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Transport is the Most Dangerous Adverse Source of Air and Noise Pollution in Big Cities

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ABSTRACT

Extreme rates of urbanization followed by many adverse environmental consequences for city dwellers in big cities of the world are dangerous for their health and well-being. This process is observed in all big cities of the world especially in south-east Asia where population of some cities including suburbs exceed 20 million. In these cities normal conditions for human living is getting dangerous. These cities are surrounded by slums with rotting and stinking trash. These insanitary conditions arouse many infectious diseases spreading in the world. Scientists and city-planners cannot find any decisive measures to stop this adverse process until now. With dramatic increase of urbanization there observed corresponding inability of municipal authorities to solve these problems resulting in uncontrolled development of big cities and its suburbs. Well-developed traffic routs, decrease of limited speed and exuberant city greenery can help to mitigate these adverse processes a little.

Keywords: City; Air; Pollution; Noise; Traffic; Greenery; Mitigation; Suburb; Slum

Introduction

Historically the rates of urbanization in the early centuries of civilization have been slow and gradual. But little by little, especially beginning from the middle of the 20th century, it began to grow and became the most dramatic after 2000s, mostly in developing countries of south-east Asia and Latin America [1,2]. Today the world is becoming increasingly urbanized. From 2007 more than half of the world's population lived in cities. But as it predicted it will go up to 60 percent by 2030 [3,4]. The rapid urbanization is resulting in uncontrolled number of light vehicles, growing number of slums, inadequate and overburdened infrastructure and such services as waste collection, road and transport infrastructure development etc. All these adverse factors increased air and noise pollution levels and deteriorated ecological sustainability of big cities [4]. Municipal authorities and urbanists occurred unready for these processes and could not keep pace with times. The results are uncontrolled development of cities and their suburbs [5,6].

Cities are the centers of economic growth of countries contributing about 60 per cent of global GDP, but they also account for about 70 per cent of global carbon emissions and over 60 per cent of resource use [7,8]. Excessive noise levels in most big cities of the world contribute to physical and psychological burden on people. Air pollution has always been considered as main source of big cities' pollution [9-10], but in the last decades due to the uncontrolled rates of city traffic growth aroused the problem of noise pollution which is not only overtook rates of air pollution but sometimes surpassed it [11-15]. Today noise pollution is a constantly growing problem in big cities of the world [16-18].

Thou trees have always been an important part of human settlements throughout the whole of human history, only lately their value for urban dwellers became accordingly considered [19-20]. Urban forests and other green spaces are closely related to landscape architecture and park development and must be done together with professionals of these fields as urban forestry includes activities carried out in the city center, suburb areas and in the interface space with rural areas [21-22]. As many parks and other green spaces are in the cities as better are their citizens protected from air and noise pollution. Well-developed green spaces in big cities act as natural air filters and buffers [23]. Trees and other green spaces absorb air and noise pollution, improving the microclimate of the city and at the same time natural resources quality including soil and water [23-24]. Foresters and ecologists know well that leaves absorb the greater part of noise coming on their surface and reflect the air the remaining part.

trees infiltrate the air from hazardous gases and microbes [25-26]. But unfortunately, in the process of infiltration trees suffer themselves too. Especially dangerous for them are fluorine, phosphorus, fluorine-hydrogen, chlorines, nitrogen dioxide. These gases getting into the leaves violate the processes of breathing and photosynthesis. Especially suffer trees with thin leaves in summertime when air temperature is above 30°C and more and air humidity is under 50%. Our recommendation is to implant in big city parks, squares and along sidewalks trees and bushes heaving thick leaves, mostly with glossy surface that reflect better part of sun rays and suffer less than trees heaving thin leaves [27-28].

Results and Analysis (Case Study of Tbilisi-Capital of Georgia)

Air Pollution

The increased rates of urbanization in the world didn't pass around Tbilisi, the capital of Georgia. Since the 1960s of the 20th centuries the population of the city nearly doubled and reached 1.4 million. This amount of population may not be dangerous for other cities, but the problem is in the geographical disposition of the city. It is located between mountains, In the depression and has uneven territory in appropriate for geometrical development of the city. It has always aroused problems of city planning and construction.

It is aggravated by the lack of enough trees and other greenery again due to lack of free spaces for them. Tbilisi is one of the oldest cities in the world comprising more than fifteen centuries. During this period the city was destroyed and burned many times by different invaders and rebuilt again [29-30]. So, the most part of the city buildings and infrastructure were built without any general plan of development. The most part of streets have been narrowing and crooked suitable for only wheelbarrows and equestrians. Only from the second part of the 19th century did the city authorities began to widen several central streets which more or less satisfy present-day requirements for city traffic movement. Other streets on the outskirts and which are located on slopes of the hills on the right bank of the river Mtkvari remain in the same condition and don't satisfy present demands for speeding traffic movement. Traffic jams take place till the late evening due to the bad passing ability of narrow streets. The air and noise pollution in these streets are the highest in the city. The river Mtkvari divides the city on two parts. Historically the right part of the river has always been developed better and this trend remains today too. It is overcrowded with buildings and government and business offices. The city always lacked enough green spaces. The several parks that were created in the second half of the 19th century have shrunk during these years and now are surrounded by buildings. All parks in the central part of the city are small, 2-5 hectares. Only Vake park is about 20 hectares, but its trees are old and need refreshment by new trees of different species and replenishment altogether.

The big cities nowadays need to have big parks in the central part as an oasis. Such parks for example have New-York -the Central park-341hectare, London-Hyde Park and Kensington Gardens-253 hectare, Paris-Bois de Boulogne-845 hectare and others [31]. Citizens of these towns can have a rest in these parks during daytime and breathe fresh air. In (Tables 1, 2 & 3) are given the official data of air pollution in the city by the ministry of Environment Protection and Agriculture of Georgia. From hazardous substances since 2011 increased the most dangerous like Carbon oxides, Nitrogen oxides, Hydrocarbons and Particular matters (Table 3). Carbon oxides increased from 37.0 in 2011 to 68.1 thousand ton in 2016. In the same period Nitrogen oxides increased from 12.8 thousand ton to 25.5 Hydrocarbons from 6.0 thousand ton to 11.2 and Particular matters (PM_{10}) from 0.6 to 1.1 thousand ton.

Table 1: Capture and emission of substances generated in stationary sources of Tbilisi (th.ton).

Year	Generated	Captured	Emitted
2005	3	0.1	2.9
2010	26.0	24.8	1.2
2015	85.5	83.6	1.9
2016	59.5	57.7	1.8
2017	28.1	26.2	1.9
2018	22.6	18.2	4.4
2019	26.7	23.5	3.2
2020	44.5	42.3	2.2

Note: Source: Ministry or Environment Protection and Agriculture of Georgia, 2020.

Table 2: Captured and Emitted Hazardous substances in stationary sources in Tbilisi (th.ton).

Year	Generated	Captured	Emitted	Share %	
				In pollution of the region	In pollution of the country
2015	85.5	83.6	1.9	100	4.2
2016	59.5	57.7	1.8	100	4
2017	28.1	26.2	1.9	100	4.1
2018	22.6	18.2	4.4	100	8.9
2019	26.7	23.5	3.2	100	8.4
2020	44.5	42.3	2,2	100	5

Note: Source: Ministry of Environment Protection and Agriculture of Georgia, 2020.

Table 3: Emission of hazardous substances from road transport by type of substences (th.ton).

Hazardous substances, year	2011	2012	2013	2014	2015	2016	2017	2018	2019
Carbon oxides (CO)	37	39.7	37.3	52.4	57.2	68.1	63.7	60.3	58.8
Nitrogen oxides (NO_2)	12.8	13.5	15	20.8	23.5	25.5	23.4	21.7	19.7
Hydrocarbons (NMVOC)	6	6.5	6.4	9.1	9.9	11.2	10.7	10.4	10.1
Particular matters (PM10)	0.6	0.7	0.7	0.9	1	1.1	1	1	0.9
Particular matters (PM2.5)	0.5	0.5	0.6	0.7	0.8	0.9	0.8	0-8	0.7
Soot (BC)	0.2	0.2	0.2	0.3	0.3	0.4	0.3	0.3	0.3
Ammonia (NH_3)	0.4	0.5	0.4	0.4	0.5	0.7	0.6	0-6	0.6
Sulfur dioxide (SO_2)	0.6	0.4	0.4	0.3	0.3	0.2	0.1	0.1	0.1
Other hazardous substances	1.6	1.7	1.7	2.3	2.6	3	2.7	2.6	2.4

Note: Source: Ministry on Environment Protection and Agriculture of Georgia, 2020.

From hazardous substances the most dangerous (by down-grade adverse effect) are Carbon Oxides (CO), Nitrogen Oxides (NO_2), Hydrocarbons (NMVOC), Sulfur Dioxide (SO_2), Particular Matters (PM_{10} and $PM_{2.5}$), Soot (BC), and Ammonia (NH_2). Combustion gases of concern include: carbon monoxide, Carbon dioxide, Sulfur dioxide and Nitrogen oxides.

Carbon Monoxide: Carbon monoxide (CO) is a colorless, highly poisonous, odorless, flammable gas that is slightly less dense than air. The most common source of carbon monoxide is the partial combustion of carbon-containing compounds, when insufficient oxygen or heat is present to produce carbon dioxide. There are also numerous environmental and biological sources that generate and emit a significant amount of carbon monoxide. It is important in the production of many compounds, including drugs, fragrances and fuels. Upon emission into the atmosphere, carbon monoxide affects several processes that contribute to climate change [32]. Several thousand people go to hospital emergency rooms every year to be treated for carbon monoxide poisoning [33,34]. It is known that carbon monoxide had been used for genocide during the Holocaust at some extermination camps (death camps) in Central Europe during World War II.

Carbon Dioxide: Carbon dioxide (CO_2) in the air is transparent to visible light but absorbs infrared radiation, acting as greenhouse gas [35,36]. Burning fossil fuels are the primary cause of increased CO_2 concentrations and global warming and climate change. About half of excess CO_2 emissions to the atmosphere are absorbed by land and ocean. Carbon dioxide content in fresh air varies between 0.036 % and 0.041 % depending on the location [37,38]. There are few studies of the health effects of long-term continuous CO_2 exposure on humans and animals at levels below 1%. Poor ventilation is one of the main causes of excessive Co_2 concentrations in closed spaces. Carbon dioxide is natural and harmless in small quantities, but as levels rise it can affect productivity and sleep [39]. High levels are directly correlated to low productivity and high sick leave making this a crucial concern in offices, schools and home environments. It is revealed in restlessness, drowsiness, increased heart rate and blood pressure, sweating and headache [40].

Nitrogen Dioxide: Nitrogen dioxide (NO_2) is a compound released during combustion processes [41,42]. NO_2 can cause irritation of eyes and throat and when inhaled might cause lung irritations and decrease lung function. In areas with higher levels of nitrogen dioxide a greater chance of asthma attacks and increase in hospital stays because of respiratory complaints are observed [43-45].

Hydrocarbons NMVOC: Hydrocarbons NMVOC: (non-methane volatile organic compounds) are collection of organic compounds that differ widely in their chemical composition but display similar behavior in the atmosphere [45,46]. NMVOCs are emitted into the atmosphere from a large number of sources including combustion activities [47,48]. They include benzene, ethanol, formaldehyde, acetone. The major sources of NMVOCs include vegetation, biomass burning and human activity [49,50].

Particular Matters (PM_{10} and $PM_{2.5}$): PM_{10} is particulate matter of 10 micrometers or less in diameter. $PM_{2.5}$ is particulate matter 2.5 micrometers or less in diameter [51]. Synonyms of particular matters are: dust, inhalable particles, respirable particles, smoke and mist. PM are important constituents of the atmosphere [52]. The sources of PM can be natural or man-made sources. There are a number of natural sources that inject million tons of PM into the atmosphere. They include volcanic eruptions, wind and dust storms, forest fires, salt spray, debris, reactions between gaseous emissions and soil erosion [53]. Man-made activities such as fuel combustion, industrial processes, Steel industry, petroleum foundries, cement, glass manufacturing industry, mining operations, fly-ash emissions from power plants, burning of coil and agricultural refuse. All these substances contribute to PM in the atmosphere.

Sulfur Dioxide (SO_2) is a gaseous air pollutant composed of sulfur and oxygen [54,55]. SO_2 is formed when sulfur-containing fuel such as coal, oil, or diesel is burned. Sulfur dioxide causes a range of harmful effects on lungs, as the EPAs, besides it causes wheezing, shortness

of breath and chest tightness, especially during exercise or physical activity; continued exposure at high levels increases respiratory symptoms and reduces ability of lungs to function; short exposure make it difficult for people with asthma to breathe when they are active outdoors; rapid breathing during exercise through the mouth; increased risk of hospital admissions or emergency room visits, especially among children, older adults and people with asthma [56].

Soot (BC): Soot (BC) is a impure carbon particle resulting from the combustion of hydrocarbons. Soot as an airborne contaminant has many different sources like coal burning, internal-combustion engines, power-plant boilers, ship boilers, central steam-heat boilers, local field burning, house fires, fireplaces. Soot, particularly diesel exhaust pollution accounts for one quarter of total hazardous pollution in the air [57]. Among these diesel emission components a particular matter has been a serious concern for human health due to its direct and broad impact on the respiratory organs. It is associated with lung cancer, influenza, asthma and increased mortality rate. Recent scientific studies show that these diseases more closely linked with fine particles ($PM_{2.5}$) and ultra-fine particles ($PM_{0.1}$) than with (PM_{10}) particles as believed before [58].

Ammonia (NH_3): Ammonia is a compound of nitrogen and hydrogen with chemical formula NH_3. It is a colorless das with distinct pungent smell. Ammonia even at dilute concentrations is highly toxic to aquatic animals and for this reason it is classified as dangerous for the environment [59]. Atmospheric ammonia plays a key role in the formation of fine particulate matter. Ammonia is a constituent of tobacco smoke [60]. In humans, inhaling ammonia in high concentrations can be fatal. Exposure to ammonia can cause headaches, impaired memory, seizures, and coma as it is neurotoxic by nature [61].

Noise Pollution

The problem of noise pollution have always been ignored until recently in the world [62]. But due to the accelerated rates of automobilization and connected with it adverse air and noise problems made scientists and city municipalities to pay due attention to these problems [63]. The same processes were observed in Tbilisi too. The Ministry of Environment Protection and Agriculture of Georgia as well as the city municipality had never published data about air and especially noise pollution. These problems have always been ignored by them. This situation is still continued now too. At the same time, it is municipality fathers' direct obligation to defend citizens from these hazardous effects and maintain normal living conditions in the city. But we believe that city authorities and organizations who are responsible for air and noise pollution always concealed this information by being afraid of people's reaction. Some journalists from TV channels measured noise pollution in different parts of the city in underground tunnels, municipal transport etc. As it occurred in underground there is about 90-92 db, in buses- about 80 db. In average there is 80-90 db in daytime. This data must be considered as a very high level of noise pollution. Noise pollution differs during the daytime and places of its measurement so it must be done by specialists with high precision devices not by amateurs. The data of air and noise pollution must be published every day in mass media along with air temperature and air relative humidity. The city dwellers must know about this information to avoid the most polluted places in the city and choose safe routes of movement themselves.

In 2015 there were about 850,000 light vehicles in Georgia. Today it must be about a million. From this amount about half of cars are registered in Tbilisi excluding the Light and heavy transit vehicles that go through the city from west to east and vice versa. The majority of cars are of second and more hands and the overwhelming part of air and noise pollution are exhausted from them. Noise pollution is the dangerously growing problem of city pollution especially in all big cities of the world. Many people may not even be aware of its adverse impacts on their health [64]. Noise pollution is a major problem both for human health and animals as well as the environment [65]. Long-term exposure to noise pollution can induce a variety of adverse health impacts like increasing annoyance, sleep disturbance, negative effects on cardiovascular and metabolic system, as well as cognitive impairment in children. Millions of people in big cities suffer from chronic high annoyance and sleep disturbance [66,67]. It is estimated that school children suffer reading impairment as a result of aircraft noise living in the neighborhood of big airports [68-70]. Despite the fact that noise pollution is one of the major public health problems in most big cities of the world there has always been and continued a tendency to underestimate it making major accent on air pollution. It's high time to change this tendency.

Conclusion

Extremely accelerated rates of urbanization in the world generate a lot of health and other adverse problems for city dwellers which are getting more and more difficult for municipal authorities to solve. The desire of people to live in cities is understandable by some reasons like finding a job, giving their children good education and so on. But it raises many problems for old native dwellers living there before as well as for newcomers too. Cities are getting dangerously overcrowded with traffic and people. This continued process is mostly observed in countries of south-east Asia and Latin America where in some of them live 20 million people and even more with suburbs. The most of big cities have growing number of light and other vehicles, crowds of people in the streets, insanitary condition and a lot of slums in the suburbs full of trash and stink substances which are the souse of bacterium and different infectious diseases that spread in the world. It is enough to see the downstream of the river Nile which is extremely dirty and people including children are swimming and bathing there. What can be done in this situation? Unfortunately scientists don't have effective measures until now to stop urbanization rates and growing rates of transport traffic gems. Our recommendations are the following: to stop further building construction, especially skyscrapers; to increase city greenery instead of building new houses. city greenery must include big and small parks, pocket and vertical greenery on buildings and roofs; making ponds where it is

possible; implanting trees bushes and half-bushes along the streets. These measures will help to increase the total space of city greenery and mitigate adverse effects from air and noise pollution. It will help citizens to breathe additional fresh air and defend their homes from extra noise pollution. It is well known that only trees, bushes and other greenery on the planet, along with Cyanobacteria (blue-green algae) and Phytoplankton in oceans and other freshwaters ecosystems are the only living organisms producing oxygen through the photosynthesis process so necessary for living organisms. From technical means: it is necessary to regulate city traffic especially on the crossroads to avoid traffic jams; to choose the most optimal traffic routs in the cities according to the present day demands and convenience for traffic and people; such type of transport as motorcycles and scooters must be strictly banned as producers of the most terrible loud noise and exhaustion of great amount of the most toxic gases that adversely impact on people; decrease transport speed in the central and over-crowded parts of the city to 30 km/h; to use zero emission buses, refuse collecting trucks and municipal vans; to develop infrastructure for safe cycling and available public bike fleet; gradual transition from internal-combustion vehicles working on fossil fuel to electric cars.

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