

Ecological Problems of Capital of Georgia and Possible Ways of Solution

Tamaz Patarkaleshvili*

Technical University of Georgia, Center studying Productive Forces and Natural Resources of Georgia. 69, M. Kostava Str. Tbilisi 0175, Georgia

**Corresponding Author: Tamaz Patarkaleshvili, Technical University of Georgia, Center studying Productive Forces and Natural Resources of Georgia, Georgia*

ABSTRACT

Pollution of large cities and industrial centers is one of the major problems of our civilization nowadays. Scientific progress that brings a lot of benefits, at the same time is accompanied with such adverse problems as: air, water and soil pollution, climate change, green house effect and others. In the Soviet period the major polluters of the atmospheric air in Tbilisi, the capital of Georgia, were plants and factories, but after breakup of the Soviet System, when plants and factories have been demolished and sold as iron scrap, the main polluter of the ambient air is remained city transport, especially light vehicles the number of which multiplied several times in last 20 years. The problem is that cars imported from EU (mostly from Germany) are as a rule of second and sometimes of third hand which already don't comply with European standards and are sold to developing countries. Increasing amount of such vehicles along with poor fuel quality, vehicle emissions standards not harmonized with present day requirements, narrow streets of the city that don't satisfy present day demands and cause traffic jams, malfunction organization of traffic movement in the city, are main causes of ambient air pollution of the city. These and other problems concerning city air condition namely, scarce green spaces not enough for purification of polluted ambient air and possible ways of improvement are discussed in the article.

Keywords: *Ambient air, Pollution, City traffic, Vehicle, Emission, Adverse, Optimization*

INTRODUCTION

Air pollution is an alteration of air quality that can be characterized by measurements of chemical, biological or physical pollutants in the air. Therefore, air pollution is undesirable presence of impurities or abnormal rise of proportion of some constituents of the atmosphere. It can be visible and invisible. Air pollution consists of harmful or poisonous substances in ambient air. It is harmful to people even if they do not have lung disease, but it is particularly dangerous for people living with asthma, COPD, and other respiratory ailments [1]

According to WHO 91% of the world's population lives in places where air quality exceeds their guidelines limits [2]. 4.2 million Die every year as a result of exposure to ambient air pollution. 3.8 million die every year as a result of household exposure to smoke from dirty cook stoves and fuel. Air pollution levels remain at dangerously high levels in many parts of the world. New data reveals that 9 out of 10 people breathe air containing high levels of

pollutants. WHO estimates that around 7 million people die every year from exposure to fine particles in polluted air that leads to diseases such as heart stroke, hearing diseases, lung cancer, chronic obstructive pulmonary diseases and respiratory infections, including pneumonia [2].

Despite progress in recent years, air pollution continues to be a serious environment and health problem. Breathing in air pollutants can irritate our airways and may cause shortness of breath, coughing, wheezing, asthma episodes and chest pain. Exposure to air pollution puts at risk for lung cancer, heart attacks and strokes and in extreme cases, premature death. Air pollution is a danger to: lung health, particularly for babies and children, whose normal breathing is faster than older children and adults; for elderly people who work or spend most of their time outdoors and for people with heart or lung disease [2].

Air Pollution Causes

Air pollution is caused by presence in the atmosphere of toxic substances, mainly produced by human activities, but sometimes

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can be result of natural phenomenon as volcanic eruptions, dust storms and wildfires.

Anthropogenic air pollution sources are: 1. Combustion of fossil fuels, like coal and oil for electricity and road transport, producing air pollutants like nitrogen and sulfur dioxide; 2. Emissions from industries and factories, releasing large amount of carbon monoxide, hydrocarbon, chemicals and organic compounds into air; 3. Agricultural activities, due to use of pesticides, insecticides, arboricides and fertilizers that emit harmful chemicals; 4. Waste production, mostly methane generation in landfills.

Air Pollution Effects

On The Environment

Air pollution has a major impact on the process of plant evolution by preventing photosynthesis, with serious consequences for purification of air we breathe. It also contributes to formation of acid rains, atmospheric precipitations in form of rain, frost, snow or fog, which are released during combustion of fossil fuels and transformed by contact with water stream in the atmosphere.

On The Global Warming

Air pollution is a major contributor to global warming and climate change. Abundance of carbon dioxide in air is one of the main causes of greenhouse effect.

On Human Health

Air pollution is a significant risk factor for human health condition, causing allergies, respiratory and cardiovascular diseases and lung damage.

RESULTS AND ANALYSIS

Tbilisi, the capital of Georgia, is one of the most ancient cities in the world. It was founded 15 centuries ago and up to the 19th century the city experienced mostly very hard periods in historical development. Being comparatively small, surrounded by bigger and more powerful countries like Iran, Turkey and Russia who had good appetite for conquering of our country that have been destroyed and burned numerous times. Especially suffered Tbilisi. It was burned and destroyed several times by Persians, Seljuk, Arabs and Mongols. As the country was very poor the reconstructions always conducted without any general plan by self-taught builders. Most of the buildings that came to us from

previous periods are subject of destruction for their present condition.

Geographically Tbilisi was founded and developing in the hollow place, on both sides of river Mtkvati, surrounded by mountains from all sides. Streets in old parts of the capital are narrow and crooked, not satisfying present day requirements. Only in new districts of the city streets are more or less normal for city traffic movement. It is one of the reasons of air pollution of the city as in slow movement car emissions of hazardous compounds increase. Being squeezed between mountains the city is aerated badly, especially its right, river-side most developed and polluted part.

In the Soviet period main sources of air pollution were plants and factories. The level of air pollution has never been measured accurately that time and mostly been concealed for citizens. But we remember clouds of smog hanging over the city in foggy days. After breakup of the Soviet system major part of plants and factories have been destroyed and sold as iron scrap. Today the main source of air pollution (more than 80%) comes from city transport, mainly light vehicles. For last 20 years number of them surpassed half million. Most of these cars are of second and sometimes of third hand [3, 4]. Majority of them (67%) are manufactured until 1999. Cars manufactured in 2000-2004 are 22%, in 2005-2009 - 7%. Comparatively new cars manufactured after 2010 are only 3% [table 1].

Table1. *Manufacture year of the cars in Georgia*

Year of manufacture	%
before 1980	7
1980-1989	18
1990-1994	15
1995-1999	27
2000-2004	22
2005-2009	7
2010 and later	3

Source: *Caucasian business week No100, 25.05.2015*

Table2. *Number of stationary sources emitting hazardous substances in Georgia (unit)*

	1995	2000	2005	2010	2015	2016	2017
Number of stationary sources	132	117	153	1099	2695	2891	2964

Source: *Ministry of environment protection and agriculture of Georgia, 2017*

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Number of stationary sources emitting hazardous substances in the country increased from 132 units in 1995 to 2964 in 2017 (table 2).

In table 3 is given data of captured and emitted hazardous substances generated in stationary sources.

Table 3. Captured and emitted hazardous substances generated in stationary sources in Tbilisi (th.t)

Year	Generated	Captured	Emitted	Share in pollution of the country, %
2015	85.5	83.6	1.9	4.2
2016	59.5	57.7	1.8	4.0
2017	28.1	26.2	1.9	4.1

Source: Ministry of environment protection and agriculture of Georgia, 2017

Table 4. Captured and emitted hazardous substances generated in stationary sources (th.ton)

	Generated	Captured	Emitted	Share of captured hazardous substances, %
		2000		
Hazardous substances, total	28.7	10.0	18.7	35.0
Solid	9.2	5.9	3.3	64.6
Gaseous and liquid	19.5	4.1	15.4	21.1
Sulfur dioxide	0.4	-	0.4	-
Carbon monoxide	3.7	1.9	1.8	51.0
Nitrogen oxides	4.1	1.0	3.1	23.5
Hydrocarbons	8.1	-	8.1	-
Others	3.2	1.2	2.0	37.4
		2010		
Hazardous substances, total	661.0	630.7	30.1	95.4
Solid	631.6	628.0	3.7	99.4
Gaseous and liquid	29.3	2.8	26.5	9.6
Sulfur dioxide	1.8	-	1.8	-
Carbon monoxide	15.1	1.5	13.7	10.0
Nitrogen oxides	4.0	1.0	3.0	25.0
Hydrocarbons	7.5	-	7.5	-
Others	1.0	0.4	0.5	40.0
		2017		
Hazardous substances, total	831.2	784.7	46.5	94.4
Solid	787.6	779.6	7.9	99.0
Gaseous and liquid	43.7	5.1	38.6	11.7
Sulfur dioxide	6.3	0.2	6.1	3.2
Carbon monoxide	19.3	2.9	16.5	14.8
Nitrogen oxides	6.4	1.0	5.5	15.0
Hydrocarbons	1.9	0.0	1.9	0.3
Others	9.7	1.1	8.6	11.0

Source: Ministry of environment protection and agriculture of Georgia, 2017

Table 5. Emission of hazardous substances from transport by their type (thousand ton)

Hazardous substances	2010	2011	2012	2013	2014	2015	2016
Carbon oxides (CO)	118.0	108.0	100.3	95.1	91.1	93.8	132.0
Nitrogen oxides (NO ₂)	20.1	21.2	22.2	22.9	23.5	25.8	28.5
Hydrocarbons (NMVOCs)	15.5	14.8	14.3	13.9	13.6	14.2	18.0
Particulate matters (PM10)	1.1	1.1	1.2	1.2	1.2	1.4	1.5
Particulate matters (PM2.5)	0.9	1.0	1.0	1.1	1.1	1.2	1.3
Soot (EC)	0.4	0.4	0.4	0.5	0.5	0.5	0.6

Ammonia (NH ₃)	0.2	0.2	0.3	0.3	0.3	0.4	0.6
Sulfur dioxide (SO ₂)	0.4	0.5	0.4	0.4	0.2	0.3	0.2
Other hazardous substances	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Source: Ministry of environment protection and agriculture of Georgia, 2017

Hazardous substances generated by stationary sources in Tbilisi diminished from 85.5 thousand ton in 2015 to 28.1 thousand ton in 2017 due to decreasing number of plants and factories who were main generators (table 3). Emission of hazardous substances from transport by their type increased especially of carbon and nitrogen oxides and hydrocarbons (Table 5). This data is given for the whole country, as to Tbilisi, Ministry of environment protection and agriculture of Georgia never open information about it. At the same time the transport sector is the main source of air pollution in Tbilisi [5, 6]. In Combustion processes the main source of hazardous substances are emitted such as: carbon dioxide (CO₂), nitrogen dioxide (NO₂), and sulfur dioxide (SO₂), solid particulates non-methane volatile organic compounds (NMVOC), *benzo[a]pyrene*, and others [7, 8, 9].

Carbon monoxide is a product of incomplete combustion due to insufficient temperature or malfunction of air supply system of the internal combustion engine. It is also emitted from energy production plants in particular those, using oil and coal combustion and from the metallurgical industry. Its adverse effect on people is revealed by suppression of oxygen transportation by blood.

Nitrogen dioxide and monoxide are the products of fuel combustion at a very high temperature in abundance of oxygen. The main sources are motor vehicle exhausts, emissions from power stations and the burning of solid waste. At high concentrations in ambient air nitrogen dioxide can irritate the lower airways of the respiratory tract, especially the lung tissue.

Health effects from **Hydrocarbons NMVOCs (Non-methane Volatile Organic Compounds)** include eye, nose and throat irritation, headaches, allergic skin reaction, vomiting, nose bleeding, fatigue, dizziness, loss of coordination, nausea and damage to the liver, kidney and central nervous system. Some organics can cause cancer in animals. Some of them can cause cancer in humans. One of the anthropogenic sources of VOC is fossil fuels (Petrol, Coal, Natural gas).

Solid particulates, often called dust, gets into the ambient air as a result of various processes, such as fuel combustion (coal, oil). Inhaling some types of solid particulates suspended in atmosphere may cause irritation of the respiratory tract (bronchial tubes, lungs). The smaller the particles, the deeper they penetrate into the human organs and the more harmful they are.

Soot or impure carbon is result of incomplete combustion of hydrocarbons. It has harmful effect on lung disease, lung cancer, influenza, asthma and increased mortality rate. Long-term exposure to urban air pollution containing soot increases the risk of coronary artery disease.

Ammonia is both caustic and hazardous in its concentrated form. It is classified as an extremely hazardous substance. Solutions of ammonia (5-10%) are used as household cleaners, particularly for glass. These solutions are irritating eyes and mucous membranes (respiratory and digestive tracts) and at lesser extent the skin. Caution should be taken that the chemical never be mixed in any liquid containing bleach. Such as household bleach, that can lead to hazardous compounds such as chloramines.

Sulfur Dioxide gets into ambient air due to the combustion of sulfur containing fuel. The main sources are power stations working on coal or black oil. Boiler rooms, metallurgical plants and diesel motor vehicles. When levels of sulfur dioxide is higher than the permissible, it irritate the upper airways of the respiratory tract.

Benzo[a]pyrene (BaP) is found in automobile exhaust fumes (especially from diesel engines). It is listed as a Group 1 carcinogen by the IARC (International Agency for Research on Cancer). Numerous studies documented links between BaP and cancer. BaP has an effect on the number of white blood cells.

The main sources of **lead and lead containing substances** in the ambient air are: motor vehicles (burning of leaded petrol) and metallurgical plants. Poisoning impact of lead is revealed at molecular and cellular levels. It impairs nervous, mental and physical development.

Pollutants emitted into the near-earth layer of the ambient air (troposphere) have not only direct impacts on human health and ecosystems but interacted between themselves to form more harmful substances for human health. Two of them so called secondary pollutants are of particular concern: troposphere ozone (O₃) and fine particulate matter (PM₁₀-solid particulates less than 10 microns).

Due to insufficiently developed municipal transport the significant part of the population uses private vehicles. Consequently the number of private cars is growing rapidly. Most of the cars are of second and third hand. Such cars don't comply with EU standards and usually are sold to developing countries like Georgia. Native, as well as foreign researchers agree that these vehicles are the main cause of ambient air pollution in Tbilisi. Narrow and crooked streets in the central part of the city is another cause of pollution as cars moving slowly with many breakings and starts, emit 3-5 times more pollutants than moving with higher speed. Improper developed crossroads also cause long traffic jams in rush hours.

It should be noted that a number of measures have been initiated in last period by city authorities for improvement of the situation. For example: approximately 1000 new buses of German production have been bought for Tbilisi transport company; alternative roads, overpasses and subways are being constructed for traffic optimization; crossroads of new design have been made that can significantly reduce number and duration of traffic jams; fuel quality standards are restricted, but they still don't meet present requirements; obligatory regular technical checking for light vehicles and municipal transport were renewed.

Ecological condition of Tbilisi is complicated by lack of large green spaces in the central, most polluted part of the city. If there would be large green spaces in the central part of the city like in London- Hyde Park and Kensington Gardens, together- 253ha., Central Park in New-York - 341ha., Bois de Boulogne in Paris-845ha. and in some other cities, the pollution could be neutralized a little by purification of polluted air and enriching it with oxygen, but it is impossible now due to absence of vacant large spaces for park development. Several small parks of 3-5 ha. Which came to us from previous periods shrank considerably. Alone trees along sidewalks have more decorative role than ecological. They suffer themselves from

polluted air. In 1960s Tbilisi took the 15th place among 16 Soviet republics with 12m² of green space per citizen. Population of the city that time was about 800,000, now it grew up to 1.3 million. So, green spaces per citizen today got still lesser. European standard of green spaces per citizen is 25m². [11, 12]

We have always been against introducing exotic, non-native species from other countries, as these species can be accompanied with unknown entomological and phytopathological infective diseases that may have adverse result on the native species. Such practice we already had in our recent period. For example: in 1956 un-barked round wood of spruce were imported to our country. As it occurred later these trees were infected with great spruce bark beetle (*Dendroctonus micans* Kug.) the beetle spread quickly in many regions of the country where spruce grow in Georgia and destroyed spruce forests on about two hundred thousand hectare [12,13]. Another example concerns black pine tree (*Pinus nigra* Arn.) that was introduced in late 1940s. This pine tree was widely used for greening of streets and parks of Tbilisi and afforestation of mountain slopes of city outskirts. Its popularity was determined by biological easiness of growing in Tbilisi climate and ability to grow on thin and barren soils. From 1960s they occurred to be infected with Zimmerman pine moth-*Dioryctria Zimmermani*. This process continued until now but the city authority didn't pay attention. Today, about 90% of all black pine trees in the city are dried out and must be logged. This process has already begun at last. After logging all these trees the green spaces of the city will diminish terribly. It will be not only ecological but great economical damage to the city [14,15]. After logging all pine trees they must be substituted by indigenous species Georgian oak tree (*Quercus iberica* Stev.), Eldari pine tree (*Pinus eldarica* Medw.) and other indigenous species. It must be a lesson to city authority not to introduce exotic species for city greening in future without foresters and phytopathologists recommendations.

It is well known that urban forests and other green spaces are very important in providing a livable environment for city dwellers and their function will become even more important in future.[16-20] Trees are urban bio-environment in cities playing moderating role (temperature, relative air humidity etc.). They muffle traffic noise, purify air by intercepting part of the pollutants, especially dust and other pollutants.

But in the process of air purification trees suffer themselves too and at the extreme levels of pollution they lose their sanitary function. Especially suffer trees with thin leaves. [21-23]. They cannot withstand air pollution and extreme noise. For example, leaves of lime trees growing on sidewalks of the central part of the city usually wither in July and August, while the same trees growing well in parks. High level of toxicants adversely influence on trees and provoke physiological and anatomical changes inciting their withering and death[24-25]. So, for the sidewalks of the city should be chosen trees with thick and glossy surface to reflect extra sun beams in hot weather and withstand air pollution. High level of toxicants adversely influence on trees and other greenery provoking physiological and anatomical changes inciting untimely withering and death.

CONCLUSION

In spite of insufficient materials and data obtained from scanty monitoring sources of ambient air pollution in the capital of Georgia we can conclude that the primary source of air pollution is city transport, especially light vehicles of second and sometimes third hand. Few monitoring locations in the city doesn't allow us to make more detailed assessment of air quality in the city. For this reason it is necessary to have at least one measurement unit for each 100 thousand citizens. The new monitoring units preferably must be located in the central, most polluted part of the city. Emission of polluted substances from the transport sector apparently be increasing and this trend will continue. The present national standards of fuel quality and vehicles emissions are much lower than of European standards. Low economic level of the country doesn't allow today the adoption of European standards, but gradual harmonization with these standards is necessary for improvement air quality. For gradual diminution of air pollution it is also necessary to improve and make more attractive the city transport system. It will help to decrease the number of private vehicles in the city. In case of rising of economic level of the country it is also reasonable to facilitate electric vehicles development. Insufficient amount of greenery in the city is another big problem due to absence of vacant spaces for their development. The central, most polluted part of the city is overcrowded by buildings. The only way in this situation is to use vacant spaces of demolished old buildings for green spaces instead of building another ones and the city

authority must be very decisive in their resolution.

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