Journal of Young Scientist, Volume VIII, 2021
ISSN 2344 - 1283; ISSN CD-ROM 2344 - 1291; ISSN Online 2344 - 1305; ISSN-L 2344 – 1283

EXAMINATION OF THE CHANGES IN THE LAST YEARS OF AZERBAIJAN'S AIR QUALITY SITUATION (AQI: AIR QUALITY INDEX)

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Abstract

The rapid economic improvement in developing countries during the last decades has been followed by growingly deteriorated air quality. Air pollution is considering one of the most critical environmental issues in the urban areas of Azerbaijan. As a result of the urbanization, emissions from oil, gas, chemistry, metal, construction material industries, and car building complex, the atmospheric air of the Absheron peninsula become the most contaminated place in Azerbaijan. The primary anthropogenic sources of air pollution in Azerbaijan are mobile sources and the oil-and-gas industry. However, the number of literature and researches was written about this problem is not adequate. In this research work, we aimed to analyze the changes in the last years of air quality in Azerbaijan. To reach our goal, we used the times series analysis method. The research is principally based on examining the air quality situation in six big cities of Azerbaijan. One of the main reasons for that was the high concentration level of PM and SO2. We also applied Air Quality Index (AQI) method to our research, and it showed that atmospheric air in Baku, Mingechevir, and Nakhchivan was heavily contaminated. Our study revealed that air quality in the big cities of the country is poor.

Key words*: Azerbaijan, air pollution, air quality, developing countries, Particulate Matter, urban areas.*

INTRODUCTION

Urban air pollutants are a complex combination of numerous organic and inorganic compositions. According to most research on air pollutants' possible health effects, it has been associated with primary pollutants (Möller et al., 1994). Regarding the World Health Organization (WHO), urban air pollution is a serious public health issue. More than 2 million premature deaths can be ascribed to the consequences of urban outdoor and indoor air pollution every year. Effects of air pollution are counted by sickness and death, decreased productivity, failed educational opportunities, and other improvement opportunities for society (Mabahwi et al., 2014).

Regarding the most recent evaluation of air quality of the European Commission, high concentrations of particulate matter (PM) caused about 348,000 premature deaths in the European Union regardless of planned notable depletions in yearly PM effect from 2000 to 2020 (Morgenstern et al., 2008). Following necessary epidemiological proofs, fine particulate matter has harmful effects on human health. Even though many research types have concentrated on respiratory health effects, there is increasing confirmation that PM is a danger factor for cardiovascular diseases (Pope et al. 2003). Moreover, regarding the current studies, people with type 2 diabetes are more susceptible to the cardiovascular effects of the airborne particle (Anderson et al., 2012).

Reliance and connection between air pollution and human health are not adequately studied in Azerbaijan. According to the examination data, 2108.5 thousand tons of wastes were discharged from stationary sources in Azerbaijan, and at that time, people who died from respiratory diseases made up 5893. Regarding the calculations, approximately 36-38% of infections are directly and indirectly associated with Azerbaijan's atmospheric air pollution (Mammadova, 2015).

The general area of Azerbaijan is 86.6 thousand km^2 (The State Statistics Committee of Azerbaijan Republic, Environment in Azerbaijan, 2017) and it is situated on the south-

eastern slants of the Caucasus Mountains (Frenken, 2009). According to the data from the State Statistical Committee of Azerbaijan Republic, approximately 12% of the surface of the country covered by forests, 1.7 % water, 55.1% agricultural fields (30.7% grazing and dried grass makings), and 31.2% are other lands (The State Statistics Committee of Azerbaijan Republic, Environment in Azerbaijan, 2017).
At the beginning of 2017, the population of Azerbaijan is accounted for 9.81 million people, and the density of the people for 1 km^2 was 113 people (The State Statistics Committee of Azerbaijan Republic, Environment in Azerbaijan, 2017). During the last five years, the median increasing rate of Azerbaijan's population is around 1.11%, and inhabitants are predicted to reach 10 million by 2020 (Rucevska et al., 2017).

The Absheron Peninsula is considering the most inhabited part of Azerbaijan, and it is the center of urbanization, infrastructure, and economic activities to both national and regional extents. The Absheron Peninsula accommodates approximately 40% of Azerbaijan's population and 70% of its industrial manufacturing. Therefore, the area is thought-out to be highly susceptible to the possible climate change persuaded threats. The peninsula economy is mainly based on oil and gas production, chemical and petrochemical industries, metallurgy, textiles, and food industry (Rucevska et al., 2017).
According to The Blacksmith Institute's research, Sumgait is included 9th place in the list of the world's worst ecological areas (Table 3). Fuller mentioned that "It is a huge, abandoned industrial wasteland" (Walsh, 2018). Regarding the recent research and data, Baku is one of the most polluted cities worldwide at the time of the Union of Soviet Socialist Republics (USSR); Baku was known for its topmost level of atmospheric contamination (Kahramanova and Namazov, 2009).
In Azerbaijan, industrial and energy sectors are considered the condemnatory creators of carbon dioxide CO2 emissions such as burning fossil fuel in energy, oil, and gas extraction (SOCAR, BP, EXXON, LUKOIL, Turkish Petroleum, etc.) (Vidadili et al., 2017). Additionally, growth in the metallurgy sector has also been caused to the enormous rise in greenhouse gas (GHG) emissions ("Aluminum" Production area of "Azeraluminum" LLC, "Dashkesen Ore Refining" JSC, etc.) (Azerbaijans, 2019). Following data from the State Statistical Committee of Azerbaijan Republic, the total amount of the GHG emissions were 75.5 million tons and per capita 3.7 ton in 2013 (Vidadili et al. 2017).

In Azerbaijan, artificial air pollution sources are mobile sources (mainly vehicles), oil and gas extraction and refining, thermal power plants and boiler houses, chemical industry, mining, metallurgy, and manufacturing industries construction materials. Among all of these sources, vehicles are responsible for air pollution in Azerbaijan (Tables 5, 6, 7) (Caucasus, 2013). For example, in 2005, the number of cars in Azerbaijan was approximately 50.000; however, nowadays, their numbers exceed 1.3 million (Salmanova 2017). Moreover, over the last decade, emissions from mobile sources have increased significantly. Within the previous ten years in Azerbaijan, the numbers of old vehicles (older than ten years) which use low-quality fuel and are not well maintained are enlarged dramatically (Popov, 2005).

The other reason for air pollution in Baku is urbanization, and more than half of the countries' industry established in Baku (Absheron Peninsula). Nonetheless, following the disintegration of the Soviet Union majority of the old enterprises were shutting down. Hence, the environmental impact in this area has been reduced. However, the oil-and-gas industry improved as a novel source of emissions, and in this case, the atmosphere of the Absheron peninsula is exposed to industrial pollution once more (Kahramanova and Namazov, 2009). Another issue with the urban population is indoor air quality. Thus, the number of people who utilize domestic heaters with alternative fuels without fuel combustion devices has increased significantly (Popov, 2005).

MATERIALS AND METHODS

Time series analysis can be described as the measurement of the data sequentially over time.

This method can be used in almost all application field, such as business sales figures (i.e., customer frequencies, production numbers), official statistics census data (i.e., personal expenditures), natural sciences (i.e., population size), envirometrics perception (i.e., temperature or pollution records). Time series analysis is used to visualize and this reliance on the past and then achieve future values forecast (Dettling, 2014). Time-series analyses handle statistical techniques to analyse and model, and arranged the sequence of observations. This modelling leads to the stochastic process model for the system which created the data (Madsen, 2008). In time series, data is positioned chronologically, and the order of the observations' existence is vital. If the chronological sequence of the data were neglected, much of the information included in the time series analysis would be lost (Modarres and Dehkordi, 2005).

To analyse historical changes in the weather, we have acquired statistical data from The World Bank, The State Statistical Committee of the Azerbaijan Republic, and the Ministry of Ecology and Natural Resources of the Azerbaijan Republic. Most of the data were available online; however, some data were obtained personally with authorities' special request.

Below given Air Quality Index table (Table 1) is established according to the 4/2011. (I. 14.) VM decree in Hungary. It describes ambient air quality based on the yearly concentration of air pollutants and is evaluated as excellent, good, adequate, contaminated, and heavily contaminated. The table is coloured from blue to red to differentiate the air quality even without reading the numbers easily. Initially, it was created for eight air pollutants: NOx, NO2, SO2, PM2.5, PM10, O3, CO, and Benzol. Because of the lack of data in our research, we will calculate Air Quality Index only for four major air pollutants, namely NO2, SO2, PM10, and CO. With the aid of this table, we will analyse the yearly air quality situation for the last decade in the big cities of Azerbaijan.

Table 1. Air Quality Index (Hungarian Air Quality Network)

Index	Evaluation	NO2 (µg/m3)	SO2 (µg/m3)	PM10 (µg/m3)	CO (µg/m3)
		average	average	average	average
		year	year	year	year
1	excellent	0-16	0-20	0-16	0-1200
2	good	16-32	20-40	16-32	1200-2400
3	adequate	32-40	40-50	32-40	2400-3000
4	contaminated	40-80	50-100	40-80	3000-6000
5	heavily contaminated	80<	100<	80<	6000<

RESULTS AND DISCUSSIONS

Table 2 demonstrates the quality of air in Baku city based on 4/2011. (I. 14.) VM yearly Hungarian Air Quality Index from 2008 to 2017. Air quality in given years in Baku city is summarized as heavily contaminated. The reason is that the PM concentration is exceeded the given maximum level more than two times in the last decade. The central part of Azerbaijan's industries was established in the Absheron peninsula, where Baku city locates. It is undeniable that emissions from these industries affecting the air quality. Another major reason for poor air quality is considering the increasing urban population and emissions from mobile sources.

Table 2. Air Quality Index in Baku

Baku	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NO2	20	20	40	40	10	20	40	40	20	30
SO2	14	15	15	16	18	11	11	14	19	26
PM	200	300	300	300	300	300	300	300	200	200
CO	2000	2000	2000	3000	3000	3000	3000	3000	1900	2000
AQI	heavily contaminated									

Regarding Table 3, it describes the quality of ambient air in Sumgait city from 2008 to 2017. From 2008 to 2011, the ambient air quality is considering heavily contaminated. Starting from 2012, air quality is described as good, as we did not have data for PM and other main air pollutants after 2011. The major reason for the poor air quality is emissions from oil, gas, chemistry, metal, construction material industries, and car building complexes located in Sumgait city. It has also been mentioned that Sumgait is considering one of the most polluted cities in the world.

Table 3. Air Quality Index in Sumgait

Sumgait	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
SO2	20	20	20	20	26	28	25	27	26	27
PM	100	100	200	200						
AQI	heavily contaminated				good					

In Table 4 Air Quality Index is shown for Ganja city from 2008 to 2017. From 2008 to 2012, air quality is ranked as heavily contaminated because of the high level of PM. Starting from 2013 to 2017 air quality situation was graded as adequate according to the level of SO2. However, these outcomes for Ganja city cannot be considered precise for Ganja, as data was not available for PM after 2012.

Table 4. Air Quality Index in Ganja

Ganja	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NO2	20	20	20	30	30	30	20	20	20	20
SO2	37	34	34	37	46	40	38	38	37	38
PM	200	100	200	200	200					
AQI	heavily contaminated					adequate				

Table 5 describes the Air Quality Index for Mingechevir city from 2008 to 2018. Compared to the PM, other pollutants did not exceed the limit value and strongly affected the air quality. However, during all given periods, the PM level overshoots the limit value more than twice. For this reason, ambient air quality in Mingechevir city is ranked as heavily contaminated.

Table 5. Air Quality Index in Mingechevir

Mingechevir	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
NO2	20	20	20	30	30	30	30	30	20	20
SO2	11	9	10	14	20	15	15	14	14	35
PM	200	200	200	200	200	200	200	200	200	200
CO	2000	2000	2000	3000	3000	3000	3000	3000	3000	3000
AQI	heavily contaminated									

In Table 6, the air quality situation in Nakhchivan city is shown, and because of lack of data, these results are based on only two pollutants: SO2 and PM. According to the examination, the air quality situation in Nakhchivan ranked as heavily contaminated. Like the above given big industrial cities, in Nakhchivan, PM is also the main air pollutant that has a detrimental effect on air quality.

Table 6. Air Quality Index in Nakhchivan

Nakhchi-van	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
SO2	52	53	41	53	56	46	49	49	50	51
PM	100	100	100	100	100	100	100	100	100	100
AQI	heavily contaminated									

Table 7 shows the Air Quality Index in Sheki city from 2008 to 2017. Between all significant pollutants in Sheki city, data was only available for SO2. Therefore, we analyzed the ambient air quality according to the only SO2, ranked as good.

Table 7. Air Quality Index in Sheki

Sheki	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
SO2	30	32	29	30	38	36	36	37	36	36
AQI	good									

CONCLUSIONS

The research work's fundamental principle was focused on examining the changes in the last years of Azerbaijan's air quality situation. To analyze the air pollution situation in the previous decades in Azerbaijan, we used the time series analysis method.

Summarization of research examination includes the average yearly concentration of PM, SO2, CO and NO2 in Baku, Sumgait, Sheki, Ganja, Mingechevir cities, and the Nakhchivan Autonomous Republic. The concentration of PM (Baku, Mingechevir, Ganja) and SO2 (Nakhchivan) exceeded the given standard limit values for Azerbaijan; we applied yearly Hungarian AQI to define general the air quality situation effectively. Our outcomes represented that atmospheric air in Baku, Mingechevir, and Nakhchivan is "heavily contaminated" Because of the lack of data for some years about PM, we could not define the accurate air quality situation in Ganja and Sumgait.

From our obtained results, we can see that in the big cities of Azerbaijan, the air was polluted from 2008 to 2018, and the major reason for the pollution was PM. The current solution is recommended by our side to authorities establish new strict policies and standards to tackle the problem with PM and other air pollutants, implement cleaner methods of transportation, invest in energy-efficient power generation, replace fuel energy with renewable energy. Furthermore, we recommend individuals to plant trees use more public transport, and recycle.

ACKNOWLEDGEMENTS

This research work was carried out with the support of The State Statistical Committee of the Azerbaijan Republic and the Ministry of Ecology and Natural Resources of the Azerbaijan Republic.

REFERENCES

Anderson J.O., Thundiyil J.G., & Stolbach A., 2012, Clearing the Air: A Review of the Effects of Particulate Matter Air Pollution on Human Health. J. Med. Toxicol, 166–175.

Azerbaijans, 2019, Azerbaijans. Retrieved Feburary 10, 2019, from http://www.azerbaijans.com/content_725_en.html

Caucasus A.B., 2013, Improvement of Legislation on Assessment and Management of Ambient Air. Azerbaijan.

Dettling M., 2014, Applied Time Series Analysis. Zurich .

Frenken K., 2009, Irrigation in the Middle East region in figures - AQUASTAT Survey 2008. Food and Agriculture Organization of the United Nations (FAO).

Mabahwi N. A., Leh O.L., Omar D., 2014, Human Health and Wellbeing: Human health effect of air pollution. Procedia - Social and Behavioral Sciences 153, 221-229.

Madsen H., 2008, Time Series Analysis. Denmark.

Mammadova S., 2015, Evaluation of Impact of Pollution of the Atmospheric Air on Health of Population in Large Cities of Azerbaijan. Journal of Agriculture and Life Sciences, Vol. 2, No. 1, 133-139.

Modarres R., Dehkordi A.K., 2005, Daily air pollution time series analysis of Isfahan City. Int. J. Environ. Sci. Tech. Vol. 2, No. 3, 259-267.

Möller L., Schuetzle D., Autrup H., 1994, Future Research Needs Associated with the Assessment of Potential Human Health Risksfrom Exposure to Toxic Ambient Air Pollutants. Environmental Health Perspectives Volume 102, Supplement 4, 193-210.

Morgenstern V., Zutavern A., Cyrys J., Brockow I., Koletzko S., Krämer U., Heinrich J., 2008, Atopic Diseases, Allergic Sensitization, and Exposure to Traffic-related Air Pollution in Children. American Journal of Respiratory and Critical Care Medicine Vol 177, 1331-1337.

Pop C.A., Burnett R.T., Thurston G.D., Thun M.J., Calle E.E., Krewski D., Godleski J.J., 2003, Cardiovascular Mortality and Long-Term Exposure to Particulate Air Pollution; Epidemiological Evidence of General Pathophysiological Pathways of Disease. Circulation, 71-77.

Popov S., 2005, Asian Development Bank . Azerbaijan Urban Environmental Profile.

Rucevska I., Kitzler C., Bogdan D., 2017, Climate Change and Security in the South Caucacus. Regional Assessment.

Salmanova A. (2017, November 14). Car import increases in Azerbaijan. Retrieved February 23, 2019, from azernews: https://www.azernews.az/business/122196.html

Shahla Kahramanova, Musaddin Namazov. Ecological condition of Baku atmosphere and its improvement way, ISOCARP Congress, 45 (2009).

The State Statistics Committee of Azerbaijan Republic. (2017). Environment in Azerbaijan. Baku.

The State Statistics Committee of Azerbaijan Republic. (2017). Interactive Map. Retrieved November 6, 2018, from https://www.stat.gov.az/map/

Vidadili N., Suleymanov E., C.B., Mahmudlu C., 2017, Transition to renewable energy and sustainable energy development in Azerbaijan. Renewable and Sustainable Energy Reviews, 1153–1161.

Walsh B., 2018, TIME.com. Retrieved from The World's Most Polluted Places - TIME: http://content.time.com/time/specials/2007/article/0,28804,1661031_1661028_1661024,00.html