Geographia Technica, Vol. 14, Issue 2, 2019, pp 10 to 19

DISPERSION MODEL PROSPECTIVE OF AIR POLLUTION IN TIRANA

Medjon HYSENAJ [1]

DOI: 10.21163/GT_2019.142.02

ABSTRACT:
Outdoor air pollution is the most hazard challenge of many governments. Strictly policies followed by continue alert thresholds are being followed. Environmental issue canalized in air quality in the capital of Albania is the prior thematic analyzed in this paper. We figured to create a filter which gradually puzzles out the leading cause to exceed the limits settled by the WHO guidelines and the EU's AAQ directives. The paper tries to create potential scenario from the replacement of the passenger's vehicle fleet from the current Euro 3 to Euro 4 and over. The opportunity to structure evaluation maps for air assessment based on the outcome creates a clear overview of the current situation. Digital maps are a potential source of solution for many environmental issues. Spatial technology is fast and reliable to estimate population exposure to outdoor pollution. Geostatistical data offer reliable solution to perceive dispersion model issues. In this paper we concentrate on air pollution data (PM10).
Key-words: *geostatistic, dispersion model, spatial technology, digital map, PM10, air quality index.*

1. INTRODUCTION

Transportation is one of the vital components in modern human daily life; however, it has both productive effects on human development and detrimental effects on public health (Al Koas, 2010). The global concern for the environment is motivated by the role that the environment has on human society (Seferkolli, 2010). The paper aims to embrace environmental challenges we are facing nowadays. Almost every government policies are running toward reducing harmful elements derived from water, earth or air pollution. The last one will turn to be primary concern in this study as it overcomes EU's AAQ directives also WHO guidelines not only in daily values but also in annual terms.

The effect of air pollution on public health, vegetation, and more generally, on the human society and the ecosystem has been a burning issue in recent years (Deb and Tsay, 2018). Air quality models are designed to create a better perspective for further decision-making and establishment of strong and healthy policies. To create predictive scenarios helps maintain the right balance through all enrolled actors. Also maximizes the chances to find the right solution to the problem. Spatiotemporal modeling methods offer expanding opportunities to environmental research because they allow a user to display and model the spatial relationships and patterns between causes and effect when geographic distribution is part of the problem (Wang, 2008). We think that actual air data retrieved from monitor stations are caused by one main factor; deteriorated use of the passenger's vehicle fleet in circulation which mainly belongs to standard Euro 3. The paper goal is to predict the air pollution trend in case of upgrading the standard of the vehicle fleet.

Air quality management includes monitoring and analysis of pollutant concentration, spatial distribution of pollutant concentration, and assessment of no. of environmental factors affected by air pollutants, health risk map (Pandey et al, 2013). Currently 27% of the urban population lives in Tirana (Our World in Data, 2017) where the world average

[1]*University of Shkodër, Department of Geography, Shkodër, Albania, medjon.hysenaj@unishk.edu.al.*

indicator is 16%. Also many developed European countries such as Italy or Germany these values are even lower respectively 9.8% and 5.8%. The impact of urban air pollution on the environments and human health has drawn increasing concerns from researchers, policymakers and citizens (Xie, 2017). Commonly used indicators describing PM that are relevant to health refer to the mass concentration of particles with a diameter of less than 10 µm (PM10) and of particles with a diameter of less than 2.5 µm (PM2.5) (WHO, 2013). According to statistics absolute deaths from ambient PM10 air pollution is followed by concerning values.

PM causes a variety of human health and economic impacts each year (e.g., mortality, morbidity, DALYs, lost income from work absences, costs of health care (USAID, 2012). The number of premature deaths caused by air pollution (due to negative impact of PM2.5) in Albania is 16.9% compared to more developed European countries most of whom rely on values below 3%. There is a large spatial variability associated with air pollution; therefore even in a small area air pollution varies widely from place to place (Wijeratne, 2003). The amount of available data is limited and subject of short term measurements. The lacks of coordination, reduced government budget, misleading enhanced policies are ranked through the major causes of the current situation.

2. METHODS AND ANALYSES

The paper emphasis the fact that we need to split the problem into several steps (**Fig. 1**) until we understand the primary cause and the future policy to follow. Through all the harmful matters regarding air pollution we decided to concentrate our study on the particulate matter also known as (PM) rather than other matters such as Nitrogen oxides (NOx), Carbon monoxide (CO), Hydrocarbons (HC), due to its high risk impact it has revealed in many similar researches. Also statistics from the Ministry of Environment confirm that the average presence of particular matter in the air compared to AAQ directives is apparently higher than other elements.

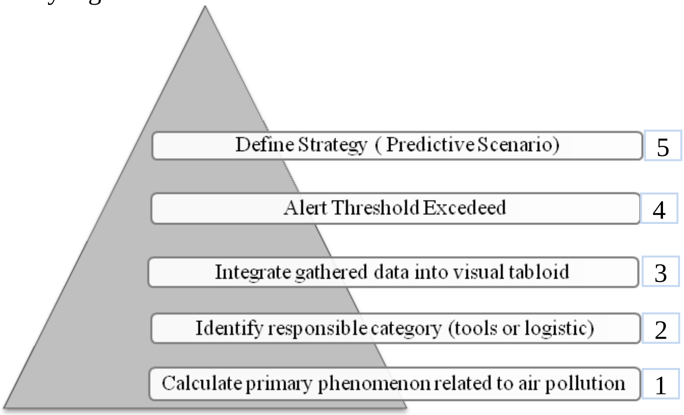

Fig. 1. Hierarchical steps for air pollution management.

PM10 originates from both natural and anthropogenic sources (Netherland Court of Audit, 2019). According to statistics the principal source of airborne PM10 matter in European cities is anthropogenic due to road traffic emissions, particularly from diesel vehicles (Air Quality in Europe, 2018). Data retrieved from IFBZ (**Tab. 1**) confirm the results follow the same trend for Tirana.

Table 1.

Primary sources of air pollution in Tirana.

	Primary sources of air pollution	**Elements/Components**	**Impact (%)**
1	Sea Air Masses	Cl	0.8
2	Soil dust including air masses from the Sahara	Ti, Mn, Fe, Sr	3.3
3	Transformation of S oxides into sulfate / burning of mazut	S, BC, V, Cr, Ni, Zn, Pb	1.1
4	Emissions from the construction industry / cement factories	Ca, Zn, BC	18.8
5	Natural source contaminated by traffic re-circulation	Ca, K, Fe, Mn, Sr, S	**42.8**
6	Traffic emissions / waste incineration or industries	V, Cr, Mn, Ni, Br, Pb, BC	13.3
7	Wood heating emissions	K, Fe, Cu, BC	19.8

Source: IFBZ (Institute of Applied Nuclear Physic)

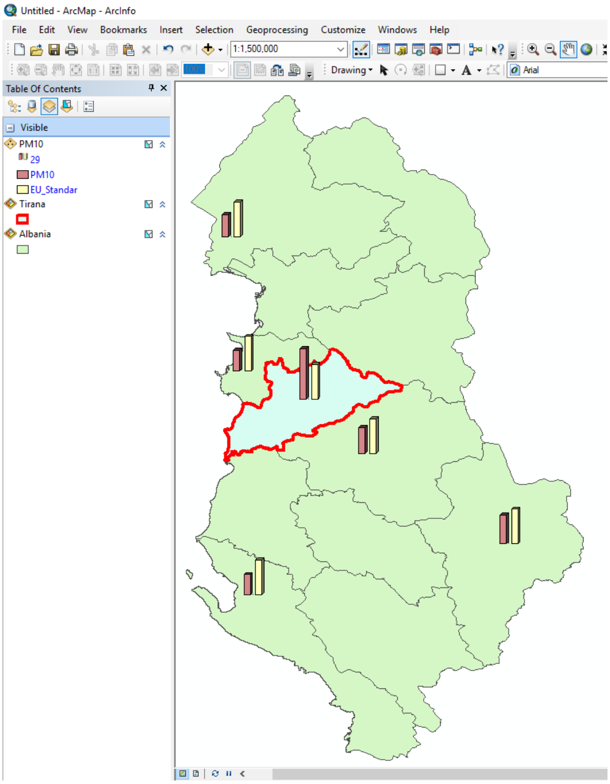

Fig. 2. Air pollution, PM10 index, Albania administrative territory (Sw; ArcMap 10.6)
Source: INSTAT; Comparative level EU Standard.

The monitor process has significant time and reliability limits. Many geographic areas still lack constant data and above all continuous control. Monitoring equipments need to be calibrated and verified. Understanding pollutants` spatial distribution and monitoring the air quality by applying geospatial approaches is challenging and topical in data quality research field (Enkhtur, 2013). At a large scale investigation (**Fig. 2**) spatial dispersion of

PM10 matters identify the capital as the most polluted zone in the country. Meanwhile other districts rely on sustainable values close or below the limits settled by AAQs directives. Due to increasing air pollution in Tirana we insist that immediate measures need to be taken by responsible actors cause every day citizens suffer first from the current situation, second from the lack of awareness. From **Fig. 3** we understand that PM10 average data from the last five years are above the limit (40 μg/m^3) daily. Not only, is the future trend to reach higher values.

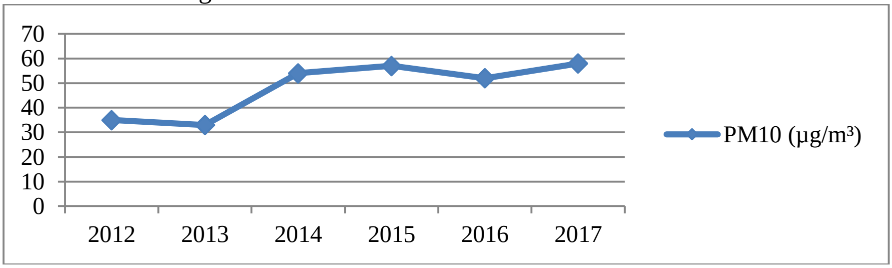

Fig. 3. Average PM10 index in Tirana; Source: INSTAT.

An important indicator of the current situation is that compared to other districts Tirana ranks at first place with 233 vehicles per 1000 inhabitants, which is far lower from the average of EU countries offered by EUROSTAT 505 vehicles per 1000 inhabitants. Meaning, emissions issues exist as a matter of fact not from large number of vehicles than the year of production and maintenance condition. We must create a better view of which category shares the largest fleet. Categorized by fuel type (**Fig. 4**) 72 % of them are diesel vehicles. We notice that passenger vehicles shares 79% of the entire fleet and that 69% of this category (**Fig. 5**) are 11-20 years old. If we compare outcome values to those in **Table 2** we notice that Euro 3 standard prevails.

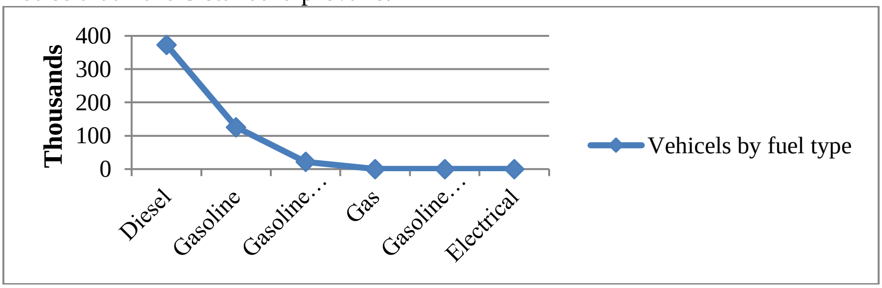

Fig. 4. Source: Ministry of Transport and Infrastructure.

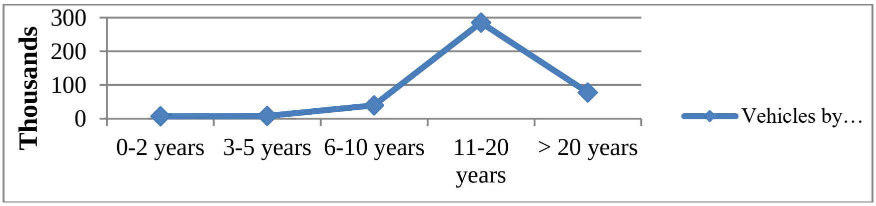

Fig. 5. Source: Ministry of Transport and Infrastructure.

Table 2.

Emissions standard - New type approvals.

Emissions standard	Applied to new passenger car approvals from:	Applied to most new registrations from:
Euro 1	1 July 1992	31 December 1992
Euro 2	1 January 1996	1 January 1997
Euro 3	1 January 2000	1 January 2001
Euro 4	1 January 2005	1 January 2006
Euro 5	1 September 2009	1 January 2011
Euro 6	1 September 2014	1 September 2015

Source: RAC, UK

After the calculation of the primary phenomenon related to air pollution (step 1) and identify responsible category (step 2) we are ready to step 3; integration of data retrieved from monitor stations into dispersion models. Our zone of study is located at latitude: 41.33°and longitude: 19.82°with an elevation: 103 m. We exploit data retrieved from five monitor stations. They are geographically distributed in areas with consistent vehicle traffic. They cover an area of 1630 km2 and 5420 m perimeter. Geographical data rely on a scale of 1: 200 m with a transverse Mercator projection; Projected coordinate system: UTM Zone 34 N. The Spatial Information Sciences (SIS) provides mature solutions for data and policy integration, since the nature of problem is specific to geo-spatial distribution [Sertel et al, 2012]. We notice four stations evidently exceed EU limit. Station 1 and 2 reveal values far behind the limit respectively by 119% and 79% (**Fig. 6**). The World Health Organization (WHO) implies air quality guidelines that are even stricter than the AAQ directives. If we compare the pollution trend focused on the city main streets and center location through a period of five years we notice that the situation has not improved or evolved at all (**Fig. 7**).

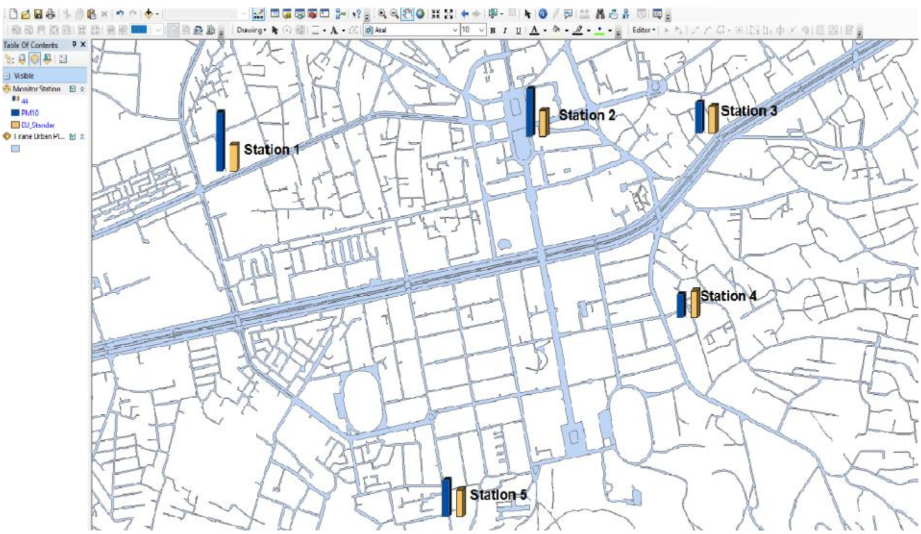

Fig. 6. Air pollution, PM10 index, city center; Data source: Ministry of Environment, 2018

Comparative level; EU Standard 40 microgram/m^3.

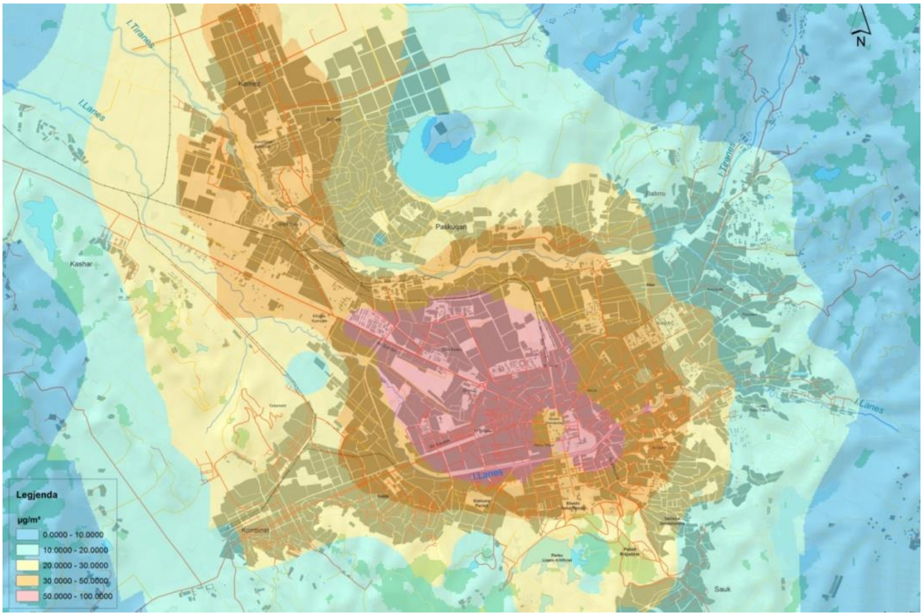

Fig. 7. PM10 dispersion; Data source: National Environment Agency, 2014.

On the other hand long terms measurements to calculate daily limit values per year could not succeed due to lack of budget and coordination between actors and policies, thought we can deduce from partially measurement retrieved from station 3 and 5 (**Fig. 8**).

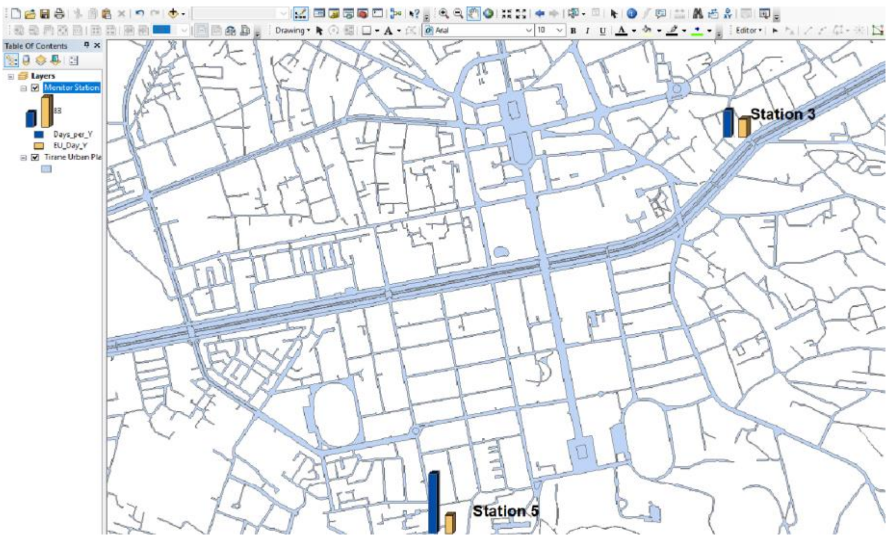

Fig. 8. Air pollution, PM10 index, Data source: Ministry of Environment
Comparative level; EU Standard 50 microgram/m3 - Permitted exceeds per year 35 days.

We have 21 days exceed from 28% time coverage at station 3 and 76 days exceed from 45% time coverage at station 5. Though a full year analytic process could lead us to an alarming situation leading approximately to 166 and 73 days of exceed from 35 days limit per year according to AAQ directives. This scenario could be even more pessimistic if we could have the possibility to apply long term measurement to station 1 and 2 which as above mentioned both denote much more polluted areas.

3. RESULTS AND DISCUSSIONS

We highlight the current environment position in the capital; also define main factors that influence its persistent deterioration. The goal is to create a clear picture for the right measures. If we consider current data, what with happen in case we decide to massively replace most of the vehicle fleet basically through long term policies supported by government and NGO actors? We deduce potential values from a possible fleet category transition. Euro 3 emissions for passenger cars is 0.05 g/km compared to Euro 4 (0.025 g/km) or Euro 5b and further (Euro 6b, c, d) which is 0.0045 g/km (**Fig. 9**). From Euro 3 to Euro 6 we notice a consistent decrease of the particular matter (PM10) emission respectively by 50 % and 91%. We exploit the outcome indicators to calculate a potential transition of fleet replacement.

Based on the emission index we settle a proportionally report between (euro 3-euro 4 reduce emission by 50%) and (euro 3-euro 5 reduce emission by 91%). If we apply this index to values retrieved from the five monitor stations we retrieve more optimistic results of air pollution (**Tab. 3**).

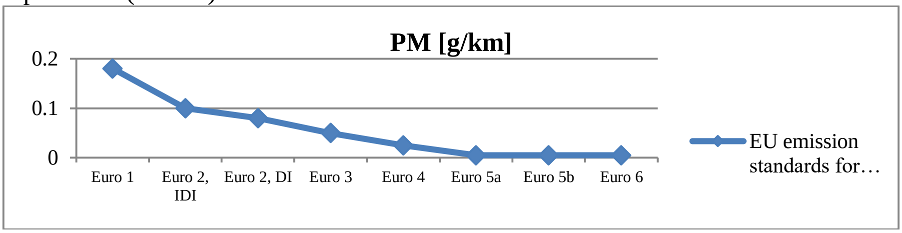

Fig. 9. Source: Ecopoint, EU emission standards for passenger cars.

Table 3.

Vehicle fleet Replacement - Potential Scenario

PM10 Scenario (Predictive data for each monitor station based on Euro vehicle emissions)					
Monitor Stations		**Euro 3**	**Euro 4**	**Euro 5b >**	
"21 Dhjetori" Street	Station 1	87.78	43.89	8	EU limit 40 microgram/m3
Municipality of Tirana	Station 2	71.85	35.9	6.4	
Ministry of Environment	Station 3	46	23	4.1	
Public Health Directorate	Station 4	34.4	17.2	3	
National Agency of Environment	Station 5	55.2	27.6	4.9	

50%

91%

(Input-Data under column Euro 3 represent current measured values; Output- Predicted Data under column Euro 4, 5; Values express microgram/m^3).

If we convert vehicles to Euro 4 all values fall approximate to settled limit or below the assigned EU threshold standard. Meanwhile Euro 5 vehicles and over not only accomplish all EU requirements but also reveal quite an optimistic panoramic situation of air quality definitely bypassing all pollution issue. We presume that the current values corresponding to the EU daily limits per year will also follow the new trend. **Figure 10**, **11** expose a future air index dispersion model based on calculated data (**Tab. 3**). Values below column (Euro 3) correspond to current measured values.

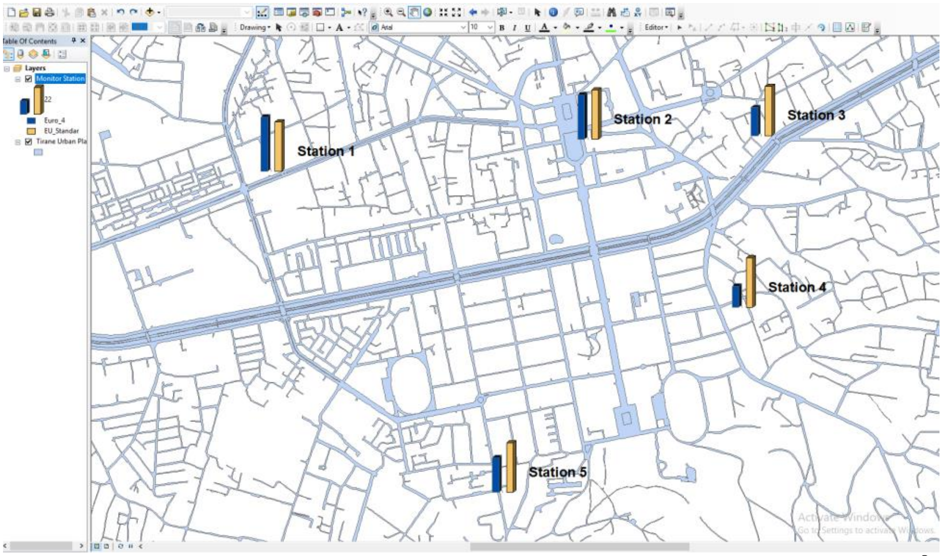

Fig. 10. Air pollution, PM10 index; Comparative level; EU Standard 40 microgram/m^3. Vehicles fleet replacement scenario to Euro 4.

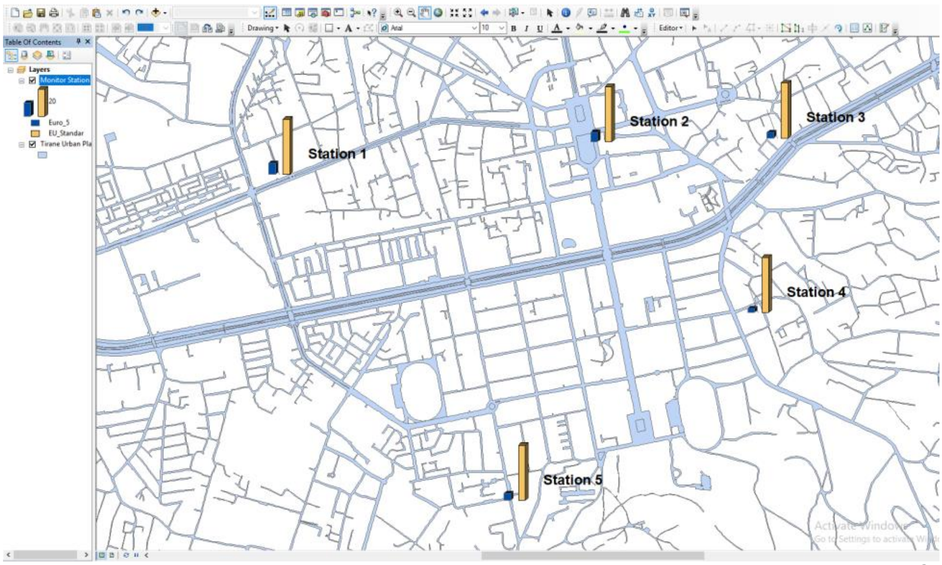

Fig. 11. Air pollution, PM10 index; Comparative level; EU Standard 40 microgram/m^3. Vehicles fleet replacement scenario to Euro 5.

5. CONCLUSIONS

The large scale development spatial tools have recognized recent years create a new exploitation perspective toward the management of environmental issues. Population perception toward air pollution must change. The ability to manage several layers contemporary intertwined with the possibility to reflect continues data results turns mapping process of primary importance to the current situation.

We believe that spatial technology creates a closer approach to the solution of managing air quality. It works as a bridge to connect all participating actors. As an issue that is strictly connected to geographical conception and spatial perspective air pollution must and should rely on spatial technology. We tried to create a filter to analyze air concern moving from the bottom to the top of the pyramid. The successive steps of the pyramid help us identify areas that crossed the red line also the principal causes.

Measured elements such as Ca, K, Fe, Mn, Sr, S address traffic re-circulation as the primary source of traffic pollution to reach a value of 43% of the total amount of elements. Approximately 70 % of the entire vehicle fleet belongs to Euro 3. Based on the emission index we settle a proportionally report between (euro 3-euro 4 reduce emission by 50%) and (euro 3-euro 5 reduce emission by 91%). If we apply this index to values retrieved from the five monitor stations we retrieve more optimistic results of air pollution.

From the held analysis we deduce that the replacement of the passenger’s vehicle fleet from Euro 3 to Euro 4 will normalize the air risk probability into appropriate value close to AAQ directives but still higher than WHO guidelines. Meanwhile a possible leap into Euro 5 definitely accomplishes both requirements. Performed calculations reveal that the current situation in Tirana has a potential solution but it requires immediate enrolment of government entities through strict policies toward environment protection.

REFERENCES

Air Quality in Europe. (2018) https://www.airqualitynow.eu/pollution_home.php

Al Koas K A. (2010) GIS based Mapping and Statistical Analysis of Air Pollution and Mortality in Brisbane, Faculty of Build Environment and Engineering, Queensland University of Technology, Australia

Deb S., Tsay R. S. (2018) Spatio-temporal models with space-time interaction and their applications to air pollution data, University of Chicago, 1–32

Ecopoint Inc. (2019) https://www.dieselnet.com/standards/eu/ld.php

Enkhtur B. (2013) Geostatistical modeling and mapping of air pollution, Faculty of Geo-Information and Earth Observation, University of Twente, The Netherlands.

INSTAT. (2017) Albanian Institute of Statistics, www.instat.gov.al

Ministry of Environment. (2017) https://mjedisi.gov.al/.

Ministry of Transport and Infrastructure. (2017) www.infrastruktura.gov.al

National Environment Agency. (2014) http://www.akm.gov.al/cil%c3%absia-e-mjedisit.html#monitorime

Netherland Court of Audit. (2019) Supreme Audit Office of Poland Joint Report on Air Quality

Our World in Data. (2017) Population in the largest city (% of urban population), https://ourworldindata.org/grapher/population-in-the-largest-city?tab=chart&time=1960..2017&country=ALB

Pandey M., Singh V., Vaishya R .C, Shukla A K. (2013) Analysis & Application of GIS Based Air Quality Monitoring- State of Art, *International Journal of Engineering Research & Technology*, 3788‒3789

Royal Automobile Club (RAC). (2018) www.rac.co.uk/drive/advice/emissions/euro-emissions-standards

Seferkolli L. (2009) An Environmental Atlas of Albania, Institute for Geoinformatics, University of Muenster

Sertel E., Demirel H., Kaya S. (2012) Predictive mapping of air pollutants: a spatial approach, Faculty of Civil Engineering, Maslak Istanbul, 5‒10

USAID, CCAD. (2012) Overview of Particle Air Pollution (PM2.5 and PM10) Air Quality Communication WorkshopSan Salvador, El Salvador

Wang X. Y. (2008) Spatial analyses of long-term exposure to air pollution and cardio respiratory mortality in Brisbane, Australia, Institute of Health and Biomedical Innovation, Queensland University of Technology

Wijeratne I. (2003) Mapping of dispersion of Urban Air Pollution using Remote Sensing Techniques and ground station data, 125‒130

World Health Organization. (2013) Health Effects of Particular Matter,

http://www.euro.who.int/__data/assets/pdf_file/0006/189051/Health-effects-of-particulate-matter-final-Eng.pdf

Xie X., Semanjski I., Gautama S., Tsiligianni E., Deligiannis N., Rajan R. T., Pasveer .F, Philips W. (2017) Review of Urban Air Pollution Monitoring and Exposure Assessment Methods, *International Journal of GeoInformation*, 389‒410