# Field work on Air Quality monitoring in Baku city

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# Contents

Introduction. Our group was assigned to measure air quality condition in the territory of Baku city. Mainly we used Air Quality Detector and $NO_2$ Detector while conducting our task. Air Qality Detector has several indicators on it, which shows different specifics of air. These are HCHO, TVOC, PM2.5 and PM10. Firstly, before introducing our findings briefly discuss each of the indicators.

*HCHO.* What's HCHO? Formaldehyde (HCHO) is a gas which is colorless and it has a choking, strong smell. Formaldehyde is one of the groups of volatile organic compounds (VOCs).

Mostly this is released to air as a result of industrial activities. It is also released from facilities used for sterilisation, such as hospitals. Releases of Formaldehyde may occur in the home, from insulation, furniture and carpets containing foam. It is contained in foods, cosmetics, pesticides, for biological specimens and for human remains. It is also found in adhesives, resins and foams and cigarette smoke. It is also produced by natural processes, such as forest fires and natural decay.

It is very quickly removed from the air by reaction with other other species in the atmosphere and is broken down in water and soil within days. As a VOC, Formaldehyde may be involved in the formation of ground level of ozone, which creates smog and negatively affect health of people. But generally it is not considered that Formaldehyde pollution has any effects on the global environment.

It has side effects to health condition. Exposure to high levels may cause throat spasms, accumulation of fluid in the lungs and in extreme cases death. Repeated exposures can lead to respiratory problems such as asthma and bronchitis. Individuals with asthma may be more sensitive to the effects of inhalation of formaldehyde. Ingestion of formaldehyde can cause vomiting, severe pain and in extreme cases coma and death. Dermal contact with formaldehyde can cause skin irritation and burns. Eye contact may cause severe burns. The effects of dermal and eye contact may appear hours after exposure. The International Agency for Research on Cancer has designated formaldehyde as a carcinogen. However, exposure to formaldehyde at normal background levels is unlikely to have any adverse effect on human health. The standard level of HCHO is 5 ug/m3.

*Nitrogen Dioxide* ($NO_2$) is one of the groups of highly reactive gases known as oxides of nitrogen oxides ($NO_x$). $NO_2$ primarily gets in the air from the burning of fuel. $NO_2$ is produced as emissions by cars, trucks and buses, power plants and off-road equipment. Breathing air with a high concentration of $NO_2$ can irritate airways in the human respiratory system. Such exposures can cause respiratory diseases and infections such as asthma, leading to respiratory symptoms (such as coughing, wheezing or difficulty breathing), hospital admissions and visits to emergency rooms. People with asthma, as well as children and the elderly are generally at greater risk for the health effects of $NO_2$.

$NO_2$ and other $NO_x$ interact with water, oxygen and other chemicals in the atmosphere to form acid rain. Acid rain harms sensitive ecosystems such as lakes and forests.

NO2 also can lead to make ground level ozone.

$NO2 \longrightarrow NO+O$

$O+O2 \longrightarrow O3$

The standard for $NO_2$ determined as $100\mu g/m^3$ .

*TVOC* 's The Total Volatile Organic Compound (TVOC) level is a measurement of the sum of all of the volatile organic compounds (VOC's) found in an air sample, which are the total amount of any emitted gases with short or long-term health effects.The TVOC is an important indication of the overall air quality in a building because there has been so much information on the TVOC levels collected over the years (see table 1). Likely other pollutants we discussed above TVOCs also can cause serious health effects. Health effects vary from minor eye, nose and throat irritations all the way to liver and kidney damage or cancer, depending on the level of exposure. It is found in paints, varnishes,cosmetics and even in cooking.

**There are no regulatory standards for TVOC's so these levels should serve as a guideline**

| TVOC Level ug/m3 | Level of Concern | Symptoms | Comments |
|---|---|---|---|
| Less than 300 | Low | No irritation or discomfort is expected. | There is a low likelihood that specific VOC sources are present |
| 300 to 500 | Acceptable | Occasional irritation or discomfort may be possible with sensitive individuals. | There is a low to moderate likelihood that specific VOC sources are present |
| 500 to 1000 | Marginal | Complaints about irritation and discomfort are possible in sensitive individuals | A moderate likelihood that specific VOC sources are it is recommended that steps be taken to identify the sources |
| 1000 to 3000 | High | Irritation and discomfort are very likely | A high likelihood that specific VOC sources are present and it is highly recommended that steps be taken to identify them. |
| More than 3000 | Very High | Irritation and discomfort are very possible. | These levels are usually found in an industrial environment where workers are exposed to chemicals |

*Figure 1. TVOC's level table*

*PM*. Particle pollution is a mixture of solid particles and liquid droplets. Particulate matter such as PM10, PM2.5 is defined as the fraction of particles with an aerodynamic diameter smaller than respectively 10, 2.5. (for your information: 1 µm =

1 millionth of a meter or 1 thousandth of a millimeter). In comparison, the average diameter of a human hair equals 50-70 μm. Bigger particles, after being emitted into the atmosphere, quickly get taken down by gravity or are washed out by rain. The finer particles can remain in the atmosphere for a longer time (a couple of days to weeks).
$PM_{2.5}$ particles are small enough to be breathed deep into the lungs. This can cause health effects. Children, people over 65, pregnant women and people with existing heart or lung conditions (including asthma) are more sensitive to the effects of breathing in fine particles. Symptoms may include wheezing, chest tightness and difficulty breathing.

$PM_{2.5}$ particles result from the burning of fossil fuels (such as coal), organic matter (including wood and grass) and most other materials, such as rubber and plastic. Motor vehicles, power plant emissions and bushfires are all major sources of fine particles.
The 24-hour concentration of $PM_{2.5}$ is considered unhealthy when it rises above 35.4 $\mu g/m^3$ and safe level of PM10 is 40 $\mu g/m^3$ defined by EU.

*PH of Water*. One of the measures we used to evaluate air quality is pH. **pH** is a scale used to determine how basic or acidic water is. pH is a measure of the hydrogen ion concentration of a solution. Solutions with a high concentration of hydrogen ions- acidic solutions have a low pH (1-7) and solutions with a low concentrations of H+ ions- basic solutions have a high pH (7-14). At room temperature (25 °), pure water is neutral and has a pH of 7. And the pH of water can be changed due to some reasons. When water left in contact with ambient air it can change its pH level.

Findings1. **Does water's pH level change upon contact with air?** We tried to answer the question and determine the correlation between air condition and pH of water. Water can change its pH when it is left in contact with ambient water. When we say air we mean both temperature and air composition. We can explain the dependence in example of rain water. The pH of rain water is around 5.6. This is due to the gaseous substances dissolved in water. And in general as temperature increases the pH of water decreases. But this can result in either a higher pH or a lower pH at higher temperature, depending on the situation. A weak acid solution when heated may give a lower pH, because of increased formation of hydronium ions(1). A saturated solution of a weak base may get a higher Ph (alkaline) when more base dissolves at a higher temperature (2). Let's explain first case(1):

Water (pure, pH = 7.0) can become more acidic when left in contact with air. The reason for this is that carbon dioxide in the air dissolves in water, and undergoes a reversible chemical reaction that produces carbonic acid, H2CO3:

$H2O + CO2 <====> H2CO3 <====> H(+) + HCO3(-)$

$H2CO3 <=> HCO3^{-} + H+ \ldots. HCO3^{-} <=> CO3^{2-} + H+$

So, the more carbon dioxide in air there is, the more strongly acidic the water may become. However, as CO2 levels increase around the world, the amount of dissolved CO2 also increases, and the equation will be carried out from left to right. This increases H2CO3, which decreases pH.

We used the pH indication paper to measure the pH of water (see Figure 2). It is note accurate method to evaluate the pH of water, but in our case it can be considered appropriate to be used.

*Figure 2. Zabrat (Coordinates: 40.447144, 4990851)*

We have conducted 48 hours observations in each place to determine correlation between air and pH of water. These observations helped us to find out the approximate level of $CO_2$ emissions in different locations of Baku and in Sumgait city. Because as we discussed above $CO_2$ is included in Variable Gases group in atmosphere composition.

We carried out this observation in totally 14 places. These points are in Yasamal, Yeni Gunashli, Neftchilar, Bakmil, Ulduz, N.Narimanov, Hazi Aslanov, Mashtaga, Mehdiabad, NZS, Zabrat, Garacukhur and Sumgait. The exact locations are shown on the map below (see Figure 3).

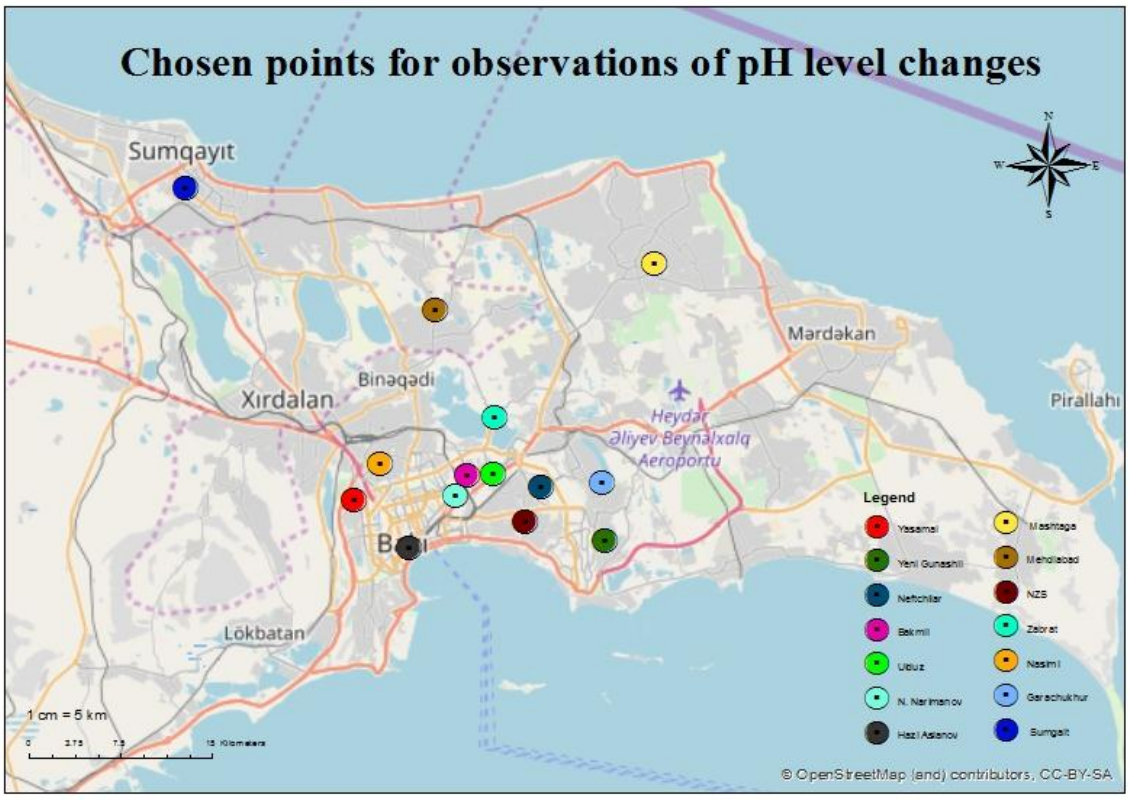


*Figure 3. Chosen points for observations of pH level changes*

Our observations are shown in Figure 4.

| Nº | | GPS | pH 1 day | pH after 48 hours | Observation date (May) |
|---|---|---|---|---|---|
| **1** | **Hazi Aslanov** | 40.373482 49.837213 | 7.5 | 8 | 28-31 |
| **2** | **N. Narimanov** | 40.402911 49.871297 | 6.5 | 8 | 28-31 |
| **3** | **Yasamal** | 40.400152 49.797369 | 7.5 | 9 | 25-28 |
| **4** | **Ulduz** | 40.415099 49.899172 | 6 | 8 | 18-20 |
| **5** | **Bakmil** | 40.414243 49.879690 | 6 | 5.5 | 18-20 |
| **6** | **Yeni Gunashli** | 40.376917 49.981389 | 6 | 9.5 | 25-28 |
| **7** | **Garachukhur** | 40.410722 49.979472 | 6 | 8 | 25-28 |
| **8** | **Nasimi** | 40.420247 49.816394 | 5 | 7 | 28-31 |
| **9** | **Zabrat** | 40.447144 49.900851 | 6 | 7.5 | 18-20 |
| **10** | **NZS** | 40.388111 49.922028 | 8 | 9 | 23-25 |
| **11** | **Mehdiabad** | 40.505989 49.857659 | 5.5 | 6.5 | 28-31 |
| **12** | **Mashtaga** | 40.531833 50.016556 | 6 | 7.5 | 28-31 |
| **13** | **Neftchilar** | 40.407056 49.934556 | 9 | 8 | 28-31 |
| **14** | **Sumgait** | 40.575806 49.671639 | 8 | 6.5 | 28-31 |

*Figure 4. pH level changes in observed points*

| Date (May) | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temperature (°C) | 26 | 28 | 24 | 23 | 24 | 24 | 23 | 24 | 23 | 22 | 23 | 25 | 28 | 29 |

*Figure 5. Temperature condition during the observation*

As we mentioned above temperature also can change the pH level of water. That's why we added the information about temperature changes during the observations (see Figure 5).

We faced the (1) (indicated above) case just in 3 observed place. These are Bakmil and Neftchilar areas (near the subway station) in Baku territory and another referred case is located in Sumgait city. The sample of water became more acidic in these distances. As we know the most common sources of $CO_2$ emissions are fossil fuel combustion, electricity generation, and also transportation activities. Based on this, we can say that places above mentioned are the most polluted places with $CO_2$ emission along the observed places.

In the second case water became alkaline. Besides the 3 places noted above are included in this case. Alkalinity in freshwater systems is derived from several sources: One of them is an atmospheric deposition of dust. And we esimate that it can be reason water to become alkaline in other observed places. And it can also be result of temperature volatility as we mentioned before.

*Figure 6. Zabrat (Coordinates: 40.447144, 4990851)*

*Figure 7. Zabrat (Coordinates: 40.447144, 4990851)*

***Findings2.*** From now on we are going to introduce our findings that we gathered by using air quality detectors that we are provided by the university. We used $NO_2$ detector and Air Quality detector to measure HCHO, TVOC a PM (2.5 a 10) levels in air that we breathe every day. We chose 14 places to observe, which have high density of the population and transportation around Baku (see figure 8). We can easily compare pollution level by each pollutant in different places in Figure 9.

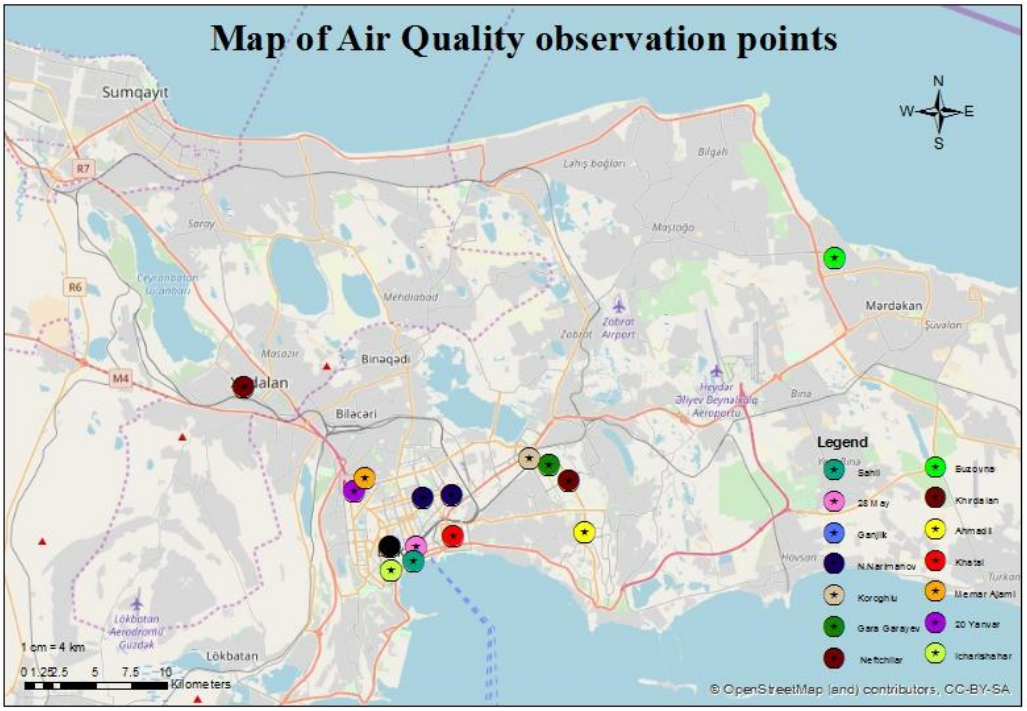


*Figure 8. Map of air quality observation points*

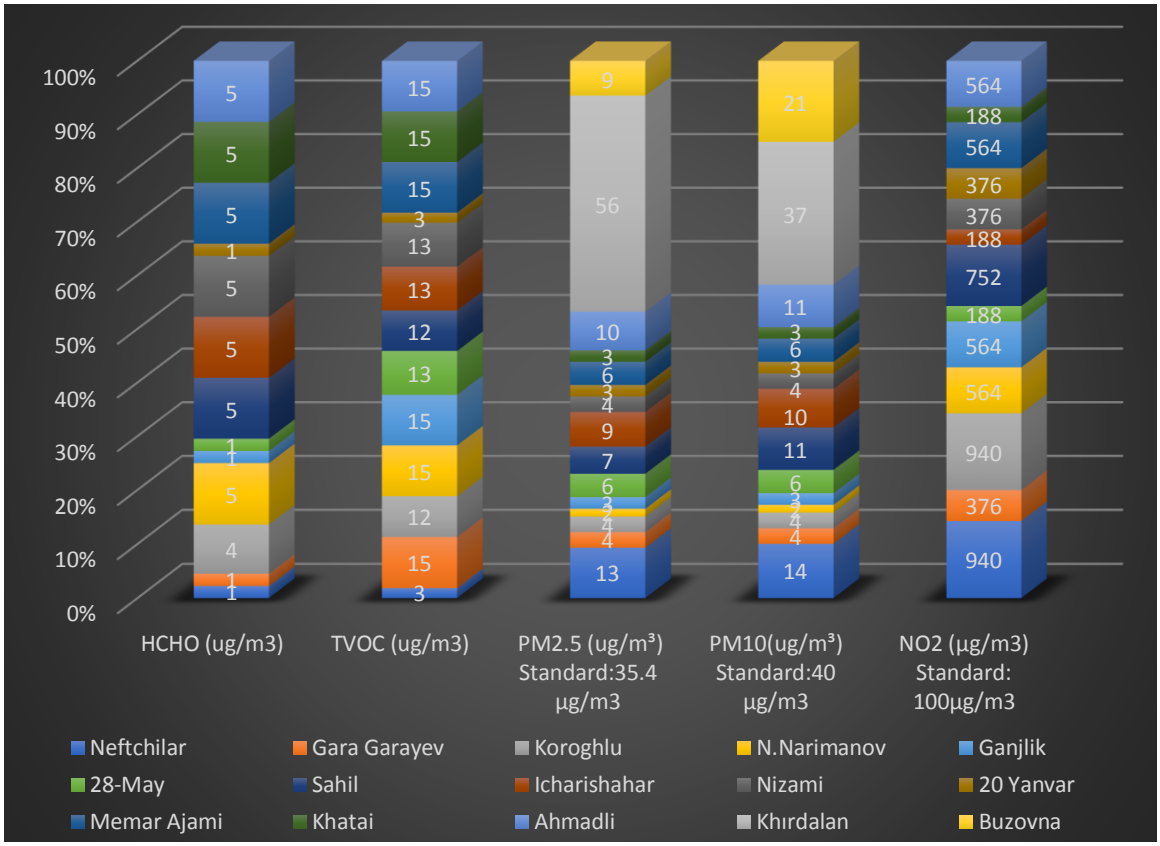


*Figure 9. The results for each pollutant in different points*

Unit measurements are shown in the table in ug/m3 (micrograms per cubic meter), for the sake of simplicity to compare results for different observations. The results we have got for each observation is shown with colored scale according to the European Air Quality Index (see Figure 10).

| Air quality index | Very good | Good | Medium | Poor | Very Poor |
|---|---|---|---|---|---|
| Ozone ($O_3$) | 0-80 | 80-120 | 120-180 | 180-240 | 240-600 |
| Nitrogen dioxide ($NO_2$) | 0-40 | 40-100 | 100-200 | 200-400 | 400-1000 |
| Sulphur dioxide ($So_2$) | 0-100 | 100-200 | 200-350 | 350-500 | 500-1250 |
| Particles less than 10 micrometer ($PM_{10}$) | 0-20 | 20-35 | 35-50 | 50-100 | 100-1200 |
| Particles less than 2.5 micrometer ($PM_{2.5}$) | 0-10 | 10-20 | 20-25 | 25-50 | 50-800 |

*Figure 10. European Air Quality Index (based on pollutant concentrations in* µg/m3)

| № | | GPS | Temperature (°C) | HCHO (ug/m3) standard: 5 ug/m3 | TVOC (ug/m3) | PM2.5 (ug/m³) standard:35.4 µg/m³ | PM10(ug/m³) standard:40 µg/m³ | NO2 (µg/m³) standard: 100µg/m³ | Air quality |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Neftchilar | 40.409979, 49.943826 | 30.9 | 1 | 3 | 13 | 14 | 940 | 50 |
| | | | 35.9 | 5 | 15 | 12 | 13 | 376 | 20 |
| 2 | Gara Garayev | 40.417888, 49.931373 | 30.3 | 1 | 15 | 4 | 4 | 376 | 17 |
| 3 | Koroghlu | 40.421108, 49.918443 | 31.3 | 4 | 12 | 4 | 4 | 940 | 5 |
| | | | 36 | 5 | 15 | 16 | 17 | 940 | 18 |
| 4 | N.Narimanov | 40.402911, 49.871297 | 29.3 | 5 | 15 | 2 | 2 | 564 | 5 |
| | | | 35.9 | 1 | 15 | 7 | 7 | 376 | 14 |
| 5 | Ganjlik | 40.400590, 49.851709 | 27.7 | 1 | 15 | 3 | 3 | 564 | 1 |
| 6 | 28 May | 40.377930, 49.847807 | 31.6 | 1 | 13 | 6 | 6 | 188 | 18 |
| 7 | Sahil | 40.372021, 49.844533 | 29.5 | 5 | 12 | 7 | 11 | 752 | 11 |
| | | | 34 | 5 | 15 | 8 | 8 | 376 | 35 |
| 8 | Icharishahar | 40.366371, 49.830584 | 29.9 | 5 | 13 | 9 | 10 | 188 | 2 |
| 9 | Nizami | 40.378965, 49.830598 | 31 | 5 | 13 | 4 | 4 | 376 | 2 |
| 10 | 20 Yanvar | 40.404261, 49.808261 | 33.6 | 1 | 3 | 3 | 3 | 376 | 4 |
| 11 | Memar Ajami | 40.410779, 49.814367 | 31 | 5 | 15 | 6 | 6 | 564 | 8 |
| | | | 37.1 | 5 | 15 | 8 | 8 | 376 | 10 |
| 12 | Khatai | 40.382954, 49.871055 | 33.5 | 5 | 15 | 3 | 3 | 188 | 4 |
| 13 | Ahmadli | 40.385307 49.953911 | 35 | 5 | 15 | 10 | 11 | 564 | 11 |
| 14 | Khırdalan | 40.454722, 49.738790 | | | | 56 | 37 | | |
| 15 | Buzovna | 40.516753, 50.111620 | | | | 9 | 21 | | |

*Figure 12. The results of Air quality monitoring in Baku city*

# Conversion units:

**NO2**

Standard for NO2-53 ppb
NO2 1 ppb = 1.88 µg/m3
53*1.88=99.64 µg/m3
Standard for NO2-100 µg/m3
Example:
Neftchilar
0.5 ppm=500ppb
1ppb = 1.88µg/m3 (NO2)
500*1.88=940 µg/m3

**TVOC and HCHO**

1mg/m3=1000 µg/m3
Example:
0.001mg/m3=1 µg/m3

**PM 2.5 and PM 10**

by µg/m3

*Figure 13. Neftchilar (Coordinates:40409979, 49.943826)*


*Figure 14. Nizami (Coordinates: 40.378965, 49.830598)*

*HCHO*. As we mentioned before HCHO is released from industrial facilities as a result of their activities.Only 4 of the chosen locations-"Garayev","Ganjlik","28 May" and "20 Yanvar" distances have less HCHO indication than generally accepted level (standard 5 ***ug/m3).***

*TVOC*. The another pollutant that have high concentration in the atmosphere is TVOC which has the same source with HCHO. İt has also other sources such as motor vehicle exhaust. All mentioned locations have high level of TVOC except nearby 20 Yanvar subway station. It doesn't have standardized norm, due to the compounds it contains. That's the reason why we can evaluate TVOC level only by comparing location indicators to each other.

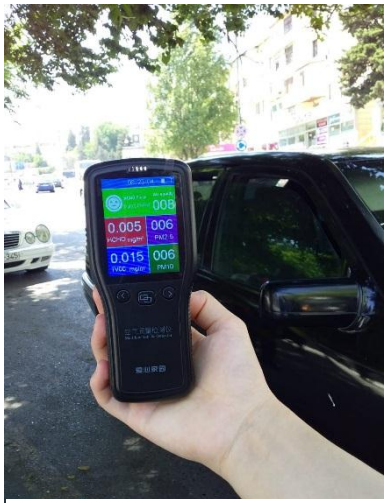


*Figure 15. Memar Ajami (Coordinates: 40.410779, 49.814367)*

*PM2.5*. İn Garayev, Ganjlik, Nizami, 20 Yanvar and Ahmadli distances PM2.5 have satisfactory level. In other words only in these places PM2.5 doesn't exceed the standard. According to European air Quality Index we can say that Khirdalan distance has dangerous amount of PM2.5 for living of people (see Figure 7). Moreover this indicator is not satisfactory in Neftchilar and Khoroghlu distances and belong to the second group (good) in Air quality index (other locations very good).

*PM10*. Due to less effect of PM10 to the health of people the norm is determined as ***40 μg/m³*** and non of locations exceed this amount. But unfourtunately, some of the areas of Baku city have near figures to this number. Khirdalan and Buzovna are that kinds of places. Additionally in Khoroghlu distance we have recorded higher amount of PM10 (17 ***μg/m³*** ) (see Figure 9). Higher level of PM10 is mostly observed in the aeras where there is high density of traffic, living premises, public caterings and population. Therefore it is non coincidental at the areas near the Khoroghlu m/s have high level of PM10. Because many major highways are crossed in this area. Neftchilar also has higher degree of PM10 compared to other parts of the city, due to a number of shopping centers being located here.

*NO2*. As it is displayed in figure 4 and figure 5 the higher levels of NO2 was observed in Neftchilar, Koroghlu, Sahil distances, followed by N. Narimanov, Ganjlik, Sahil, Memar Ajami and Ahmadli. Therefore these parts of the city were included in "very unhealthy" category in Air quality index. Likely in the case of othter pollutants discussed above the reason for high amount of NO2 in atmosphere can be explained with high traffic density. That's why Koroghlu and Neftchilar leading the list. There are large crossing avenues in these areas. $NO_2$ level increases near the traffic jams, especially in rush hours. Exactly for tis reason to reach more accurate results we did our observations twice ( 31 May and 24 June) within these locations (Neftciler, Narimanov, Khoroghlu, Memar Ajami ) with approximately one month interval. The results on 31 May were observed at evening time (6-7 pm(rush hours)) and the results for 24 of June were gathered during morning hours (11-12 pm). These numbers obviously show the changes in NO2 level depending on the daytime due to traffic density.


*Figure 16. Neftchilar (Coordinates: 409979, 49943826)*

Recommodations. Air condition of the city is one of the important environmental issues to be focused. Because it directly affects ecosystems surrounding the society and health condition of all livings. Therefore making needed changes on the way of improvement of air quality is unavoidable. Otherwise current and specially future generation will suffer and have to pay for all these environmental problems. Below we give some recommodations to reduce the pollution level and to provide future generations with better air condition.

From our point of view, more strict regulations over the operations conducted by the industrial facilities will be one of the important steps to reach these goals. The harmful releases from plants and factories should be filtrilised before entering the atmosphere. Furthermore to make policies and promote use of more eco-friendly

products (specifically motor vehicles) within the members of the society. And to obtain fast and effective results all these activities should be done under the control of the government. To create incentives for people to use public transportation means is one of the most obvious examples. Use of the alternative transportation vehicles such as tram (tram-car) can significantly reduce overall level of pollutants entering the atmosphere. Some countries have succesful examples which improved air quality condition by introducing new regulations related to the use of transportation vehicles, such as motivating people to use bicycle (Norway).

Reduction of the ammount of pollutants in the atmosphere can also have economical benefits. Because naturally pollution of the air creates additional direct or indirect costs for businesses, and for households hospital bills resulted from diseases caused by air pollution is indirect effect. The economy can save money by spending less on improvement of environmental condition surrounding us, than spendings to pay for the costs resulted from environmental pollution.

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