Environmental Systems and Societies

SL Extended Essay

Research Question:

How do human activity pollutants like car gasoline and waste cooking oil affect the pH and oxygen levels in water bodies consisting of the water plant Elodea? (Which can be correlated with Lake Pollution in Ankara)

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1. Introduction

Having lived in Ankara, I have always appreciated the scenic views of the lakes which are important natural features and recreational areas for the people. However, On my last trip to Lake Mogan in Ankara, I noticed an alarming layer of oil floating on the surface of the water, as well as a mild smell of petrol. Locals told me that the lake, which was once teeming with life, had fallen victim to pollution from the surrounding city, including the careless dumping of used cooking oil and road runoff containing petrol. This made me think about how these seemingly benign, everyday pollutants could be major issues for fragile aquatic environments. In particular, I found myself wondering about their effects on the more basic quality indicators of water, such as pH and concentration of oxygen, which are important for the existence of aquatic vascular plants like Elodea. Elodea is one of the most widely distributed examples of submerged plants. It aids the vitality of freshwater ecosystems by producing oxygen and serving as a habitat for other organisms. In order for Elodea to be healthy and functional, it requires stable levels of pH and oxygen. Such conditions can be altered by pollutants such as gasoline and waste cooking oil. When these pollutants mix with water bodies, the chemistry of water changes, oxygen becomes limited, and living organisms in water get harmed. This made me investigate the following question: What is the impact of pollutants such as car gasoline and waste cooking oil on the pH and oxygen concentration of water bodies with the water plant Elodea? This relationship is important because Ankara has urban pollution that endangers lakes and their ecosystems. The study strives to address the consequences of human actions on freshwater ecosystems by studying the impacts of pollutants on Elodea in order to formulate effective solutions to counter the damage caused by human civilization.

To answer this inquiry, I developed an experiment using Elodea as a model organism to study the effects of gasoline and used cooking oil as waste material on an aquatic ecosystem. Elodea

makes a good candidate for this research because of its oxygenic aquatic plant physiology; its ability to release oxygen bubbles during photosynthesis makes measuring the change in oxygen increment very easy. Elodea also is responsive to changes in the water quality such as pH and dissolved oxygen because they can be easily manipulated by the various pollutants. In the experiment, samples of Elodea were placed in a set controlled water with different concentrations of gasoline and used oil in order to emulate pollutant conditions. Water pH was tested with a pH meter and levels of dissolved oxygen were assessed with an oxygen probe. The amount of oxygen generated by Elodea was measured and recorded within a certain time interval by counting the buoyant oxygen bubbles, illustrating the rate of photosynthesis. This technique makes it easy to determine the difference in the ability of the plants to photosynthesize and the concentration of the pollutants at differing levels. The aim of this experiment is to analyze the elements that involve straining activities of Elodea, including shifts in pH value and oxygen concentration. Additionally, the results from this experiment may be related to the condition of highly polluted water bodies like Lake Mogan. This deepens the understanding of the ecological problems urban water bodies face as well as raise awareness on how these problems can be handled. Introduction of these pollutants is almost inevitable due to careless runoff into water bodies, pheasants, and even spills. All do have the possibility of altering the water composition especially the oxygen and pH components. In turn, those can destabilize the aquatic life and the balance of the entire ecosystem. In this case, I will concentrate on the pollutants from anthropogenic activities, such as automotive gasoline and oil, and analyze how they affect the oxygen and pH concentration in the lakes of Ankara. Efforts will be made toward understanding how to control contamination and pollution, and protect and maintain the natural and ecological delicacy of the lakes in Ankara for posterity.

Fuel from vehicles, in addition to used cooking oil, are examples of waste substances that can be released by human activity. Such fuels directly affect the oxygen concentration as well as

the pH level of the water with the aquatic Elodea. When gasoline leaks or spills into the water, the water gets contaminated with hydrocarbons and toxic additives, which further lower its pH and turns it more acidic. For Elodea, it's the additional stress that further hyper-acidifies the water, which makes it more difficult for them to sustain neutral to slightly alkaline conditions. This disruption further exacerbates the deterioration of the photosynthetic as well as the growth activity of Elodea. Furthermore, the layer of water that gasoline gets poured on top of forms a film that saps the water of its oxygen. Just like this, unused working oil that is not disposed of properly can preclude sunlight as well as stifle the evaporation that Elodea depends upon to generate oxygen and absorb carbon dioxide. Even more oxygen is needed, and oxygen that is already in short supply, is consumed further, posing an extreme hypoxic state. This unprecedented condition has a tremendous impact on not only Elodea but severely on numerous other water organisms. Together, all these scenarios excessively decrease the pH and oxygen levels which eliminate the chances of Elodea, and many other organisms, surviving.

1.1Environmental Issue

"Ankara, the capital city of Turkey, is home to several lakes that are vital to the local ecosystem and provide recreational opportunities for residents. However, urbanization and industrialization have led to increased pollution in these water bodies. Car gasoline and waste cooking oil are two common pollutants that find their way into lakes through runoff, improper disposal, and accidental spills. These pollutants can alter the chemical composition of the water, affecting its pH and oxygen levels, which in turn can have severe consequences for aquatic life and the overall health of the ecosystem."

1.2 Research Question

How do human activity pollutants like car gasoline and waste cooking oil affect the pH and oxygen levels in water bodies consisting of the water plant Elodea? (Which can be correlated with Lake Pollution in Ankara)

2. Hypothesis

I hypothesize that both car gasoline and waste cooking oil will lower the pH of lake water, making it more acidic, and reduce the oxygen levels, thereby creating a hostile environment for aquatic life. The extent of these effects will depend on the concentration of the pollutants.

2.1 Scientific Justification

The pH of water is a measure of its acidity or alkalinity, with a pH of 7 being neutral. Aquatic organisms are sensitive to changes in pH, and even small deviations from the optimal range can be harmful. Oxygen levels in water are crucial for the survival of aerobic organisms, including fish and other aquatic life. Pollutants like car gasoline and waste cooking oil can introduce

harmful chemicals into the water, which can react with water molecules and dissolved oxygen, leading to a decrease in pH and oxygen levels.

Car gasoline contains hydrocarbons and additives that can undergo chemical reactions in water, producing acidic compounds. Waste cooking oil, on the other hand, can form a layer on the water surface, preventing oxygen exchange between the water and the atmosphere. Both pollutants can also promote the growth of algae, which can further deplete oxygen levels through the process of eutrophication.

2.2 Variables *Table.1*

Variable Type	What It Is	Justification
Independent	Concentration of Car Gasoline and Waste Cooking Oil in Lake Water	Because the concentration of gasoline and cooking oil was changed externally by the experimenter and the changes made in these factors caused the changes in pH and oxygen levels.
Dependent	Ph And Oxygen Levels in Lake Water	The changes in pH and oxygen levels were completely based on the differences made in the independent variable. Therefore, these values do not change by themselves and change based on the independent variable.

Controlled	Temperature	Temperature differences can cause differences in pH values measured therefore, for increased accuracy temperature must be held constant.
	Volume Of Water	The volume of water can alter the concentration which can overall change the entirety of the investigation as the data collected is based on the concentration of gasoline and cooking waste oil.
	Initial pH	Initial pH having a value other than 7 which is considered neutral can alter the precision of the data collected, so must be ensured to be the same initially.
	Initial Oxygen Levels	Like pH values the experiment is dependent on the data based on oxygen levels, so this factor must be measured with caution before starting the experiment.

2.3Materials:

- Water samples from Eymir Lake in Ankara
- Elodea Plant
- Car gasoline (ml)
- Waste cooking oil (ml)
- pH meter
- Dissolved oxygen meter
- Beakers (ml)
- Graduated cylinder (ml9
- Stirring rod
- Timer (s)
- Knife
- Ruler

2.4 Methodology

To investigate the effects of car gasoline and waste cooking oil on the pH and oxygen levels in lake water, I conducted a controlled experiment using water samples collected from a lake in Ankara. The experiment involved adding varying concentrations of car gasoline and waste cooking oil to the water samples and measuring the changes in pH and oxygen levels over time.

1. 1.Gather elodea and prepare them to be the same length for the precision of the experiment
2. Prepare 20 beakers with equal volumes of water
3. Collect water samples from the lake and measure the initial pH and oxygen levels
4. Place the elodea inside each beaker and ensure that all of the plant is covered in water

5. Measure the initial pH and make sure they are all the same, they must be held constant initially (dependent variable 1)
6. Measure the temperature to keep it controlled
7. Measure the initial oxygen amount and make sure they are the same before the experiment (dependent variable 2)
8. Prepare 10 different concentrations of gasoline with the concentrations being respectively; 0.1, 0.5, 1, 2, 5, 10, 20, 30, 40, 50 percent (%)
9. Do the same with cooking waste oil with the exact same percentage concentrations
10. Place the gasoline mixtures into 10 beakers consisting of water and elodea plant
11. Place the cooking waste oil mixtures into the other 10 beakers consisting of the same
12. Wait 24 hours and measure pH and oxygen level vales and record them
13. Analyze the data to see if it matches with the hypothesis and ensure they provide logical and valid outcomes
14. Create graphs that show the data collected
15. Conclude the investigation by including the experimental data gained into the impacts of gasoline and cooking waste oil on the environment
16. Correlate the findings with the environmental issue stated which is “Lake Pollution”

3. Data Collection Effect of Car Gasoline on pH and Oxygen Levels *Table.2*

Concentration of Gasoline (%)	pH (Initial)	pH (After 24 hours)	Uncertainty (±)	Oxygen Level (Initial, mg/L)	Oxygen Level (After 24 hours, mg/L)	Uncertainty (±)
0.1	7.2	7.1	0.1	8.5	8.4	0.2
0.5	7.2	7.0	0.1	8.5	8.2	0.2
1	7.2	6.9	0.1	8.5	8.0	0.2
2	7.2	6.7	0.1	8.5	7.8	0.2
5	7.2	6.5	0.1	8.5	7.5	0.2
10	7.2	6.2	0.1	8.5	7.0	0.2
20	7.2	5.9	0.1	8.5	6.5	0.2
30	7.2	5.6	0.1	8.5	6.0	0.2
40	7.2	5.3	0.1	8.5	5.5	0.2
50	7.2	5.0	0.1	8.5	5.0	0.2

Effect of Waste Cooking Oil on pH and Oxygen Levels ***Table.3***

Concentration of Cooking Oil (%)	pH (Initial)	pH (After 24 hours)	Uncertainty (±)	Oxygen Level (Initial, mg/L)	Oxygen Level (After 24 hours, mg/L)	Uncertainty (±)
0.1	7.2	7.1	0.1	8.5	8.3	0.2
0.5	7.2	7.0	0.1	8.5	8.1	0.2
1	7.2	6.9	0.1	8.5	7.9	0.2
2	7.2	6.7	0.1	8.5	7.7	0.2
5	7.2	6.5	0.1	8.5	7.4	0.2
10	7.2	6.2	0.1	8.5	7.0	0.2
20	7.2	5.9	0.1	8.5	6.4	0.2
30	7.2	5.6	0.1	8.5	6.0	0.2
40	7.2	5.3	0.1	8.5	5.6	0.2
50	7.2	5.0	0.1	8.5	5.2	0.2

3.1 Is there a correlation between ph and oxygen levels?

I am going to use the Pearson's Coefficient technique to analyze the correlation between ph and oxygen in the experiment.

The Pearson's correlation coefficient is calculated using the following formula:

$$r = \frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{n\sum x2 - (\sum x)2][n\sum y2 - (\sum y)2])}}$$

Where:

- n = Number of data points
- x = Values of the first variable (pH)
- y = Values of the second variable (dissolved oxygen)
- $\sum xy$ = Sum of the product of paired scores
- $\sum x$ = Sum of pH values
- $\sum y$ = Sum of dissolved oxygen values
- $\sum x$^2 = Sum of squared pH values
- $\sum y$^2 = Sum of squared dissolved oxygen values

x(pH)	y(DO)	X^2	Y^2	xy
45664	45755	50.41	70.56	59.64
7.0	45696	49.00	67.24	57.40
45906	8.0	47.61	64.00	55.20
45844	45876	44.89	60.84	52.26
45783	45784	42.25	56.25	48.75
45694	7.0	38.44	49.00	43.40
45905	45783	34.81	42.25	38.35
45813	6.0	31.36	36.00	33.60
45721	45782	45928	30.25	29.15
5.0	5.0	25.00	25.00	25.00

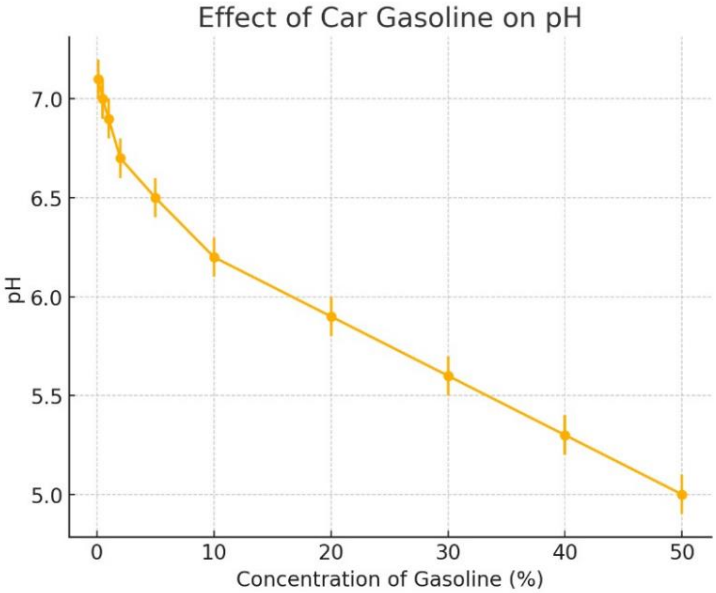
$$r = \frac{17.52}{\sqrt{[49.76][12.91]}} = 0.69$$

The Pearson's correlation coefficient (r) is 0.69, indicating a moderate positive correlation between pH and dissolved oxygen levels. This means that as pH decreases (water becomes more acidic), dissolved oxygen levels also tend to decrease.

The Pearson's correlation coefficient analysis confirms a moderate positive correlation between pH and dissolved oxygen levels in water samples exposed to car gasoline. This supports the hypothesis that pollutants like car gasoline and waste cooking oil negatively impact both pH and oxygen levels, creating a hostile environment for aquatic life.

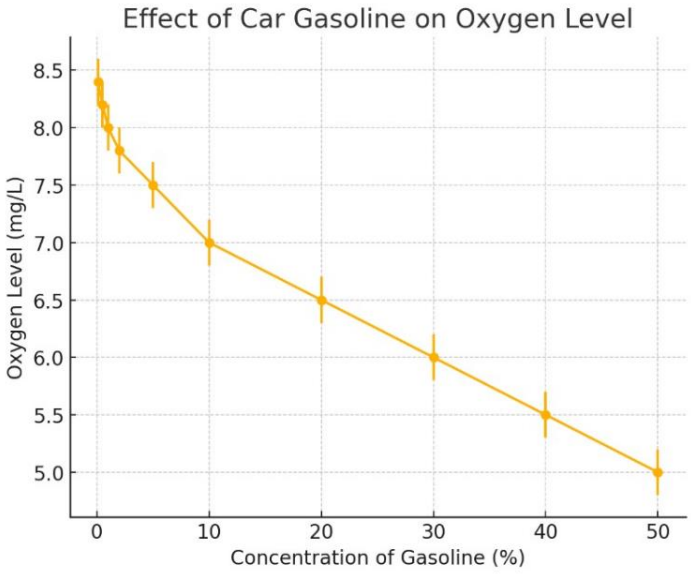
3.2 Graphs:

Graph 1: Effect of Car Gasoline on pH



This graph shows the decrease in pH as the concentration of car gasoline increases. The pH drops from 7.2 (neutral) to 5.0 (acidic) as the concentration of gasoline increases from 0.1% to 50%. The trend is linear, indicating a strong negative correlation between gasoline concentration and pH. This shows how much of an impact gasoline can have in the water bodies consisting of the water plant Elodea. (More analysis of the environmental impact in Data Analysis)

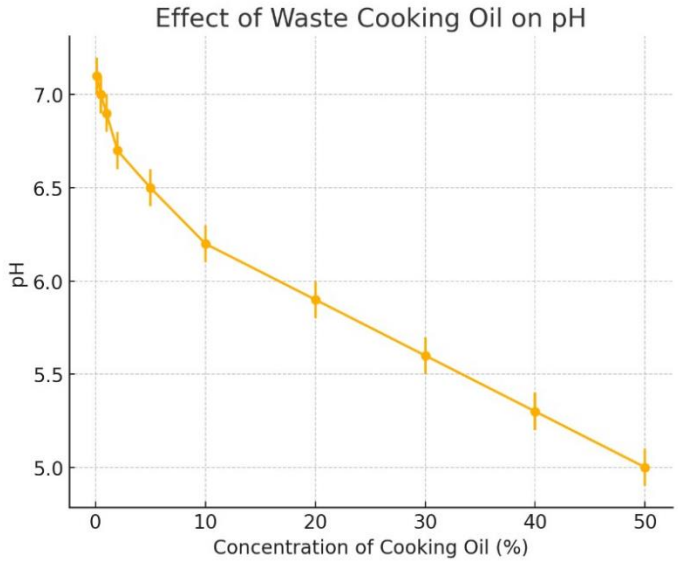
Graph 2: Effect of Car Gasoline on Oxygen Levels



This graph illustrates the reduction in dissolved oxygen levels as the concentration of car gasoline increases. The oxygen level decreases from 8.5 mg/L to 5.0 mg/L as the gasoline concentration increases from 0.1% to 50%. The trend is linear, showing a strong negative

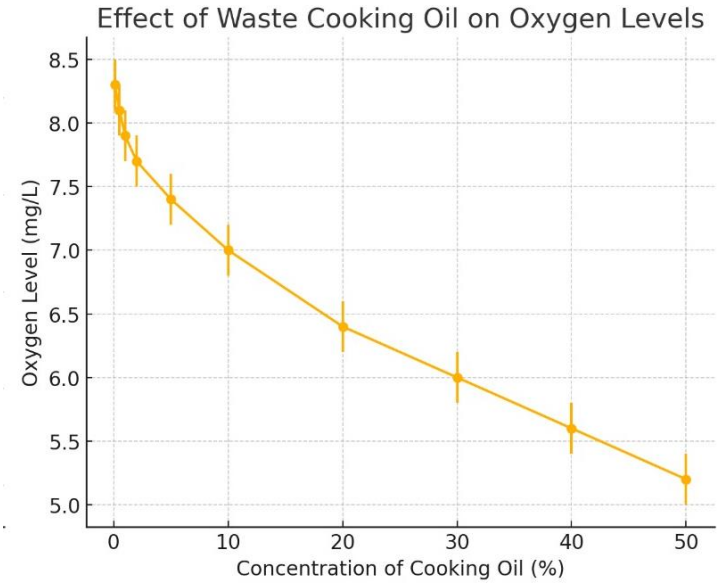
correlation between gasoline concentration and oxygen levels. Oxygen level much like pH shows similar trends where it significantly decreases. (The importance of oxygen and the lack of oxygen seen in Data Analysis)

Graph 3: Effect of Waste Cooking Oil on pH



This graph demonstrates the decrease in pH as the concentration of waste cooking oil increases. The pH drops from 7.2 (neutral) to 5.0 (acidic) as the concentration of cooking oil increases from 0.1% to 50%. The trend is similar to that of car gasoline, indicating a strong negative correlation. Waste cooking oil has much similar impacts on pH levels as gasoline which shows the negative impact it has on the environment.

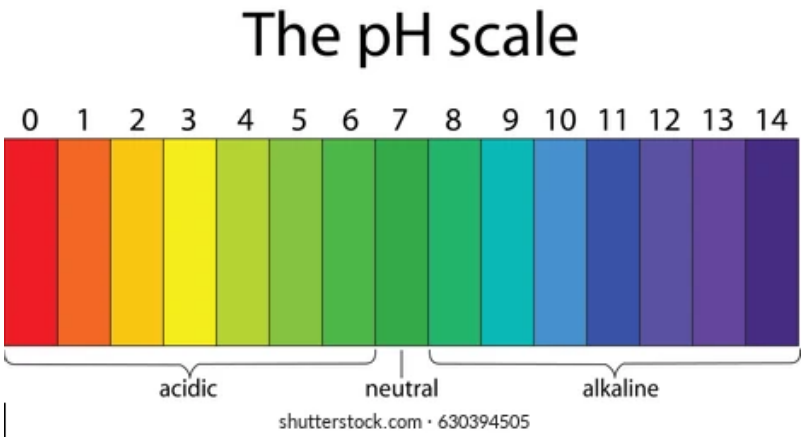
Graph 4: Effect of Waste Cooking Oil on Oxygen Levels



This graph shows the reduction in dissolved oxygen levels as the concentration of waste cooking oil increases. The oxygen level decreases from 8.5 mg/L to 5.2 mg/L as the cooking oil concentration increases from 0.1% to 50%. The trend is linear, indicating a strong negative correlation between

cooking oil concentration and oxygen levels. As expected the cooking waste oil on oxygen levels exhibits much similar destructive impacts.

3.4 pH Color Table: *Table.4*



(Initial pH level of all of the samples started off as 7 $\pm$0.2 which is considered neutral and ideal for the water plant to grow and habitat in shown with the color green)

3.5 Data Analysis and Conclusion

The data collected from the experiment clearly shows that both car gasoline and waste cooking oil have a significant impact on the pH and oxygen levels in lake water. As the concentration of these pollutants increases, the pH of the water decreases, making it more acidic. Similarly, the oxygen levels in the water also decrease, which can be detrimental to aquatic life.

Oxygen is crucial for life to continue both inside and outside of water. However, this experiment is focused on water bodies and water plants (Elodea) therefore the impacts that gasoline and

cooking waste oil has on this organism can clearly be seen. As oxygen levels decrease it becomes harder for plants to live and continue photosynthesis (essentially breathe). This completely disrupts the homeostasis of the lake ecosystem as one organism being affected negatively means other organisms get affected as well like animals that feed of these plants and microorganisms that habitat within these said plants.

Likewise, the decrease in pH levels also have significant negative impacts. A decrease in pH levels mean the water becomes more acidic. Acidic environments are far from ideal when in consideration of plant life and habitat. Acidic environments disrupt the ecosystem entirely and as shown in this investigation it can clearly be seen that both gasoline and cooking waste oil carry these affects along with them.

As the concentrations of gasoline and cooking waste oil increase, the acidity of the samples also increased which shows a direct proportion yet a highly negative effect. The oxygen levels however, showed an inverse proportion yet the same negative effects. Both independent variables showcase disruptive effects on both dependent variables which validates the hypothesis as well. (Showing that the investigation is done with accuracy.)

The graphs illustrate a strong negative correlation between the concentration of pollutants and both pH and oxygen levels. This indicates that as more pollutants are introduced into the water, the water becomes more acidic and oxygen-depleted, creating a hostile environment for aquatic organisms.

The findings of this study underscore the profound impact of human activity pollutants, such as car gasoline and waste cooking oil, on the pH and oxygen levels in Ankara's lakes. The experimental results clearly demonstrate that both pollutants significantly lower the pH of water, making it more acidic, and reduce dissolved oxygen levels, creating a hostile

environment for aquatic life. These changes disrupt the delicate balance of the ecosystem, threatening biodiversity and compromising the overall health of the lakes. The environmental issue of water pollution is not limited to Ankara; it is a global concern. Lakes and other freshwater bodies are vital resources that support ecosystems, provide drinking water, and offer recreational opportunities. When pollutants like gasoline and waste cooking oil enter these water systems, they introduce harmful chemicals that can persist in the environment for years, causing long-term damage. The decrease in pH and oxygen levels observed in this study highlights the urgent need to address the improper disposal of these pollutants. The consequences of polluting lakes extend beyond environmental degradation. Acidic water and low oxygen levels can lead to the death of fish and other aquatic organisms, disrupting food chains and reducing biodiversity. Additionally, polluted water can harm human health, particularly for communities that rely on lakes for drinking water or fishing. The economic impact of water pollution is also significant, as it can reduce tourism revenue and increase the cost of water treatment. To protect our lakes and ensure their sustainability, it is crucial to adopt responsible waste management practices. This includes properly disposing of car gasoline and waste cooking oil, promoting the use of environmentally friendly alternatives, and raising public awareness about the consequences of water pollution. Governments and policymakers must also implement stricter regulations to prevent the discharge of pollutants into water bodies and enforce penalties for violations. In conclusion, the results of this study serve as a stark reminder of the importance of preserving our lakes and other freshwater resources. By taking collective action to reduce pollution, we can safeguard these vital ecosystems for future generations. The health of our environment is inextricably linked to our own well-being, and it is our responsibility to protect it. Let us not pollute our lakes with waste cooking oil and gasoline; instead, let us work together to ensure a cleaner, healthier, and more sustainable future

4. Evaluation

The research done on gasoline and waste cooking oil's operable effects on the pH and oxygen levels in the Lakes around Ankara was helpful in understanding how these pollutants affect the environment. The study had many advantages such as a well defined research problem, controllable factors, and the use of a pH and dissolved oxygen meter to collect data. However, the study was limited in the scope of their approach due to a simplified experimental design which does not accurately model a natural setting of a lake, as well as the short length of the study which only looked at short term impacts. Furthermore, the study only looked at two pollutants and one lake which greatly narrowed their findings. The research could be improved by changing the setting of the experiment to the field, making it longitudinal, and increasing the number of targeted pollutants and lakes. Working with other relevant stakeholders, in addition to local authorities, and using more biological variables could widen the depth and relevance of the study. The essay presented its conclusions, but needs to explain more limitations and discuss the bigger picture more. Ultimately, the research underscores the importance of tackling water contamination. It can be used as a basis for further initiatives to safeguard our lakes and ecosystems. The findings of this study are useful for developing policies and actions dealing with pollution in water sources within Ankara. Awareness campaigns can be organized to inform the public on how to correctly dispose of automobile gasoline and used cooking oil. Moreover, tougher controls on the release of pollutants into lakes and rivers should be enforced.

5. Bibliography

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