Clean Air Matters: A Study on the State of our Atmosphere

Organisation: Gozo College Middle School
Student(s): GLOBE Team
Grade Level: 6th - 8th Grades (Middle School, ages 11-14)
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Report Type(s): International Virtual Science Symposium Report
Protocols: Atmosphere
Presentation Type: Poster
Optional Badges: I am a Data Scientist, I am a Collaborator, I make an Impact

Abstract:

Air quality and the level of air pollution are important factors and have significant impacts on the health and well-being of humans. It is now considered that any level of air pollution is not acceptable and poses a risk (World Health Organisation 2021 9789240034228-eng.pdf (who.int)). Nitrogen dioxide (NO_2) is a pollutant commonly found in the air and is produced by burning fossil fuels such as coal, oil, and gas. High levels of nitrogen dioxide can have negative impacts on human health, including respiratory problems and an increased risk of heart disease. It can also contribute to the formation of other air pollutants, such as ozone and particulate matter, which can also harm human health and the environment. There are often wide variations in local air quality that go undetected and so we started to investigate the quality of the air around our school. This was done using a specialised monitoring device, a diffusion tube, to detect the concentration of NO_2 in the air. The data collected from the diffusion tube was analysed to determine the average levels of NO_2 in front of our school. The NO_2 level was compared with other localities in Gozo and with a school in Ireland. Ireland and Malta are two countries that have different levels of NO_2 and air quality, based on several factors such as population density, industrial activity, transportation, and energy production. Through this investigation, some strategies have been developed to reduce nitrogen dioxide emissions and improve air quality.

Key words: air quality, nitrogen dioxide, atmospheric conditions, schools, urban areas, heavily trafficked areas.

Research Questions

- What are the levels of nitrogen dioxide in front of the school?
- How do nitrogen dioxide levels in our school area compare with those of other schools in Gozo and one in Ireland?
- How has the level of nitrogen dioxide changed over time and what are the primary causes of these changes?
- What measures can be taken to reduce the levels of nitrogen dioxide in the air and improve air quality?

Introduction

The aim of the study is to find out the extent of the levels of nitrogen dioxide present in the area around the school. In this study, we used the experimental method, where a diffusion tube was carefully set up in the main school areas facing the street that is frequented by students and staff daily. Temperature and atmospheric conditions were taken on a regular basis during every school day between 17th October, and 14th November 2022. Finally, the diffusion tube was taken down and sent to Gradko Environmental Laboratory for analysis. This study contributes significantly to the importance of reducing NO_2 emissions for the well-being of citizens and for the environment in general both on a local and on global level.

High levels of nitrogen dioxide cause harm to the human respiratory tract and increase a person's vulnerability to, and the severity of, respiratory infections and asthma. Long-term exposure to high levels of nitrogen dioxide can cause chronic lung disease and are carcinogenic. People with asthma, as well as children and the elderly, are generally at a greater risk.

NO_2 reacts with other chemicals in the air to form both particulate matter and ozone. Both are also harmful when inhaled due to effects on the respiratory system (QG 2016 https://www.qld.gov.au/). NO_2 and other NOx interact with water, oxygen and other chemicals in the atmosphere to form acid rain. Acid rain harms sensitive ecosystems such as lakes and forests. Additionally, the nitrate particles that result from NOx make the air hazy and difficult to see though. Furthermore, NOx in the atmosphere contributes to nutrient pollution in coastal waters (EPA 2021 https://www.epa.gov/).

Gozo College Middle School (GCMS) is situated on the smaller island of Gozo which is part of the Maltese Islands (Figures 1). There is usually relatively less traffic in Gozo but there still is a substantial number of cars per capita. GCMS is in the farther end (north-east side) of the main town of Rabat or Victoria, in Europe Street which is parallel to the main road. The school has its frontage overlooking a secondary road which is being increasingly used by traffic to avoid the main road. Air quality in the Maltese Islands is considered to be between good to

moderate (IQAir 2022 [Gozo Air Quality Index (AQI) and Malta Air Pollution | AirVisual (iqair.com)](#) (Fig. 2)

Figure 1 Map of the Maltese Islands

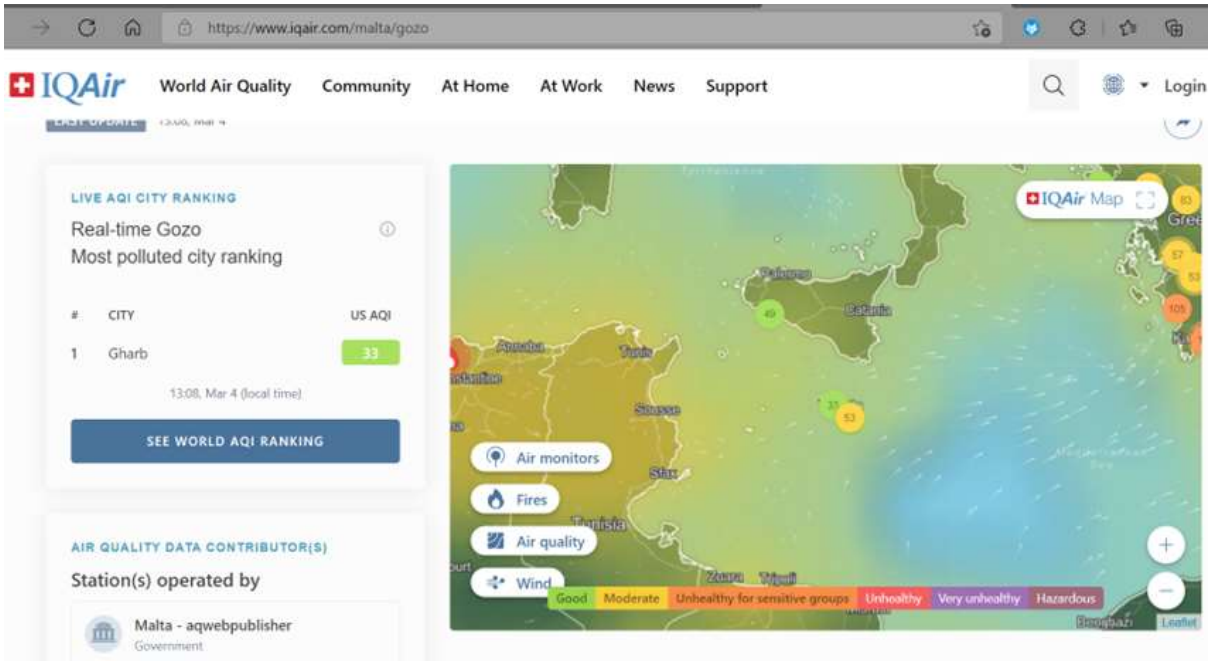

Figure 2 IQ Air Quality map of the middle of Mediterranean featuring Malta and Gozo.

Study site

GLOBE students decided to test the school area for nitrogen dioxide emissions and compare it to tests carried out last year at the same time of year and at the same entry point. It is an ideal area as Gozo College Middle School, this year is situated in Europe Street, Rabat or Victoria, the main town of the Island of Gozo (Fig. 3), which is the second island in size of the Maltese Archipelago (Population of Gozo 37, 342 (2021), Average Population Density: 557km²; max. length: 13.34km; max. width: 7.15km; Area 67.1km². Wikipedia 2021 Gozo - Wikipedia). Also, such an analysis would provide an opportunity for the students to take effective action since they are part of the area and are the commuters to the school.

Figure 3 Map showing layout of the town of Victoria/Rabat in relation to the other villages in Gozo. Note its central position and the necessity of crossing it to reach the other end of the island.

Figure 4 Gozo College Middle School is situated next to the Gozo College Secondary School this year as the original Middle School is being rebuilt together with the Gozo Sports Complex next to it. Note the position of the school in relation to the rest of Victoria/Rabat.

Methodology

One diffusion tube was fixed at the entrance of the Gozo College Middle School (Fig. 5, 6, 7) where students arrive into both the Middle and Secondary school in the morning and leave in the afternoon. The diffusion tube was placed to measure nitrogen dioxide levels in the air. It was set up on Monday, 17th October, 2022 (Fig. 8).

Figure 5 Gozo College Middle School is situated on the top right-hand side of the complex overlooking Ewropa Street.

Figure 6 Aerial view of school complex with the two main roads (Fortunato Mizzi Street [main road] and Ewropa Street [secondary road now being more frequently used to avoid traffic congestion] of Victoria (Rabat), Gozo.

Figure 7 Nearer aerial view showing bus lane on right with parked cars as cars are allowed to park on weekends and school holidays. Gozo College Middle School is on the left-hand side of the photo next to the secondary school.

Figure 8 Putting up the diffusion tube at the school entrance on 14th October 2022.

Atmospheric and temperature readings were also taken over a four-week period to support the results of the average nitrogen dioxide levels. These were taken from the same site. Students made cloud observations using the GLOBE Observer App, measured air pressure, air temperature, humidity and surface temperature (Fig. 9) and took a traffic count tally on a regular basis (Fig. 10). The last day of observation and data collection was 14th November 2022. Then, the diffusion tube was taken down and sent to Gradko Environmental Laboratory in the UK, for analysis. In the meantime, we communicated with Mercy College in Sligo, Ireland and introduced ourselves and our intended investigations.

Figure 9 Measuring weather parameters using a data logger.

Figure 10 GLOBE student tallying traffic on a traffic survey sheet.

Results

The screenshots below show data uploaded on GLOBE website during observation period between October 2022 and November 2022 (Figures 11, 12, 13, 14, 15, 16 and 17). Besides collecting daily readings of air temperature, barometric pressure, humidity and cloud cover and type together with surface conditions following GLOBE Protocols, the students carried out a traffic count (Fig. 18)

Air Temperature

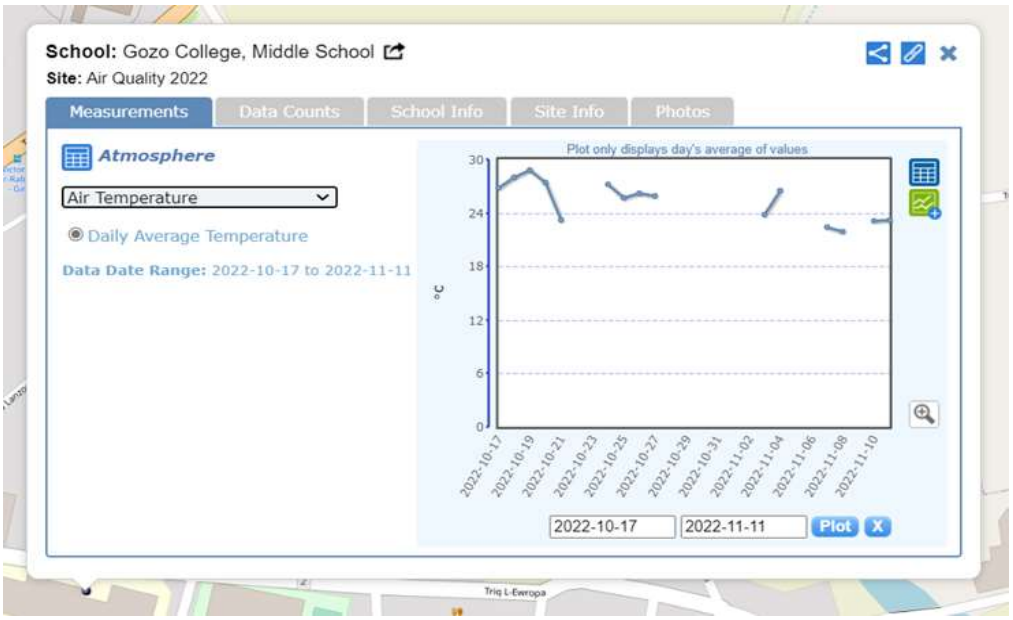

Figure 11 Air Temperature plot of VIZ GLOBE

Air Temperature Noons

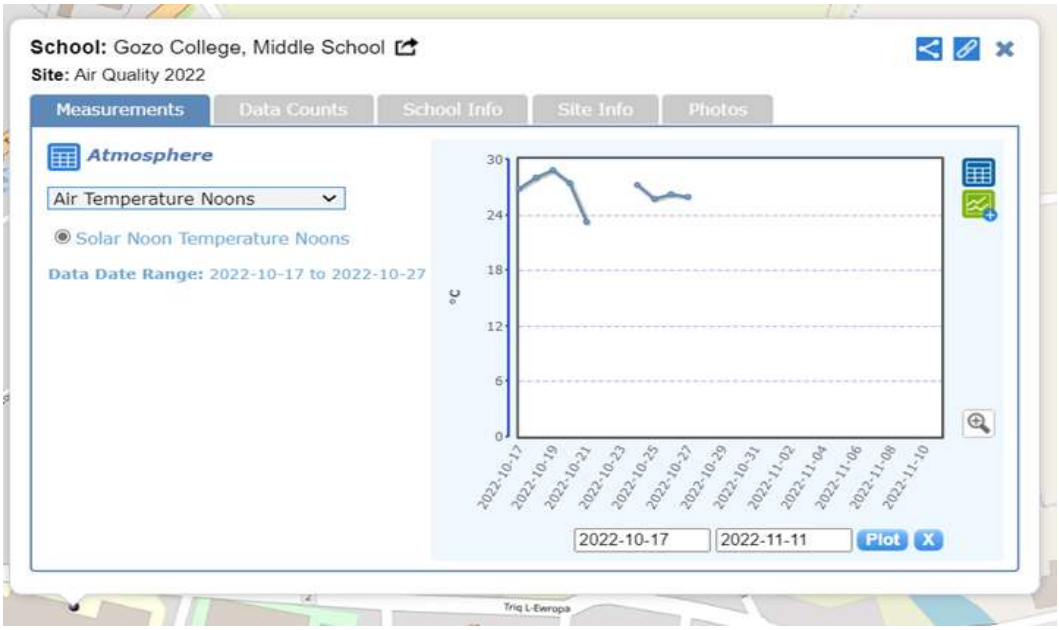

Figure 12 Air Temperature noons plot of VIZ GLOBE

Barometric Pressure Noons

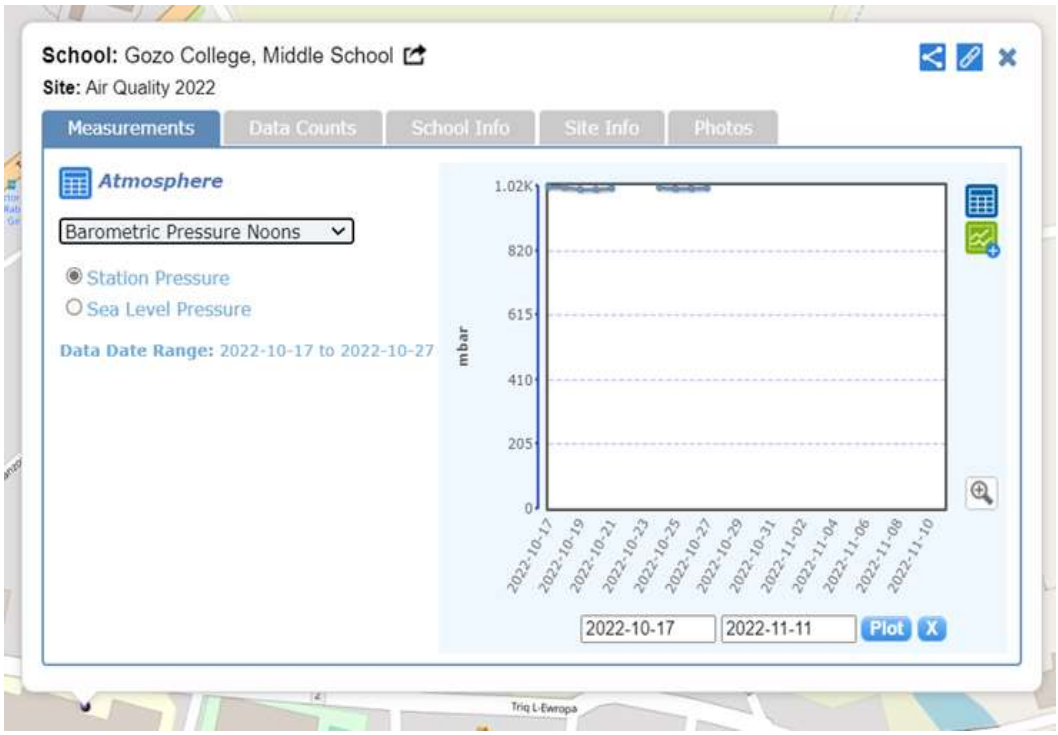

Figure 13 Barometric pressure noons plot of VIZ GLOBE

Barometric Pressures

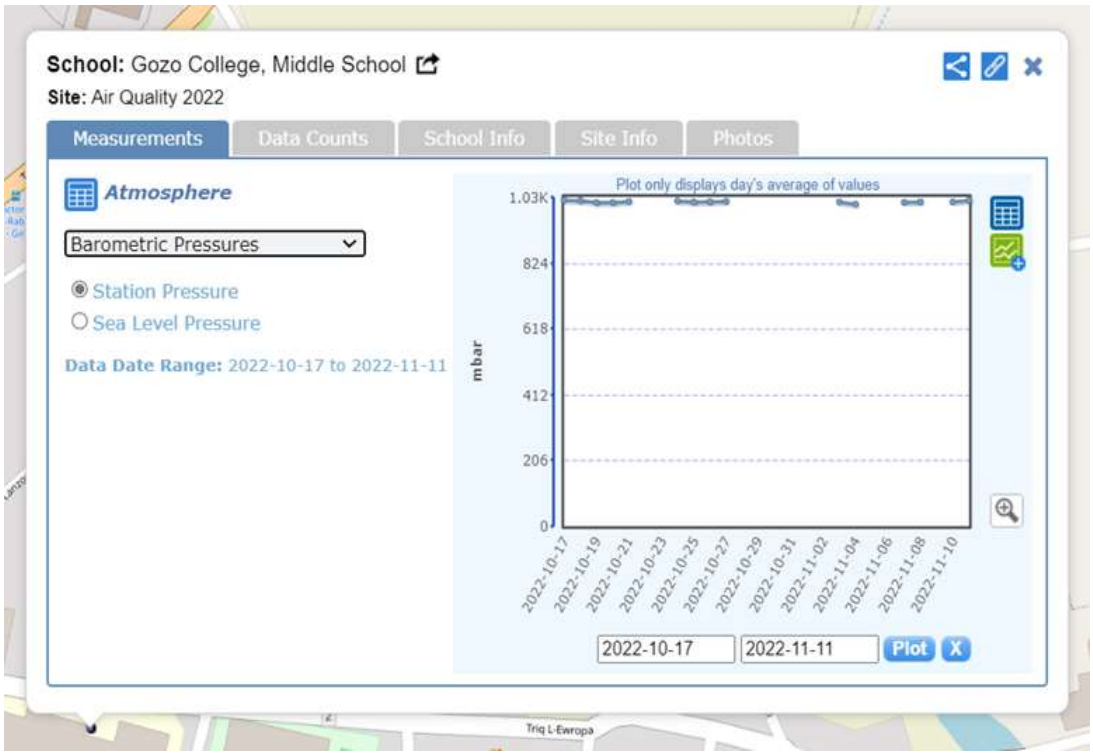

Figure 14 Barometric pressure plot of VIZ GLOBE

Relative Humidities

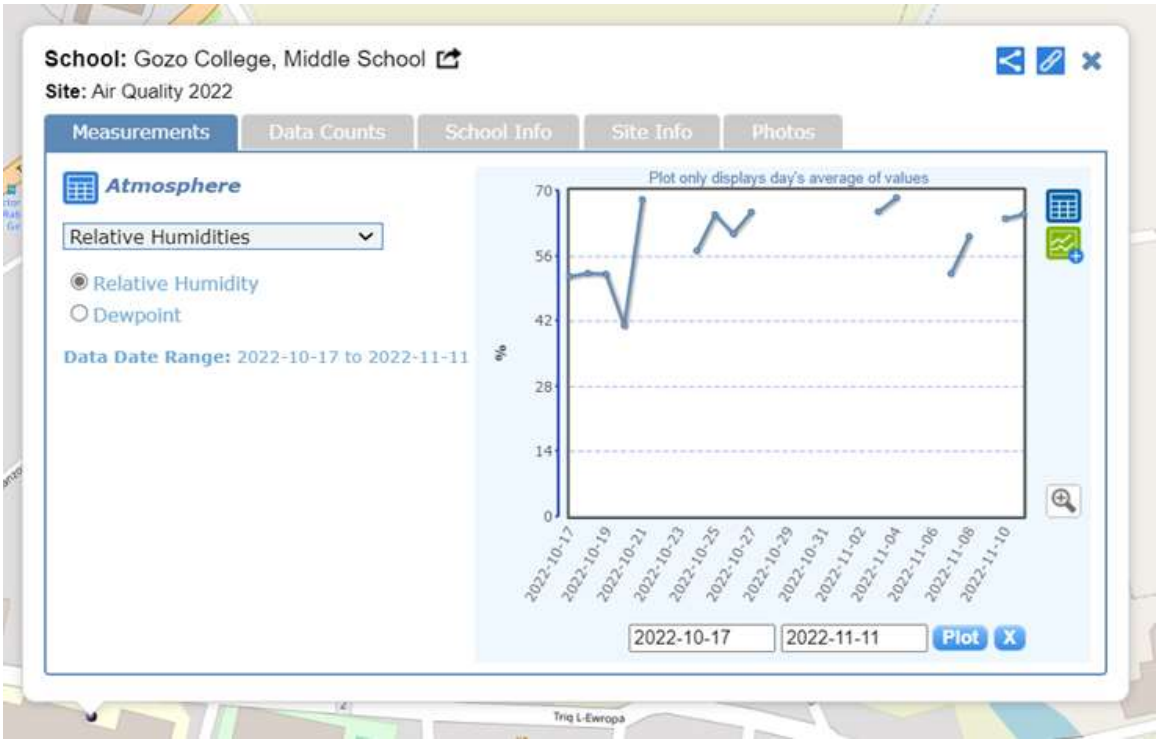

Figure 15 Relative humidities plot of VIZ GLOBE

Clouds

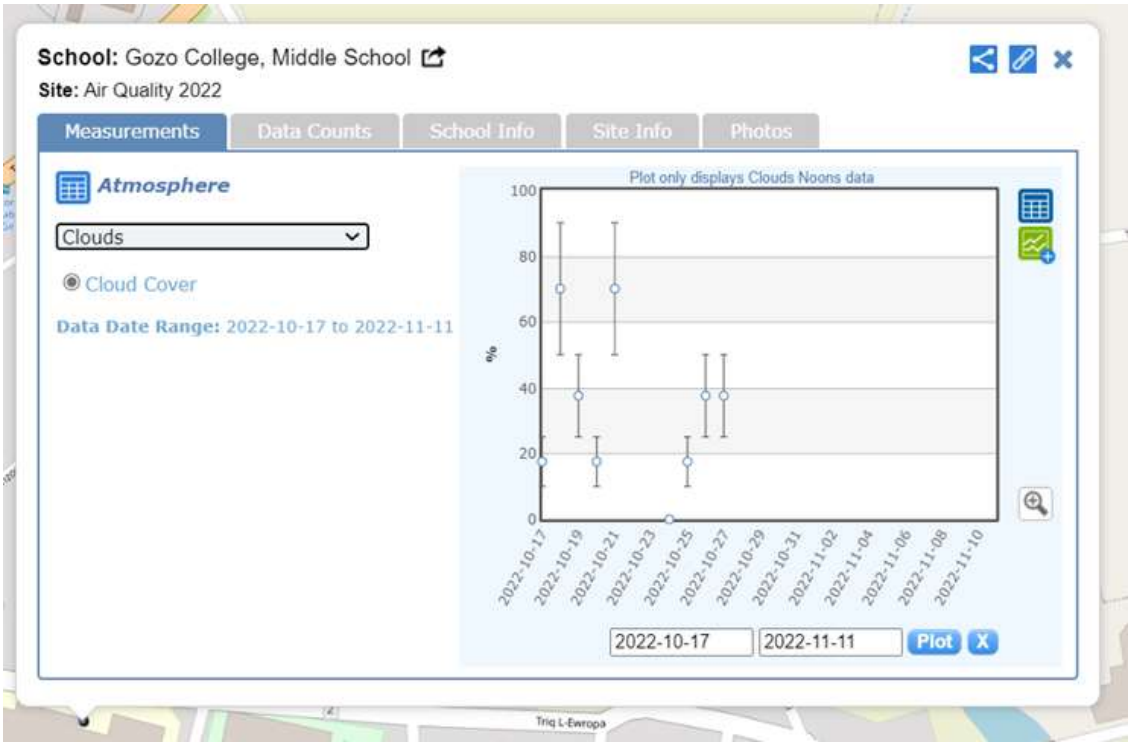

Figure 16 Clouds plot of VIZ GLOBE

Clouds Noons

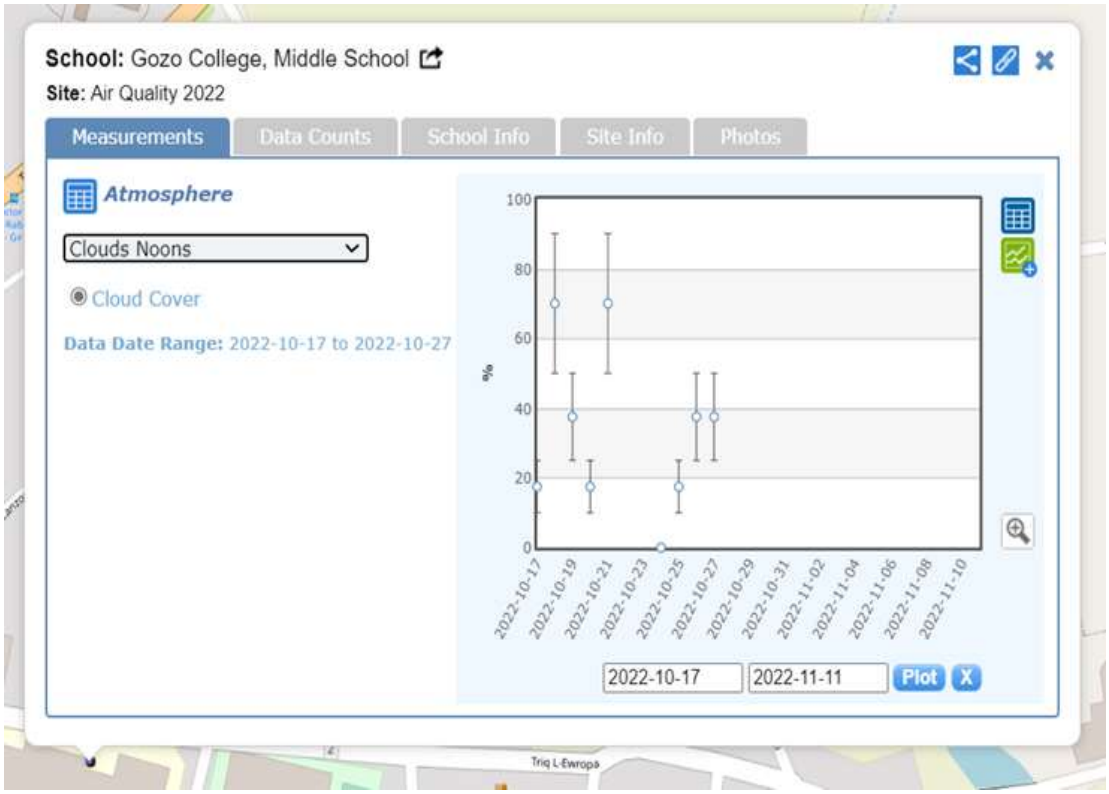

Figure 17 Clouds noons plot of VIZ GLOBE

Traffic count

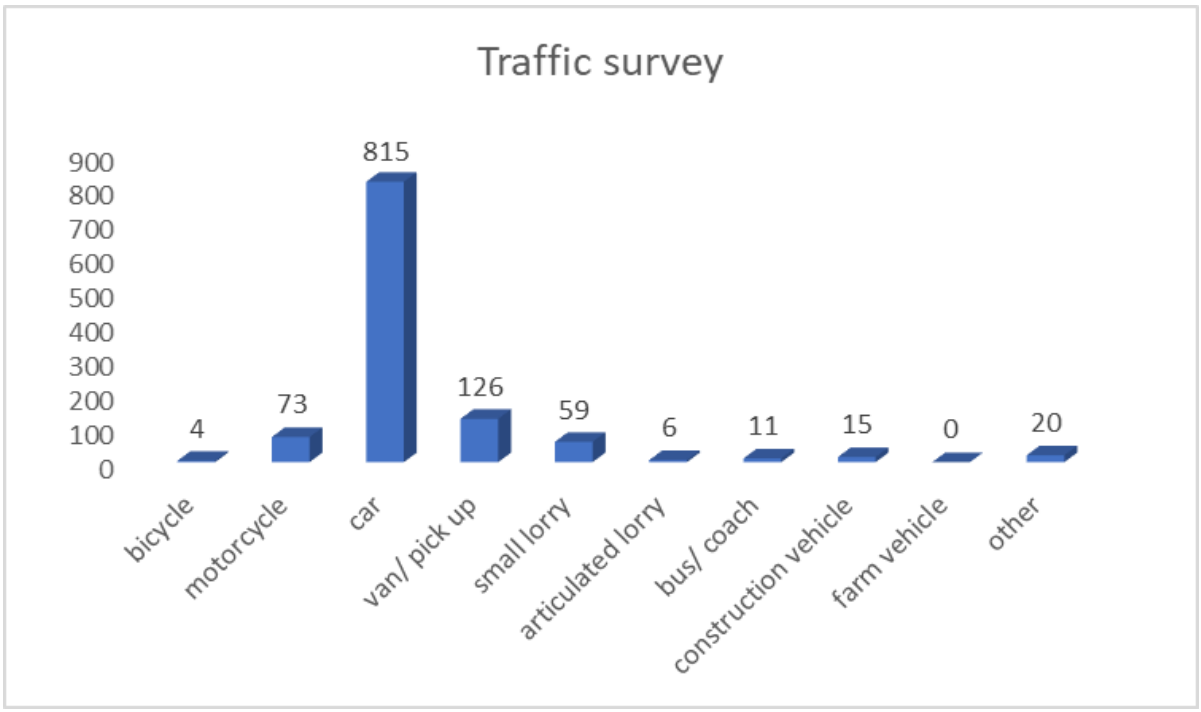

Figure 18 Traffic count results.

Discussion

The levels of nitrogen dioxide (NO_2) can vary between settlements in Gozo, Malta, depending on several factors such as population density, transportation, industrial activity, and energy production. In general, urban areas, particularly those with high levels of transportation and industrial activity, tend to have higher levels of nitrogen dioxide. For example, settlements with a higher concentration of vehicles, such as Victoria, may have higher levels of nitrogen dioxide compared to settlements with fewer vehicles and lower population densities, such as Xewkija as seen in the results by Gradko (Fig. 19). In fact, the number of cars recorded during the traffic count was 815 cars. However, it is important to note that nitrogen dioxide levels can also be influenced by other factors such as weather patterns, topography, and local emissions sources. Therefore, it is difficult to make generalisations about nitrogen dioxide levels between settlements in Gozo without conducting specific monitoring and analysis of local conditions. To understand and address the specific challenges with air quality in Gozo, it is important to regularly monitor and analyse nitrogen dioxide levels, as well as other pollutants, in each settlement, and take action to reduce emissions and improve air quality.

Location	Sample Number	Exposure Data Date On*	Exposure Data Date Off*	Time* (hr.)	µg/m³ *	ppb *	µg NO_2 on tube
Gozo College Middle School, Europe Street, Victoria, Gozo	2096424	17/10/2022	14/11/2022	671.87	30.70	16.02	1.50
St. Francis Primary School, Main Gate Street, Victoria, Gozo	2096425	17/10/2022	14/11/2022	672.00	36.90	19.26	1.80
Gozo College Rabat Primary School, Triq Vajringa, Victoria, Gozo	2096426	17/10/2022	14/11/2022	668.88	39.62	20.68	1.93
Gozo College Xewkija Primary School, Triq Tal-Hamrija, Xewkija	2096427	17/10/2022	14/11/2022	671.83	3.79	1.98	0.19
Gozo College Sannat Special Unit School, Sannat Road, Sannat	2096428	17/10/2022	14/11/2022	672.00	20.74	10.83	1.01
Gozo College Zebbug Primary School, St. Andrew Street, Zebbug	2096429	17/10/2022	14/11/2022	669.58	6.53	3.41	0.32
Sir M.A. Refalo Sixth Form, Fortunato Mizzi Street, Victoria	2096430	17/10/2022	14/11/2022	672.25	43.10	22.50	2.11
Sacred Heart Minor Seminary, Enrico Mizzi Street, Victoria	2096431	14/10/2022	14/11/2022	739.17	33.56	17.52	1.80
Laura Vicuna Primary School, Ghasri Square, Ghasri	2096432	17/10/2022	14/11/2022	671.80	5.61	2.93	0.27
Gozo College Qala Primary School, Triq it-Tempju, Qala	2096433	17/10/2022	14/11/2022	671.75	28.82	15.04	1.41
Gozo College Gharb Primary School, Triq il-Vizitazzjoni, Gharb	2096434	17/10/2022	14/11/2022	672.50	9.96	5.20	0.49

Figure 19 Results from Gradko Laboratories, placing our school 5th from 11 schools.

Conclusion

Following the reading of results and their comparison with the results taken last year at the same time of year and from the same site, we were shocked to discover that emissions had gone up from 19.20 **µ**g/m² to 30.70**µ**g/m². Reasons for this change were discussed and the plausible explanations students came up with were:

1. the increase in the amount of construction on the island generally and in the next-door area where a public gym and two schools are under construction and
2. the use of this street, which is parallel to the main road, by an increasing number of vehicles to avoid getting caught up in traffic jams on the main road.

Malta, like many other densely populated areas, faces air quality challenges due to emissions from transportation and industrial activities. The island has a high density of vehicles and a relatively high level of air pollution, particularly in urban areas. In recent years, the Maltese government has taken steps to improve air quality, including the implementation of stricter emissions standards for vehicles, the promotion of alternative modes of transportation, and the development of renewable energy sources. However, there is still work to be done to improve air quality in Malta and address the health impacts of air pollution.

After analysing data and results the students concluded that planting more trees would help to mitigate pollution in front of the school. Three trees were bought and planted, namely an olive, a fig and a kumquat tree. Students also planted several crops for the same purpose and to decrease the carbon footprint and packaging. On the next school outing, the school decided to go to the event place on foot as a whole school to instil a sense of responsibility towards air quality. Moreover, the GLOBE team is working on an educational drive to encourage students and staff to carpool, use public transportation, or bicycles while stressing the importance of air quality and the impacts of pollution, including the health effects and the impact on the environment. There is also a plan to regularly monitor and report on the school's progress towards improving air quality and reducing emissions.

References:

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Wikipedia 2023 https://en.wikipedia.org/wiki/Gozo (Accessed February 2023).

Badge description

I am a Data Scientist: Students analysed their own data (from their measurements). They were able to analyse bar graphs to interpret the data. They also became aware of the limitations of the data and could only draw conclusions from the samples studied. From the data analysis, the students answered their research questions.

In the photos, GLOBE students are collecting data and uploading it to GLOBE database.

I make an Impact

The research helped students and the community recognize the effect of air pollution. In addition to taking measurements at school, students also disseminated their knowledge among family and friends. They planted trees and started growing crops at school and encouraged walking instead of using transport.



GLOBE students planting crops


Planting trees

Promoting walking instead of using transport

I am a collaborator

GLOBE students from Gozo College Middle School participated in online meetings with students from Mercy College, Sligo in Ireland. They spoke about their experience with The GLOBE Program, shared information about the school and culture. Last by not least they shared and compared the results of NO2 levels and discussed the reasons for the difference in NO2 levels and put forwards solutions to improve air quality around in their neighbourhood.