# Algae and wastewater reuse

**G11, semester 1, Sharkya STEM school, 2020-2021**

**Group no. 221901**

## Table of Contents

# Introduction

Through our faith in the soul of our Teamwork and working together as one hand.

We are happy to introduce our portfolio to you. This portfolio represents our work, achievements, and the result of the integration between learning outcomes in our study throughout our second year in STEM schools. It is a pleasure to present our ideas in our portfolio, hoping that it will assist the nation to solve its problems and issues. As known, the Egyptian nation faces challenges, and through our work, we will try to solve some of these challenges like Address and reduce pollution fouling our air, water, and soil in addition to, Improve the Sources of Clean Water. The previous challenges are barriers for our country; to reach the desired target, which is sustainable development goals (SDG) and the perfect for the nation so that our project is trying to assist our country in beating these problems.

So, we will do our best to overcome the problem and we will make a new and creative design, that satisfies our needs; using the engineering design process, scientific research, and innovation; achieving a helpful assist for the Egyptian nation. We hope that our work admires your pleasure.

# Present and justify a problem and solution requirements

# Egypt Grand Challenges

Our Egyptian nation tries to achieve sustainable development goals, but a myriad of challenges is hindering and limiting the development. We mentioned some of these grand challenges and what statistics assert about.

- Improve the use of alternative energy.
- Recycle garbage and waste for economic and environmental purposes.
- Deal with urban congestion and its consequences.
- Work to eradicate public health issues/disease.
- Increase the industrial and agricultural bases of Egypt.
- Address and reduce pollution fouling our air, water, and soil.
- Improve uses of arid areas.
- Manage and increase the sources of clean water.

- Deal with population growth and its consequences.
- Improve the scientific and technological environment for all.
- Reduce and adapt to the effect of climatic change.

## Address and reduce pollution fouling our air, water, and soil:

One of the worst challenges, human-made during his Industrial Revolution Development and rare of using scientific methods, is pollution. Due to the pollution, the environmental resources had harmed and damaged like, food, air, and materials we use to make various products that help us in our daily life, and this ensures the extinction of life on our green globe.

### A myriad of reasons engenders pollution for the environment for instances:

The greenhouse gases, the illegal ways for getting rid of the factories' rubbish, and the loose erroneous irritation methods for soil. All these reasons are little mistakes of humans dealing with the environment that can lead to the destruction of the ecosystem. We can divide the pollution's actions with the environment into **three types:**

### Air pollution:

A combination of solid particles and gases in the air as car emissions, greenhouse gases, and harmful chemicals from factories, dust, pollen,

and mold spores may be suspended as particles in the air. The effect of air pollution is catastrophic on human health especially the respiratory system and immune system in general. Surely, similar effects act on plants, in that case, the plant's ability, to make photosynthesis process and generate oxygen, is inquiry affected by the contamination of pollution.

## Water pollution:

*Figure 2 Represents Water pollution effect on water areas.*

The entry of toxic substances into water areas such as lakes, rivers, and oceans, getting dissolved in them, being suspended in the water. This degrades the quality of water. Not only does this spell disaster for aquatic ecosystems making some types of fish endangered with extinction, which affects the food chain of some living organisms. and rendering it toxic to humans or the environment, the pollutants also seep through and reach the groundwater, which might end up in our households as contaminated water we use in our daily activities, including drinking. The furthermost reasons for the contamination are the industrial waste discharge and the sewage of big cities is sometimes thrown in the water, and the most important one is the water used in cooling nuclear power plants which causes a mutation in the species of aquatic creatures.

## Soil pollution:

*Figure 3 Represents Soil pollution effect on environment.*

the presence of toxic chemicals, pollutants, or contaminants in the soil is in high enough meditations to be of risk to plants, wildlife, humans, and of course, the soil itself. Arable land is turning to desert and becoming non-arable at ever-increasing rates, due largely in part to global warming and agricultural fertilizers and pesticides. leading to the inability of the soil to produce plants

or the toxicity of the growing plants in that polluted soil. Soil can be polluted by the burying of nuclear wastes or the waste materials in it, the most common toxic elements found in the soil are lead, mercury, arsenic, and polyaromatic hydrocarbons.

## Manage and increase the sources of clean water:

*Figure 4 Water sources In Egypt*

Water is one of the foremost important substances on earth. All plants If there was no water there would be no life on earth. Water is additionally essential for the healthy growth of farm crops and farm stock and is employed within the manufacture of many products. It is most vital that the water which people drink and use for other purposes is clean water. This suggests that the water must be freed from germs and chemicals and be clear. And that we know that the share of the water on earth is about three percent. And this is often a touch quantity. There is another problem which only about 1.2 percent are often used as drinking water; the remainder is locked up in glaciers, ice caps, and permafrost, or buried deep within the ground. Most of our beverage comes from rivers and streams. Now, many problems have appeared. Like pollution, population growth, drought, and so on. To affect these all problems, we must manage and increase the sources of unpolluted water. Most of the countries try to implement this solution by Educating the population to consume water for only beneficial things, interesting in the water supplies and reservoirs, making new ideas such as convert the wasted water to clean water or convert the water of oceans and seas to freshwater. In Egypt, there are some main resources that we use to get water. The government always works on these water resources to save water and increase them in the future.

## Importance of the improvement of clean water sources:

Improvement of the sources of clean water and reducing the water usage has a great reflection on our nation:

1. Egypt did not suffer from the water poverty problem and supply villages that do not have a water infrastructure until now.

2. It can cover more green areas and increasing the supply of food.

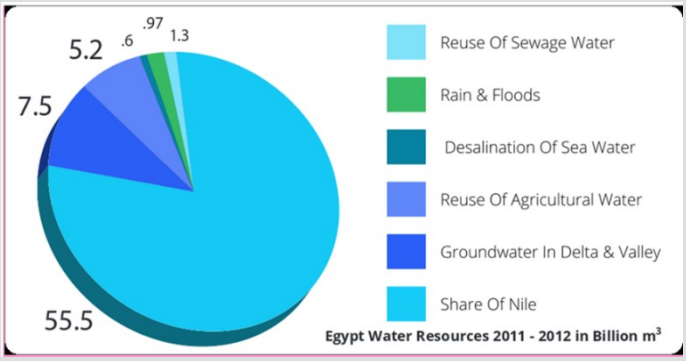


*Figure 5 Represents clean water resources in Egypt.*

3. It can provide water to the industries that depend on it that lead to:
   I. Increasing the national income.
   II. Reducing carbon emissions due to the move to hydroelectric power.

4. Improving the sources of clean water can lead to decreasing the spreading of the diseases and the weakness of the immune system.

## The erroneous consequences of wasting clean water resources:

1. declining in arable land available for agriculture that led to:

   I. decreasing the supply of food.
   II. increasing unemployment levels as.
   III. decreasing the national income.

2. Scarcity of water-based industries

3. After more and more time-wasting water the future generation would not have enough water in everyday life.

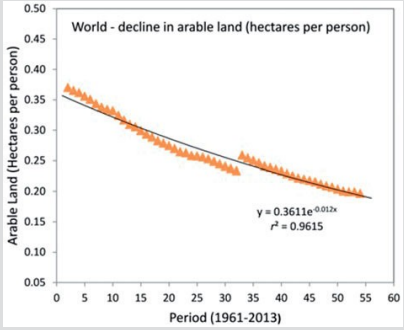


*Figure 6 World-decline in arable land*

4. It may lead to decreasing the immune system and the diseases we became wide-spreading.
5. Until now, many villages do not have water. If we still waste more water, the water will not cover those areas forever.

## Problem to be Solved

### The Address and reduce pollution fouling our air, water, and soil:

*Figure 7 Pollution*

Pollution is the introduction of damaging materials into the environment. These negative materials are called pollutants. These pollutants can be natural such as volcanic ash and big storms or by human activity such as garbage, burned fossil fuels, smoke, and nuclear reactor. The most important things that suffer from pollution on earth are air, water, and soil. In Egypt, water pollutions problems are the most complicated issues than other problems.

Because the sources of clean water in Egypt are limited on the Nile River, precipitations, and groundwater. The reasons for these problems are industrial wasted materials, mining activities, and many other human activities. Air pollution may be a mixture of chemicals, particulate, and biological materials that react with one another to make tiny dangerous particles. It contributes to breathing problems, chronic diseases, increased hospitalization, and premature mortality. Soil pollution has more catastrophic causes on the ecosystem and human health.

## Air Pollution:

## Reasons:

1- After the man used most of the fossil fuels as resources like coal and petroleum in most of his life. However, the combustion of these fuels leads to emitting Sulfur dioxide that can cause respiratory issues such as bronchitis.

*Figure 8 fossil fuel*

2- Agricultural activities by farmers, who burn old crops as the burning of rice straw in October in upper Egypt. Therefore, the ammonia gas is emitted, while it is one of the greenhouse gases and has a loose erroneous impact on health like headaches, respiratory tract, lung damage, blindness, and even death.

3- Another erroneous consequence for the industrial revolution manufacturing industries, that release a huge amount of carbon monoxide, hydrocarbons, organic compounds, and chemicals into the air. Catastrophic causes happen when talking about health headaches, dizziness, vomiting, and nausea.

## Causes:

1- Respiratory and heart problems are the most hazardous bad consequences of air pollution facing the global causing asthma, chronic bronchitis, emphysema, heart attacks and strokes even cancers. Reaching the 4.6 million one dies every year due to air pollution.

2- Global warming with the increasing of emitting the greenhouse gases producing an increase in sea levels and melting of ice from colder regions and icebergs besides of the disasters might face the coastal cities.

3- Acidic rains because of nitrogen oxides and sulfur oxides are delivered into the environment during the consumption of petroleum derivatives. At the point when it rains, the water beads consolidate with these air poisons, become acidic, and afterward fall on the ground as a corrosive downpour. Corrosive downpours can make extraordinary harm to people, creatures, and harvests.

## Water Pollution:

## Reasons:

1- Industrial waste is produced with an incredible amount of waste, which contains toxic chemicals and pollutants, causing air pollution and damage to the environment.

2- Oil spill positions a huge threat to marine life when a large amount of oil spills into the sea

*Figure 9 water pollution*

and does not dissolve in water. It causes issues for local marine wildlife, including fish, birds, and sea otters.

3- Petroleum derivatives like coal and oil, when consumed, produce a significant measure of debris in the air. The particles which contain poisonous synthetics when blended in with water fume bring about a corrosive downpour. Additionally, carbon dioxide is delivered from the consumption of petroleum derivatives, which brings about an unnatural weather change.

**Causes:**

1- The harmful impacts lead to badly affecting on health as bacterial, viral, and parasitic diseases like typhoid, cholera, encephalitis, poliomyelitis, hepatitis, skin infection, and gastrointestinal are spreading through polluted water. It is recommended to examine the water quality on regular basis to avoid its destructive effects on human health. Domestic and agricultural waste should not be disposed of without treatment.

2- Destruction for the aquatic life in water areas as polluted food for aquatic organisms so it will break the food chain for the systems, so the effect touches the human.

3- Issues in planting soils and crops, so an economic disaster will enter countries leading starvation and poverty for a high percentage of global.

**Soil Pollution:**

**Causes:**

1. Mining activities involving the crushing and processing of raw materials, as an example, heavy metals, emitting toxic substances.

2. Agricultural activities involving the diffusion of herbicides, pesticides, or insecticides and fertilizers.

3. The storage of waste in landfills involving because the waste products may leak into groundwater or generate polluted vapor.

## Reasons:

1. Climate change causes deforestation which causes a change in the rain cycle and this contributing factor to global warming.

2. Deforestation is the act of clearing an extensive area of trees. It makes the soil easily carried away by soil erosion. This leaves land barren and incapable of supporting plants.

3. Loss of soil fertility with the quick growth of population and using the chemicals on soil a lot. All of these make food production droplets.

## The management and increase the sources of clean water:

Water on our life has a great impact. If we waste water it will damage our health directly by drink this water or indirectly by transfer diseases to animals, crops, and other organisms, and these diseases will transfer later to the human body.

*Figure 11 water uses.*

So, we should improve the sources of clean water in many ways. For example, river and lake purification help to keep the water clean. we can decrease the usage of nonrenewable resources that emissions many acids that react later with water vapor cause an acidic rain.

The positive consequences of mange and **improve clean water supply:**

## Economically:

### Saving money:

According to water.org there are $260 billion is lost globally each year due to lack of basic water and sanitation this is because of the time spend to seek safe water accounting for billions of dollars in last economic opportunities.

improving access to clean water and sanitation can have a great economic return Improving household water and sanitation access impacts household finances and ultimately the economy at a macro level. For example, access to clean water and a toilet at home can reduce a family's health care costs. Worldwide access to basic water and sanitation would result in $18.5 billion in economic benefits each year from avoided deaths alone. Every $1 invested in water and sanitation provides a $4 economic return from lower health costs, more productivity, and fewer premature deaths.

Empowering families through small, affordable loans: Clean water at home allows women and their families to discover their income-generating potential. Instead of walking to find water, they have time to earn money by doing things like sewing, farming, and teaching. It is with income from these activities they can break the cycle of poverty.

## Social:

It can impact the health care of the people of in the society:

For example, Averted cases of diarrheal disease, Reduced malnutrition, enteropathy, malnutrition-related conditions (stunting), Less dehydration from lack of access to water, and fewer disaster-related health impacts.

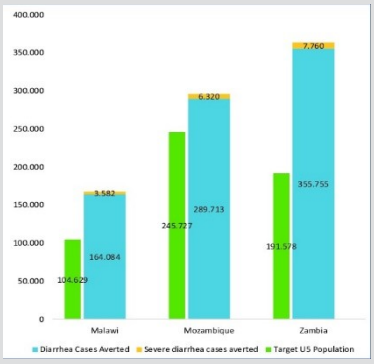

*Figure 12 Averted cases of diarrheal disease.*

It also prevents disease: Fatal medical conditions like cholera, typhoid, and hepatitis A all occur because of the consumption and or the presence of contaminated water.

Helps in Getting Rid of Toxins: Clean, fresh, and clean water also help in getting the body rid of all kinds of toxins, whether they are created due to bodily reactions, acquired from outside sources, or ones that occur because of the consumption of contaminated water.

Needed for Agriculture and Food Production: When it comes to the production of food, safe water is an essential part. If the crops and grains are given dirty polluted water, the bacteria and disease will spread to those who consume the fresh produce. Therefore, water that is used for agriculture must also come from safe and clean resources.

## Environmental:

Water is home to millions of species, ranging from the tiniest organisms measured in microns to blue whales up to 30 meters long and weighing up to 200 tones. Every


*Figure 13 Drought*

year new species are discovered in the depths of the oceans. This why clean water is very essential. Having clean water can help to protect marine life. Leading to the survival of many fish populations. And help in keeping the variety in species in the marine life.

# Research

## We learned from our research about the problem that:

The problem of pollution has become one of the most dangerous problems that faces Egypt in recent years. Egypt has many projects to reduce this problem. And the biggest project in the world for reusing water is the Mahsamma Agriculture drainage plant in Ismailia.

## We learned from our research about solutions that have been tried that:

We have searched about some prior solutions that have been already tried inside and outside Egypt and we gained some information about our challenges like the advantages and the disadvantages of recycling, reduce, and reuse water. We concluded that there are some perfect projects in the world in water treatment, but reuse water is rare. For this, we benefit from the solutions as an explanation of how we can reuse water by changing in the process.

### 1- The topics that we searched about: -

- Water pollution in Egypt.
- Agriculture.
- Drainage water.
- Algae.

### 2- The topics that related to problems: -

- Water pollution.
- Lack of water sources.
- Water usage.
- Agriculture wastewater.

### 3- The topics that are related to solutions: -

- Mahsamma agriculture drainage plant.
- Reverse Osmosis membrane system (RO).
- Ways to reuse water.

# Other Solutions Already Tried

## Ozone Treatment System:

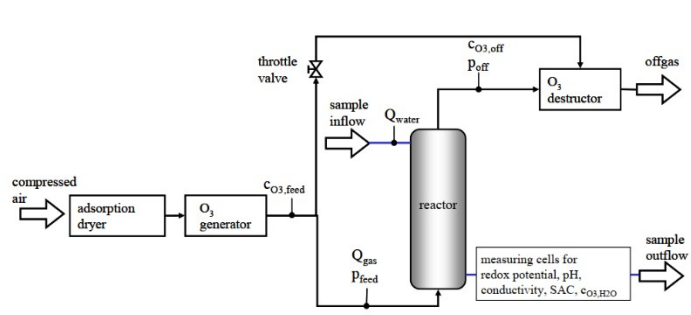


*Figure 14 Represents the ozone treatment process.*

The paper industry is a high-water consumer. The potential of reusing treated wastewater instead of freshwater would allow countries to reduce fresh water consumption. However, treating wastewater from different industries is a challenging problem, as this water contains a great amount of contamination.

One of the solutions that have been done in Germany and Austria is an ozone treatment system. This method utilizes the ability of ozone to split long-chain compounds that are contained in fully biologically treated mill effluents and form inert residual chemical oxygen demand (COD), consequently, making the compounds biodegradable again. This can be considered as decreased COD, an increased biochemical oxygen demand within 5 days (BOD5), and a much higher (BOD5)/COD ratio, showing the improved biodegradability. Also, many parameters rather than biodegradability are affected positively by ozone such as organic load, color, and adsorbable organ halogens (AOX).

Figure (5) illustrates the process. First, ozone is produced from dried compressed air. Next, in the reactor, the ozone-containing gas is passed through a frit and rises through the water to be ozonized. After that, part of the ozone in the gas diffuses into the water, is dissolved, and reacts with substances in the water. Finally, the ozone destructor destroys the ozone that remains in the gas, and the treated water can be used again in different industries.

## Advantages:

1- Advanced water treatment by ozone has many advantages. It reduces the organic load by up to 90%.

2- It is easily maintained.

## Disadvantages:

1- It is not economically worthwhile, as it is considerably expensive.

## Trickling Filter:

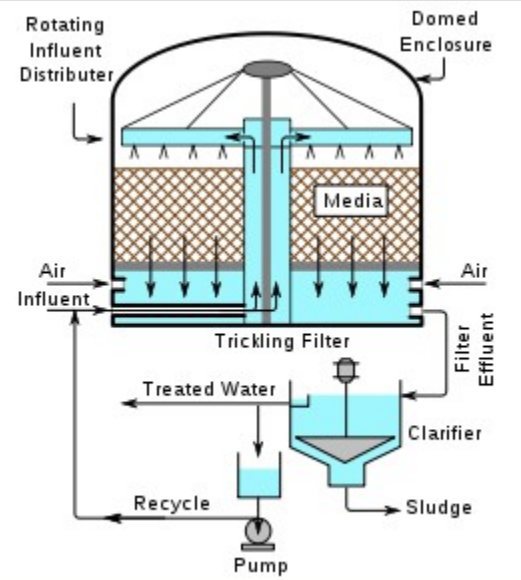


*Figure 15 Represents the Trickling filter process.*

A trickling filter is a bioreactor that uses mineral inert media or plastic as a biofilm substratum. Trickling filter systems have been used in many countries such as turkey and Palestine to treat wastewater from different industries, making them capable of reusing water either in the same industry or in a different one. Trickling filter components are a distribution system, rock or plastic media contaminant system, ventilation system, and underdrain. First, primary effluent is either pumped or flows by gravity to a trickling filter distribution system, where they are distributed over the trickling filter biofilm carriers. The biofilm carriers are made of materials that are of high porosity to avoid clogging and promote ventilation. As the water trickles down, the microorganisms in the biofilm degrade organic matter, nitrify, denitrify, etc. depending on the operating conditions. Figure (15) a complete trickling filter system.

## Advantages:

1- Simple and reliable process that is maintained easily.

2- Very effective in the removal of ammonia from wastewater, which causes many serious problems such as the immediate burning of the nose, eyes, throat, and respiratory tract.

3- The cost to operate a trickling system is very low.

## Disadvantages:

1- After trickling filter treatment, additional treatment may be needed for the effluent to meet discharge standards.

2- Potential for vector and odor problems.

## Reverse Osmosis Membrane System (RO):

*Figure 16 Reverse Osmosis Membrane System.*

Reverse osmosis operation system using spiral membranes is an efficient system to reuse, recycle, and desalinate for water. The spiral membrane system is constructed from a membrane flat sheet, it is comprised of three layers: 1- polyamide layer 2- Polysulfone layer 3- polyester base, a feed channel spacer is used to provide turbulence and creates space between the membrane and wasted water. The system's sheets after being rolled, to form a RO element, can remove 90% of contaminants such as total dissolved solids (TDS), nutrients, chemicals, and microorganisms. A permeate tube coupling is used as a transition for water to transfer from a RO element to another. The number of RO elements are seven. Finally, wasted water flows inside the rolled sheets in a spiral direction and is collected in the core tube as pure water but wastes are rejected by a concentrate pump. Every day 8 million liters are sent off for further treatment.

## Advantages:

1- Low cost for use with popular materials in and can be simplified.

2- Safe on human health and the environment.

3- Maintenance.

4- It has high efficiency for remove contaminants reaches 90%.

### Disadvantages:

1- It removes all minerals for water so, no benefits are found in water for drinking.

2- Acidic water has resulted in low PH.

## Al Mahsamma Agricultural Drainage Plant:

*Figure 17 Al Mahsamma Agricultural Drainage Plant.*

Al Mahsamma agricultural drainage treatment, recycling, and reuse plant have won the best recycling, and reuse of water in 2020. This project is in Egypt, Ismailia, and east of the Suez Canal. The $100m projects, built on an area of 42,000 sqm, was inaugurated by President Abdel Fattah Al-Sisi in April. It holds a daily capacity of 1mcm/day, making it the world's biggest agricultural drainage treatment plant for water recycling and reuse. The drainage works to the automatic operation of the station leads to preserving the technical efficiency of the equipment and ensuring the quality of water throughout its life, noting that the cost of a cubic meter of water produced in the station amounts to 35 piasters. The plant aims to treat wastewater that will be transported by siphons from the west of the Suez Canal to irrigate Sinai lands with an approximate control of 60,000 acres at a disposal of about 1 million cubic meters/day, and it will carry out the transfer and transit of one million and 250 thousand cubic meters of drainage water per day to the east of the canal to irrigate and cultivate about 60 One thousand acres in Sinai to be added to the agricultural area. The salinity level of entry into the Mahsamma plant in Ismailia is the same as the salinity of the exit from the plant for

reuse in agriculture. Al Mahsamma forms part of Egypt's advanced and multi-pronged approach to ensuring the country's water security through wastewater treatment, desalination, and the preservation of natural water resources. The plant's daily capacity will contribute to the conservation of the natural ecology of the Al Temsah Lake, located west of the Suez Canal, which has been impacted by wastewater disposal.

## Advantage:

**1-** Very big project in this field

**2-** Low cost

**3-** Save a large amount of wasted water.

## Disadvantage:

**1-** It does not remove all pollutants from water, so the water is usually used for agriculture or industry.

# Generating and Defending a solution

# Solution and Design Requirements

As any project has design requirements, that calculates the range and the level of success of the solution so, according to us and our project the work was as possible to increase the characterizes of the prototype and its success, so we pushed hard to accomplish as possible as design requirements and our design requirements are:

1- Safety
2- Low cost
3- Applicability
4- Simplicity
5- Efficiency
6- Eco friendly

## First safety:

Is the first and most crux point that design requires is solving any problem, a safe way to go on should be chosen, in order not to cause other problems that cannot be solved.

## Second low cost:

The solution must solve the riddle using low cost by using cheaper material in the prototype and this solves the problem with more efficiency.

## Third applicability:

The solution can be made in real-life or no and mean if the solution can work or be applicable and feasible. That measure by showing the prototype, test plan, and results. Measuring this design requirement by making the prototype can work and be a real project.

## Forth simplicity:

The prototype is very simple and consists of very cheap, simple, and available materials to increase the ability to use the solution.

**Fifth efficiency:**

This point is depending on the applicability of the prototype and the accuracy of the result, the prototype has high efficiency on the product, water, and in the second procedure.

**Sixth eco-friendly:**

That our solution does not harmful to the environment and can increase the green land in the Egyptian nation.

## The design requirements, that are suitable for this capstone:

### 1. Low-Cost:

The prototype must be made with cheap materials.

### 2. Eco-Friendly:

Our target is to make the prototype from widespread materials in the ecosystem as much as possible.

### 3- Water Quality:

The project should reduce the total dissolved solids in water (TDS). Also, keep the water pH as normal as it can, and finally, the dissolved oxygen saturation should be saved (DOS).

# Selection of solution

During the research journey about the approach for solving the problem and by the prior solutions. We found that the total amount of water in irrigation in Egypt is increasing at a high rate and Our capstone project's main idea is to frustrate the water wasting by reducing the water pollution. Immense quantities of water are wasted but can be harvested, the irrigation for the agricultural areas is considered as one of the vast processes in wasting water. However, the edit in the process is skeptical and simple. Algae is overspread in our nation and its usage will decrease the total dissolved minerals in water and save its PH. Also, so the excess water can be reused in the same process and irrigation for different soils. Therefore, the addition of algae on the soil in agricultural areas will allow the water to be less polluted and achieve our design requirements that are low cost, eco-friendly, and the water quality.

## Parts of the Prototype:

1- Container

2- pipe

3- Part of Soil

4- Chlorophyta algae

## Container:

this is the base of our prototype where soil will be put, and pipe will be joined. Its importance is to protect the prototype and joined together.

## Pipe:

the joining tool between the container and cylinder as it is the path for excess water to be collected.

## Part of Soil:

The main part for our tests and prototype. That water will path on it and will decide the amount of excess water.

### Chlorophyta Algae:

The crux part for the prototype and the solution for decreasing the water contaminants. It will be put on the soil where the water will pass.

## Selection of Prototype

For the seek of reducing wasting water, the decision was algae in problem-solving in the prototype for this semester, which depends on absorbing chemicals in the water as nitrates and phosphate, by adding them to the soil. Therefore, the excess water will be less polluted and with preserving the water's PH scale. Also,

the soil will be protected from excess chemicals from the chemical fertilizers, so the lifetime of the fertility of the soil will be increased not restricted.

This prototype meets our four design requirements, first one is a high efficiency, as our prototype can reduce the water pollution and its wasting in real life with insignificant limitations, the second one is the low cost while the algae are available in our nation in the high spread. the third one is the eco-friendliness, as it does not pollute the environment and protect the environment resources, the fourth one is water quality as our project must be with fewer total dissolved solids and the water's PH is preserved and finally, the dissolved oxygen will not be affected.

## Our Prototype has two test plans:

1. **The excess water:**
   By analyzing the water's PH and the total dissolved solids (TDS).

2. **Algae's percent to the water:**
   Testing the suitable amount for using the algae on soil for water. By calculating the excess water results.

# Constructing and Testing a Prototype

# Materials and Method

## Materials:

| Item | Description | Quantity | Usage | Price | Image |
|---|---|---|---|---|---|
| 1 | Box from wood | 1 | Representing the agriculture area | 70 L.E |  |
| 2 | Water PPR pipe | 27 *cm* | To drainage the farmland .through it | L.E 5 |  |
| 3 | Soil | 4 *Kg* | The farmland | ..... |  |
| 4 | Motor | 1 | Powering the device of irrigation | .... |  |
| 5 | Key (switch) | 1 | Control the device of irrigation | L.E 5 |  |
| 6 | Water bottle cap | 3 | Making a small fan to spread the water | ..... |  |
| 7 | Water hose | 3 *m* | Suctioned and distributed water | L.E 3 |  |
| 8 | Battery | 1 | Give energy to the motor | L.E 3 |  |

The overall cost for designing and testing the project is **91 L.E**.

## Methods:

1- We prepared a box from wood with 38cm length, 27cm width, and 17cm height. To represent the area of agriculture. (fig.18)

*Figure 18 The Box*

2- We put a plank of wood at 28cm of the length of the box. To split the box into two parts. The first part is a simulation of the farmland and the second part is the simulation of the canal which is used for drainage and irrigation of the farmland.

3- We made a circular hole in the plank with a radius of 2cm to put a 27cm water PPR pipe in it and across the area of the farmland. This pipe has small holes in it to be the source of drainage for farmland. (The way of agriculture drainage). (fig.19)

*Figure 19 The pipe*

4- We make a device to irrigate the farmland by using some simple materials. First, we get the small motor and affixed it in one bottle cap. Second, we made a shape of a fan by another bottle cap and put it in the motor. Third, we close the first bottle cap with another. Finally, we made two holes in the final shape and put a water hose in each one. And first water hole relates to the canal and the second relates to the farmland. Same as the figure (20). This device is used to transfer the water from the canal to the farmland. (The way of agriculture irrigation).

5- To make the water applicable again, we used algae. The function of algae is to absorb all the nutrients and pollutants in water. We planted the algae in the canal to be grown. And our device suctioned the water with algae to distribute and spread out them on the farmland. The farmland will irrigate with clean water and benefit from algae as fertilizers.

*Figure 20 the device*

# Test plan

Any project must be tested to know if it is successful or not. Our prototype was tested more than once to make sure that the project achieved the design requirements which are: low-cost, eco-friendly, and water quality. Each time the test plan was done, a new problem appeared but was handled. The prototype was developed then we did a test plan again until we obtained the best result.

## The design requirements:

### 1. Low-Cost:

The prototype must be made with cheap materials.

### 2. Eco-Friendly:

the prototype should not have any carbon footprints in the Eco-system and restrict the pollution for the environment.

### 3- Water Quality:

the project should reduce the total dissolved solids in water (TDS); to be between 200 and 500 mg/L. Also, keep the water PH near to 7 as it can and finally the dissolved oxygen saturation should be saved (DOS) to be 5 mg/L.

## Steps of doing the test plan:

1-We get the wasted water from Egyptian agriculture drainage.

2-We divided the water into 4 beakers and each beaker with 250 ml of water.

3- We measured the TDS and PH of each beaker and record them as the results before modifying.

4-We get some amount of life algae which is green algae. Then we weight it (by using Digital balance) and put specific different masses in each beaker.

*Table 1 samples Algae mass*

| $Algae_{mass}$ | *Sample 1* | *Sample 2* | *Sample 3* | *Sample 4* |
|---|---|---|---|---|
| *Value* | 300.38 *gm* | 277.4 *gm* | 418.76 *gm* | 194.43 *gm* |

5- We kept it for one week in a good place and after that, we separated the algae from the water. Finally, we measured the TDS and PH of each beaker after the purification of water.

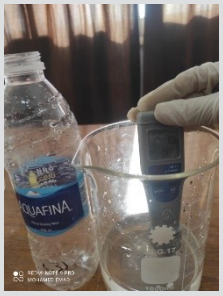


*Figure 21 testing PH sample 3.*

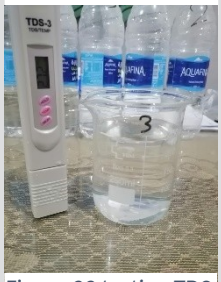


*Figure 22 testing TDS sample 3.*

Our prototype is only a simulation of the farmland and irrigation and drainage process.it represents the way that we used the algae to purification the water and reuse it in irrigation again. Finally, our prototype is matched all the design requirements. Because we did not affect the water quality, our materials are very simple, available, and little cost, the prototype is Eco-friendly, and the project has high efficiency, and it is equal TDS efficiency is 60.54% and PH efficiency is 100%.

# Data Collection

After we test our prototype and measured the TDS and PH of each sample.

Using the following tools, we managed to test the TDS and PH of our **project:**

TDS-3: For measure TDS

PH meter: To calculate PH

Digital balance: To measure algae mass and beakers' mass.

The first is to measure the TDS of each sample (using TDS-3). And we calculated all results before and after adding algae and it is shown in the following **tables:**

*Table 2 samples TDS before adding algae.*

| $TDS_{before}$ | *Sample 1* | *Sample 2* | *Sample 3* | *Sample 4* |
|---|---|---|---|---|
| *Value* | 687 | 691 | 690 | 688 |

*Table 3 Samples TDS after Adding Algae.*

| $TDS_{After}$ | *Sample 1* | *Sample 2* | *Sample 3* | *Sample 4* |
|---|---|---|---|---|
| *Value* | 326 | 399.3 | 272.3 | 442.6 |

And the decrease in TDS between after and before is shown in the following **graph:**

Second, we measured the PH of each sample (using a PH meter). And we calculated all results before and after adding algae and it is shown in the following **tables:**

*Table 4 Samples PH before adding algae.*

| $PH_{before}$ | *Sample 1* | *Sample 2* | *Sample 3* | *Sample 4* |
|---|---|---|---|---|
| *Value* | 8.05 | 8.04 | 8.01 | 8.00 |

*Table 5 Samples PH after Adding Algae.*

| $PH_{After}$ | *Sample 1* | *Sample 2* | *Sample 3* | *Sample 4* |
|---|---|---|---|---|
| *Value* | 7.2 | 7.3 | 7 | 7.4 |

And the decrease in PH between after and before is shown in the following **graph:**

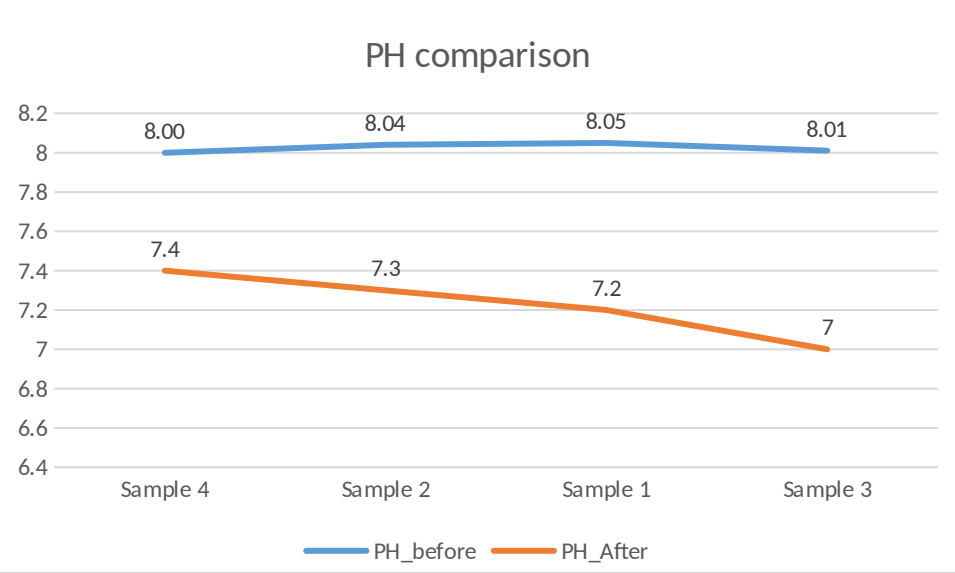


*Figure 24 PH Comparison*

After that, we calculated the efficiency of the TDS and PH by using the following **equations:**

$$The\ efficiency\ of\ TDS = \frac{TDS_{old} - TDS_{new}}{TDS_{old}} \times 100$$

$$The\ efficiency\ of\ PH = \frac{\left|PH_{new} - PH_{old}\right|}{\left|PH_{old} - 7\right|} \times 100$$

And the calculated efficiency numbers for each TDS sample.

**Efficiency TDS:**

$$The\ efficiency\ of\ TDS_{sample\,3} = \frac{TDS_{old} - TDS_{new}}{TDS_{old}} \times 100 = \frac{690 - 272.3}{690} \times 100 = 60.54\,\%$$

$$The\ efficiency\ of\ TDS_{sample\,1} = \frac{TDS_{old} - TDS_{new}}{TDS_{old}} \times 100 = \frac{687 - 326}{687} \times 100 = 52.55\,\%$$

$$The\ efficiency\ of\ TDS_{sample\,2} = \frac{TDS_{old} - TDS_{new}}{TDS_{old}} \times 100 = \frac{691 - 399.3}{691} \times 100 = 42.21\,\%$$

$$The\ efficiency\ of\ TDS_{sample\,4} = \frac{TDS_{old} - TDS_{new}}{TDS_{old}} \times 100 = \frac{688 - 442.7}{688} \times 100 = 35.65\,\%$$

And it is shown in the following table:

*Table 6 TDS efficiency*

| *Efficiency TDS* | *Sample 1* | *Sample 2* | *Sample 3* | *Sample 4* |
|---|---|---|---|---|
| *Value* | 52.55 % | 42.21 % | 60.54 % | 35.65 % |

This graph represents the efficiency for TDS of each **sample:**

*Figure 25 TDS efficiency*

Then the calculated efficiency numbers for each PH sample.

**Efficiency PH:**

$$The\ efficiency\ of\ PH_{sample\,3} = \frac{|PH_{new} - PH_{old}|}{|PH_{old} - 7|} \times 100 = \frac{|7 - 8.01|}{|8.01 - 7|} \times 100 = 100\,\%$$

$$The\ efficiency\ of\ PH_{sample\,1} = \frac{|PH_{new} - PH_{old}|}{|PH_{old} - 7|} \times 100 = \frac{|7.2 - 8.05|}{|8.05 - 7|} \times 100 = 80.95\,\%$$

$$The\ efficiency\ of\ PH_{sample\,2} = \frac{|PH_{new} - PH_{old}|}{|PH_{old} - 7|} \times 100 = \frac{|7.3 - 8.04|}{|8.04 - 7|} \times 100 = 71.15\,\%$$

$$The\ efficiency\ of\ PH_{sample\,4} = \frac{|PH_{new} - PH_{old}|}{|PH_{old} - 7|} \times 100 = \frac{|7.4 - 8|}{|8 - 7|} \times 100 = 60\,\%$$

And it is shown in the following **table:**Table 7 pH efficiency

| *Efficiency PH* | *Sample 1* | *Sample 2* | *Sample 3* | *Sample 4* |
|---|---|---|---|---|
| *Value* | 80.95% | 71.15% | 100% | 60% |

This graph represents the efficiency for the PH of each **sample:**

*Figure 26 PH efficiency*

**Test Plan Precision:**

To make our result more precision we make four samples and measure the mass of the algae that added to the backers three times and take the average to reduce the error as much as we could. And we did that also in the TDS and PH.

# Evaluation, Reflection, Recommendation

# Analysis and Discussion

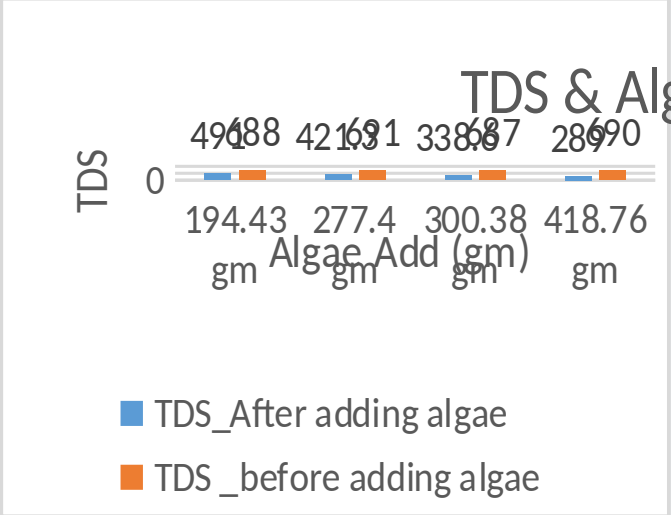


*Figure 27 TDS & Algae.*

Many grand challenges face Egypt every day and increased among years like pollution, lack of water sources, recycling. For this, our project is working on increase the sources of water by little cost on the country. So, we used algae to absorb all the chemicals, nutrients, and phosphates from drainage water. This will make the water applicable again and farmers can reuse it. We chose algae because it is a natural plant in our life, very cheap, and available on any land. We make the test plan on our project on four samples of water each sample with a varied number of algae. After one week, we split the algae from water and measured the TDS and PH of the water. After examining data of the test plans from the four samples, our solution accomplished the three main design requirements which are, inexpensiveness, eco-friendliness, and high-water quality. Subsequently fixing all problems we confronted by altering the egregious algae and preparing the water samples, the high-water quality design requirement's efficiencies. So, the pH test on the samples, which reached an efficiency of 100%, besides, the TDS test, which has an efficiency of 60.54%. This means that the number of algae is inversely proportional to the TDS and PH test same as fig. 27 & 28. These results

*Figure 28 PH & Algae.*

showed that the solution can unravel the overusing water in agricultural practices during the irrigation process. Thus, it can be an answer key for the pollution of soil, water, and air, besides, improving and increasing the sources of clean water. Since these two grand challenges have antagonistic relations. In our prototype, we used simple materials and all of them are available. This makes our project little cost. The project is applicable to achieve it in the real life. Because all the materials are available on large scale.

# Recommendations

If the agriculture wastewater has a huge number of heavy metals, we recommended using a Rose Nile to reduce this amount to the normal range. But one of the disadvantages of Rose Nile is that it evaporates around 1 liter per day of water. We can also substitute Green Algae (Chlorophyta) with Azolla that can clean water.

Microalgae-derived products have multi-functional properties in agriculture, facilitating nutrient uptake, improving crop performance, physiological status, and tolerance to abiotic stress. Thus, we suggest using this type of algae instead of Green algae hence, we do not have the axis to use it.

As we know, there are many types of soil, but we focus on this project in Clay soil, so we also recommend using the type of soil.

# Learning Outcomes

| Name of subject | Code | How it is useful for us |
|---|---|---|
| Chemistry | CH.2.01 | Quantitative analysis to define the pollution in the water and each concentration to work on water quality. Especially, we used TDS and we measured it by ppm. Resins and EDTA. We took these as examples to know what the mechanism of purification of water is and how we will reuse the water by editing the process or adding something to it. |
| Chemistry | CH.2.02 | We learned about water and its properties. This helped us to know the effect of the solutes on the physical or chemical properties of water. |
| Chemistry | CH.2.03 | We learned about the PH of water and this helps us to measure the PH and what are the sequences of adding any solute on the PH. |
| Geology | ES.2.01 | We used the description of water to define our problem and know what the pollutants of water are. |
| Geology | ES.2.02 | We used the factors that affect the water quality to define our solution. |
| Geology | ES.2.04 | We learned about pollution in surface water, kinds of the pollutants of water, and the wastewater in the world and its consequences. This helped us to determine our problem and its solution. |
| English | EN.2.01 | Thesis statement and how to write it to summarize a paragraph and to get the most important points. |
| Computer science | CS.2.02 | **Databases are structured to facilitate the storage, retrieval, modification, and deletion of data in conjunction with various data processing operations.** A data table may be a group of related facts arranged in |

| | | |
|---|---|---|
| | | labeled rows and columns and is employed to record information. Its purpose is to assist sort, analyze, and compare data gathered from a science experiment or scientific research. |
| Math | MA.2.01 | Functions and mathematical equations have a real direct connection with our capstone first leaner function is the function that expresses the relation between two factors are connect Positive and the opposite relationship we can use this function to Express the relation between two factors Whether it was expelled or reverse like: the relation between TDS and number of Algae. |
| Physics | PH.2.03 | We learned from electricity and the flow of dynamic electricity to construct our prototype. Also, we benefit from the electric current and potential difference to know how many volts that the motor need. The types of connections were very useful too. And we used it to connect the batteries to get the total volts which we needed. |

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