

The Relationship between Mosquito Larvae Amount and Water Quality

GLOBE Schools: Xin-Wu Senior High School, Taiwan

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Abstract

Our school is located at Xin-Wu district, the coast of Taoyuan County, northern Taiwan. Last summer vacation, dengue fever, which usually occurs in southern Taiwan, caused cluster infections in Taoyuan for the first time. Although our school is not the place where the local cases appear, many of school students come from the epidemic area. Dengue fever is likely to spread to Xin-Wu District through people's movement. We tried to find the relationship between water quality and mosquito habitats, eliminate larvae, prevent the spread of dengue fever in Xin-Wu District through GLOBE Protocols and mosquito habitat mapper observations.

We choose three sites located near our school – Cat alley, Green Water, Water alley. Larvae only be found at Cat Alley. Measurements were conducted according to GLOBE Hydrology and Atmosphere protocols. The research had a 1-month duration (from 27 Jan 2021 to 24 February 2021) but suspend the study during Chinese New Year (10 Feb, 2021 to 16 Feb,2021). From the results of the research, it was found that the water at Cat Alley is more polluted than others. The pH value all falls on 3~11 that agreed with other studies' findings. There is no obvious correlation between the number of larvae and the amount of dissolved oxygen, and it is more related to the water temperature. The value of nitrate nitrogen in Cat Alley is higher, and the value of the other two sites is lower. It is speculated that although larvae like clean and still water, water that is too clean is not suitable for larvae to survive. Small fish have been found near the water collection site at Cat Alley, so it is speculated that the larvae may have been eaten by the fish.

Key words: mosquito larvae, water temperature, DO, pH, Nitrate nitrogen

1. Research questions

Our school is located at Xin-Wu district, the coast of Taoyuan County, northern Taiwan. It has a rich cultural landscape. In addition to the well-known Hakka settlements, ponds, drainage ditch, and paddy fields, the alleys and lanes in the settlements and public buildings are more humanitarian and richer in local characteristics.

Last summer vacation, dengue fever, which usually occurs in southern Taiwan, caused cluster infections in Taoyuan for the first time. According to a press release from the Taiwan Centers for Disease Control of the Ministry of Health and Welfare, a total of 73 cases have been reported as of December 9, 2020. Of the local dengue cases, 23 of them live in Taoyuan City (Source: <https://www.cdc.gov.tw>). Our school is located in Xin-Wu District, Taoyuan City. Although it is not the place where the local cases appear, the students come from various regions, many of them also come from the epidemic area. Dengue fever is likely to spread to Xin-Wu District through people's movement. Since joining the GLOBE observation club on campus, We have had the opportunity to use the GLOBE Observer APP to record the habitat of mosquitoes. I hope to find mosquitoes habitats, eliminate larvae, and prevent the spread of dengue fever in Xin-Wu District through GLOBE Protocols and mosquito habitat observations.

Research questions:

- A. What is the temperature, the Nitrate, the pH and dissolved oxygen level of the ditches or ponds near Xin-Wu Senior High School? Is the water clean or polluted?
- B. How water quality, such as water Temperature (T), Dissolved Oxygen (DO), Nitrate Nitrogen(N), pH value, Conductivity (EC) and Total Dissolved Solids (TDS), affects larvae amount at these water bodies?
- C. What are the most important water variables to the mosquito larvae amount?

Hypotheses:

- A. Mean water quality will be the same without major deviations on the different water bodies during the winter vacation.
- B. Because larvae grow in clean, still water, it is speculated that water with higher water temperature, higher DO, less Nitrate Nitrogen(N) and neutral pH may have more larvae.
- C. The most important water variables to the mosquito larvae amount are DO and temperature.

2. Introduction and review of the literature

We usually use water Temperature (T), Dissolved Oxygen (DO), Nitrate Nitrogen(N), pH value, Electric Conductivity (EC) and Total Dissolved Solids (TDS) to describe the water quality.

Refers to the concentration of oxygen dissolved in water. In the practice of river water quality management, the amount of dissolved oxygen is regarded as the main indicator for judging water quality. Generally speaking, the higher the concentration, the better the water quality. The saturated dissolved oxygen in water is affected by the water temperature and the dissolved substances in the water. The higher the water temperature, the lower the saturated dissolved oxygen (concentration). The basic survival of fish requires DO in the water to be 3mg/L or more than 4mg/L. The high temperature reduces the amount of dissolved oxygen in the water. When the dissolved oxygen in the water is lower than 2mg/L, it may cause the fish to die from hypoxia[1]. How about mosquito larvae? Previous studies indicated that mosquito larvae are unaffected by DO depletion; however, under experimental conditions, reduced levels of DO resulted in reduced larval survival and prolonged development time for *Cx. Pipiens*. [2]

Nitrate nitrogen is the final product of nitrification in the nitrogen cycle, so nitrate nitrogen can indicate the degree of pollution of the water body. When the nitrate nitrogen content in rivers, lakes or reservoirs is too high, it is easy to cause algae to multiply, which makes the water body show eutrophication[1].

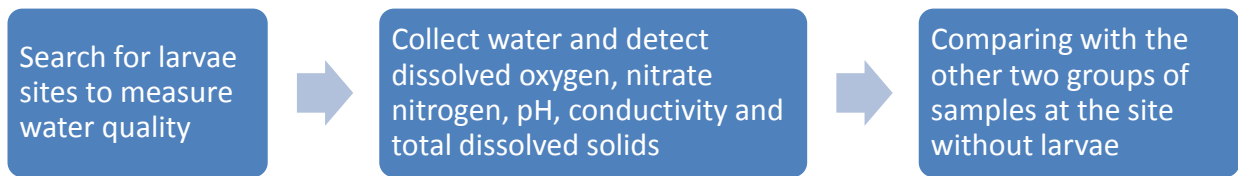
The pH refers to the logarithmic value of the reciprocal of the hydrogen ion concentration in water. Generally, the pH value of natural water is mostly in the neutral or slightly alkaline range. If the water is polluted by industrial wastewater or mine wastewater, its pH value may change significantly; the pH value will affect the growth of organisms, the precipitation and dissolution of substances, Water and wastewater treatment, etc[1]. In general, larvae of most mosquito species can tolerate acidic or alkaline conditions in nature with pH values between 3–11.[2]

The total amount of solid substances dissolved in water (including soluble bicarbonate, chloride, sulfate, calcium, magnesium, sodium and potassium, etc.; volatile and non-volatile solids). Its concentration will affect the taste of drinking water. The measurement method is the residual weight of the water sample after filtering ($0.45 \mu m$) and drying the filtrate at $103^{\circ}C \sim 105^{\circ}C$ [1].

Electrical conductivity (EC)Indicates the ability of water to conduct current. The conductivity is related to the total concentration of ions in the water, mobility, valence, relative concentration and water temperature. Generally, the higher the conductivity, the

more electrolyte content in the water. Since most salts are ionizable, conductivity can also indicate the amount of total dissolved solids in water. Too high electrical conductivity has an adverse effect on irrigation, so electrical conductivity is one of the important indicators of irrigation water quality. The electrical conductivity is measured by the reciprocal of the resistance measured when a current passes through a liquid column with a length of 1 cm and a cross-sectional area of 1 cm², so the unit is usually expressed in mho/cm. If the conductivity is small, it will also be expressed in mmho/cm of 10⁻³ or μmho/cm of 10⁻⁶ mho/cm [1].

3. Methods and Materials



Study site

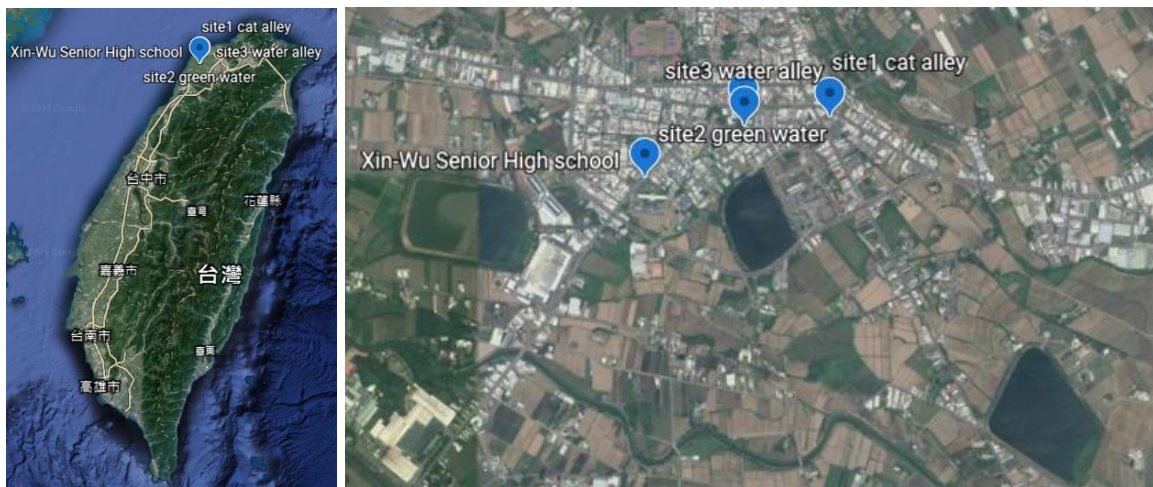


Figure 1: the three study sites map (adapted from Google Earth)

Water quality of Xin-Wu were measured at specific stations near the famous landscape. We choose three sites located near our school (Figure 1). Where we often have school field trip about culture there. The weather in Xin-Wu is usually nice and warm. The average temperature in January and February ranges from 14.6 to 16.7 °C in winter 2021. However, the temperature will down to 6 °C when the cold snap hits and up to 26 °C when there is no special weather event occur. This year, we have less rainfall than usual. Table 1 list the information of those study sites.

Table1. the information of study sites

Site no.	Site name	Latitude	Longitude	Elevation
1	Cat Alley	24.9720	121.1082	93m
2	Green water	24.9721	121.1039	88m
3	Water Alley	24.9712	121.1039	88m

Site 1 : It's a drainage ditch. It is located in the downtown area in Xin-Wu. We take samples twice or thrice a week at about 1 to 2 p.m. in the afternoon. We found mosquito larvae only at this site.

Site 2 : It's a pond near site 3. It is also located in the downtown area in Xin-Wu. This site is near library. The land use is a park providing people to rest. We take samples twice or thrice a week at about 1 to 2 p.m. in the afternoon. The water is so green that we called this site as green water.

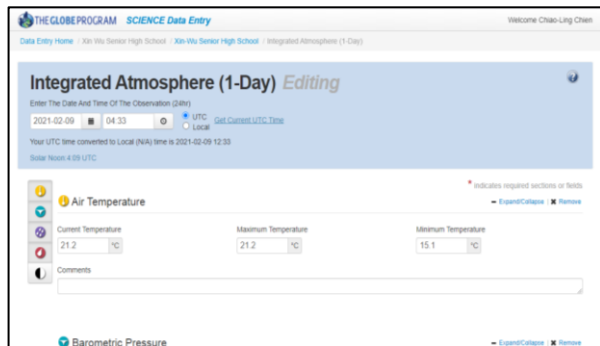
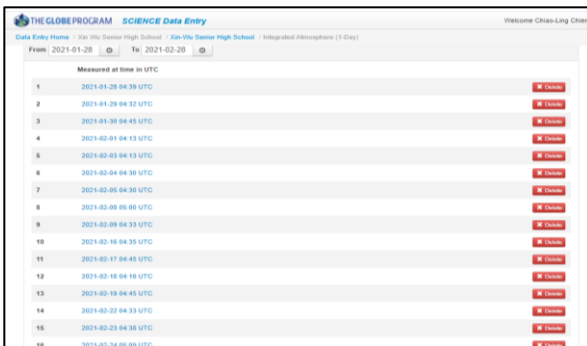
Site3 : It's a drainage ditch. It is located in the downtown area in Xin-Wu. We take samples twice or thrice a week at about 1 to 2 p.m. in the afternoon. We found no mosquito larvae at this site.

GLOBE protocols

Measurements were conducted according to GLOBE Hydrology protocols. The temperature of air (an atmosphere protocol) were measured with digital thermometers. The temperature, pH value, EC, TDS of water is measured with probe. The Dissolved Oxygen(DO) and Nitrate(N) of water was measured with chemical kit. Furthermore, the Central Weather Bureau provided every day atmospheric data.

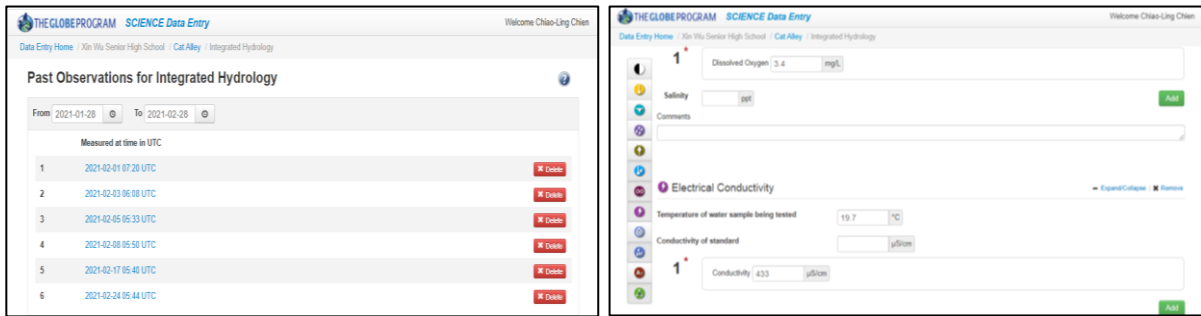
GLOBE protocols used: -Atmosphere

Parameters measured: -Atmospheric temperature, relative humidity, rainfall, barometric pressure and sky condition



GLOBE protocols used: -Hydrology

Parameters measured:- water DO, Nitrate, pH, temperature, EC, TDS



Data Collection

In order to compare the data, measurements were taken the same days of the week at almost the same time at all stations. The research had a 1-month duration (from 27 Jan 2021 to 24 February 2021). Measurements were mainly conducted on Monday, Wednesday and Friday from 1 to 2 p.m. at stations Cat alley, Green water, Water alley. We suspend the study during Chinese New Year (10 Feb, 2021 to 16 Feb,2021), the big vacation for every family to get together.

4. Results

Figure2 shows GLOBE Visualization screenshot. We use GLOBE data entry desktop form to input data. The water Temperature (T), Dissolved Oxygen (DO), Nitrate Nitrogen(N), pH value, Conductivity (EC) and Total Dissolved Solids (TDS) of study sites are presented in Table 2.

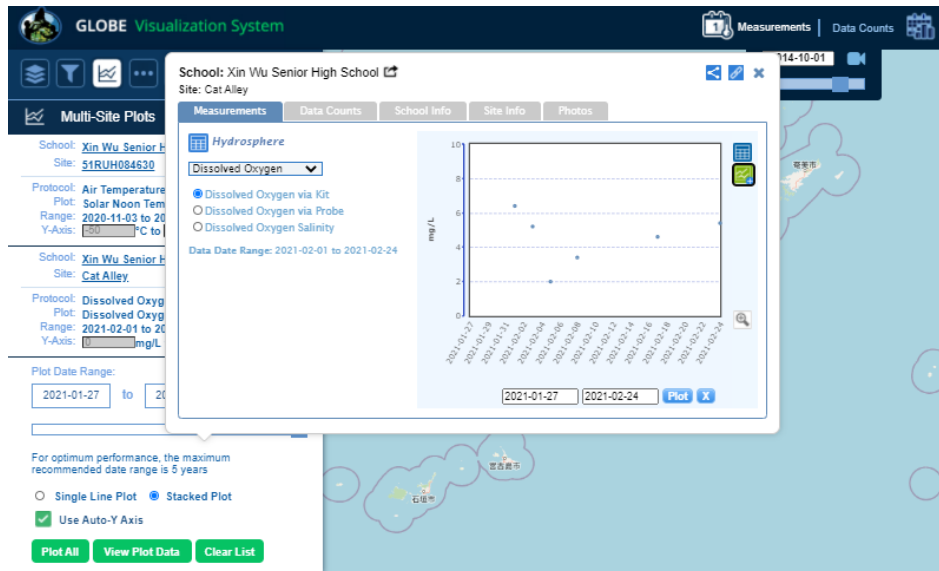


Figure 2 GLOBE Visualization screenshot

Table2. the data collected from 3 study sites

Date	Time	Water	T (°C)	DO (ppm)	Nitrate Nitrogen (ppm)	Nitrate (ppm)*4.4	pH value	EC (µS/cm)	Salt Conductivity	TDS (ppm)	Salt (ppm)	Remarks
27-Jan		Green Water		10	0	0						
29-Jan		Green Water		10			9.24	340		224	170	
29-Jan		Water Alley		7.8	0.1	0.4	7.04	310		204	155	
1-Feb	15:00	Cat Alley	24.6	6.4	0.8	3.5	7.62	410		270	205	126 mosquito larvae
1-Feb		Green Water	21.8	8	0	0	9.86	314		207	157	
1-Feb	15:40	Water Alley	21.8	5.8	0.1	0.4	6.7	297		196	148	
3-Feb	14:08	Cat Alley	22	5.2	0.8	3.5	7.29	453		298	226	10 mosquito larvae
3-Feb		Green Water		8.6	0	0	9.63					
3-Feb	14:50	Water Alley	21.4	6	0.1	0.4	6.6	297	626	196	149	
5-Feb	13:33	Cat Alley	21.7	2	1	4.4	7.5	428	475	282	214	0 mosquito larvae
5-Feb	13:45	Green Water	21.5	10.2	0	0	9.65	322	700	212	161	
5-Feb	14:06	Water Alley	22.1	6.2	0.1	0.4	6.58	301	838	198	150	
8-Feb	13:50	Cat Alley	20	3.4	0.8	3.5	7.45	433	1140	285	216	0 mosquito larvae
8-Feb	14:19	Green Water	19.6	10.2	0	0	9.52	318	2710	210	159	
8-Feb	14:45	Water Alley	19.2	6	0.1	0.4	6.62	302	942	199	151	
17-Feb	13:40	Cat Alley	19.2	4.6	1	4.4	7.28	389	1284	256	194	3 mosquito larvae
17-Feb	14:08	Green Water	19.7	8.8	0	0	9.04	326	1163	215	163	
17-Feb	14:33	Water Alley	19.7	6.2	0.2	0.9	6.8	304	1219	200	151	
24-Feb	13:44	Cat Alley		5.4	0.8	3.5						0 mosquito larvae
24-Feb		Green Water				0						
24-Feb	14:50	Water Alley		10.2	0.2	0.9						

Figure 3 shows that the Dissolved Oxygen of water was much higher at site Green Water, which has no larvae in the water. The measured values were in the range of 8 ppm up to 10 ppm. The Dissolved Oxygen of Cat Alley ranks second; the least Dissolved Oxygen is Water Alley. Dissolved Oxygen of Cat Alley was the lowest in 5 February.

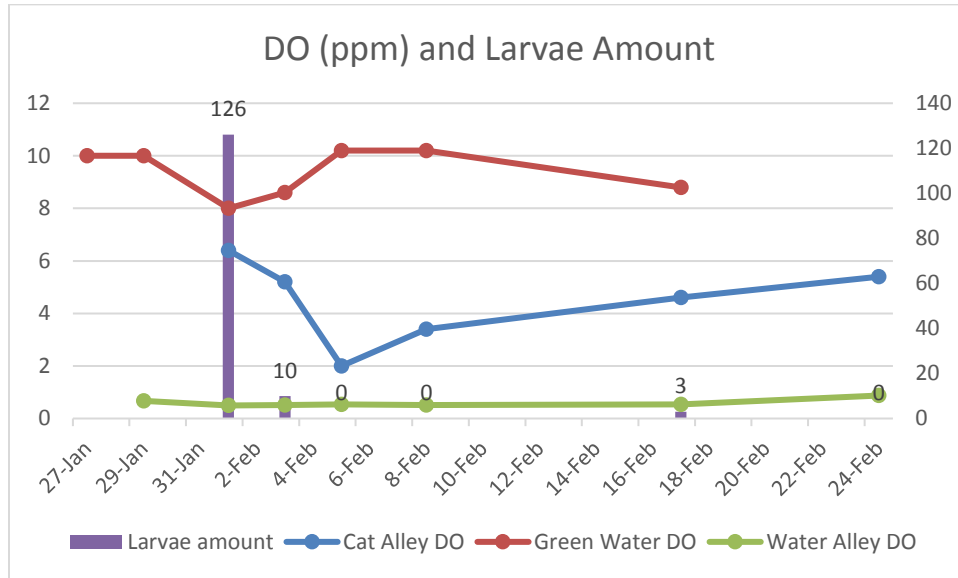


Figure 3 Temporal variation of Dissolved Oxygen of water in three site and the amount of mosquito larvae.

Because we took the water sample back to the school for testing, we are not doing the experiment immediately after the water sample is collected, so there may be errors in the temperature of the water sample at the measuring station. In Figure4, it is seen that water temperature at all three sites was almost the same.

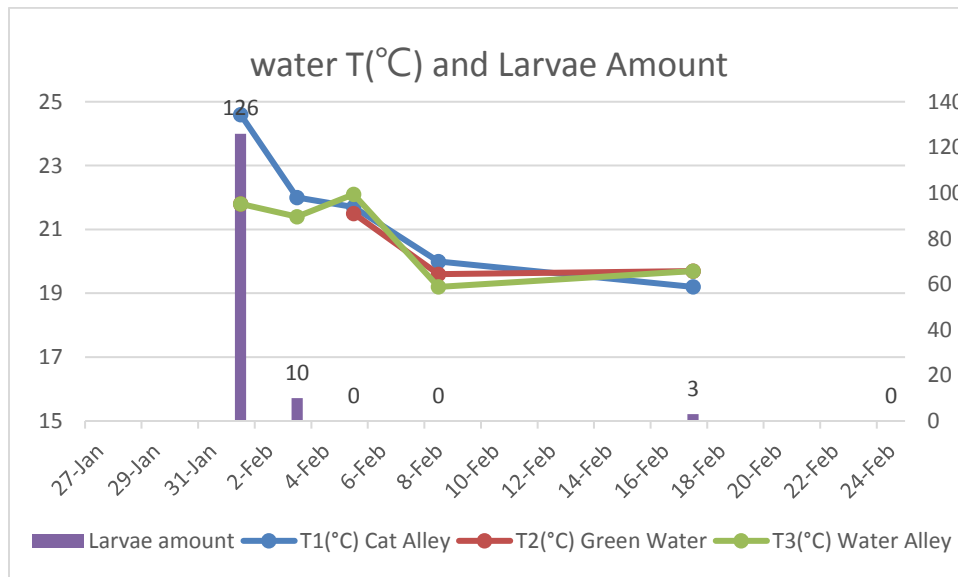


Figure 4 Temporal variation of water temperature of water in three site and the amount of mosquito larvae.

In Figure5, The value of nitrate nitrogen in Cat Alley is relatively high and the variation is large, while the value of Green Water and Water Alley is very low and the variation is small.

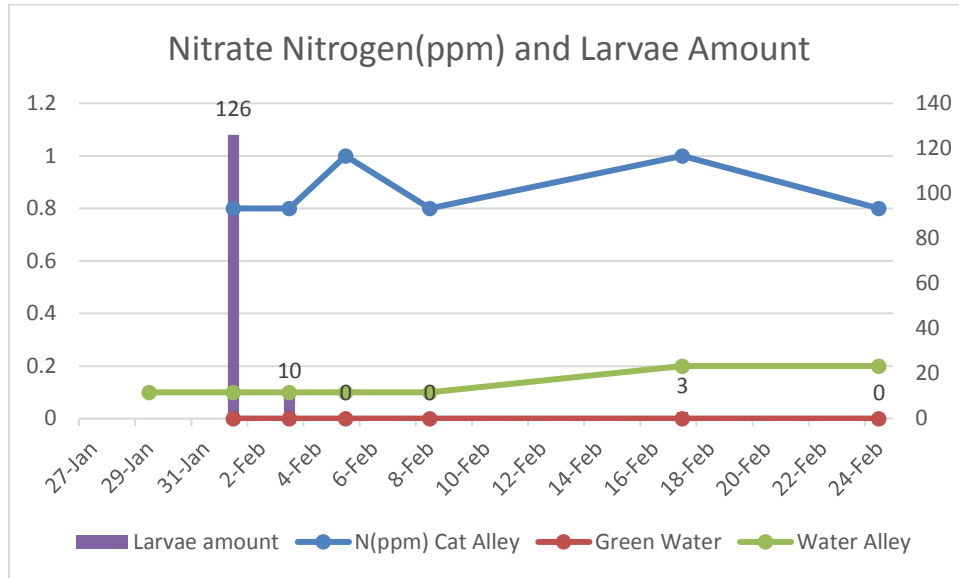


Figure 5 Temporal variation of Nitrate Nitrogen of water in three site and the amount of mosquito larvae.

Figure6 present the air temperature range is mostly between 14°C~26°C. On February 1, February 3 and February 17, when there are larvae, the temperature was fall between 19°C~24°C.

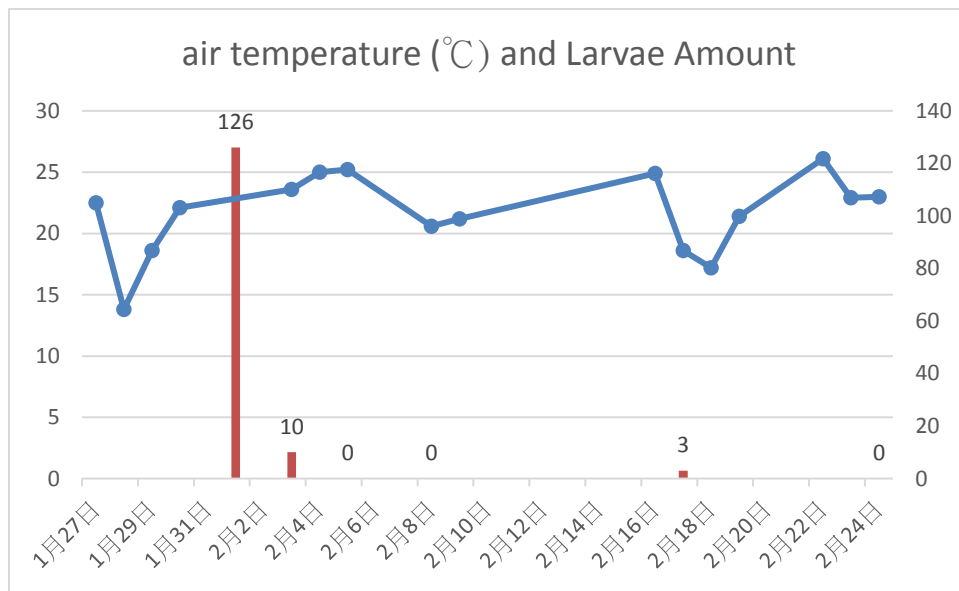


Figure 6 Temporal variation of air temperature in Xin-Wu Senior High School. (near site 1.2.3)

5. Discussion

Comparing the data of Cat Alley and the number of larvae collected, it was found that the number of larvae collected on February 1 was 126, the dissolved oxygen is increased. In another day, the number of larvae drop down to 10 on February 3, Its dissolved oxygen decreased. However, when we found no larvae on February 5, the dissolved oxygen was much less than that on February 1 and February 3. On February 8, February 17, and February 24, the number of larvae on February 8 was 0, and the amount of dissolved oxygen was higher than that on February 5. On February 17, although we found 3 larvae in the water sample, but the amount of dissolved oxygen was lower than the amount of dissolved oxygen without larvae on February 24. From this phenomenon, it can be inferred that there is not much relationship between larvae and the amount of dissolved oxygen.

From Figure 4, we can find that the water temperature of Cat Alley was the highest on February 1, and the number of larvae was the most. The water temperature on February 3 decreased, and the number of larvae decreased compared with that on February 1. The water temperature on the day was lower than that on February 1 and February 3, and only 3 larvae was found. It can be inferred that larvae and water temperature are more related.

Figure 5 shows the Nitrate Nitrogen and air temperature. We found that Cat Alley has a higher nitrate nitrogen value. We speculate that it's because people live next to Cat Alley, pollute the water of Cat Alley and cause mosquitoes to breed.

Figure 6 shows the air temperature. We found there is no obvious correlation between the number of larvae and temperature.

6. Conclusions

- A. From the results of the research, it was found that the water at Cat Alley is more polluted than others.
- B. The pH value all falls on 3~11 that agreed with other studies' findings.
- C. There is no obvious correlation between the number of larvae and the amount of dissolved oxygen, and it is more related to the water temperature.
- D. The value of nitrate nitrogen in Cat Alley is higher, and the value of the other two sites is lower. It is speculated that although larvae like clean and still water, water that is too clean is not suitable for larvae to survive.
- E. Small fish have been found near the water collection site at Cat Alley, so it is speculated that the larvae may have been eaten by the fish.

7. Citations

- (1). Environmental Protection Administration, Executive Yuan, R.O.C. (Taiwan)
<https://wq.epa.gov.tw/EWQP/zh/Encyclopedia/NounDefinition>
- (2). Grech MG, Manzo LM, Epele LB, et al. Mosquito (Diptera: Culicidae) larval ecology in natural habitats in the cold temperate Patagonia region of Argentina. Parasit Vectors. 2019;12(1):214. Published 2019 May 7. doi:10.1186/s13071-019-3459-y
- (3). GLOBE Hydrology protocol and atmosphere protocol

8. Badge Descriptions

[Collaborator-](#)

Our water quality measurement is carried out in the form of division of labor. We have measured DO and Nitrate Nitrogen, pH and EC and TDS. There are many advantages of the division of labor, such as making the whole measure process faster and more efficient. If you encounter difficulties in the middle of the process, we can provide more ideas, discuss the problems raised in the process, communicate with each other and learn more effectively.

[Data Scientist-](#)

We used GLOBE Observer APP to record mosquito larvae habitat. Through the APP, we knew the larvae type we collected was not the target larvae which spread disease. We also used this APP to record sky condition. During that period, we suffer air pollution(haze) many times. There are obvious change in atmospheric condition. After finishing atmospheric and hydrology data entry, we found significant changes in water temperature, DO, barometric pressure and air temperature. Through visualizing the variables of those factor, we was able to draw conclusions about their relationships.

When we collecting water sample of green water, there are passersby who told us the water was not so green last year. We wonder why the water is so green now and we were surprised that it used to be clean and clear just several months ago. We planed to keep collecting the water quality data until next summer coming. Now and in the future, we will keep going being data scientist.

[Make an Impact-](#)

Our GLOBE community has been using mosquito habitat mapping APP since the year before last. Once larvae continue to be found in a specific place in our school, we will notify the General Affairs Office for disinfection, which also reduces the number of mosquitoes in the school. A similar effect was observed when collecting water samples outside the school. When we collected hundreds of larvae for the first time, the number of larvae dropped

sharply when we collected samples next time. Perhaps it is because the changes in the natural environment have reduced the number of larvae, but it is also possible that the mosquitoes felt that this place was not suitable for laying eggs. Because we often collect water, and the number of larvae has dropped sharply. Another time when the seniors were observing the larvae through a mobile phone microscope, they discovered that there was a paederus (a kind of worm that can corrode the skin). We immediately notified the school officers to remind students and teachers to be careful of paederus.

We feel that doing these observations is very meaningful, it can help us improve our lives and make the world a better place.