be over those that the European Union and Albanian government set as standards. Furthermore, the lack of sustainable transport in the city, resulting in the purchasing of older buses, will likely influence the purchase of private cars, furthering the emission issue in the city. The research will be conducted throughout a week's time in Tirana. Specific locations for data collection for PM10 and PM2.5 emissions will be determined by various criteria that need to be met, such as high traffic areas. An emission monitor will show the real-time

data in these seven chosen locations. Accompanying the collection of empirical data, 8 interviews will be conducted across various mediums. Some interviews will be in person, while some will be over online meeting platforms such as Zoom. These interviewees were chosen based on several different criteria that needed to be met in order to fulfill the need for the information missing from online research. Some interviewees were members of the Tirana Municipality, Non Governmental Organizations (NGO), academic experts, or family members that are native to the country and can provide real experiences on the topic.

A theoretical framework will be used in order to connect concepts to real life events. The framework being used throughout this thesis will be the Source Apportionment framework. Source Apportionment will aid in "relat[ing] emissions from various pollution sources to air pollution concentrations at a given location (receptor) and for a given time period" (Thunis et. al. 2022, page 4). The theoretical framework will compare emissions gathered to the standards set by the European Union.

The structure of this thesis will follow a general outline. Each chapter will contain several parts and within those parts, separate sections will outline the main argument or findings for each chapter. Chapter 1 will discuss the literature review which includes an introduction into the thesis and will outline the issues that contributed to the evolution of the thesis. Chapter 2 will discuss the methodology used to collect the data and interviews as well as address any limitations. Chapter 3 will present the results from the data collection and the interviews. Chapter 4 will discuss the findings and relate it back to the theoretical framework. Chapter 5 will discuss recommendations based on what the findings showed. Chapter 6 will summarize the above chapters into a conclusion.

The main purpose of this thesis is to identify the emission issues, based on data, in the city of Tirana, Albania. The collection of data will contribute to the overall findings, as well as the

interviews that will be conducted. The thesis's main findings hope to contribute greatly to the improved evolution of Albania.

Chapter 1. Literature Review

Part 1. Introduction

1.1 Albanian History

Albania experienced a complex and repressed history over the past few centuries, from Ottoman rule to the totalitarian communist regime that overtook the country in the wake of World War II. In Postwar Europe, Communism took hold in regions under Soviet influence. Albania was not spared from this trend when in 1944, Enver Hoxha rose to power. Hoxha was extreme in his methods, cutting off Albania from the outside world, and created laws which made Albanians de facto prisoners in their own land. Until the fall of communism, "Albania used to be a very hermetic country much like North Korea" (Mirel Sharxhi, personal communication, 25 May 2023). The country did not get its first taste of democracy until the collapse of communism in the early 1990s.

The Communist Party officially rose to power during this time under Hoxha's rule after the second World War, claiming the victory solely on their efforts for the defeat from the Nazis. Post-war Albania was dismal, consisting of mostly poor, war torn areas that longed for aid from the government. Hoxha, ever the opportunist, saw this as an open opportunity for the Communist Party, and himself, to gain control of Albania. To do this, Hoxha, acting as the head of the provincial government, capitalized on the needs of Albania and nationalized industry, transport, and land (Abrahams 2016, 17). The elections during 1945 officially appointed Hoxha as prime minister, foreign minister, defense minister, and the Army's commander in chief which officially created the People's Republic of Albania (Abrahams 2016, 17).

Hoxha also idolized Joseph Stalin and his strategies with which he controlled the government and Soviet citizens. In turn, Stalin admired the force in which Hoxha took over Albania for the Communist Party. As a result, he gave him aid in any ways necessary to keep the cult of personality of communism relevant enough in Albania. In today's Albania, brutalist buildings mirroring those of communist times in Russia during the Cold War stand in the city and the countryside, depicting the influence Stalin and the rest of the communist persona on Albania. Amongst the harsh rules of the regime was the abolishment of private cars, as car ownership was restricted to those within the high ranks of the Communist Party. All others had to take the public bus which only ran in the city of Tirana, bike, or walk on foot. The migration of people at this time from places in the rural mountainous regions to more densely populated areas became nearly impossible. The reason for restriction was deliberate, there was no movement of people from place to place which made it easier to keep track of the citizens for surveillance purposes and to ensure there were no escapees. During this time, transportation was not being invested in by the government, and there are no records of emissions of any kind during the communist rule.

Figure 1. A timeline of what communist Albania looked like from 1840-1999

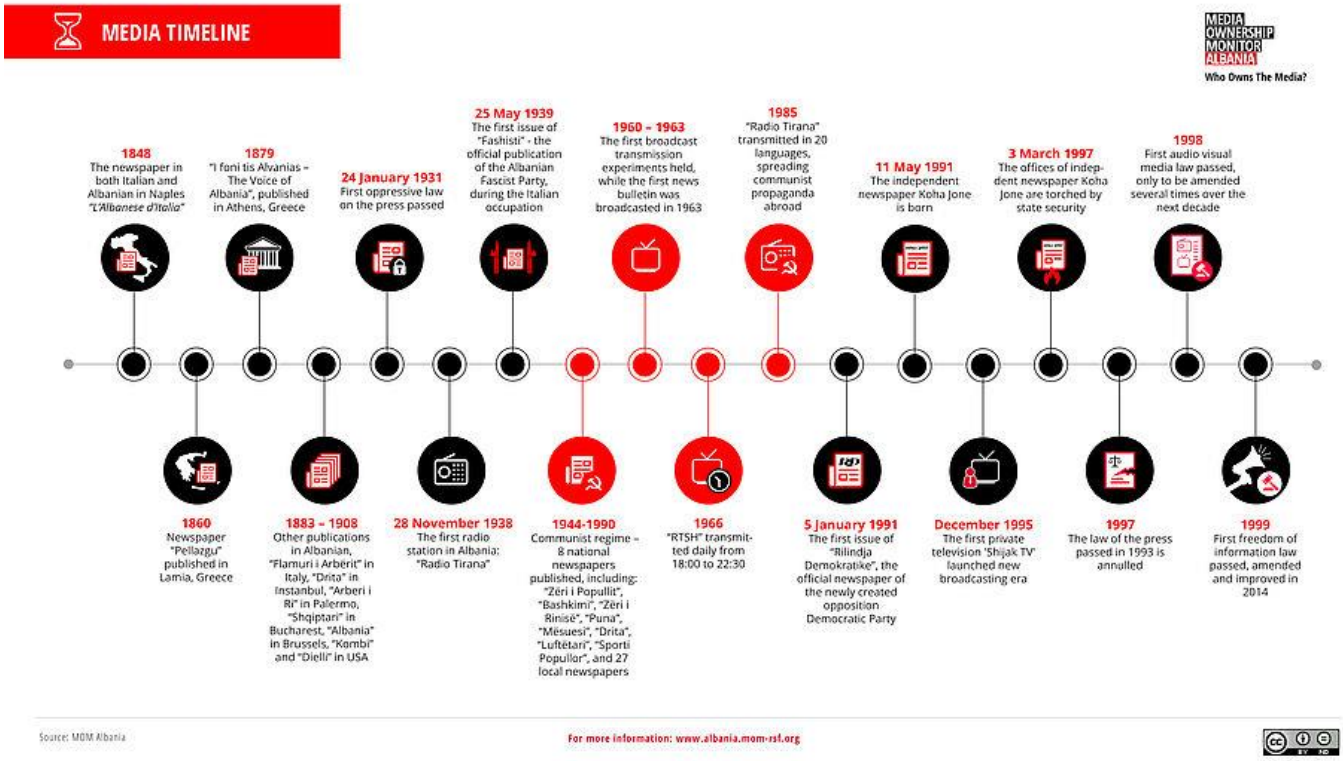


Figure 1. This timeline shows what amount of influence the media had on Albanian citizens from 1848-1999. It is important to note the timeline between 1944-1991 when the communist party was in charge in Albania.

Image source: Albania Media Ownership Monitor. URL: https://albania.mom-gmr.org/en/context/history. Accessed on July 24, 2023).

1.2 Transportation During Communism

During communism, travel around Albania was an all-day affair, due to the lack of transportation options that the country offered. This was mainly due to the fact that, "Under communism, private car ownership in Albania was prohibited. However, in a marked contrast to other East European communist countries, Albanian cities did not develop good quality public transport systems. Bus services were poor and no urban rail infrastructure was built" (Pojani. 2011). During the communist rule, my cousin, Mirel Sharxhi, had to travel to the capital of Tirana, Albania for high school and university from Korçë, 166.4 Km from the capital city of Tirana (which is now a three hour drive away from the capital of Tirana via the main highway, or a five

hour drive from Tirana through the dirt roads in the mountainside). Mirel described the trip as dreadful. He stated that, "The road was in terrible shape, and it took 8 hours to travel from Korçë to Tirana. The main vehicles of transportations were old buses from Eastern European countries and the train from China" (Mirel Sharxhi, personal communication, 25 May 2023). A round trip from Korçë to Tirana and back would have looked as followed:

> "To travel from Korçë to Tirana you have to buy the ticket 5 days before the trip and if you can not buy the ticket 5 days before, you had to use connections to buy a ticket. The bus used to leave Korçë at 3:00 a.m. and dropped you off in Guri i Kuq (Near Pogradec) where you would get on the train. The train used to leave at 5 am and you will arrive in Tirana by 11 am. Trains rarely were on time. Traveling back from Tirana to Korçë was more difficult. The train used to leave Tirana at 3pm and arrive in Guri i Kuq by 9pm. The problem was buying the ticket from Guri i Kuq to Korçë. The Korçë bus agency used to send only 2-3 buses to pick up people in Guri i Kuq and usually there were much more people than the buses used to accommodate. There were countless times that I spent the night in Guri i Kuq until in the morning where the buses from Korçë used to come and pick the rest of the people from the previous night. In the summer it was ok, but in the winter was a real torture" (Mirel Sharxhi, personal communication, 25 May 2023).

Travel during communism was anything but easy. The lack of public trains and buses made it hard for people to move about the country, but this was deliberate due to the lockdown of the country from the rest of the world. Along with this, the government did not invest any money towards public transportation. In the cities, most got around by foot, bike, or bus. In the countryside, donkeys, horses, and bikes were the main modes of transportation as the people in the countryside rarely had the opportunity to visit the capital. A traveler in the mid 1970s, Simone Adams, recounted her journey from Tirana to Korçë "took 6 hours on unpaved roads that went through the mountains. My return in the 1980s was not any better" (Simone Adams, personal communication, 25 May 2023). Transportation remained abysmal through the entire reign of the communist party, only improving slightly once communism officially fell in 1992. However, the country of Albania is still significantly behind the rest of Europe in terms of emission standards from public and

private transportation today. These complications from Albania's past have not helped it achieve its ultimate goal of joining the European Union (EU).

1.3 Albania's Assent into European Union (EU) Accession

As of 2023, there are 27 countries that are members of the European Union, which emerged in the aftermath of centuries of war, with European countries realizing "that it is better to work together than fighting against each other" ("Easy to Read – about the EU | European Union" n.d.). Member countries in the European Union's economies "is the single market. It enables most goods, services, money and people to move freely throughout most of the continent" ("Easy to Read – about the EU | European Union" n.d.). EU membership benefits member states through increased economic stability, the promotion of individual freedoms, and fosters peace amongst states. In addition to these benefits, membership means gaining access to EU funding, a significant factor for states with smaller economies.

Albania officially submitted their application to become a member of the European Union on April 24, 2009 and was granted candidate status in June of 2014 ("Albania" 2023). Albania has not been admitted into the EU for several reasons, most being that they are not in compliance with several of the standards that the EU sets, and not economically stable enough to do so alone. Part of the EU's mission is the funding of projects within member countries, noting that its goal is to "invest[ing] in the future of its citizens by supporting the creation of a sustainable, green, safe and smart transport system. The projects that we have selected, which cover all modes of transport across Member States…" ("Albania" 2023). Although not yet a member, the EU does provide some funding to Albania "in a wide range of areas – from agriculture to transport, green energy to support for entrepreneurs, and much more" ("WeBalkans | Your Story, Our Future | EU Projects

in the Western Balkans" n.d.). The aid of the European Union to Albania is imperative, and the acceptance into the EU would benefit the transportation of Albania significantly.

Looking at emission standards, Albania is far from complying with the strict emission standards set by the EU. For this thesis, emission standards will solely focus on those of PM2.5 and PM10 emissions. To set these standards, The EU decided on the basis of a " 3-year running annual mean PM2.5 concentration averaged over the selected monitoring stations in agglomerations and larger urban areas, set in urban background locations to best assess the PM2.5 exposure of the general population" ("EU Air Quality Standards" n.d.). As seen in Figure 2, the emission standards for PM2.5 emissions are now down to 20 micrograms per cubic meter (μg/m³) and PM10 emissions are down to 50 (μg/m³). Contrastingly to this, the Albanian limit for PM emissions are 25 μg/m³ for PM2.5 emissions and 60 μg/m³ for PM10 emissions. Albania is significantly above the EU norms, and because of this and many other factors, has not been admitted into the European Union.

Figure 2. Emission Standards set by the European Union

Pollutant	Concentration	Averaging period	Legal nature	Permitted exceedences each year
Fine particles ($PM_{2.5}$)	25 μg/m³	1 year	Target value to be met as of 1.1.2010 Limit value to be met as of 1.1.2015	n/a
Fine particles ($PM_{2.5}$)	20 μg/m³	1 year	Stage 2 limit value to be met as of 1.1.2020 ***	n/a
Particulate matter (PM_{10})	50 μg/m³	24 hours	Limit value to be met as of 1.1.2005 **	35

Figure 2. This chart shows the emission standards set by the European Union, highlighting the PM10 and PM2.5 emission levels. Averaging period, concentration, and permitted exceedances each year should be noticed.

Image source: European Council. URL: https://www.consilium.europa.eu/en/policies/enlargement/albania/. Accessed on June 3, 2023).

Figure 3. Air pollution Levels in Tirana

Micro-gram/ m3	'76-'80	'81	'85	'90	'00	'01	'02	'03	'04	'05	'06	'08	'09	Alb. Av.	Alb. Norm	European Union Norm	WHO Norm
SPM (Dust)	286				306	304	308	370	370	365	338	348	323	250	140	70	60
PM_{10}					237	169	151	175	166	172	163	173	148	119	70	40	30

Figure 3. PM10 air pollution levels in Tirana from 2000-2009 with the Albanian average, norm and European Union norm for comparison. Those above the EU norm are shaded in yellow

Image Source: Dorina Pojani "*From carfree to carfull: The environmental and health impacts of increasing private motorisation in Albania"* URL: https://www.researchgate.net/publication/227619994_From_carfree_to_carfull_The_environmental_and_health_impacts_of_increasing_private_motorisation_in_Albania (Accessed June 4, 2023).

Part 2. Diesel Car Pollution and Transportation in Tirana, Albania

2.0 Public Transportation Worldwide

Public transportation, mainly focusing on train systems and buses, are an integral part of every urban city in order to reduce emissions and traffic through the city and, in return, streamlining commuting for the people and creating a better and healthier city. Transportation worldwide is always adapting to growing technology; however, some cities are better at this adaptation than others. For example, developed countries, defined as "ha[ving] a mature and sophisticated economy, usually measured by gross domestic product (GDP) and/or average income per resident…have advanced technological infrastructure and have diverse industrial and service sectors. Their citizens typically enjoy access to quality health care and higher education" ("What Is a Developed Country | BDC.Ca" n.d.) often have better transportation policies and infrastructure than developing countries do. In this section, transportation policies in developed countries, differing to that of Albania, will be analyzed.

Developing countries face similar issues with establishing and maintaining public transportation, as well as making it accessible for everyday life. One of the main issues is funding. According to the European Union, “Even if city administrations can get behind a project, they often have trouble mobilizing public money, whether through taxation or by borrowing” (“Easy to Read – about the EU | European Union” n.d.). Many countries do not have the infrastructure or credibility to borrow or use money on public transportation. In Albania, other issues, such as healthcare or human rights, are seen as a more important and immediate issue to spend the money on. Another issue is that planners need to build a consensus on how to build the public transport system. “Construction of a system on an avenue with a dedicated lane takes up space that cars could use, creating competing interest groups. But more than such battles, planning is most often held up by a lack of constructive communication” (“Easy to Read – about the EU | European Union” n.d.). A project can take years, and with many people working on the project, it can get held up by opposing opinions.

Second world countries, although not all the same, face similar challenges when trying to implement public transportation. Unfortunately, it often is a financial issue for the countries, as its growing and developing economy is not equipped to support the investment in public transportation. However, Albania is in a unique situation, as they were locked off from the rest of the world until the 1990s, not developing at all. Albania, similar to other developing countries, faces issues of infrastructural red tape and financial issues, but also has outside factors greatly influencing the lack of public transportation in the city.

2.1 Public Transportation in Tirana Today

During communism, public transportation was abysmal, and privatized car ownership was forbidden. The buses that Albania acquired came from other communist countries, often ones that were no longer needed by that country. "Tirana inherited a small bus fleet (114 buses) from the communist era, which covered 12 routes, with an average distance of 12 km per route. The bus stock was dilapidated. The average age was 20 years. On any given day, only about half the buses were in service. The buses were usually overcrowded, and did not follow a schedule" (D. Pojani 2010). The buses were not a reliable mode of transportation for many as, "Buses had low standards of hygiene, maintenance, and service… During Tirana's hot summer months the air within the buses was unbreathable. During the commute peaks and on rainy days overcrowding became extreme" (D. Pojani 2010, page 69). Unlike public transportation in many other European countries, public transportation throughout the city today is privatized by several companies. Many of the buses that are owned by the companies are sold by wealthier countries that need to get rid of their older models of buses. Many companies dominate the road, as seen in Figure 4. However, many, including myself, find it hard to navigate the very unreliable bus schedule. On the Municipality of Tirana, the transportation department's website, there are no directions or schedules for the buses, only a map of the lines that are running and bus stops. There are no online directions to buy a ticket online nor any directions that explain where to buy a ticket or how much money (in Albanian Lek) a ride would be. The buses were very hot and crowded, and often standing was the only option while riding the bus. A secondary source online, an app called Moovit, was the only online, real time source that found detailed trips that the buses made and where to meet them. As far as it is known, the app has no affiliation with the Municipality or any other governmental organization of Tirana.

Figure 4. Four different types of public transportation buses in Tirana

Figure 4. Four different types of public transportation buses in Tirana operated mostly through different companies. Several different style and colored buses can be seen in Tirana on a daily basis.

Image source: Samantha Nasson. Captured May 5-11, 2023.

Albania is faced with the issue of not having a public metro, tram, or commuter rail system inside the capital city or anywhere else in the country. There are few railways operating in the country, none available within the cities. As a result of this lack of rail infrastructure, the only public option is by bus. There are new bike lanes in the city around 3-4 years old, approximately 33 km of bike lanes running throughout Tirana (anonymous, personal communication, 8 May 2023). The bike lanes were implemented to try and influence the alternative decision in favor of bike transportation, which is better for the environment and for the health of the people. Unfortunately, the bike lanes are not everywhere in the city, causing it to be somewhat unsafe for cyclers to navigate the city on the main streets, where cars and buses rule the road.

Unfortunately, for the capital city of Tirana, public transportation lags significantly behind EU capital cities. The buses are overcrowded and do not follow a set schedule, often getting stuck in traffic themselves. Transportation in Albania is mostly reliant on the alternative, private car travel. A densely packed city, unfortunately, means a plethora of pollution and traffic from these cars.

2.2 Traffic and Cars in Tirana

Communism officially fell in Albania in 1992, opening the chance for private ownership of cars for all citizens of Albania. From there on many, who longed for the independence they were never allowed to have, obtained cars for their families. “The rich and middle-class sections of the population are increasingly car-dependent. Not only were cars purchased to fulfill mobility needs but were also seen as symbols of freedom and social status” (E. Pojani, Van Acker, and Pojani 2018). As of right now, there are 233 cars per 1000 inhabitants, meaning for every one to three people there is a car (anonymous, personal communication 08 May 2023). Diesel cars produce severe emissions, affecting the health of the people and the environment of Albania, especially during the commuting hours.

Traffic in the capital city of Tirana, during rush hours of 7:30-9:00 a.m. and 4:00-5:30 p.m., jams the roads for the majority of the time. Everyone personally driving to and from work are responsible for the traffic jams, as well as buses carrying its capacity of travelers. Everyday, there are 400,000 cars per day that travel in and out of Tirana, 60,000 of those coming from outside cities (Anonymous, personal communication, 08 May 2023). During the height of traffic, the air pollution is significantly worse when compared to the middle of the day/night.

2.2.1 Maintenance of Cars in Albania

Albania has normalized the ownership of cars privately, but unfortunately it is at the expense of the environment and human health. Many cars in Albania are older, causing an increase of emissions and little is being done about the maintenance of the cars in the area. Comparing the maintenance in Albania to that of the United States highlights the issues with the Albanian transportation system.

Some parts of the United States, cars have an inspection sticker stating the month and year on the bottom left corner of the windshield. The stated date is to remind the driver/owner of the vehicle that the car is due for an inspection that month. The inspection is performed through licensed inspection stations and the following is checked in order to pass inspection for that year: safety testing (includes breaks, steering, suspension, etc), emission testing (ensure the vehicle is in compliance with the state set emission standards), software testing, and other actions ("Massachusetts Vehicle Check | Mass.Gov" n.d.). If the car does not pass any of the set tests and is not fixed before being driven off of the lot, the car will be deemed illegal and the car registration will be suspended and unable to be driven on the road.

Albania has a different system for inspecting a car. Contrary to that of the United States, Albania is on a bi-yearly system of car maintenance (anonymous, personal communication, 8 May 2023). According to an article from 2014, "Tirana's vehicles are dominated by diesel cars, with more than ¾ of them older than 10 years" (Mulla, Shtjefni, and Londo, 2014, page 1). Older cars tend to need more maintenance, as the car gets older the mechanics age with it. However, there is not a strict restriction on cars that do not pass the inspection test, which includes emission monitorization (anonymous, personal communication, 8 May 2023). So, if a car on the street does not pass the inspection, occurring every two years, then there is little enforcement on getting it off of the road. "By the end of 2005, only 61% of passenger cars had been subject to technical inspection; many car owners had failed to appear at the control centres. Moreover, the vehicles that failed the inspection were not immediately identifiable by the road police because no stickers were displayed on the vehicle, thus suffering no consequences" (D. Pojani 2011). More than half of cars were allowed on the road after failure.

2.3 Diesel Car Market

The influx of cars in a post-communism Albania provided a unique market for those with other cars in other countries that were seeking to get rid of their older car. Due to the poor state of the people of Albania, many were not in the market, even today, for new luxury cars. However, the status symbol of owning a luxury car, like Mercedes or Audi, is worldwide. Albania is different in the aspect that the citizens were not able to own one for most of their life. Many want what they can not have, so the used automobile market boomed after communism fell in the 1990s.

During this period of time in the 1990s, diesel engine cars were introduced to the market in hopes to provide a better alternative to petrol/gas engines. Many studies showed that the diesel cars got more miles to the gallon (or km to L) than those that ran on petrol. Although diesel fuel is notably more expensive than gas, it ends up being cheaper due to the better efficiency of diesel fuel. According to a study in 2013, “Europe's car fleets have been persistently transformed from being petrol-driven to diesel-driven over the last 20 years” (Cames and Helmers 2013). Figure 5 depicts the increase of diesel car registration in the European Union, Japan, and the US from 1990-2010. As seen, the European Union during the 1990s into the 2000s increased their use of diesel engines. With the increase of buying also means the increase of selling, and the older diesel engine cars were being sold in Albania, primarily those made from German engineering. Along with this, in 2015, the Volkswagen diesel scandal broke the news stating that, “Volkswagen violated the Clean Air Act by the sale of approximately 590,000 model year 2009 to 2016 diesel motor vehicles equipped with “defeat devices" in the form of computer software designed to cheat on federal emissions tests. The major excess pollutant in this case is oxides of nitrogen (NOx), and is a serious health concern” (US EPA 2015). These cars were banned off of the road, so they ended up in some of the only places left that allowed them, including Albania. “Ever since the Volkswagen emissions

scandal that began in September 2015 and announcements of bans on polluting diesel-powered cars in Germany, countries in Eastern Europe have been flooded by imported used automobiles with low emission standards" (Jovanović 2018). Today, Mercedes Benz with diesel engines dominate the road in Albania, as they are relatively cheap and last quite a long time. According to a 2002 New York Times published article, "it is possible to spot virtually every model of Mercedes produced since the 1970's. From the plushest new S-Class to battered sedans from a bygone era, they outnumber all other brands by as much as two to one" (Simpson 2002). According to the Transportation Department's Sustainable Mobility Plan, "the percentage of diesel cars in the total vehicle fleet is also high at 63%, compared to the EU average of 41% (Tirana GCAP, 2018)" ("Sustainable Urban Mobility Plan for the City of TIRANA [Volume I - STATUS ANALYSIS]" n.d.). Due to the large number of cars and the diesel engines, Tirana has an extremely high pollution rate that has a drastically negative effect on the environment.

In 2019, the Albanian government enacted a law that would help combat some of the worst air pollution issues in Europe. Albania "adopted a decision banning imports of cars older than 10 years and not meeting the Euro 5 emission standard as of January 1, 2019, in an effort to reduce air pollution" (Jovanovic 2018, n.p.). According to the European Union, the Euro 5 emission standard "proposes to set tighter emission limits of particles and of NOx for new cars and vans sold in the EU market (e.g. 80% cut in the emission limit for particulate matter from diesel cars)" ("Euro 5 and 6 Will Reduce Emissions from Cars" n.d., 6). This was a step in the right direction for Albania to help combat their emission issue from cars, but a member of the Tirana Municipality stated, "there are many cars that are on the road from before that, so what are we supposed to do? Most are with diesel engines, rather than the ones in the US that use petrol" (anonymous, personal communication, 8 May 2023).

Figure 5. "Diesel car penetration in major world markets. Expressed as percentages, either annual new car registrations or annual entire car fleet composition" (ACEA 2022).

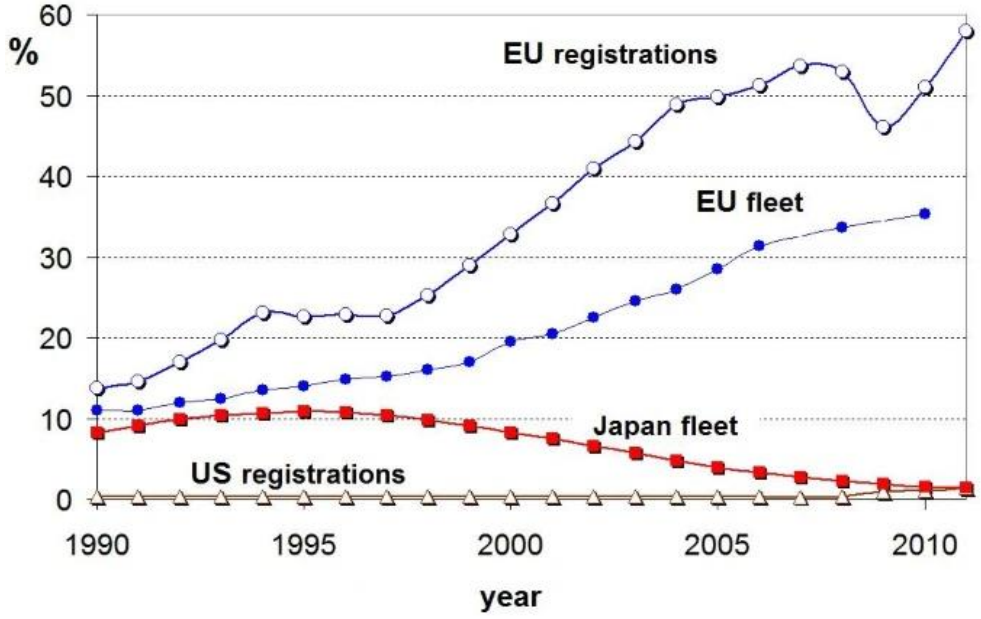


Figure 5. This comparative line graph shows the EU registrations and fleet for diesel cars compared to the US registrations and Japan fleet. It should be noted that the EU is significantly higher than the US and Japan.

Image Source. ACEA Driving Mobility For Europe Data sources: EU registration data[5, 13]; data 1990 to 1993 (Western Europe, including Iceland, Norway, Switzerland); data 1994 to 2011 (EU-15); EU fleet data for 2006, 2008 and 2010 (ACEA, http://www.acea.be); EU fleet data 1990 to 2005[14]; Japan fleet data[15]; US registration data 2000 to 2011 ([16], data extrapolated back to 1990)" (Cames et al., 2013, par. 7).

2.4 Diesel Engines vs Petrol Engines

In this section, gas and petrol are used interchangeably as it is noted that, "Gasoline also known as petrol is an energy-dense secondary fuel that can be thought of as an energy currency. It is used to power many heat engines, most importantly it acts as a fuel for a large proportion of cars" (Energy Education The University of Calgary).

Diesel engines became popular during the 1970-1980 gas shortage crisis in the Western Hemisphere. In the United States, "[the]oil embargo of 1973, oil prices jumped 350%, and the higher costs rippled through the economy" ("Energy Crisis" 2015). This crisis spread to the western world, affecting all parts, including Western Europe (Auffant 2022, n.p.). During this time,

manufacturers of cars started to turn towards diesel engines as an alternative. It resulted in cars getting better mileage to the gallon/liter and was even marketed as "good" for the environment, per testimonies from Stephen and Susan Nasson who lived through the crisis. Diesel engine cars became highly sought after to be an alternative to gas engines, as diesel was a cheaper alternative than gas during this time. The trend stuck mostly in Europe and faded out in the states due to the different taxation laws on gas and diesel. In the US, gas engines are almost exclusively bought. As seen in Albania, diesel engine cars are a norm for most people. The prices, as of 03 July 2023 show that the price of diesel was €1.81 ($1.67) ("Albania Diesel Prices, 03-Jul-2023" n.d.) and gasoline was €1.84 ($1.68) ("Albania Gasoline Prices, 03-Jul-2023" n.d.) However, studies showed that diesel engines were not the environmental bargain that the industry said it was.

2.4.1 Diesel Engines

Diesel engines are starkly different from gas engines, creating a different chemical reaction in order for the engine to start. Life-long diesel mechanic Donald Mahoney, of Ralph Mahoney and Sons Inc. Truck Repair, states that, "Diesel engine fuel is injected into the air in the engine which is under an intense amount of pressure. This then creates heat which burns the fuel. This combustion is constantly ongoing while the vehicle is on, creating soot. The increase of soot happens when the engine is working harder or is at a higher speed" (Donald Mahoney, personal communication, 26 January 2023). The soot and exhaust that come out as a result of this process proves harmful to the environment. Out of the 400,000 cars that are in circulation in Tirana, "76% of the vehicles are private cars, and more than 85% of them use diesel fuel" according to a 2008 study (Mulla, Shtjefni, and Londo, 2014, page 1). Diesel engine cars, although getting better

mileage for the gallon, cause severe pollutants that harm the environment and, in turn, contribute to climate change.

2.4.2 Petrol/Gas Engines

A more popular choice of car, especially in the United States, is the petrol/gas engine car. Many see this car as a go-to due to the cheap fuel cost and, if the right model of car is bought, good mileage to the gallon. According to Mahoney, "Gas engines create the same combustion as diesel, but do it before the engine is fully on. Gas engines use spark plugs at the beginning of ignition to create this process. The spark lights the gas unlike the diesel engines, which compress the air and turn it into heat…This creates a lot fewer damaging emissions than the diesel engines" (Donald Mahoney, personal communication, 26 January 2023). The gas engines, although releasing more emissions, do not release the same amount of the detrimental emissions as diesel engines. Therefore, as far as private car buying goes, petrol engines are a more environmentally friendly choice.

2.4.3 Diesel and Petrol Emissions

Diesel cars produce chemicals similar to that of petrol engines. However, diesel cars emit much more of a harmful chemical than petrol engines. Nitrous oxide and carbon dioxide are emission results of starting a diesel and petrol engine. As seen in Figure 6, diesel engines emit more nitrous oxide emissions than gas engines, but less carbon dioxide emissions than petrol engines. According to the Environmental Protection Agency, "The impact of 1 pound of N2O on warming the atmosphere is 265 times that of 1 pound of carbon dioxide" (US EPA 2015, n.p.). Nitrous oxide "stays in the atmosphere for an average of 114 years, where it can be converted into nitrogen oxides that deplete the stratospheric ozone layer and expose the Earth to more solar

radiation, thereby damaging crops and human health" (Brind'amour and Nathan Lee 2022, n.p.). Nitrous oxide has a more immediate damage to the atmosphere, as it is 265x worse for the environment than carbon dioxide. Therefore, diesel cars are worse for the environment than petrol cars.

Figure 6. Emissions from Diesel and Petrol Engines

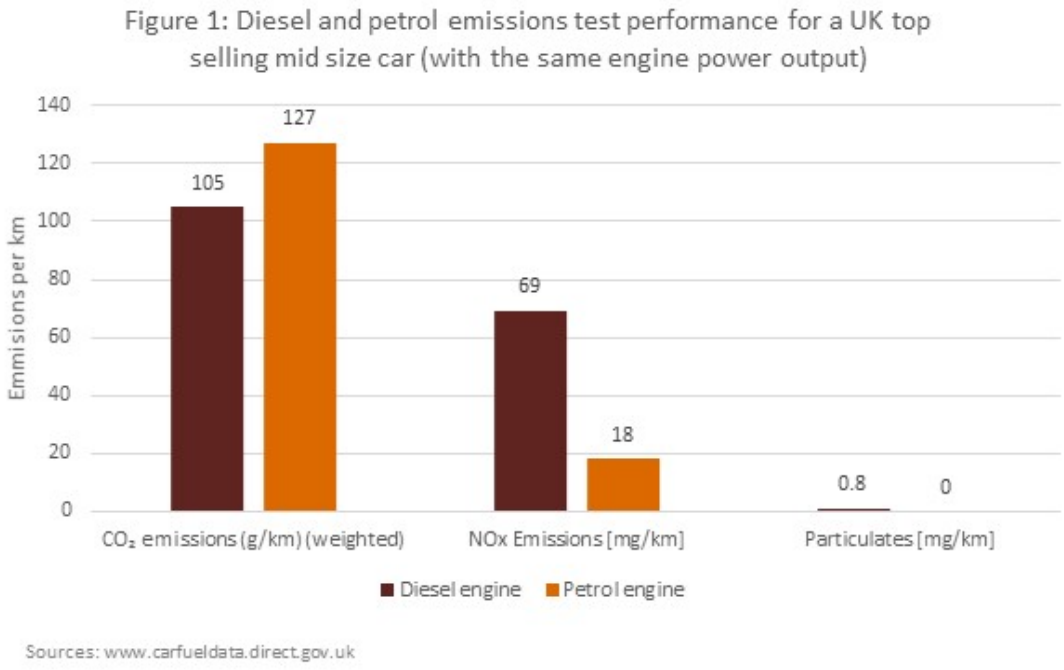


Figure 6. This graph depicts the emissions from diesel and petrol engines from the same test.

Image source: UK Government. URL: https://www.gov.uk/co2-and-vehicle-tax-tools. Accessed on July 1, 2023).

2.4.4 Particulate Matter (PM)

Particulate Matter (PM) is an emission that contributes greatly to the destruction of the ozone layer and the warming of the environment. "Particles are defined by their diameter for air quality regulatory purposes. Those with a diameter of 10 microns or less (PM10) are inhalable into

the lungs and can induce adverse health effects. Fine particulate matter is defined as particles that are 2.5 microns or less in diameter (PM2.5)" ("Inhalable Particulate Matter and Health (PM2.5 and PM10) | California Air Resources Board" n.d.). As seen in Figure 7, PM emissions are less than that of the width of a human hair. Diesel engines release a large amount of particulate matter when running, specifically PM10 and PM2.5 emissions. PM emissions are air pollutants, in which "different components of PM can have either warming or cooling effects on the climate" (ORD US EPA 2014)(Environmental Protection Agency 2022, par. 3). Along with the PM10 and PM2.5 emissions, diesel engines release " A special class of particulates. The solid material in diesel exhaust is known as diesel particulate matter (DPM). More than 90% of DPM is less than 1 μm in diameter (about 1/70th the diameter of a human hair), and thus is a subset of PM2.5" (Environmental Protection Agency 2022, par. 3). Particulate matter is damaging to the environment and to human health, causing long term effects to those who consistently inhale it and, in some severe cases, can cause premature death. Diesel engines are responsible for a large portion of these emissions, which is why Albania is still seeing an increase in PM emission pollution, especially in the city of Tirana. Diesel engine emissions "contribute to the development of cancer; cardiovascular and respiratory health effects; pollution of air, water, and soil; soiling; reductions in visibility; and global climate change" (Lloyd et al. 2011).

PM emissions, highlighting here both PM10 and PM2.5 emissions, are extremely harmful especially in the exhaust of diesel cars as they have been cited as one of the largest contributors to air pollution globally (Lloyd et al. 2011). Due to the constant use of these engines in Tirana, Albania, the country is faced with an air pollution issue. Harmful emissions are entering the air and body causing disastrous effects. Albania needs to combat their emission levels and use of

diesel engines if they have a chance to gain EU membership and contribute to the fight against global warming.

Figure 7. PM 10 and PM2.5 Emission Sizes

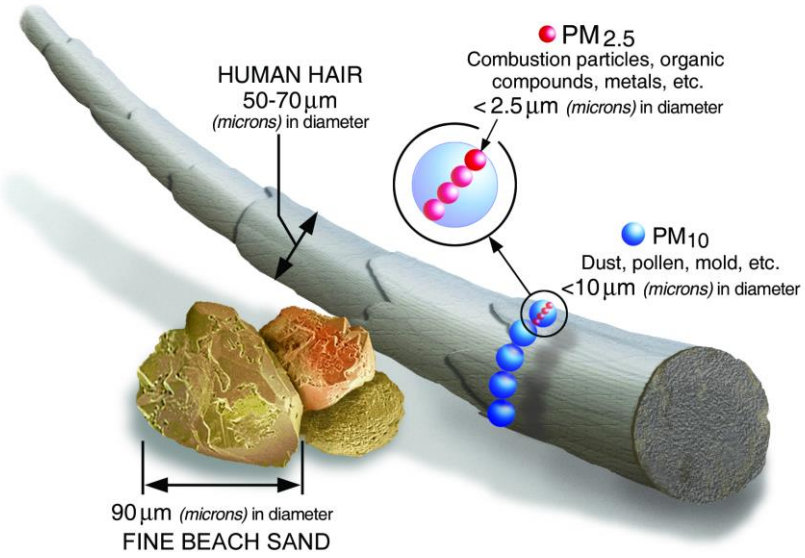


Figure 7. PM 10 and PM2.5 emission sizes compared to a human hair and a grain of sand.

Image Source: Environmental Protection Agency. URL: https://www.epa.gov/pm-pollution/particulate-matter-pm-basics. (Accessed on June 20, 2023).

2.5 Literature Review Summary

The literature review supported the claim that diesel emissions from car engines have a detrimental effect on the environment. Especially in the city of Tirana. Due to Albania's unique past and its relationship with private cars, Tirana is in a unique position regarding emissions. Albania is a candidate country for EU membership, but one of the factors holding them back is the increased emissions, such as PM10 and PM2.5 emissions, mostly stemming from their lack of public transportation and increase in private car ownership. Public transportation in Tirana is only in the form of a bus system, which often proves to be an unreliable mode of transportation for many.

Having a privately-owned car in Albania is mostly seen as a status symbol, as the past laws during communist rule forbade the private ownership of a car (Pojani 2011). Therefore, many other European countries view Albania as an easy market to sell older, used vehicles. Many of these older cars have diesel engines and dated technology, adding to the emission issue within the city. From these cars, PM emissions threaten the environment and the health of the city goers from a day to day basis. However, little is being done about the research of these emissions and its connection to the poor public transportation in the city. Therefore, this thesis is important as it will aim to collect data on emissions from several locations within the city as well as evaluate the usability of the transportation. From there on, recommendations will be made based on the findings and research in hopes that Albania will one day become a member of the European Union.

Chapter 2. Methodology

Part 3. Research Design

The methodology for this thesis was important to the development of gathering conclusions for the support of the hypothesis. Location decisions, instrument choice, fieldwork data collection, and qualitative interviews were all deemed a necessary part in the construction of the research design. This research was primarily focused on empirical data collection through fieldwork and semi-structured, open-ended interviews in an attempt to collect missing data from the country of Albania in the capital of Tirana, to help prove and potentially combat their issue with air pollution. This chapter outlines the methodology used to collect the data. Due to the empirical nature of this thesis, it was decided that personal data collection was necessary as well as interviews.

The research design was based mainly on the need for quantitative data collection. According to the Language Institute of Chulalongkorn University, quantitative research methods is a "type of research that is `explaining phenomena by collecting numerical data that are analyzed using mathematically based methods (in particular statistics)'" (Sukamolson, n.d.). Although statistics will not be used as heavily, data collection and comparisons are used to conclude and support the thesis. Along with this, qualitative methods were used as a secondary support to data collection. Due to the staggering lack of information and data on the subject, interviews were conducted and deemed necessary to support the data.

Qualitative interviews were semi-structured consisting of open-ended questions in hopes that the interviewees would provide their own interpretation of the question. The structure for these interviews followed the directions of the article, *"The joys and challenges of semi-structured interviewing"* by Eike Adams. The use of semi-structured qualitative interviews is "to aim to

explore in-depth experiences of research participants, and the meanings they attribute to these experiences. Such interviews are a particularly useful research tool in situations where little is known about the topic of interest" (Adams 2010, n.p.). The structure for these interviews followed Adams's structure of: **Preparation**: Location, Technical, Contextual, Safety, **During**: Listening carefully, Managing silences, Being non-judgmental, Allowing the participant to guide, Focus, professionalism and emotional control, **After**: Extensive field notes, Supervision or discussion (Adams 2010, n.p.).

Qualitative and quantitative data were collected through several different methods, both being extremely important to the development and outcome of the research. Due to the lack of information online about the emissions in Tirana, these primary methods of data collection were extremely important.

3.1 Theoretical Framework

A theoretical framework is needed for this study to help outline and identify a theory for the research and data collection. A theoretical framework "provides a well supported rationale to conduct your study, and helps the reader understand your perspective. A good theoretical framework assures the reader that the type of investigation you propose is not based solely on your personal instincts or guesses, but rather informed by established theory and empirical facts obtained from credible studies" (Simon and Goes, n.d.). This thesis focuses on the environmental effects that diesel car emissions, PM10 and PM2.5, have on the increasing air pollution concern in Tirana, Albania.

To assess this issue, the theoretical framework being used is a Source Apportionment framework. "Source apportionment (SA) is a technique used to relate emissions from various

pollution sources to air pollution concentrations at a given location (receptor) and for a given time period" (Thunis et. al. 2022, page 4). According to the JRC Technical Report, the steps needed to establish this methodology within the framework include:

"(1) a relevant indicator to characterize air pollution (e.g. PM2.5, PM10, population exposure…). In this document, we use concentrations as indicators. (2) a receptor and its spatio-temporal characteristics, i.e. the area and time period over which the indicator is averaged (e.g. yearly average PM2.5 at a given location). (3) a source (area, sector…) and its spatio-temporal characteristics (e.g. time period and area over which the source is assessed). (4) the SA methodology to capture the processes that relate the source to the receptor" (Thunis et. al. 2022, page 4).

Throughout this thesis, air pollution, PM10 and PM2.5 emissions were analyzed and compared to those of the European Union emission standards. The relevant indicator, step 1, used in this study was PM10 and PM2.5 concentrations. Step 2 identified the spatio-temporal characteristics as a weekly average of PM10 and PM2.5 emissions at seven different locations. Step 3 categorized the area that the study was going to be conducted in, which was within the city of Tirana, Albania. After, step 4 outlined the Source apportionment (SA) methodology. In this thesis, it pertains to the data collection, both qualitative and quantitative, that can be seen in the methodology section of this thesis.

Source apportionment (SA) aids this thesis in the identification of PM emission data and its effects on the environment. With this framework, the data will be further analyzed and compared to that of the European Union standards set. This framework will support the research questions as well as help the construction of the analysis from the data collected.

3.2 Data Collection Locations

Data collection locations were an extremely important choice as they would assist to clearly illustrate the emission issue in Tirana. The locations were chosen based on a myriad of reasons.

Firstly, the bus schedule, seen in Figure 8 , was analyzed and it was noticed that the intersections of Zogu Boulevard Crossroad (location A), Zogu I Zi Rotary (also known as Sheshi Karl Topia) (location B), Sheshi Ataturk (location C), and Desh. Myslim Crossroad (location F) was also a nexus for bus lines. Multiple interviewees, such as Dr. Pojani and a member of the Tirana Municipality also suggested that these intersections were worth including for data collection. Along with these four locations that were spotted on the map, Vasil Shanto Crossroad (location D) was chosen based on an article written about PM10 emission data in 2012 at this location. The article cites this location as "one of the main Tirana city crossroad[s]"(Totoni and Baraj 2013, page 1). Due to the data of this crossroad being available from the 2012 study, this location was chosen due to its increased traffic congestion and the potential possibility to compare emissions to the ones gathered for this thesis.

The last two locations were chosen as a 'control' for the data collection. A comparable location without the presence of traffic was chosen in order to get somewhat accurate readings for an area in Tirana with proper space for pedestrians. Varying variables are important in data collection as "the more variables, the more complex the study and the more complex the statistical analysis" (Kaur n.d.). Taiwan park (location E) was chosen as it is a "complex to the side of the green area, which is like an island in the Park" (Visit Tirana) as well as its ample green space in the heart of the capital city. The second, and last variable, which was also chosen for this reason was Skanderbeg Square (location G). The square marks the middle of the city for most people, as it is "[a] giant pedestrian area and according to Mayor Veliaj, the biggest in the Balkans. The elements of the new square are: almost 28 000 square meters paved with tiles from all the places where Albanians live" ("Skanderbeg Monument and Square, Tirana Monuments, Monuments in Tirana, Tirana Cultural Sites" n.d.). Dr. Pojani and a member of the Tirana Municipality suggested

that these were the lowest trafficked areas while also providing pedestrian access and some green space. An analysis between heavily trafficked areas and low trafficked areas were taken in hopes that it would support the need for better urban planning.

The seven data locations were carefully chosen; however, a main limitation was attempting to identify the busiest areas in Tirana. Due to the lack of information on the country, it was difficult to pick the locations. It was useful to get some insight from the municipality as well as Dr. Pojani when picking out the locations. The seven chosen stayed constant over the course of the data collection. The exact locations can be seen in Figure 9 as well as the route that was walked for all 5 days data was collected, seen in Figure 10.

Figure 8. Bus routes and stops in Tirana

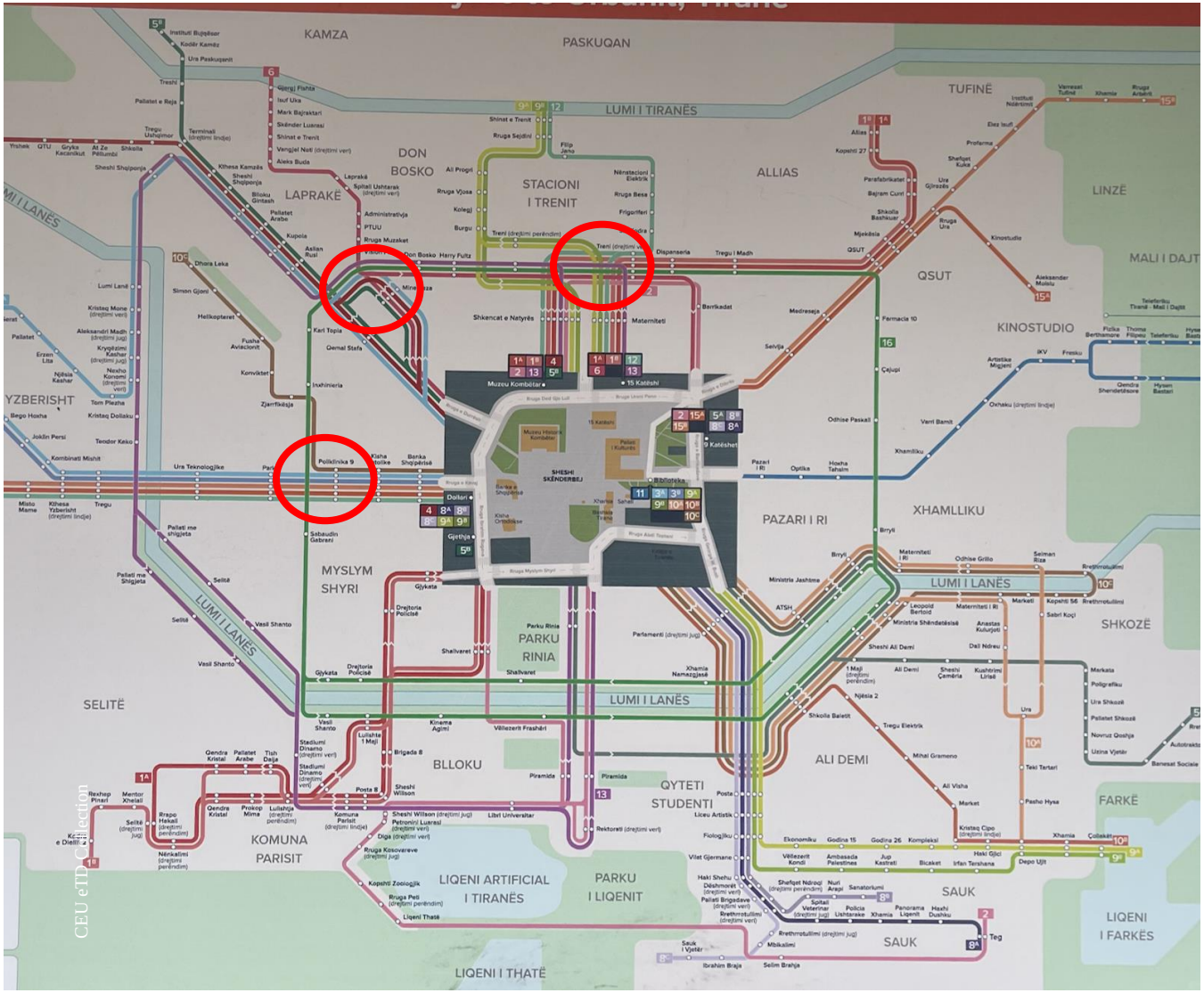


Figure 8. Bus routes and stops in Tirana as seen from the Municipality map shown on some bus stops. Circled are the areas that were decided to be locations for data collection based on the intersections of bus lines.

Image Source: Samantha Nasson. Collected May 20, 2023.

Figure 9. Points Showing Where Data was Taken

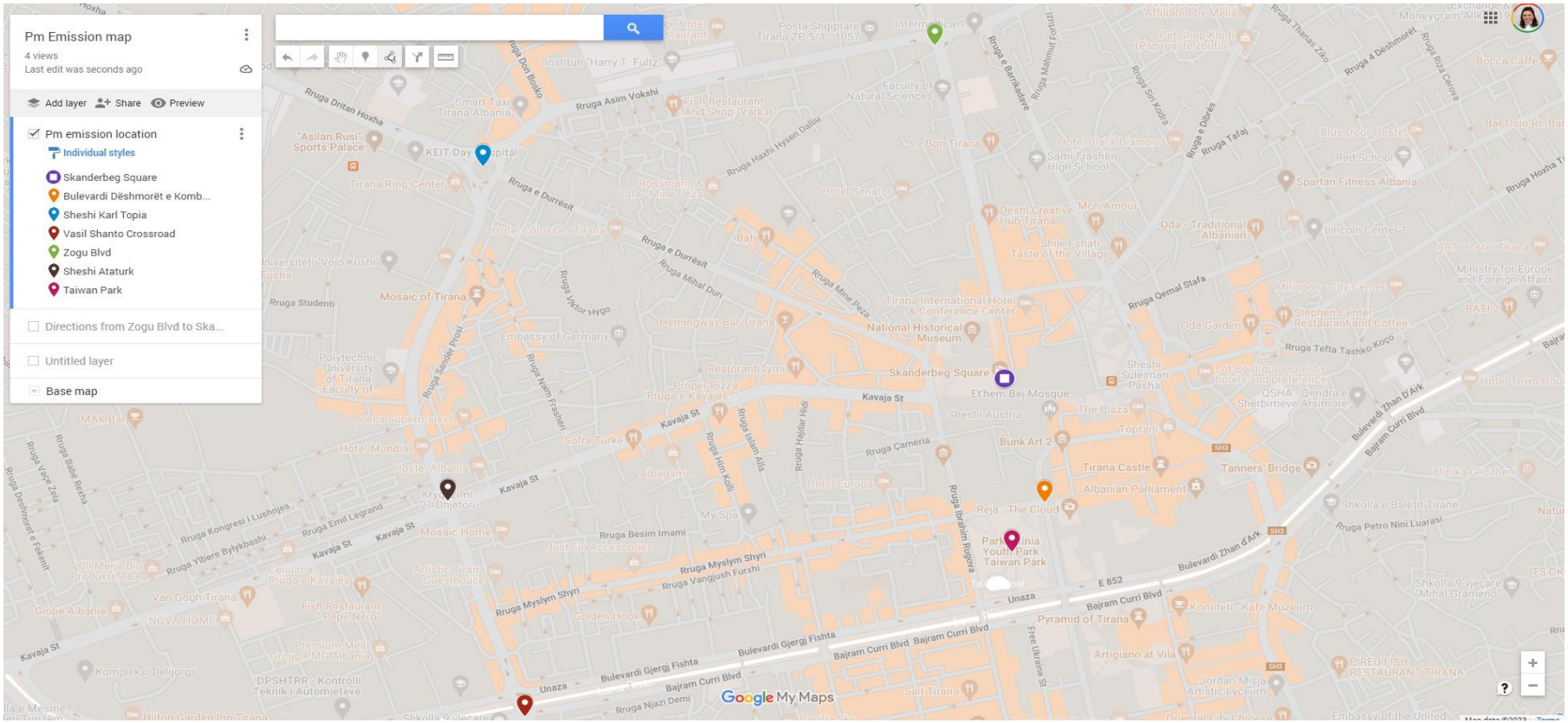


Figure 9. Points on the map show where data was collected for the PM emission research.

Image Source: Samantha Nasson. Created April 20, 2023 via Google Maps.

Figure 10. Map Showing the Walking Route Taken

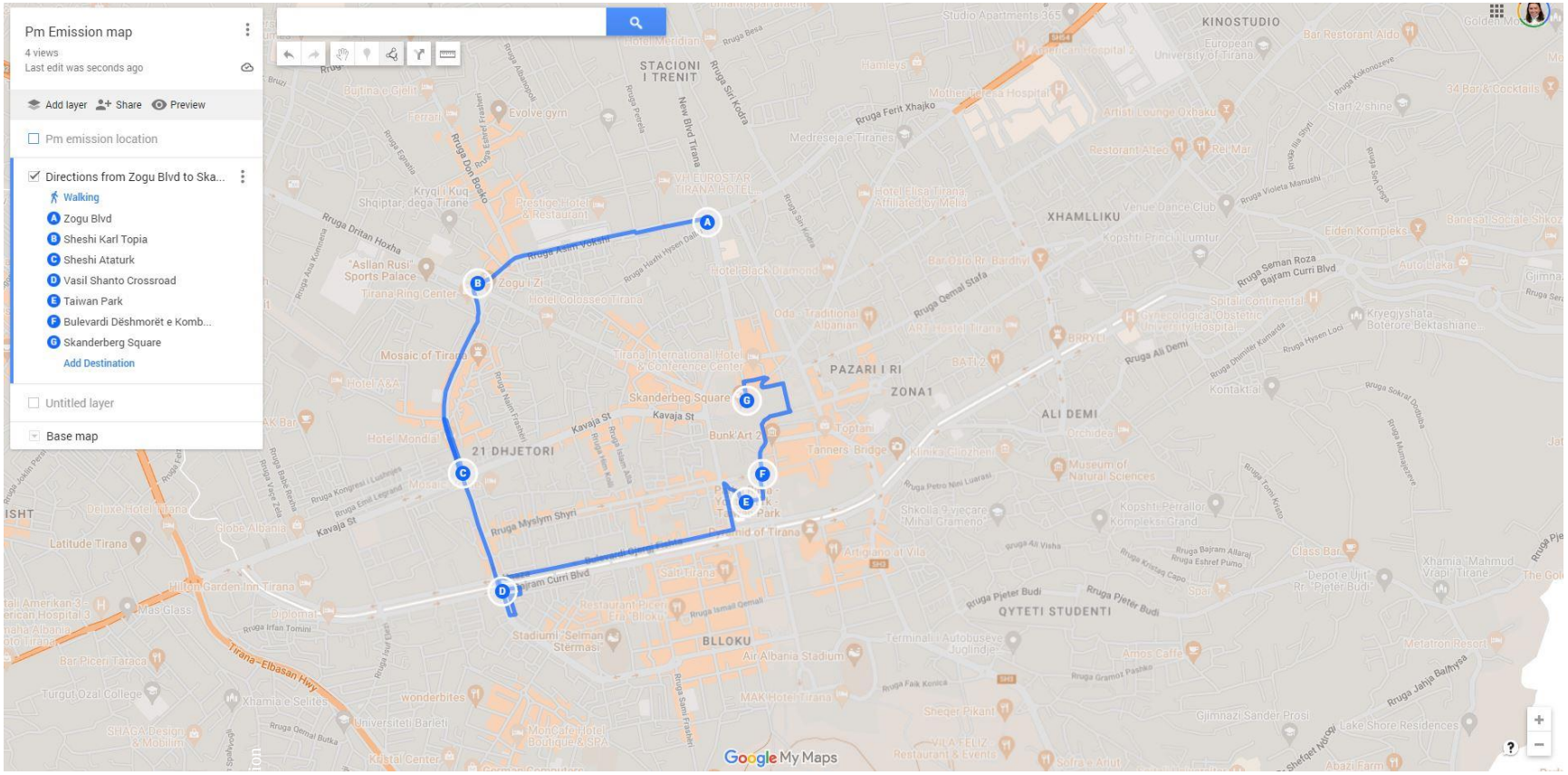


Figure 10. Map showing the route walked for the week in order to collect data for the day.

Image Source: Samantha Nasson. Created April 20, 2023 via Google Maps.

3.3 Instrument

To measure PM emissions, a special monitoring device was obtained to "measure air pollution exposure from traffic, industry, agricultural burning or wildfires" ("AirVisual Series Air Quality Monitors | IQAir" n.d.). Several companies were consulted and asked about pricing, but due to the restrictive budget, a smaller, cheaper emission instrument was bought and used. The certified reviews of the product were considered when making the final decision on the exact instrument. A hand-held air quality monitor was ordered, "*Air Quality Monitor, Formaldehyde Detector, Portable Multifunctional Digital PM2.5 Air Quality Detector Monitor for Indoor and Outdoor Use*" from the Garosa Store, as seen in Figure 11. The air quality detector showed Pm10 emissions, PM2.5 Emissions, Air Quality Index which were used in the data collection. When plugged into a battery, the instrument would take approximately ten seconds to calibrate and level out. From there, the number that appeared on the screen after ten seconds, lasting for at least another ten seconds was recorded.

Figure 11. PM emission monitor used for data collection

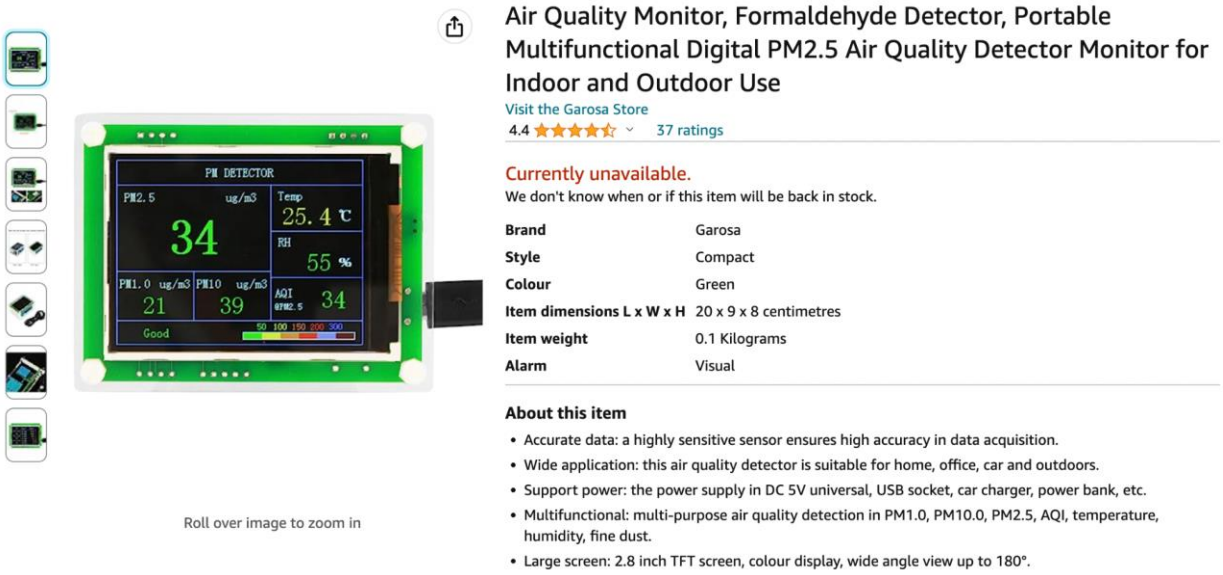


Figure 11. The above image shows the monitor used to conduct the research. The monitor showed PM2.5, PM10, temperature, and AQI for the location it was at.

Image Source: Amazon. URL: https://www.amazon.de/gp/product/B07WFB4X5X/ref=ppx_yo_dt_b_asin_title_o07_s00?ie=UTF8&psc=1. Accessed on April 18, 2023).

3.4 Data Collection

3.4.1 Personal Data Emission Collection

According to an anonymous source interviewed at the Tirana Municipality Circular Economy Department, rush hour in Tirana lasts from 7:00-9:30 in the morning and then again from 4:00-5:30 in the evening. The department source suggested the best time to go out to collect data was in the evening rush hour due to the increased safety aspect of conducting it mid-afternoon. The route taken was decided based on the closest proximity to the point stayed at in order to streamline data collection (closest to point A as seen in Figure 10). Before the final trial was decided and recorded, a one trial day was conducted to ensure the feasibility of collecting the data

on foot. It was found that the PM emissions and the air quality index was hindered when it was precipitating during data collection. Therefore, the week of data collection had to be based on not only the time of day, but the weather as well.

Data was collected in the 3rd week of May from Monday to Friday during the peak commuting hours because of the favorable weather conditions. The location was predetermined and mapped before the data collection, and the PM10, PM2.5, and AQI were measured during collection. Figure 12 depicts what a regular reading on the instrument shows including: PM emissions (both 10 and 2.5), temperature, humidity, and AQI.

The detector had to be plugged into an outside source, in this case a portable battery/charger, in order for the instrument to operate. From there, the instrument took approximately ten seconds to calibrate and even out, showing the real-time emissions data. The number that showed and did not variate from was transcribed and written down for each section, as well as the time, location, and date which corresponded.

Data collection lasted for five days and was completed in roughly 2-2.5 hours each day. Most days, the route was walked by foot to get accurate emission data for the city of Tirana. Some days, the bus was taken as time was an issue due to weather predictions of possible precipitation. After the bus departed, the data instrument needed to be calibrated prior to use, as it would pick up the emissions from directly behind the bus. Sixty to ninety seconds was needed before the collection could begin again. Data collection was deemed finished after the last viable collection was taken on the Friday of the selected week, concluding the experiment.

Figure 12. Example of a reading from the emission instrument

Figure 12. An example of a reading from the monitor used to collect data.

Image Source: Samantha Nasson. Captured May 10, 2023

3.4.2 Qualitative Interviews

Qualitative interviews provide a unique and in depth understanding into the lives and perceptions of the interviewees. “Qualitative researchers are interested in understanding how people interpret their experiences, how they construct their worlds, and what meaning they attribute to their experiences” (Merriam et al. 2016, page 6). Ideally, a group of interviewees would be chosen in order to get testimonies from different concentrations of people in Albania. For example, government officials and local citizens were interviewed, giving different perspectives on the issue of diesel car emissions.

Interviews were conducted in order to gain information that could not be found online or through literature. Air pollution, primarily from car emissions, in Albania is not heavily reported compared to other countries. Information on this specific issue was somewhat scarce, even from Non-Governmental Organizations that tasked themselves with the data collection. In person interviews had to be collected in order to obtain facts, especially those from local government agencies.

Primary literature was searched for online through scholarly sources such as Google Scholar, ResearchGate, etc. A draft literature review with sources was compiled in order to sort through the data that was available through outside research. The draft literature review consisted of approximately twenty potential sources that could be used and cited throughout the paper. From there, gray literature, "information produced outside of traditional publishing and distribution channels, and can include reports, policy literature, working papers, newsletters, government documents, speeches, white papers, urban plans, and so on" (McKenzie 2022) was obtained and reviewed in order to look at a different perspective. Gray literature aided in the compiling of literature sources to observe a more personal and public take on the emissions issue without physically being in the country itself. After all necessary literature was collected, reviewed, and reviewed for content, the in-person interview guides were created.

After the draft questions were constructed, a pilot testing occurred in order to determine what considered the most important of the drafted questions. Pilot testing is "a small-scale study or a pretest for a particular research instrument such as an interview guide or a questionnaire" (Shakir and Rahman 2022). Pilot testing included distributing these questions to family members and other colleagues, primarily those in the facilities and maintenance field, to ensure the right

terminology was being used. After the feedback was received, the questions were rewritten with the given information. From there, in person interviews were conducted.

In person, semi-structured interviews were decided based on a myriad of criteria. The first was researching who oversaw emission statistics and/or public transportation in Albania and finding their contact information. The online website contact form, a general contact inquiry for the Albanian Ministry of Infrastructure of Energy in Tirana (MIE), was filled out in hopes of getting a response. Along with that, a couple of local Non-Governmental Organizations (NGOs) were contacted after it was found that they were potentially collecting data for emission statistics. With their aid, they advised that the Tirana Municipality general contact email be filled out and sent, which would eventually get filtered to the department best suited to answer the question. After no response from the MIE, the municipal office of Environmental Management, Circular Economy and Energy Resource, Municipality of Tirana and the Transportation Management Department in the Municipality of Tirana responded personally. From there, emails were exchanged and in person interviews were set up. Around 12 employees were contacted for an interview, eight of them responded and accepted to an interview.

All eight interviewees agreed to be recorded for the majority of the interview, but some asked for privacy when answering specific questions. Some interviewees elected to remain anonymous and some allowed their names to be cited within this thesis. Government officials were selected based on their specific connection to transportation and emissions in Tirana, which influenced the evolution of the questions that were being asked. Other family members, who resided in Albania and those who visited were also chosen to be interviewed. A local NGO was contacted and interviewed, chosen because of their work measuring and investigating pollution in Tirana.

One of the main resources for this thesis and the development of the research question was influenced by the literary works of Dr. Dorina Pojani of the University of Queensland. Dr. Pojani was interviewed as an expert interviewee. Dr. Pojani's research covers various aspects of the built environment, including urban design, transport, and housing - in both the Global North and South " ("Dr Dorina Pojani - UQ Researchers" n.d.). Two of her publications, *"Urbanization of Post-communist Albania: Economic, Social, and Environmental Challenges" and "From carfree to carfull: The environmental and health impacts of increasing private motorisation in Albania"* were the most influential for this paper. Dr. Pojani was emailed and eventually a virtual meeting via Zoom was conducted. After talking with Pojani, the thesis was finalized and other interviews were conducted for further study based on her influence.

The NGO that responded first was the best fit, The Milieukontakt Organization which dedicates itself to "Serving society towards Sustainability" ("ABOUT US | Mileukontakt Albania" n.d.). Email exchanges between the researcher and the correspondent occurred and an in person semi-structured interview was scheduled for 3 May 2023. The two members of the NGO, Valbona Mazreku and Albana Bregaj Joxhe, were interviewed and research was exchanged upon request. Milieukontakt aided with the research and data collection, as well as providing a place to work. One of the first necessary steps was retrieving bona fide information and data as well as citizen reports of the issue of emissions in Tirana.

One of the more significant parts of this thesis was citizen testimony and concerns, as it discusses an everyday issue for the people of Tirana. Luckily, family members who live, lived, or visited Albania numerous times were interviewed in addition to the already stated interviewees. Life during communism, including transportation, was provided firsthand by a testimony via an online interview by Mirel Sharxhi as well as life after the fall of communism. Transportation and

visitation testimonies were given by another online interview by Simone (Mona) Adams who traveled to Albania during communism twice and again once communism fell. A more recent testimony was given by another family member who still currently resides in the country of Albania, but would like to remain anonymous. A recollection of the growth of Albania in the past twenty years was given via an in person semi-structured interview through online meeting platforms such as Zoom and Microsoft Teams. Understanding life during communism, including transportation habits, is important to provide a timeline of growth for the government and habits of the people.

In total, eight interviews were conducted in two different modes, online or in person. The saturation point was reached after the eight interviews, across multiple interviewee disciplines, were conducted. Although some of the emailed interviewees did not respond, those interviewed and chosen provided necessary information on the issue of public transportation and car emissions within the city of Tirana. A limitation that was observed was that the government was reluctant to answer many emails, as the research was not sponsored or local. After the interviews were finished, the recordings were then transcribed and coded for easier reading.

3.4.3 Limitations to Research

Limitations during research were all noted as they occurred. Limitations to the research and the study are "characteristics of design or methodology that impacted or influenced the interpretation of the findings from your research" (Price and Murnan 2006, 66-67). Several limitations were noticed before, during, and after the interviews were conducted. Limitations for data collection were noted primarily before and during the data collection. Throughout the

research, there were limitations during both the quantitative data collection and the qualitative in person interviews.

During the personal data collection in the field, it was noticed that there were a few limitations to the research. First was the instrument as it was relatively inexpensive compared to the official instruments used by IQ Air company costing approximately $300.00. Unfortunately, due to the limited budget of the research grant given, a smaller, potentially less accurate emission monitor had to be purchased. Secondly, the data was taken from the sidewalk and crosswalks of the points. In order to get a more accurate reading, the data should have been collected in the middle of the road/intersections. However, due to several safety reasons, this was physically impossible. Lastly, it was noticed that cigarette smoke alters the readings of the instrument. Since the readings had to be taken from a sidewalk or crosswalk, for safety reasons, it was often noticed that the instrument had to be recalibrated and data had to be retaken due to the passing smokers. According to a study, “24.8 percent of Albanian adults (42.9 percent of males and 7.1 percent of females) are current smokers” (“Survey on Tobacco Consumption in SEE Countries: Albania 2019” n.d.). As seen in Figure 13, when a smoker goes by the PM emissions and the AQI spikes to severely unhealthy levels, compared to the more uniform readings taken as seen in Figure 12.

Ethical limitations were outlined before the research took place. This included, but not limited to, the addition of a confidentiality agreement, potential hazards and benefits, and informed consent when conducting interviews and research. Interviewees were promised anonymity when needed as well as assurance of safety during interviews. The ethical checklist can be found in the Appendix section of this thesis

Figure 13. Emission Monitor and Smoking

Figure 13. Emission monitor showing the drastic effects smoking has on nearby readings

Image Source: Samantha Nasson. Collected May 18, 2023.

Qualitative, in person interviews, had its limitations when conducting as well as those mentioned above. Consent was taken before starting the interviews. Most of the interviewees responded "yes" to this question, however, it was noticed that at some points information was potentially withheld. It should be noted that "only 10 percent of respondents [in Albania] believe that corruption has decreased in the last two years and 96 per cent believe corruption in the public sector remains a problem (Transparency International 2013b)" (Jenkins et al. 2014, 1). Due to the real possibility of corruption in the government, limitations to this have to be addressed. While the interviewee felt the interviewees were trustworthy and felt like the information was true, the

limitation still has to be addressed. Another limitation was the language barrier between the interviewer and the interviewee. Since Albanian is the official language and I am not fluent, it was hard to communicate with people as many of them struggled with their English, like I struggled with my Albanian.

Limitations occur naturally, but it is important to acknowledge as the research may have some limitations within it. Such limitations mentioned are "important to understand for placing research findings in context, interpreting the validity of the scientific work, and ascribing a credibility level to the conclusions of published research" (Ioannidis 2007). The acknowledgement of these limitations was pertinent to the success and finalization of the thesis.

Chapter 3. Results

4.1 Data Collection Process

Testing consisted of one working week (five days) once a day during rush hour from the hours of 4:00pm to 5:30pm. The parameters recorded during the emissions data collection were, Particulate Matter 10 (PM10), Particulate Matter 2.5 (PM2.5), Air Quality Index (AQI), longitude, latitude, time, and date which corresponded with the location. Each day, there were seven locations that remained constant throughout the testing period. The locations and the route walked did not change remaining consistent for the duplication of the study day by day. The European emission standards for PM2.5 and PM10 emissions are shown in Table 1.

Data was collected during this week based on the weather patterns. It was noticed that when precipitation occurred, the emissions would be skewed. A test data collection occurred the week before in order to assure the feasibility of the experiment. Data was mostly reliant on self-collection; however, secondary data was used by Milieukontakt and Green Lungs Albania. The emissions, both PM10 and PM2.5 were aligned with the hypothesis.

Table 1. European, Albanian, and WHO Emission Standards for PM2.5 and PM10

Pollutant	**Albanian Limit in µg/m³**	**European Limit in µg/m³**	**WHO Recommendation in µg/m³**
Fine Particles (PM2.5)	25	25	50
Particulate Matter (PM10)	60	50	50

Table 1. EU, Albanian, and WHO emission standards and recommendations for PM2.5 and PM10 particles

4.2 PM10 Emission Results

Due to the lack of public data on the past PM10 emissions of Albania, little is known about the growth or reduction of emissions in the capital city of Tirana. During data collection in May, PM10 emissions were analyzed and compared to the emission standards set by the European Union. These emissions could aid in determining whether or not Albania is on the right path for future EU membership.

Data collection produced results showing the PM10 emission levels in several areas of Tirana which were deemed as heavy traffic locations that created the methodology for collection. Table 2 depicts the results from the experiment. It is important to look closely at the PM10 emissions, Time, and Location for all 5 days to fully comprehend the data collected. Table 3 shows the mean PM10 emissions from each location across the 5 days that was observed. The PM10 emissions were observed to be higher than the 24-hour average than that of the European Union standards, which is 50 μg/m³ according to the European Commission and (Table 1) as well as the Albanian limit of 60 μg/m³ according to Milieukontakt Albania (Table 1). Graph 1 illustrates the average PM10 emissions taken for each location compared to the European Union limit for said emissions. The Pm10 emission locations that were over the EU limit were: Zogu Boulevard Crossroad at 66 μg/m³, Zogu I Zi Rotary (Sheshi Karl Topia) at 53 μg/m³, Vasil Shanto Crossroad at 56 μg/m³, and Desh. Myslim Crossroad at 65 μg/m³. The PM10 emission locations that were above the Albanian Limit were only Zogu Boulevard Crossroad at 66 μg/m³ and Desh. Myslim

Crossroad at 65 µg/m³. An example of how the mean of the emissions was calculated is below. This formula was used for each data set.

Formula 1. Mean Calculation Example

$$\text{Mean} = \frac{Sum\ of\ Terms}{Number\ of\ Terms}$$

Mean for Zogu Boulevard Crossroad (in µg/m³)

$$\frac{55+53+61+82+77}{5} = 65.6 \text{ rounded to the nearest whole number… } 66$$

Equation 1. An example of how the mean emissions for each location were calculated.

A bar chart was constructed in order to better view the emissions that were collected across the 5 days. Graph 2 depicts all of the PM10 emission values by location for all 5 days. The black horizontal line across the 50 µg/m³ emission line shows the European Union emission limit for PM10 emissions for 24 hours. Although the emissions were only observed at each location for roughly ten minutes, it should be noted that the means of each location were calculated from all of the data from the working week, showing a better estimate of the average emissions over the period. It should also be noted that there was a spike of emissions towards the end of the working week, mainly Thursday and Friday. It was observed that there were significantly more cars on the road during this period of time.

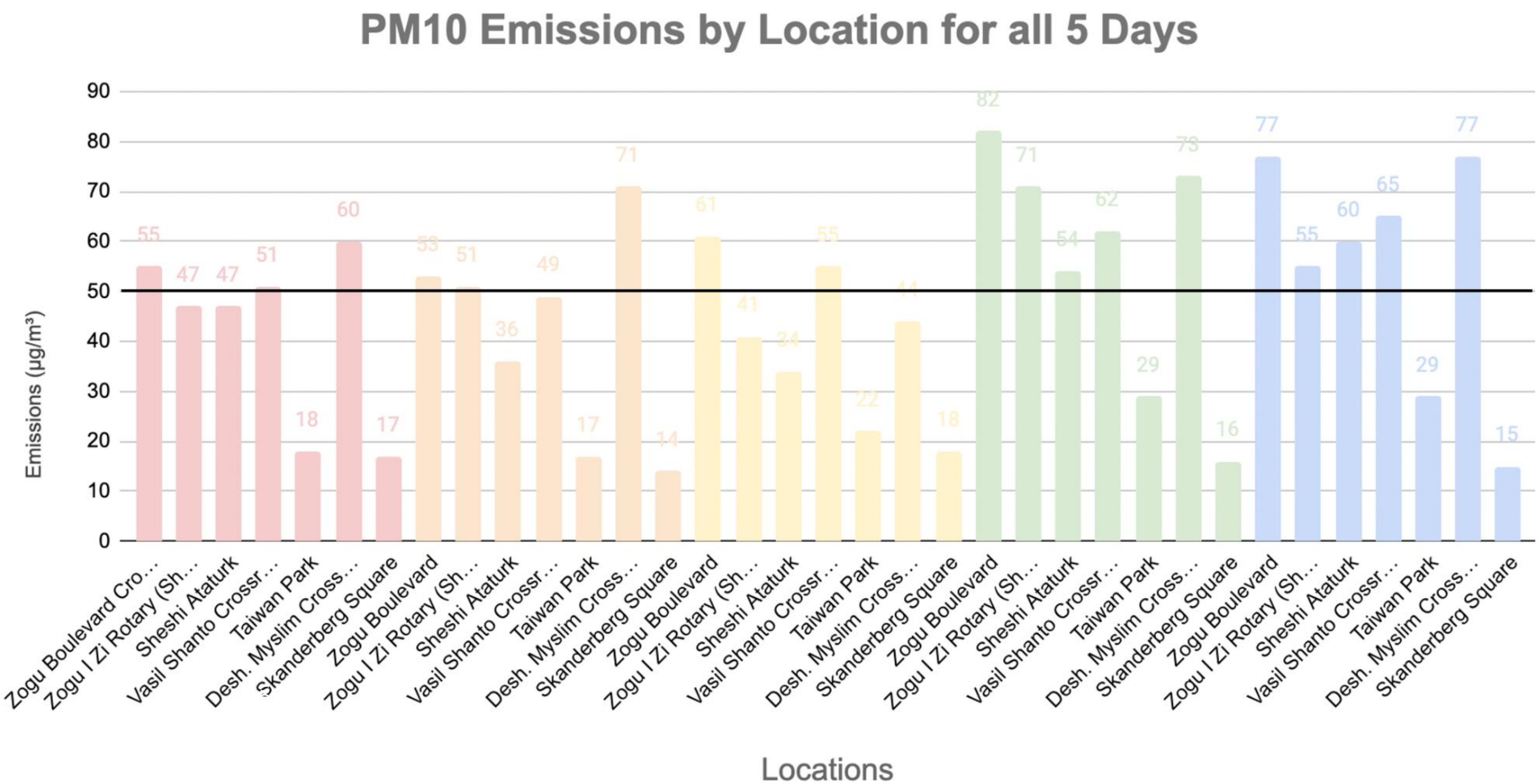
Table 2: Tirana Emission Data for the week of May 22, 2023

Date	Time	Location	Latitude	Longitude	Pm10 (in µg/m³)	Pm2.5 (in µg/m³)	AQI
May 22, 2023	16:30	Zogu Boulevard Crossroad	41.33592	19.81627	55	47	120
May 22, 2023	16:49	Zogu I Zi Rotary (Sheshi Karl Topia)	41.33309	19.80437	47	40	110
May 22, 2023	16:56	Sheshi Ataturk	41.32571393	19.80353219	47	39	109
May 22, 2023	17:02	Vasil Shanto Crossroad	41.32129	19.80547	51	44	120
May 22, 2023	17:20	Taiwan Park	41.32491078	19.81832859	18	17	60
May 22, 2023	17:23	Desh. Myslim Crossroad	41.32938	19.82494	60	55	124
May 22, 2023	17:27	Skanderbeg Square	41.32855	19.81802	17	16	55
May 23, 2023	16:18	Zogu Boulevard	41.33592	19.81627	53	43	119
May 23, 2023	16:40	Zogu I Zi Rotary (Sheshi Karl Topia)	41.33309	19.80437	51	42	117
May 23, 2023	16:53	Sheshi Ataturk	41.32571393	19.80353219	36	33	99
May 23, 2023	17:04	Vasil Shanto Crossroad	41.32129	19.80547	49	42	117
May 23, 2023	17:24	Taiwan Park	41.32491078	19.81832859	17	16	59
May 23, 2023	17:26	Desh. Myslim Crossroad	41.32938	19.82494	71	62	153
May 23, 2023	17:34	Skanderbeg Square	41.32855	19.81802	14	14	54
May 24, 2023	17:01	Zogu Boulevard	41.33592	19.81627	61	49	131
May 24, 2023	17:19	Zogu I Zi Rotary (Sheshi Karl Topia)	41.33309	19.80437	41	36	102
May 24, 2023	17:29	Sheshi Ataturk	41.32571393	19.80353219	34	32	93

May 24, 2023	17:38	Vasil Shanto Crossroad	41.32129	19.80547	55	46	127
May 24, 2023	17:58	Taiwan Park	41.32491078	19.81832859	22	20	67
May 24, 2023	18:00	Desh. Myslim Crossroad	41.32938	19.82494	44	38	107
May 24, 2023	18:04	Skanderbeg Square	41.32855	19.81802	18	16	59
May 25, 2023	15:53	Zogu Boulevard	41.33592	19.81627	82	79	162
May 25, 2023	16:19	Zogu I Zi Rotary (Sheshi Karl Topia)	41.33309	19.80437	71	61	153
May 25, 2023	16:24	Sheshi Ataturk	41.32571393	19.80353219	54	44	122
May 25, 2023	16:43	Vasil Shanto Crossroad	41.32129	19.80547	62	51	139
May 25, 2023	17:02	Taiwan Park	41.32491078	19.81832859	29	29	86
May 25, 2023	17:04	Desh. Myslim Crossroad	41.32938	19.82494	73	62	153
May 25, 20233	17:10	Skanderbeg Square	41.32855	19.81802	16	16	55
May 26, 20233	16:02	Zogu Boulevard	41.33592	19.81627	77	72	125
May 26, 2023	16:20	Zogu I Zi Rotary (Sheshi Karl Topia)	41.33309	19.80437	55	49	108
May 26, 2023	16:35	Sheshi Ataturk	41.32571393	19.80437	60	49	120
May 26, 2023	16:50	Vasil Shanto Crossroad	41.32129	19.80547	65	53	135
May 26, 2023	16:55	Taiwan Park	41.32491078	19.81832859	29	29	86
May 26, 2023	17:03	Desh. Myslim Crossroad	41.32938	19.82494	77	67	148
May 26, 2023	17:10	Skanderbeg Square	41.32855	19.81802	15	15	54

Table 2. Emissions collected for each location. The table includes the time, place, latitude and longitude, PM10, PM2.5, and AQI for each location by day.

Graph 1. PM10 Emissions by Location for 5 Days based off of Table 1 Data



Graph 1 Graph showing the PM10 emissions by locations for all 5 Days based off of Table 1 data. The horizontal black line shows the EU standard of emissions (50

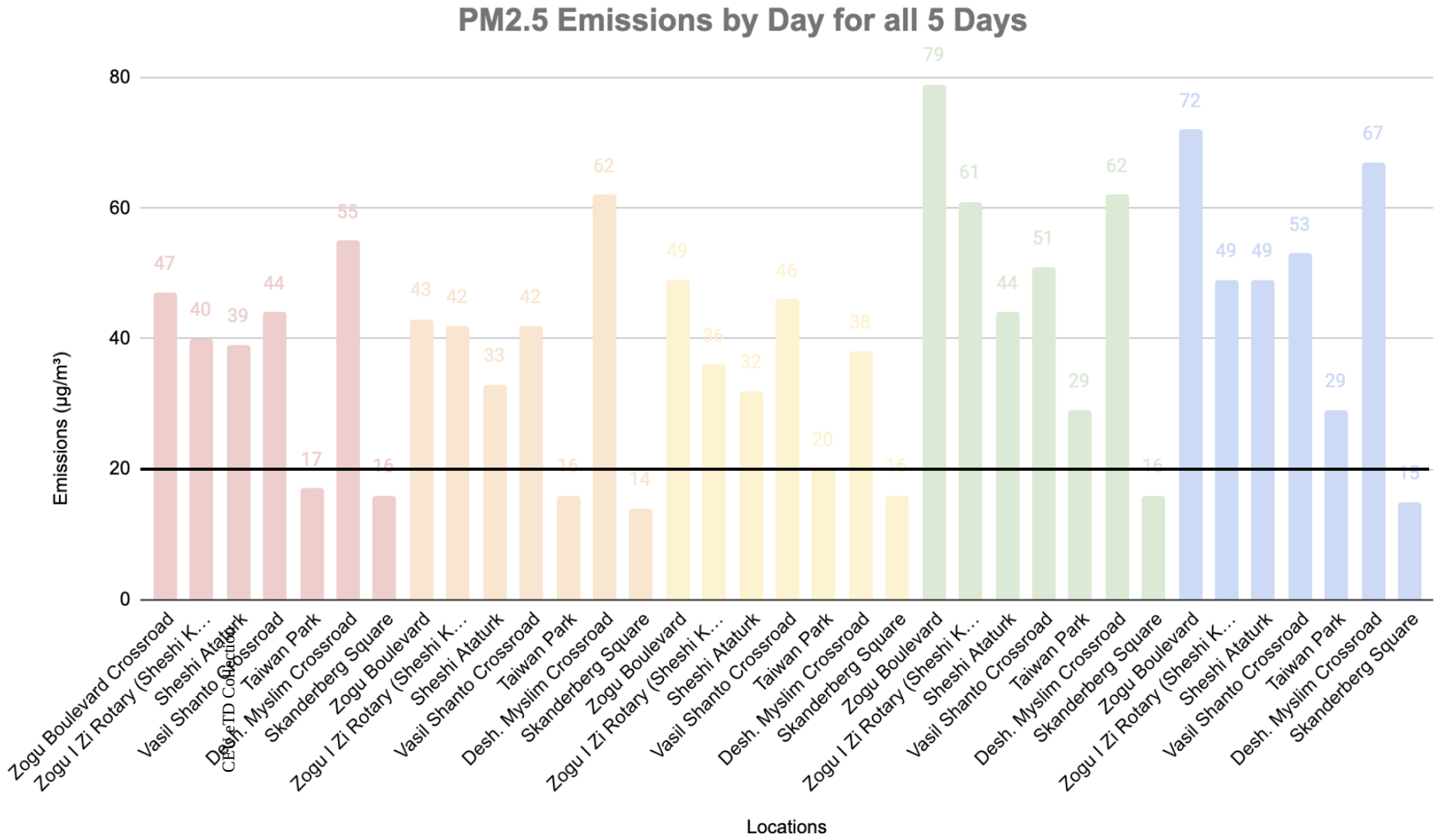
Table 3. Mean for each location based off of Table 2's data

Location	Pm10 Average (in µg/m³)*	Pm2.5 Average(in µg/m³)*	AQI Average*
Zogu Boulevard Crossroad	66	58	131
Zogu I Zi Rotary (Sheshi Karl Topia)	53	46	118
Sheshi Ataturk	46	39	109
Vasil Shanto Crossroad	56	47	128
Taiwan Park	23	22	72
Desh. Myslim Crossroad	65	62	137
Skanderbeg Square	16	15	55

*all averages were rounded to the nearest whole number

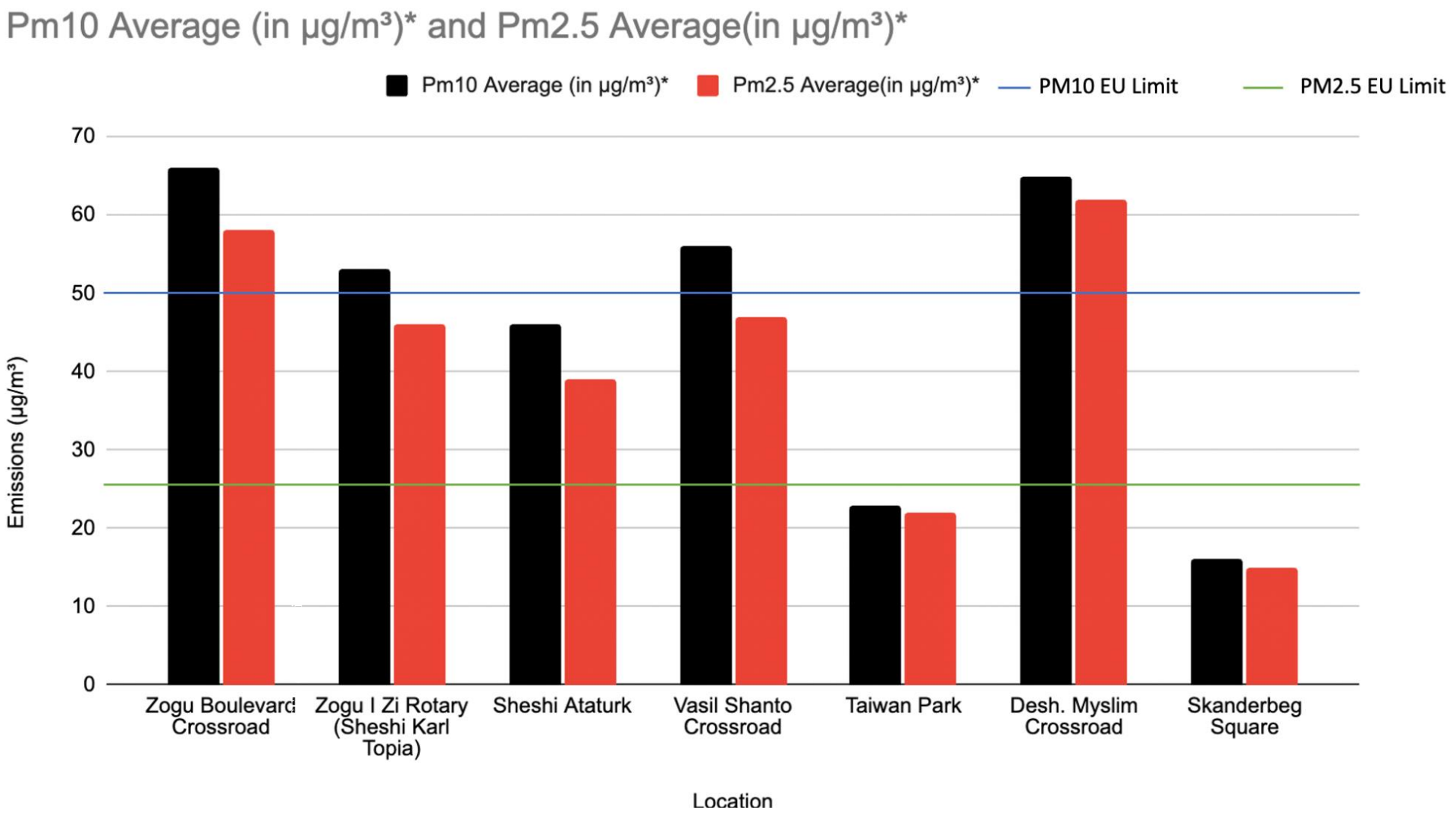
Table 3. Mean of PM10, PM2.5, and AQI for each location

Graph 2. PM2.5 Emissions by Location for 5 Days based off of Table 1 Data



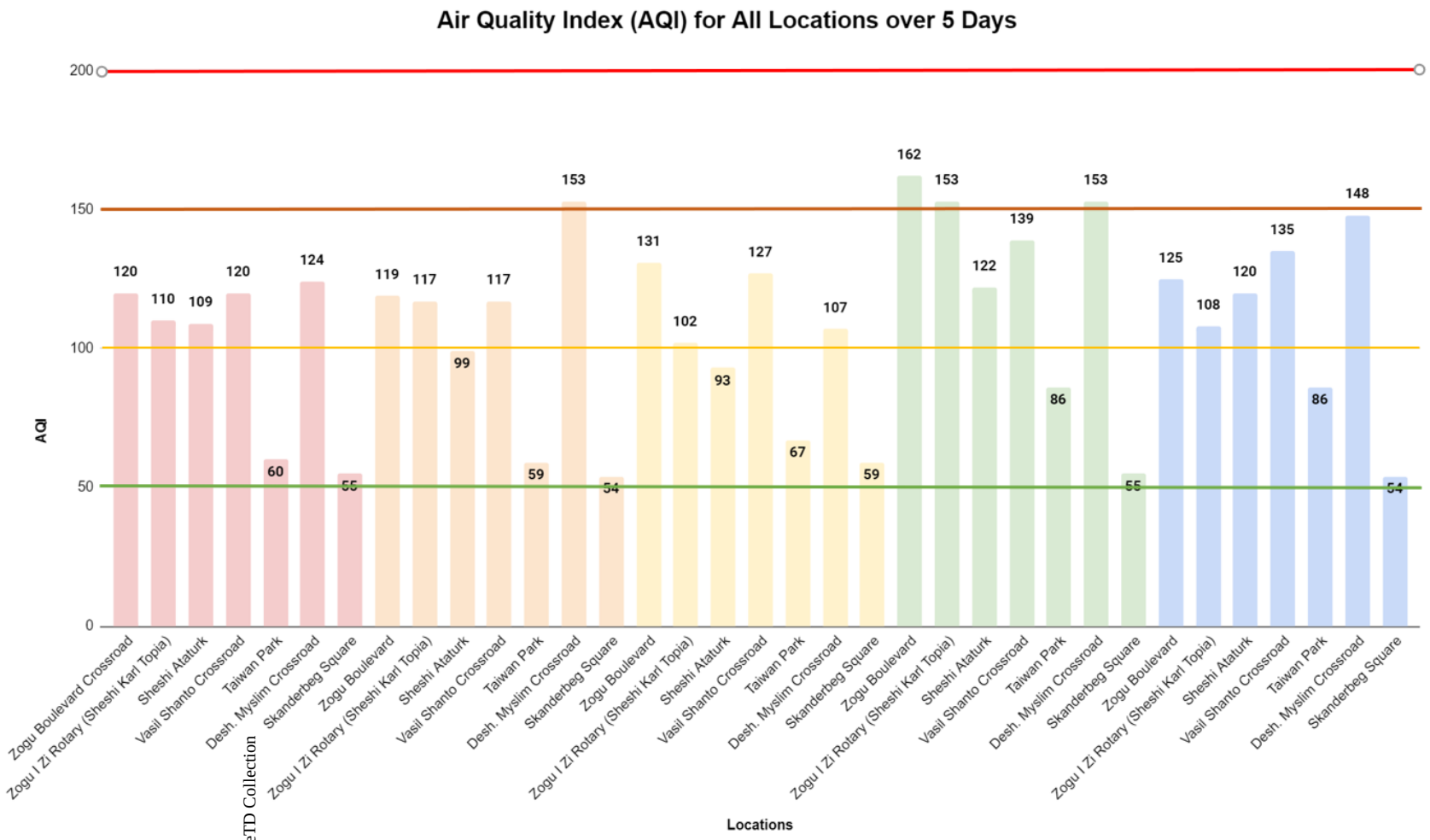
Graph 2. PM2.5 emissions by day for all 5 days. The horizontal black line shows the EU standard of emissions (20)

Graph 3. PM10 and PM2.5 Average by Location for the 5 Days



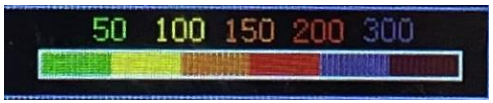
Graph 3. This graph shows the PM10 and PM2.5 emission averages for all 5 days for each location. The horizontal green line shows the PM2.5 emission standards set by the EU and the blue horizontal line shows the PM10 emission standards set by the EU.

Graph 4. AQI For All 5 Days by Location



Graph 4. AQI for each location over 5 days. Each horizontal bar symbolizes the cutoff for each emission status, which corresponds to the scale below.

Legend: 50: Healthy, 100: Unhealthy, 150: Unhealthy, 200: Unhealthy, 300: Severely Unhealthy



Scale from PM monitor

4.3 PM2.5 Emission Results

PM2.5 emissions similarly lack the prior data like PM10 emissions. During data collection in May, PM2.5 emissions were analyzed and compared to the emission standards set by the European Union. These emissions, as well as PM10 discussed above, could aid in determining whether or not Albania is on the right path for future EU membership.

Data collection produced empirical data of PM2.5 emissions for each location across a 5-day period of collection. Table 2 shows the results from the data that had been collected at each location which coincided with locations used for PM10 emission data above. It is important to look at the Location, Time, and PM2.5 emissions for a better analysis of each value at the location for that day. Graph 2 depicts the data from the table using a more visual approach. The graph shows the data collected at each point for that day as well as showing the European limit set for PM2.5 emissions, which is 25 μg/m³. It can be seen that the graph shows that most data points are above the European limit and well above the Albanian limit of 25 μg/m³. The only locations that do not go over the limit are the control locations of Taiwan Park and Skanderbeg Square.

The mean, or average, of the PM2.5 emission data was calculated to show a more accurate, long term value of PM2.5 emissions for each location. The mean was calculated for each location using the same formula listed above in section 4.3. It was repeated as many times as necessary to complete the table. Table 3 shows the mean of each location based on the PM2.5 emissions collected throughout the week. The mean emissions for these locations were above the Albanian and European average of 25 μg/m³: Zogu Boulevard Crossroad at 58μg/m³, Zogu I Zi Rotary (Sheshi Karl Topia) at 46 μg/m³, Sheshi Ataturk at 39 μg/m³, Vasil Shanto Crossroad at 47 μg/m³, and Desh. Myslim Crossroad at 62 μg/m³. The control locations, Taiwan Park at 22 μg/m³ and

Skanderbeg Square at 15µg/m³, were the only two locations that did not average over the limit set by both the European Union and the Albanian Government. It can be better seen in Graph 3 depicting the mean of the emissions per location compared to the EU limit.

It was concluded that the data supported the hypothesis that both the PM10 and PM2.5 emissions in Tirana, Albania would be above the limit set by the European Union. According to the data, the emissions were also above the limit set by the Albanian Government as well.

Chapter 4. Discussion

5.1 PM10 Emissions in Tirana- Key Findings

European Union member countries must be able to maintain their emissions within the set limit by the EU. Countries that cannot do this, usually, are not admitted into the European Union, blocking potential member benefits. According to Milieukontakt Albania, "In the 2019 Pollution Index (Numbeo), Tirana ranks as one of the most polluted cities in Europe" while "Europe's least polluted city is Helsinki, the capital of Finland" ("How Polluted Is the Air in Tirana? | Mileukontakt Albania" 2023). Numbeo, classifying themselves as the 'world's largest database', ranks Tirana, Albania as the third worst polluted European city with a pollution index of 86.6 , behind Chelyabinsk, Russia with an index of 88.7 and the number one polluted city Tetovo, North Macedonia with an index of 95.6 for the year 2023 ("Europe: Pollution Index by City 2023 Mid-Year" n.d.).

A study in 2012 analyzed PM10 emissions in Tirana at only one crossroad, Vasil Shanto, which also was a chosen location for this data collection in the thesis. During this study, the Albanian emissions limit for PM10 emissions was an astounding 150 µg/m³ compared to that of the 50 µg/m³ the European Union had set for their emissions during this time (Totoni and Baraj 2013, page 1). Pojani, in her paper, wrote in 2011 that, "by 2015 current limits will be updated to match EU standards" (Pojani 2011). Although the data is lacking for the 2015 emission levels in Albania, today's regulations for PM2.5 emissions match those of the European Union, but PM10 standards in Albania are higher than the EU. Pojani's prediction for emission standards in Albania were to mirror those of the EU.

The data collected from each location, shown in Graph 1, depicts the PM10 emissions by location for all 5 days. On the graph, it can be seen that several locations surpass the EU standard for PM10 emissions for a 24-hour period, represented by the horizontal black line. On average, 4/7 locations were above the EU limit, as seen in Graph 3. The four locations: Zogu Boulevard Crossroad, Zogu I Zi, Vasil Shanto Crossroad, and Desh. Myslim Crossroad were all over the EU limit of 50 µg/m³. However, only Zogu Boulevard Crossroad and Desh. Myslim Crossroad were above the Albanian limit of 60 µg/m³, depicted in Graph 3. The increased emission limit poses a significant threat to the environment as it may seem that 2/7 locations shown are not in compliance when compared to Albanian standards, rather than the 4/7 for the European Union's standards.

PM10 emissions have a disastrous effect on the environment and the health of the people inhaling the pollutant. While collecting data, the haze and smell of soot from vehicles was extremely noticeable even without an instrument, further adding to the worry about the environment from these engines. In an interview with Dr. Pojani, she stated that, "Tirana is the kind of place where you can still smell the pollution. I think that's because there is still diesel being used" (Dr. Dorina Pojani, personal communication, 6 March 2023). The high level of PM 10 emissions contributed to the unhealthy status of the Air Quality Index numbers, which can be seen in Graph 4. The higher the PM levels, the higher the Air Quality index number.

PM10 emissions in Tirana have not been kept historically since 2018. Due to this gap of information, there is no good way to determine from the past two decades how Tirana is fairing in terms of their emission levels. According to the study by Totoni et al. in 2012, "[t]he concentrations of PM10 range from 8.33 g/m3 to 92.14 g/m3 and the average mass concentration for PM10 is 34.25 g/m 3 . Only 11.4% of daily concentrations measured exceeded the EU limit value of 50 g/m 3 , whilst all of them are well below the limit value of 150 g/m 3 established by Albanian Standard

of Air Quality" (Totoni and Baraj 2013, page 1). Data for PM10 emissions can be compared to this statistic to identify a trend in emissions. Table 3 and Graph 3 show the calculations of the mean PM10 emissions by location. It should be noted that 4/7 (57%) of the locations chosen were above the European Union standards of emissions, while 2/7 (29%) were above the Albanian Standards. Data from 2012-2018 is scarce, showing no congruent data until 2018.

Green Lungs Albania, a project funded by the European Union challenged with "creat[ing] a national network of NGOs to address issues related to air quality, through access and transparency in information and advocacy for strengthening the regulatory framework in the air sector" ("Green Lungs" n.d.) was able to compile their own data and find the mean average for several locations, many of which overlapped with this study. Figure 14 shows the averaged emissions from 2018-2022. Along with that, a comparison can be made to Figure 15, which shows the averaged emissions from 2022-2023. The parameters of the study, such as time, repetition, and singular data are not available from these maps. Therefore, it is difficult to determine if the data improved or worsened for each time frame. It should be noted that PM10 emissions skyrocketed at almost every location between the two figures, showing that emissions got worse over time. Locations in this study: Zogu I Zi, Vasil Shanto, and Desh. Myslim Crossroad can be located on the map as well. Zogu I Zi, seen on the map down below in the blue circle, averaged 24 µg/m³ for 2018-2021, while in 2022-2023 it averaged 147 µg/m³. According to the data collected for this thesis, which can be seen on Map 1, the one week average for Zogu I Zi during rush hour traffic was 53 µg/m³. The 2018-2021 data was in compliance with The European Union standards for air pollution, however, the 2022-2023 data and the data collected for the week was not in compliance and was significantly over the emission standards set for PM10 emissions, 50 µg/m³. Contrastingly, the emission data collected and the emission average for 2018-2021 was in

compliance with the Albanian emission limit of 60 μg/m³. The two figures and the data collected show the increase of PM10 emissions in Tirana over the past 5 years. The six other locations: Zogu Boulevard Crossroad, Sheshi Ataturk, Vasil Shanto Crossroad, Taiwan Park, Desh. Myslim Crossroad, and Skanderbeg Square saw an increase of emissions based on the Green Lungs data shown in the two figures and the data collected during the research. It can be concluded that there is a significant increase in the amount of emissions in Tirana within the past five years.

PM10 emissions continue to rise in Tirana. While walking through the densely populated city, the smell and sights of air pollution are obvious. Tirana needs to make a change in order to combat the rising emissions, predominantly within the governmental sector. Along with PM10 emissions, PM2.5 emissions, arguably worse for health, are continuing to rise as well.

Map 1. PM10 mean emissions in Tirana

Map 1. Map 1 shows the mean PM10 emissions calculated for each location in Tirana.

Image Source: Samantha Nasson. Basemap Used: Dark Grey Canvas Base provided by Esri. PM emissions provided by Samantha Nasson.

Figure 14: PM10 Emissions in 2018-2021 throughout Tirana

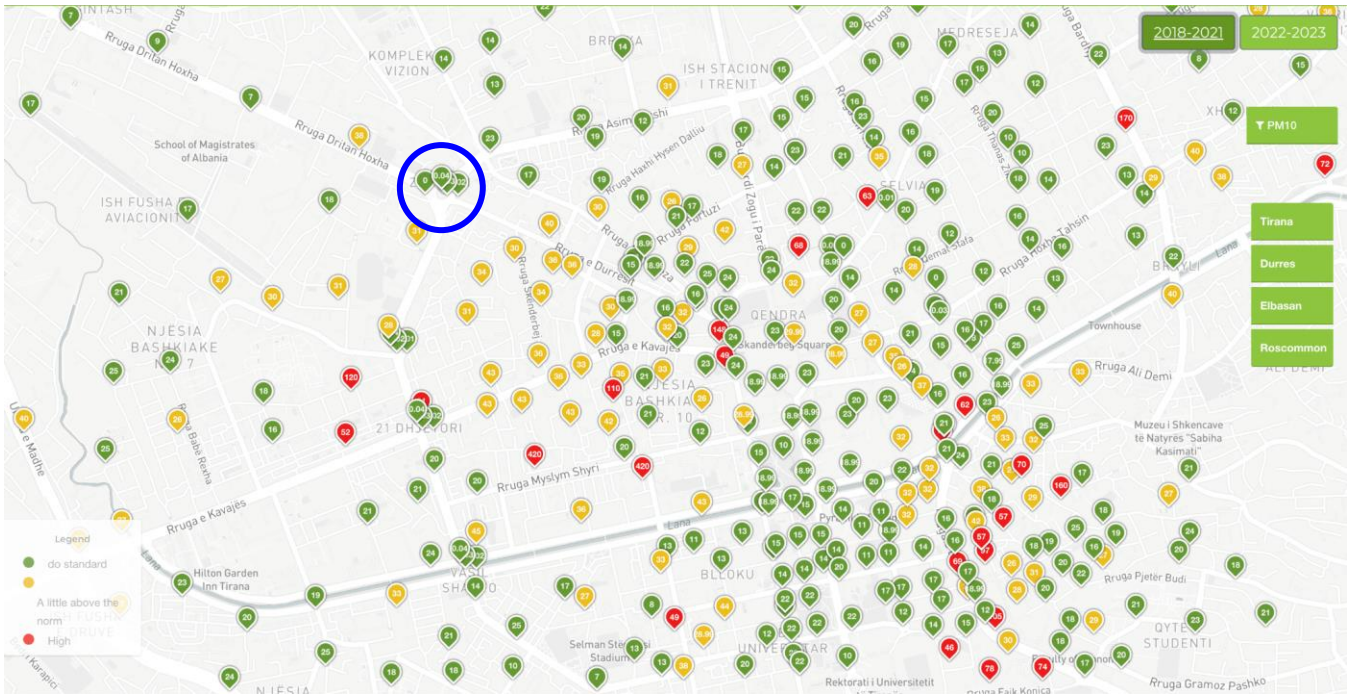


Figure 14. PM10 Emissions for the years 2018-2021 throughout Tirana. The blue circle is the location mentioned above.

Image Source: Green Lungs Albania. URL: https://greenlungs.al/. Accessed May 21, 2023.

Figure 15: PM10 Emissions in 2022-2023 throughout Tirana

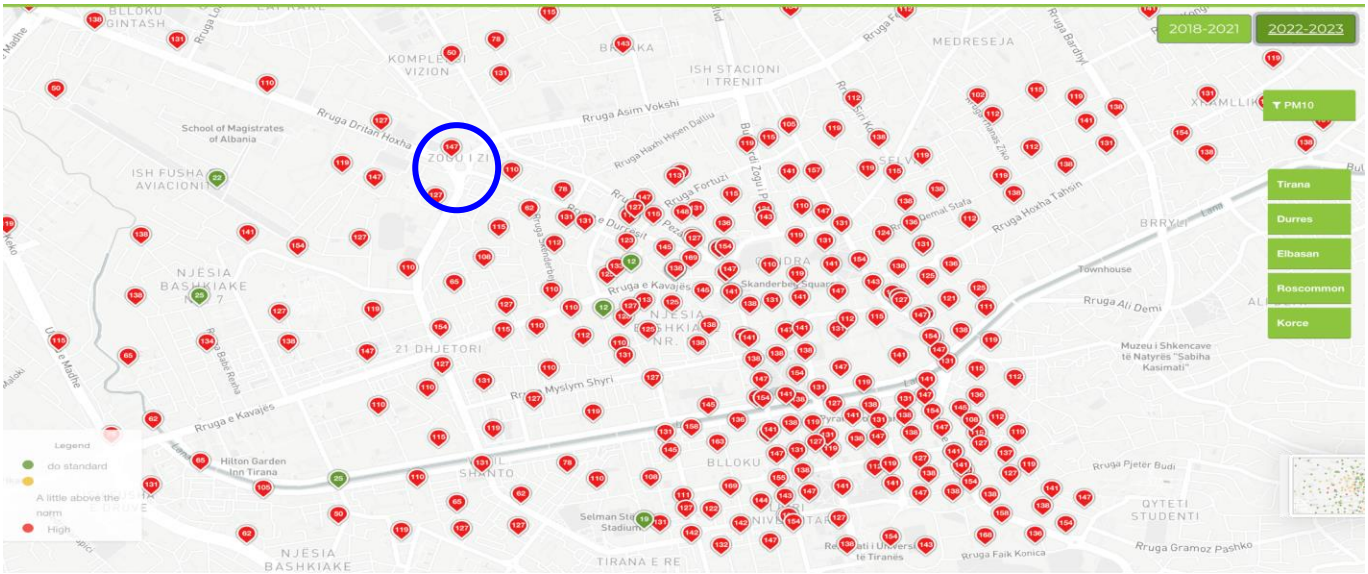


Figure 15. PM2.5 Emissions for the years 2022-2023 throughout Tirana. The blue circle is the location mentioned above.

Image Source: Green Lungs Albania. URL: https://greenlungs.al/. Accessed May 21, 2023.

5.2 PM2.5 Emissions in Tirana- Key Findings

PM2.5 emissions were measured in addition to PM10 emissions. Little is known about the history of PM2.5 emissions in Albania, as there has not been a published study like the article observing the data from 2012 PM10 emissions in the Vasil Shanto Crossroad. Therefore, it is slightly more challenging to identify an emission timeline as long as the one that was compiled for PM10 emissions. The PM2.5 emission data collected can be used and compared to the data that is conveyed by the figures provided from Green Lungs Albania.

Green Lungs Albania compiled data to show the average PM2.5 emissions at selected locations in Tirana. Currently, there are 366 "checkpoints" in Albania that monitor air quality which operate under the organization ("Green Lungs" n.d.). For comparison, Zogu I Zi will be chosen as an example location in order to show the PM2.5 emission trend from 2018-2023. In the 2018-2021 data, the Zogu I Zi rotary averaged 17 μg/m³ as seen in Figure 16. In the 2022-2023 data, the location averaged 99 μg/m³ as seen in Figure 17. The data taken in May of 2023 during data collection for this thesis shows an average of 46 μg/m³, which can be seen in Map 2. The European Union norm, also the Albanian standard, is 25 μg/m³. Zogu I Zi, in 2018-2021, was under the standard, however, the 2022-2023 data and the data collected across 5 days shows the average being above the two similar standards. The six remaining locations, Zogu Boulevard Crossroad, Sheshi Ataturk, Vasil Shanto Crossroad, Taiwan Park, Desh. Myslim Crossroad, and Skanderbeg Square also saw an increase of PM2.5 emissions throughout the 5 years. It can be concluded that there is an increase of PM2.5 emissions from the past 5 years, according to both Green Lungs Albania and the data collected for this thesis.

The conclusion after comparing the data from 2018-2023 shows a drastic increase in PM2.5 emissions with the average trending upwards, as seen from the two data points of 17 μg/m³ in

2018-2021 to 99 μg/m³ in 2022-2023. The data that was collected, during the five day research study, shows an average being higher than the standards set by both governmental bodies. This then poses the question of why this is the case, how it is harming civilian life, and if anything, how can it be combatted.

Map 2. PM2.5 Mean Emissions in Tirana

Map 2. *Map 2 shows the mean PM2.5 emissions calculated for each location in Tirana*

Image Source: Samantha Nasson. Basemap Used: Dark Grey Canvas Base provided by Esri. PM emissions provided by Samantha Nasson.

Figure 16: PM2.5 Emissions in 2018-2021 throughout Tirana (Courtesy of Green Lungs Albania)

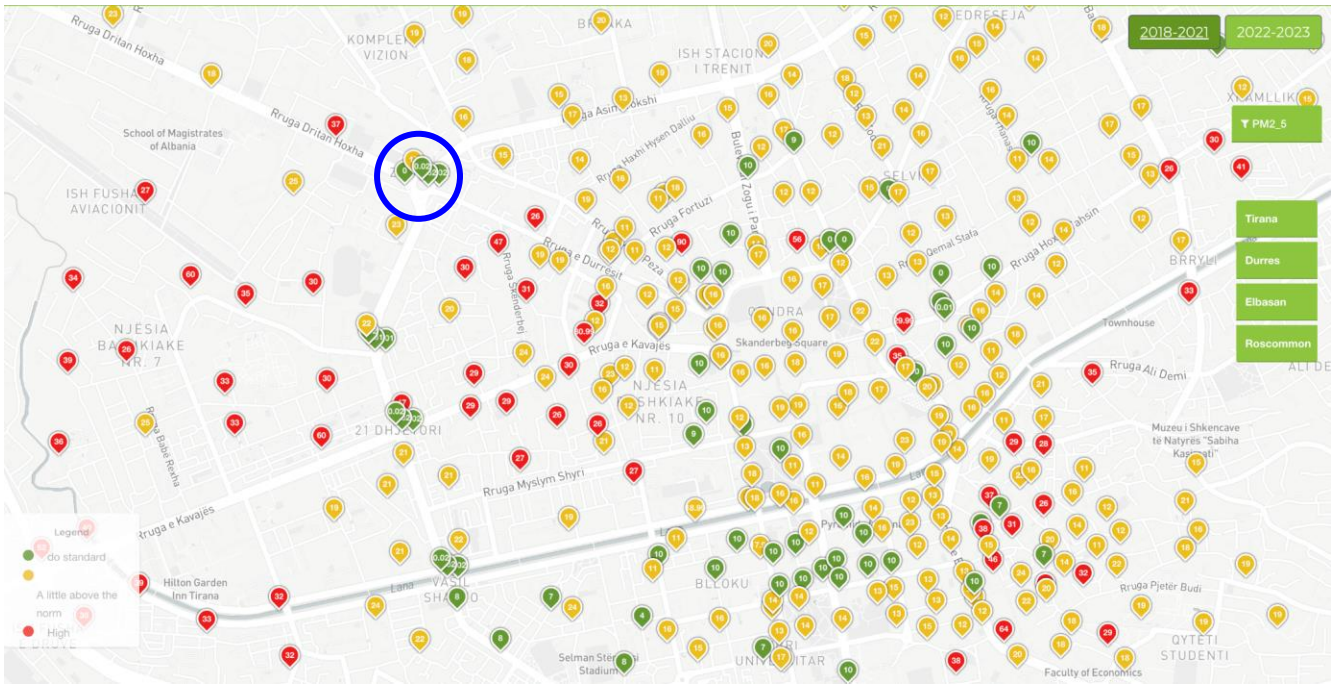


Figure 18. PM2.5 Emissions for the years 2018-2021 throughout Tirana. The blue circle is the location mentioned above.

Image Source: Green Lungs Albania. URL: https://greenlungs.al/. Accessed May 21, 2023.

Figure 17: PM2.5 Emissions in 2022-2023 throughout Tirana (Courtesy of Green Lungs Albania)

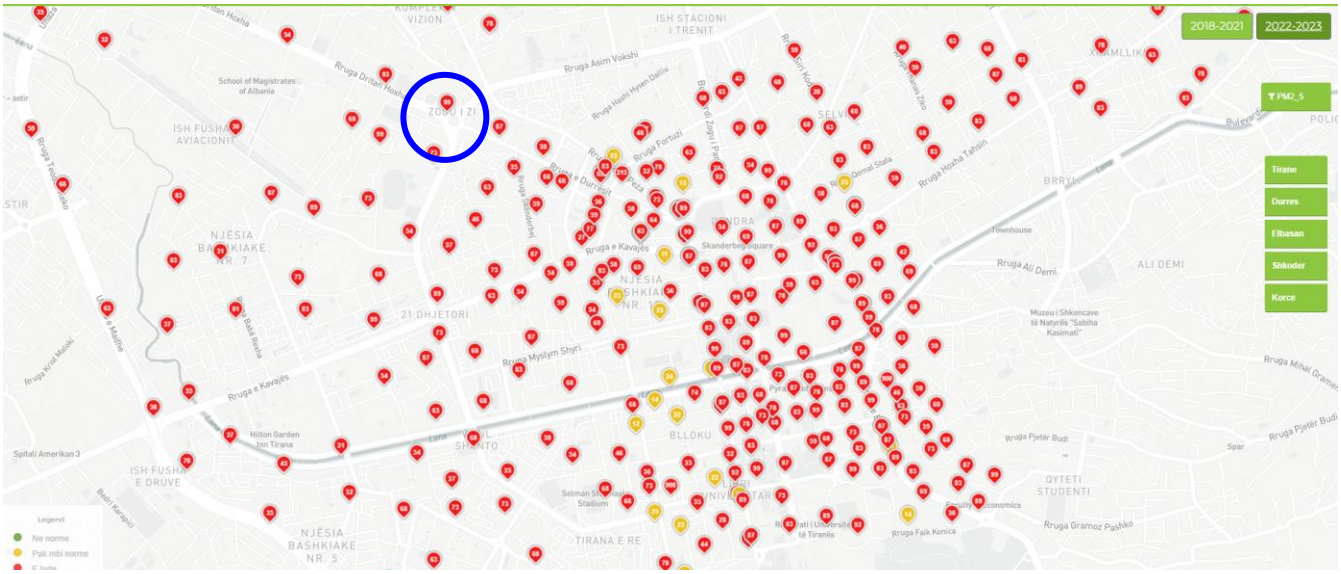


Figure 19 PM2.5 Emissions for the years 2022-2023 throughout Tirana. The blue circle is the location mentioned above.

Image Source: Green Lungs Albania. URL: https://greenlungs.al/. Accessed May 21, 2023.

5.3 Factors Affecting PM Emissions in Tirana

5.3.1 Diesel Engine's Effects on PM Emissions in Tirana

Diesel engines contribute to the pollution crisis, releasing harmful gasses into the air and soil. Diesel cars produce similar emissions as petrol engines; however, the quantity of emissions are starkly different. Two of the biggest emission compounds released from vehicle exhaust are Nitrous Oxide (N2O) and Carbon Dioxide (CO_2) ("Vehicle Emissions | Green Vehicle Guide" n.d.). According to the United States Environmental Protection Agency (EPA), "The impact of 1 pound of N2O on warming the atmosphere is 265 times that of 1 pound of carbon dioxide" (OAR US EPA 2015b). As seen in Figure 6, while petrol engines release more CO_2 emissions, diesel engines release more N2O emissions which have a greater effect on the environment. Environmental damage from these emissions can cause reduced air quality, as seen in the data collected during the study for Tirana. Along with these emissions, Particulate Matter, focusing on PM10 and PM2.5, are released from soot as a result of the combustion process within the engine (Donald Mahoney, personal communication, 26 January 2023). It can be deduced that the more diesel engines on the road, the higher the AQI and PM emissions, both PM10 and PM2.5.

Particulate Matter is not only harmful to the environment, but to human health as well. PM emissions cause damage to lungs and can lead to death if exposed long-term. According to the World Health Organization and the European Union, "Both short- and long-term exposure to air pollution can lead to a wide range of diseases, including stroke, chronic obstructive pulmonary disease, trachea, bronchus and lung cancers, aggravated asthma and lower respiratory infections. "The World Health Organization (WHO) provides evidence of links between exposure to air pollution and type 2 diabetes, obesity, systemic inflammation, Alzheimer's disease and dementia.

The International Agency for Research on Cancer has classified air pollution, in particular PM2.5, as a leading cause of cancer" ("How Air Pollution Affects Our Health" 2023). Albania, and other developing nations, face a higher pollution rate due to the fact that, "Particulate matter emissions from diesel engines are considerably higher (six to ten times) than from gasoline engines" (Reşitoğlu, Altinişik, and Keskin 2015). Since diesel engines are the dominant form of transportation in Tirana, this aids in explaining why the air quality index is so high compared to other cities who use less diesel engines less, such as those in the United States. "More than 50 % of the total PM emissions are soot that is seen as black smoke" (Reşitoğlu, Altinişik, and Keskin 2015). The black smoke emitted as a result from the combustion in diesel engines can be seen in the distance of the city when looking down the Tirana streets. A personal observation was noticed that during rush hour, when the data was collected, the smell and sight of soot from old diesel engine cars was increasingly noticeable, compared to when it was not rush hour. There seemed to be a lingering haze of soot when looking at the rolling mountains that surround Tirana. These emissions contribute to the abhorrent Air Quality Index of Tirana and the high levels of both PM10 and PM2.5 emissions.

The effect that PM emissions have on the environment can be observed when walking down the streets of Tirana. PM emissions damage soil and farm crops as well as acidifying lakes and other bodies of water upon air pollution damage (OAR US EPA 2016). Albania heavily relies on agricultural produce, which is a factor that is hindered by PM emissions from diesel engines, causing cultural pastimes to fade and living conditions to decline. Albanians have the opportunity to reduce their emission output, yet some are reluctant to do so as the law does not force citizens to comply, especially when it concerns car maintenance.

5.3.2 Car Maintenance in Tirana

Typically, in the United States, a licensed operating driver has to take their vehicle for a yearly inspection that includes safety checks and, most importantly for the environment, emission testing. If the car does not pass inspection, it is restricted from driving on the road until the issue is fixed. Albania's car inspection and maintenance system is not as streamlined as it is in the United States. Most likely, this is because of all of the older cars that are in circulation in the Tirana area. "According to official data, at the end of June 2019 the overall fleet consistency was of around 630 000 vehicles and 29% (179 167) are registered in the Municipality of Tirana. Around 78% of the registered vehicle fleet of Tirana consist of individual automobiles" where "The average age of the overall fleet is very high at 18 years with average car fleet age being 13 years. (anonymous, personal communication, 17 May 2023). The age greatly corresponds to the increased emissions, as older cars were not manufactured to comply with emission standards.

The results from the data collected and the testimonies from citizens depict the reasons and effects that sub par car maintenance has on the city of Tirana.

A bi-yearly inspection of a car is mandatory in Albania. An inspection, according to a member of the Tirana municipality, can look like this:

> "Bi-yearly, your car is due for a mandatory inspection. Usually, people are pretty good at making sure they get it checked because, if not, it is technically illegal. So you bring it to your local mechanic and he checks everything, including emission levels based on the standards set by our government. After it passes, you pay and leave. Simple. They did make a new law stating that any car made before 2005 cannot be bought and driven on the road, but what do you do about the ones that already exist on the road? Those are the real polluters" (anonymous, personal communication, 8 May 2023).

The cars that were manufactured before the year 2005, most likely, are not in compliance with the emission standards.

This poses the question of how the cars are still on the road. Albania's politics can be corrupt, where many had an "experience of bribery in Albania: around 70 per cent in the years 2006 and 2007" (United Nations Office on Drugs and Crime, 2011, Page 11). These bribes could be seen in any sector of politics. "a relatively high value [of corruption] is registered for police officers, car registration officers and judges/prosecutors, indicating that they also request the payment of bribes with a certain frequency from the citizens with whom they deal" (United Nations Office on Drugs and Crime 2011), page 22). While walking through the streets of Albania, bribery was seen on the streets. A driver had gotten pulled over by the police and, when asked for their information, handed the police around 2000 LEK (around $20) to rip up the ticket; the method had worked. If corruption in day-to-day life can happen this easily, it can happen at any sector of government, including the motor vehicle department. This observation with the testimonies from the municipalities show that cars that do not pass emission testing can still be allowed on the road, with the right amount of money in the hands of the right people.

Although the qualitative data collected does not directly support the claim that car maintenance in Tirana is corrupt, literature and personal observation support the assertion. Therefore, maintenance of cars in Tirana, including emission testing, may not be followed as harshly as it is in other countries, like the United States. The increased emissions most likely are coming from these 'out of regulation' cars.

5.3.3 Life with High Levels of Emissions

Due to the exponentially high level of emissions, the city of Tirana faces a myriad of issues, environmentally and health wise. The cause for this is due to the "shift from public and non-motorized transport modes towards private cars has led to a host of problems including enormous

health and environmental damage. The capital was not designed to accommodate car traffic and is in a gridlock much of the day" (D. Pojani 2011). The increased amount of cars on the road, primarily those being with diesel engines, cause disastrous effects. While walking through the streets of Tirana, it was personally observed that sidewalks and roads were not paved well; in fact, sidewalks did not exist in some areas. Many pedestrians did not obey traffic laws, such as stopping at stop signs or crossing the street only when the light prompted them to. This most likely caused increased traffic issues in the city. It was also observed that cars would pass by, when the opportunity was had, on either side of the road causing a potential hazardous situation on the road. The increased number of cars on the road can be directly correlated with the traffic patterns in Tirana, in return, causing an increase of PM emissions that were collected during research.

5.3.4 Noticeable Public Transportation Issues in Tirana

Working and reliable public transportation in a large city is imperative in order to diminish the emissions and lessen traffic throughout the city. Public transportation makes it easier to move throughout the city and commute from outside without the use of a car. Unfortunately, Albania does not have the infrastructure at the moment to construct any underground railways about the city. Relying only on a privatized bus system, Albania does a poor job in ensuring that these buses are in good condition, are environmentally friendly, and run on time.

The public bus system in Albania is one that many meet with contempt. According to Dr. Pojani,

"There's people that live in car owning households, but they still have to rely on the public chances system because the man in the house usually controls the keys to the car. This means that it gets crowded on the bus, even though it's not very good. The buses usually run on their own time and get crowded and hot in the summer. That leaves people with dissatisfaction and then if they can afford some kind of alternative, they'll go for it the moment they can for the car. People might do their best while they're

students, but then once they get a job, they start earning a salary, they're like, well, so I'll buy my own car now, like everyone else" (Dr. Dorina Pojani, personal communication, 6 March 2023).

Dr. Pojani talks about the dissatisfaction many have with the public transportation system, noting it to be an out of date system, especially the buses that can range from 10-20 years old. Buses are privatized, meaning multiple companies own several bus lines in Tirana. According to the transportation department's publication about their 'Suburban Mobility Plan Management', emissions from the transportation sector greatly contribute to the growing pollution problem within the environment ("Sustainable Urban Mobility Plan for the City of TIRANA [Volume I - STATUS ANALYSIS]" n.d., page 75). It was noticed that there were no real bus stops, like in many countries with a vestibule to wait in, but consisting just of a pole. The locals are aware of where the bus stations are, but public transportation is not accessible to those who are not familiar. Once on the bus, one can notice that it is old and run down, hot, and mostly crowded all the time. The bus runs on a schedule, but often gets stuck in the traffic from the several hundred thousand cars that dominate the streets, causing it to be an unreliable source of transportation. However, Albania is making some plans for the future in hopes that public transportation will develop into a sustainable way of transport.

On 24 April 2022, Tirana observed their first "Car Free Day" which was an initiative planned by the transportation sector of the Tirana Municipality to decrease emissions and help clear the polluted air for the day ("Car-Free Day Being Observed in Tirana | Albanian Telegraphic Agency" n.d.). However, Tirana is extremely underserved in terms of public transportation. According to an anonymous source at the transportation department, "there is only transport by bus because of the city's cultural and infrastructure past. So the actual infrastructure is not prepared for a metro, for example. Meanwhile, a tram system will be implemented in the city soon" (anonymous, personal communication, 17 May 2023). Future plans are being made in order to

better the transportation situation in the city; however, there needs to be a significant and rapid change if emission standards are to be met in order to gain membership into the European Union.

Managing transportation through the city is a challenge as an outsider, as most bus stops do not have a timetable posted or specific bus routes highlighted that correspond with the stops. When data was collected, it was observed that when a bus passed, the emissions skyrocketed into 'unhealthy' levels. An anonymous source stated, "even though some of the buses will display that they are 'electric' it is not true" (anonymous, personal communication, 8 May 2023). It can be likely inferred that the emissions levels are higher in the city and above the standards are partly due to the unhealthy public transportation that is offered.

6.4 Outside Factors Halting Tirana's Progress

6.4.1 Political Distrust

According to the World Population Review, it was calculated that the population in Tirana for 2018 was 475,600 people, while the 2023 population is 520,100 people ("Albania Population 2023 (Live)" n.d.). "The population is constantly increasing in Tirana, as more young people want to live and work in the city. This is causing not only a housing problem, but a population density issue in the city" According to Dr. Pojani (Dr. Dorina Pojani, personal communication, 6 March 2023). The more people who choose to work and live in the city means the more cars that will be on the road. "Urban densification and infill development of the urban core, combined with the reduction of public green spaces (rather lost due to land development) has led to higher indicator of pollutants' concentration in the air" ("Sustainable Urban Mobility Plan for the City of TIRANA

[Volume I - STATUS ANALYSIS]" n.d., page 75).. Due to the lack of public transportation, there is no alternative to travel rather than in a private car.

The obsession with privatized cars stems from Albania's communist party. Since communism fell, "the public [still] has little interest in the common good, no belief that the citizens can bring about public action for its benefit nor much belief in the legitimacy of the law. Furthermore, public officials, in a habit of working in a context free of political input, are not accustomed to considering the desires of the public" (D. Pojani 2011, n.p.). The government has not been receptive to the needs of the public, likely contributing to the lawlessness of car owning. The government's neglect for the situation can be seen by the multitude of cars on the road. A source from the municipality said "it is hard to bike to work. There are just so many cars that you have to dodge. That is why we all take cars" (anonymous, personal communication, 8 May 2023). Politics in Albania do not help with the need for reform, often halting the process when elections switch who is in office.

During the month-long research trip, Albania held local elections for offices. Tirana's mayoral and municipality race was publicized, but not to a great extent. The main mayoral candidates, including the recent winner Erion Veliaj, were posted on various lampposts, but other than that, the election candidates did not publicly campaign. The lack of propaganda for candidates supports the claim from Pojani that citizens do not pay attention to elections due to distrust. According to a news source, "Preliminary turnout reported by the Central Election Commission was 37.79 percent, one of the lowest turnouts registered in any election to date" ("Ruling Socialist Party Wins in Albania's Local Elections-Xinhua" n.d.), n.p.).

After several interviews, it can be concluded that governmental bodies cannot be trusted to carry out certain actions that Tirana needs. Furthermore, testimonies from those within the

municipalities had the illusion of being truthful, but due to the fact that the interviews were recorded, it can be inferred that not all of the information or truth was given. Some testimonies tiptoed around the truth during the recorded sessions. Literature, as seen in the review, somewhat refutes the claims given that Tirana is on the path towards a more sustainable future, especially with those in office. The distrust and ignorance of political doings contribute to the increased emission in Tirana. They will most likely not get to the EU standards if political officials do not intervene and citizens do not comply.

6.4.3 European Union Accession Progress

Albania is constantly making changes to the country in hopes that the European Union will accept them as a member. By getting admitted into the union, the hope is that Albania will officially transition from a developing country into a developed country. Albania needs to make drastic changes to decrease emissions and improve public transportation if they hope to gain admission into the EU.

In 2022, Tirana was named the European Youth Capital, aiming to encourage youths in their pursuit for their future ("Tirana: European Youth Capital 2022! | European Youth Portal" n.d.). The European Union is attempting to encourage young citizens of Albania to pursue a future that will shape Albania for the better. Currently, Albania is on step 4/9 of the EU accession progress, according to the We Balkans EU Organization that aims to "seeks to raise awareness and increase knowledge and understanding of EU-Western Balkan relations and of EU enlargement policy" ("WeBalkans | Your Story, Our Future | EU Projects in the Western Balkans" n.d.). Albania, as of 2022, is in the beginning stages of negotiations with the Intergovernmental Conference on accession negotiations ("WeBalkans | Your Story, Our Future | EU Projects in the

Western Balkans" n.d.). It is estimated, by a volunteer of the Young Europeans Ambassador programme, that Albania hopes to be admitted into the EU by 2027-2030 (anonymous, personal communication, 20 June 2023). Albania is still evolving in order to comply with EU standards. As seen from the data collected, Albania's PM10 and PM2.5 emissions are above the EU standards for emissions.

Albania is currently being aided by the EU in regards to transportation issues and decreasing their emissions. Several projects which are being funded by the EU are currently being implemented within Albania. In 2022, the Western Balkans Investment Framework, funded by the European Union, endorsed a bypass spanning 20km that runs between Kashar and Mullet via Vaqarr within Tirana (WeBalkans EU 2023) in hopes of clearing congestion throughout the city and, in return, reducing air pollution in the capital. A bypass would create an alternative route to go around the city for transportation purposes, rather than through it. The bypass would aid in dispersing traffic and emissions.

Another project that the EU funded within Albania in terms of transportation and pollution was the Hani i Hotit railway line. The EU accepted the project in May of 2023 which would create a Trans-European Railway that would bring the "infrastructure to EU standards and will create conditions for the development of passenger and freight services in Albania. By increasing the quality, availability and reliability of rail services, the project will develop multimodal and intermodal transport in Albania and the wider region, and thus facilitate trade and economic links with neighboring countries and EU member states"("VORE HANI I HOTIT RAILWAY LINE - GLOBAL GATEWAY" n.d.). By greenlighting the project, Albania will be one step closer to creating a more advanced public transportation system throughout urban and rural areas, which is much needed as the roads from the city to the countryside are not always paved. This railway

would greatly impact Albania's contention for membership, bringing it much closer to being a reality.

Projects funded by the European Union are imperative to the evolution of the country. As seen with the Green Lungs Albania project, they highlight the issues within the country in hopes that the proper governmental bodies will deem them an issue that needs to be fixed. Albanian citizens need to make drastic changes to their way of life if they ever hope to gain admission into the European Union.

6.5 Summary of Results

Shown in the data that was collected during the field research process for emissions, it was found that both PM10 and PM2.5 emissions were mostly above the European and Albanian standards for air quality. Public transportation was found to be heavy emitters as well as not being accessible in terms of availability, punctuality, and overall poor quality of the buses. The lack of reliability on the public transportation directly leads to an increased number of cars on the road, mainly those being older with diesel engines. Diesel engines cause greater pollution, as illustrated by the data collected. Public transportation in Tirana needs to be focused on if the country wants to succeed in their wish of joining the EU.

Chapter 5. Recommendations

Throughout this thesis, several issues within the country of Albania have become clear along with the long-term goal of becoming a European Union member country. Therefore, recommendations of how to fix the issue, based on personal and factual opinion, will be suggested. These recommendations will be given based on the data and observations collected, as well as what was learned through the literature review and additional research.

7. 1 Privatized Car Protocols

7.1.1 Car Maintenance

In terms of the influx of cars in Tirana, there should be some changes made in terms of car maintenance protocol, especially emission testing. Currently, the government calls for car maintenance to occur every other year. Along with this, the cars that do not pass inspections are not always restricted from the road, as gathered by testimonies and literature sources. The recommendation that should be heeded is to reform the maintenance protocol, using the United States as a blueprint for standards of inspections. By having yearly, mostly non-corrupt inspections, only cars that are properly equipped to be on the road will be allowed. There should be government sponsored mechanics that perform these inspections, focusing on small owned businesses and encouraging citizens to bring their cars into those shops. By having yearly inspections, emissions can be tested on a more frequent basis, potentially leading to the decrease of emissions in the cities, further adding to the journey of meeting the EU standard of emissions.

7.1.2 Shift towards Electric Vehicles

In the event that public transportation is not as normalized in Albania due to its past anti-car ownership laws, a shift towards privatized electric vehicles could be useful in decreasing the emissions from diesel and petrol engines. Electric vehicles release zero emissions via tailpipe, according to the US Department of Energy ("Alternative Fuels Data Center: Emissions from Electric Vehicles" n.d.). Diesel engines emit black soot filled with pollutants, which are a common mode of transportation in Albania. In the data collected, the pollutants at various crossroads were well over the maximum emission standards. A transition by the government to support the purchase and use of electric vehicles would provide benefits to not only the pursuit of EU emission standards, but to a better environment. Currently, the Tirana Transportation Department within the Municipality has proposed measures to include "an incentive ranging from 5% to 10% of the purchasing cost for a new electric car; ii) free maintenance and ancillary services for electric car owners; iii) incentives and discounts offered also to hybrid car owners" ("Sustainable Urban Mobility Plan for the City of TIRANA [Volume I - STATUS ANALYSIS]" n.d.), page 56). With these incentives being approved by the government, more citizens would be persuaded to buy electric vehicles. Tirana needs to shift towards sustainable methods, including public transportation.

7.1.3 Sustainable Public Transportation

Albania relies solely on buses for public transportation throughout the city of Tirana. Unfortunately, Tirana did not have the infrastructure when it was liberated in the 1990s to create a metro and tram system throughout the city. Due to this reason, Tirana is behind in terms of public transportation compared to that of the European Union. If Tirana were to implement more public

transportation into their city, they should do it sustainably. Currently, Tirana has plans to administer a tram system within the city, according to a source at the Transportation Department (anonymous, personal communication, 17 May 2023). Trams and metros, which should mirror that of Vienna's transportation system with the goal of "Conserving resources, reducing energy consumption, cutting CO2 emissions" (Linien n.d.). Albania should continue their pursuit for sustainable transportation in order to cut emissions and traffic in the city and streamline transportation. Moving towards newer models of buses, especially ones that run electric, would greatly benefit the city in terms of emissions as well. So far, Albania is promoting some of their buses run on electricity; however, a source in the government said that "a lot of the buses are marketed as being electric, but they really are not" (anonymous, personal communication 8 May 2023). Bringing the standards of public transportation up to the EU norm would enhance their chances of being admitted into the EU.

Decision makers, mainly policymakers, should take advantage of the various funding opportunities that the European Union provides Albania with. From those projects mentioned in the discussion session, policy makers should publicize the opportunities given by the European Union to citizens in hopes that project proposals supporting sustainability in transportation and emission reductions would emerge. Citizens should be kept up to date and educated about the issues, specifically those within the terms stated in the thesis. Programs, such as We Balkans EU, can educate the public, especially their youth ambassador program. EU funded programs should become common knowledge if the country is serious about joining the union.

These recommendations were concluded as a result of the data gathered throughout the thesis process. Recommendations should be taken into consideration and implemented within the

municipality for best results. These recommendations can aid Tirana with reducing their emissions and improving their public transportation.

Chapter 6. Conclusion

Throughout this thesis, the purpose of this thesis was to collect data and interviews about the air pollution and transportation issues in Tirana, Albania today. The hypothesis for this thesis was that air pollutants, mainly PM10 and PM2.5, contribute to the growing air pollution crisis due to the influx of privatized cars in the city since the fall of communism. Private cars are the norm in Albania, as the substandard and limited public transportation system continues to deteriorate. The lack of and age of public transportation adds to the pollutants in the city. The main objective(s) were to analyze the research questions: 1) What are the PM10 and PM2.5 emissions at selected locations in Tirana and how do they compare to the Euro 6 standard of emissions? 2) What is public transportation like in Tirana and how does it contribute to the city's emissions? How can it be changed/fixed? 3)What are the main factors holding progress back? Does this stem from Albania's communist past? These research questions were explored, and conclusions were made based off the data. The thesis was inspired by the historical ban of privatized cars in Albania during communism, leading to a boom of car buying, especially older cars with diesel engines, when communism fell.

8.1 Key Findings

8.1.1 PM 10 Emissions

Both qualitative and quantitative research was conducted in Tirana, Albania in order to support or refute the hypothesis asserted at the beginning of the thesis. Emission data, PM10 and PM2.5 measurements, collected over the course of five days at seven different locations in Tirana showed that emissions were mostly over the European Union and Albanian standards for

emissions. PM10 emission standards in Albania have a limit of 60 µg/m³ while the EU has a limit of 50 µg/m³. The mean emissions for these four locations were over the European Union Emission standards: Zogu Boulevard Crossroad at 66 µg/m³, Zogu I Zi Rotary (Sheshi Karl Topia) at 53 µg/m³, Vasil Shanto Crossroad at 56 µg/m³, and Desh. Myslim Crossroad at 65 µg/m³. Due to the differing limits between Albania and the EU by an extra 10µg/m³, the only locations that were above the Albanian standards for PM10 emissions were Zogu Boulevard Crossroad at 66 µg/m³ and Desh. Myslim Crossroad at 65 µg/m³. These findings show that the Albanian government may not have deemed the emission issue as urgent since only 2/7 of the locations were above the Albanian standards, while 4/7 of emissions were over the EU standards. In conclusion, the PM10 emissions are over the EU standards and the Albanian standards for emissions, hindering them from furthering their candidacy for EU membership.

8.1.2 PM2.5 Emissions

Another portion of the hypothesis estimates that PM2.5 emissions in Tirana would be above the EU and Albanian emission standards, 25 µg/m³. Data was collected at the same five locations across the same week during the same time as the PM10 emissions. The five locations that averaged over the emission standards were: Zogu Boulevard Crossroad at 58µg/m³, Zogu I Zi Rotary (Sheshi Karl Topia) at 46 µg/m³, Sheshi Ataturk at 39 µg/m³, Vasil Shanto Crossroad at 47 µg/m³, and Desh. Myslim Crossroad at 62 µg/m³. The only two locations that were not above the emission standards were the two locations that were included to show emissions levels in green spaces throughout the city, those being Taiwan Park at 22 µg/m³ and Skanderbeg Square at 15µg/m³. In conclusion, PM2.5 emission data that was collected were well over the Albanian and

EU emission standards, holding them back from becoming a more viable candidate for the European Union.

8.1.3 Public Transportation

Issues with public transportation in Tirana were hypothesized that due to the poor status of public transportation within the city, more people would rely on buying private cars, which would add to the emission issue in Tirana. Public transportation in Tirana relies on several privately owned bus lines that run throughout the city. However, there are very few official bus stops, most stops are just a pole or are only known by the locals. It is hard to find any bus schedules, as it is not posted at any of the stops, as well as the bus lines or routes. The buses often get stuck in the traffic throughout the city, causing them to be an unreliable source of transportation. The frustration from the bus riders often turn people towards owning their own car, causing an increase of emissions within the city. Adding to this, a lot of the buses are older, some still in use from the communist era, some given by countries that no longer need the older buses, further contributing to the emission problem. In conclusion, it was found that public transportation was not as usable and efficient as it could have been. The lack of infrastructure to improve transportation in the country causes Albania to fall behind the expected EU level of transportation.

8.1.4 Albania's Politics- Potential EU Membership Status

Currently, Albania has a lot to reform if they hope to be admitted into the European Union within this decade. The perception of the government from citizens notes corruption as one of the major problems. Corruption most likely helps contribute to the lack of progress the country has on combating their emission levels within the city. Another issue within the government is the lack

of infrastructure within the country. Financially, Albania is not able to fund several projects to combat emissions when issues such as human rights and healthcare are deemed more important by the people who want the money to be allocated towards those causes. It is important to take advantage of the several EU funds that are granted to the country for issues like emission testing and enhancing public transportation within the city. If Albania were to combat their corruption issues and educate the people about the EU funded projects available, membership into the EU would not be a dream but a reality in the near future.

8.1.5 Implications

The research collected during the construction of this thesis proved that the averaged emission levels of PM10 and PM2.5 in Tirana were mostly above the standards for the European Union and Albania. The study conducted showed that the city of Tirana must make a change in order to combat their emission problems. This research contributes to the academic world greatly, as a paper addressing the situations has not been updated with personally collected data since 2015. Although projects, such as Green Lungs, are collecting data on emissions, the implications of public transportation and its effect on EU membership status is not compared. Future studies can use the data collected in order to identify the outstanding issues that Albania still faces in the city of Tirana and how far they have evolved since then.

8.1.6 Personal Reflections

On a personal level, this study was particularly exciting for me to conduct as the topic has been studied by myself since November of 2022. Having the opportunity to conduct in person research and interviews within the country of Albania was truly a dream come true. I was lucky

enough to have the data and interviews collected support my hypothesis of the issues present due to the high level of emissions. To combat these issues, Albania needs to make serious governmental changes in order to, one day, become a member of the European Union.

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Appendix

Ethical Policy on Research

Checklist on Ethical Issues in Research

This checklist is intended as a guide for CEU students/researchers in planning, designing and carrying research, and for applying approval to the Ethical Research Committee. The numbers in brackets indicate the relevant section of the Guidelines on Ethical Research. In case applying for approval from the Ethical Research Committee, provide explanatory answers that enable the Committee to assess whether the Guidelines were followed.

A. General information

1. Project name/Title of thesis/dissertation:
Pollution in Tirana, Albania: A look into a post-communist nation's transportation pollution rates and an assessment of their public transportation usability.
2. Name(s) of Applicant(s):
Samantha Nasson
3. Contact information of applicants:
Nasson_samantha@student.ceu.edu
4. Department/Research Center:
Department of Environmental Sciences and Policy

5. Research Supervisor (if applicable):
Zoltán Illés
6. Supervisor's contact information:
illesz@ceu.edu
7. Date by which a decision on this application is required in order that the project can proceed as planned, if approval is required:
4/5/23
8. Expected date of completion:
31/8/23
9. Abstract of the project/thesis/dissertation:

Albania's pollution crisis is an issue that has been on the forefront since the fall of communism in the 1990s. Under communist rule, privatized car ownership was illegal. After the fall of communism, car sales began to boom. Today, "Many of the cars are diesel engines that, on average, are at least ten years old and produce copious amounts of gas emissions" (Mulla et al. 2009). The lack of environmental regulations in the country poses an interesting issue of how to lessen emissions. Outdated cars with little maintenance supervision causes an increase of pollution, as cars do not have to meet a specific standard to be on the road. Most times, governmental corruption overpowers laws and causes harm not only to the people, but the environment too. Governments lack of standards allow diesel cars without proper maintenance to continue to be driven on the road, causing an abundance of older cars with diesel engines to be the norm for transportation (Mulla et al. 2009). Public transportation in Albania is abysmal, as their busses do not run on a set schedule and does not keep up with the continuing growth of Tirana's population. Albania needs to become a member of the European Union (EU) to help combat climate change. With increased funding and baseline regulations for car emissions, Albania could change their future and decrease their car pollution.

Unfortunately, environmental research in Albania is not heavily funded like other issues, partly due to governmental corruption trying to hide the countries shortcomings and the lack of money available. Not a lot of research is available online, which is why it is imperative to go and collect data in person.

B. Funding

10. Sources, researchers' and their organisation's financial interests and ethical issues in case of external funding:
CEU Funding: 700 euros

C. Participants

[If the research does not involve human subjects, go to section D.]

11. Does the study involve human subjects, and how? [Who will participate in the research? How will the subject/respondent group be chosen, what sampling techniques will be deployed? In which ways the participants will be involved? (2.1)
Participants include members of the Tirana Municipality in various Sectors in Tirana, Dr. Dorina Pojani, and members of Milieukontakt Albania- NGO.
12. Are there potential benefits and hazards for the participants? [Are there risks to the subject entailed by involvement in the research? Have procedures been established for the care and protection of subjects? Will the participants be informed of possible risks and hazards?] (2.2 – 3.4)
All participants are asked if it is ok to record during their session and if it is ok to name them, or if anonymity is needed.
13. Does the research involve any risks or pose danger to the researcher(s)? [If yes, what procedures will be adopted to minimize the risks? Have the health and safety guidelines relevant to the area and character of the research been consulted and implemented?] (4)
no
14. Will all procedures ensuring that consent is informed be followed? [Including the possibility for withdrawing consent] (5.1)
yes

15. Are the recruitment procedures well planned, and risks of coercion considered? [Is there any sense in which subjects might be "obliged" to participate – or are volunteers being recruited? Does the participation of research involve financial or other remuneration?] (5.2)
Nothing is obliged, all of it is on their timeline and by their rules.
16. Does the research involve incompetent adults, children or contexts where obtaining consent is impossible (i.e. public context, groups)? [Which "consent"-procedures will be applied instead?] (5.3 – 5.5)
no
17. Does the research involve deception? [This will not be applicable to many studies. In case deception of participants is involved: how is the impossibility to employ alternative non-deceiving method of research justified? How is the deception integral to the viability of research? Will debriefing be employed and how will the participant's reactions influence the use of the data obtained?] (5.6 – 6)
no
18. Will confidentiality and anonymity be secured?(8)
yes
19. Will data protection and storage requirements be followed? (8)
yes
20. Are there any plans for future use of the data beyond those already described?
no

D. Other Aspects:

21. Dissemination of findings: [What is the anticipated use of the data, forms of publication and dissemination of findings etc? In areas where information is jointly owned by participants as co-researchers attention should be paid to how they want to use the data.]
Data from Milieukontakt will be used, but citations will be given as they require it but nothing else.
22. Have you considered how to ensure that ethics considerations are reviewed as the project proceeds? [This is particularly relevant for projects that go on over a longer time period.]
yes
23. Is there any other information, which you think would be relevant to the reviewers', or your own, consideration of the ethical issues raised in this documentation?
no

DECLARATION

The information supplied above is to the best of my knowledge and belief accurate.

Signature of Applicant: .....

Date: **May 4, 2023.....**

Interview Questions

Before the interviews were conducted, questions that were pertinent to the thesis needed to be outlined and examined. Although many interviews had to be tailored to who was being interviewed, the following questions were somewhat uniform:

1. Standard introductory questions:
    a. "How are you?"
    b. "Is it ok if I record"
    c. "What is your official title and what does your work entail?
2. "What is the main contributor to emissions in the city"
3. "What does public transportation look like in your perspective? How is it compared to what it used to be?"
4. "Do you know of any future plans for public transportation/ reduction of emissions by cars?"