An international comparative study of nitrogen dioxide levels recorded at schools in Malta and Ireland

GLOBE teams at Gozo College Secondary School & St Michael School in Malta,
Kishoge Community College & Ramsgrange Community School in Ireland

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Abstract

This is a GLOBE international comparative air quality investigation between four schools from the countries of Malta and Ireland that began in October 2021. Air pollution is a growing concern across the globe, in fact according to the World Health Organisation, air pollution is one of the greatest risks to health. This project is focused on measuring nitrogen dioxide, a gaseous traffic-related pollutant that is emitted from vehicle exhausts in combination with gathering GLOBE protocol atmosphere data and traffic count data from around schools. Four schools from a mix of urban, suburban, and rural areas received 3 nitrogen dioxide (NO_2) diffusion tubes each to place outside at their school for a period of 4 weeks. The tubes were placed: near a main road; at a car park/drop off location; and one in a relatively sheltered area away from traffic. The purpose of this project is to investigate local variations in nitrogen dioxide levels around schools, to demonstrate the link between traffic volume and recorded nitrogen dioxide concentrations, and to understand what other parameters influence nitrogen dioxide concentration in the atmosphere.

Research Questions

- How do nitrogen dioxide levels vary between four different schools?
- Can we demonstrate a clear link between observed traffic volumes at our schools and measured nitrogen dioxide levels?
- What other parameters influence recorded nitrogen dioxide levels?

Introduction

GLOBE Ireland and GLOBE Malta are presenting a collaborative project from 4 schools on the topic of air quality outside at schools.

Air pollution is a growing concern across the globe, in fact according to the World Health Organisation, air pollution is one of the greatest risks to health. The topic of air pollution has received recent attention with the occurrence of the covid-19 pandemic and the increased focus on the air we breathe. The most polluted areas tend to be heavily populated cities and other urbanised areas.

The schools that took part in this project measured nitrogen dioxide, a traffic-related gaseous pollutant that originates from vehicle exhaust emissions. The European Environmental Agency estimates that, in 2019, nitrogen dioxide (NO2) alone was linked to 40,400 premature deaths (Source EEA Website). The highest levels of nitrogen dioxide are typically found closest to busy roads. There are often wide variations in local air quality going undetected that can have significant impacts on the health and wellbeing of local communities. The collection of local measurements on nitrogen dioxide can highlight NO2 'hotspots' that could be harmful to the community. By measuring nitrogen dioxide, the students are contributing meaningful data that can ultimately benefit the environment.

The schools that took part in this collaborative project also linked their nitrogen dioxide results to other physical parameters (e.g. air temperature, cloud observations, wind) and traffic counts to better understand the factors that influence air pollution.

Fig. 1 Google Map showing location of Gozo College Secondary School in the centre of the island of Gozo and St Michael School in centre of Malta.

Fig. 2 Google Map showing red dots for Dublin school (East Ireland) and Wexford school (South-East)

Research Methods

Planning the Investigation

Each school received 3 diffusion tubes to place at 3 different locations around their school grounds. The tubes are mounted by teachers and students at three locations at their school: one near a main road; one at a car park/drop off location; and one in a relatively sheltered area away from traffic. The tubes are left in place for 4 weeks. At the end of the period, the tubes are taken down and sent to a laboratory (Gradko UK) for analysis. The laboratory analyses the tubes and provides an average NO2 (µg/m3) value for each tube for the period of measurement.

Fig. 3 Setting up of one of the diffusion tubes at the main entrance point of Gozo College Secondary School

Carrying out the Investigation

During the 4-week observation period the students measured the air temperature, observed cloud cover using the GLOBE Observer App (Fig. 4) and described the general outlook of the weather following the steps of the GLOBE Protocols (GLOBE, 2014). Each school conducted travel count surveys (Fig. 5) using a tally method on road(s) near their schools for short periods. Students counted every vehicle that passed for a given time period and then calculated the amount of vehicles per 5 minute intervals. The students collaborated through Zoom sessions (Fig. 6) where they introduced themselves and the location of their school. The students discussed location where diffusion tubes were set up. After the observation period, the students had another zoom meeting to discuss findings and share results.

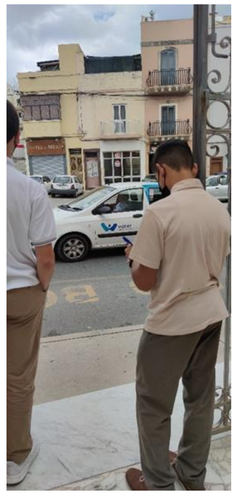


Fig. 5 Conducting traffic survey

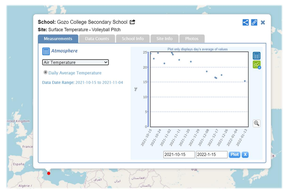
Fig. 4 Cloud observations

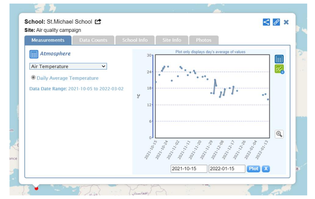
Fig. 6 Virtual meetings on Zoom

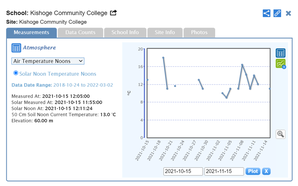
Results

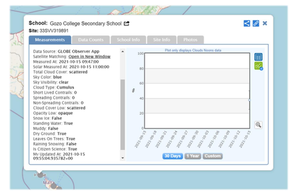
Analyzing Data

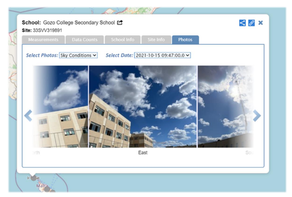
Diffusion tubes were sent to Gradko laboratories in UK while the raw data from atmospheric observations of clouds and air temperature, collected during October and November 2021 following GLOBE Protocols guide, was uploaded onto the GLOBE website. During the second zoom meeting which took place on Friday, 28th January, 2022 students from all collaborating schools discussed results.

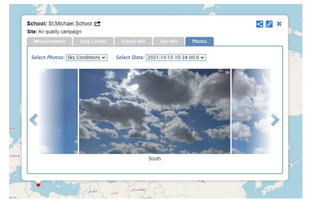








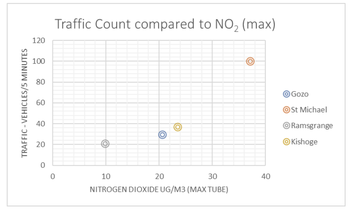




Air Temperature,, Cloud Cover and Sky Conditions plots of VIZ GLOBE

Location of Diffusion Tube	NO_2 µg/m³
Ramsgrange CS – School Car Park	3.89
Ramsgrange CS – Sheltered are at back of school	9.85
Kishoge CC – Near road entering school	20.46
Kishoge CC – Student drop-off point	23.74
Kishoge CC – Sheltered area	17.71
Main Entrance School, Europe Street, Victoria Gozo	19.02
Entrance to Parking @ Europe Street, Victoria Gozo	20.56
Ground Turf Area at Gozo College Secondary School	12.78
Road side of St. Michael School St. Venera	37.06
Parking Entrance at St. Michael School St. Venera	22.61
Balcony overlooking school ground at St. Michael School	22.44

Laboratory results of nitrogen dioxide in diffusion tubes



Discussion

Interpreting Data

After the 4-week observation period students and teachers for all 4 collaborating schools met virtually, this time to share results, compare data and discuss their findings.

The students recognised that the NO2 levels recorded are variable between schools and between different locations at each school. The lowest recorded NO2 value was measured at Ramsgrange Community School in Ireland and the highest NO2 value was measured at St Michael's school in Malta. The students noticed that the maximum values recorded were in proximity to roads and drop-off points near the schools. The lowest values recorded were in sheltered areas.

The students compared their NO2 results to the traffic count data they collected. They identified a strong correlation between the number of vehicles counted and the measured NO2 concentrations where the most heavily trafficked area correlates to the highest recorded NO2 concentration.

The students compared their NO2 results to their cloud observation data and recorded air temperatures. The students noticed the variability in recorded air temperature during the measurement period. In Ireland, the temperature varied between 9 and 18 degrees Celsius and in Malta temperature varied between 13 and 28 degrees Celsius. A correlation between air temperature and measured NO2 could not be identified. Likewise, students did not identify a relationship between cloud cover and sky visibility and recorded nitrogen dioxide levels, however it is noted that more data is needed to explore this topic further.

Fig. 7 Discussing results and findings on Zoom

Conclusions

Drawing Conclusions & Next Steps

The students identified a strong correlation between traffic volumes and recorded NO2 concentration levels. The students did not stop here. Having discovered the effects of traffic on air quality around the school, they wanted to bring change, be agents of change and think like engineers.

The students suggested ways on how to reduce NO2 levels both at local and national level in Malta and Ireland.

The recommendations from this project are:

- Continue to monitor nitrogen dioxide around schools and gather more detailed weather observations to identity parameters that affect the results.
- Gather more detailed traffic data to understand traffic flow and identify potential traffic-solutions around schools, for example, limiting the number of cars that can enter the school grounds.

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