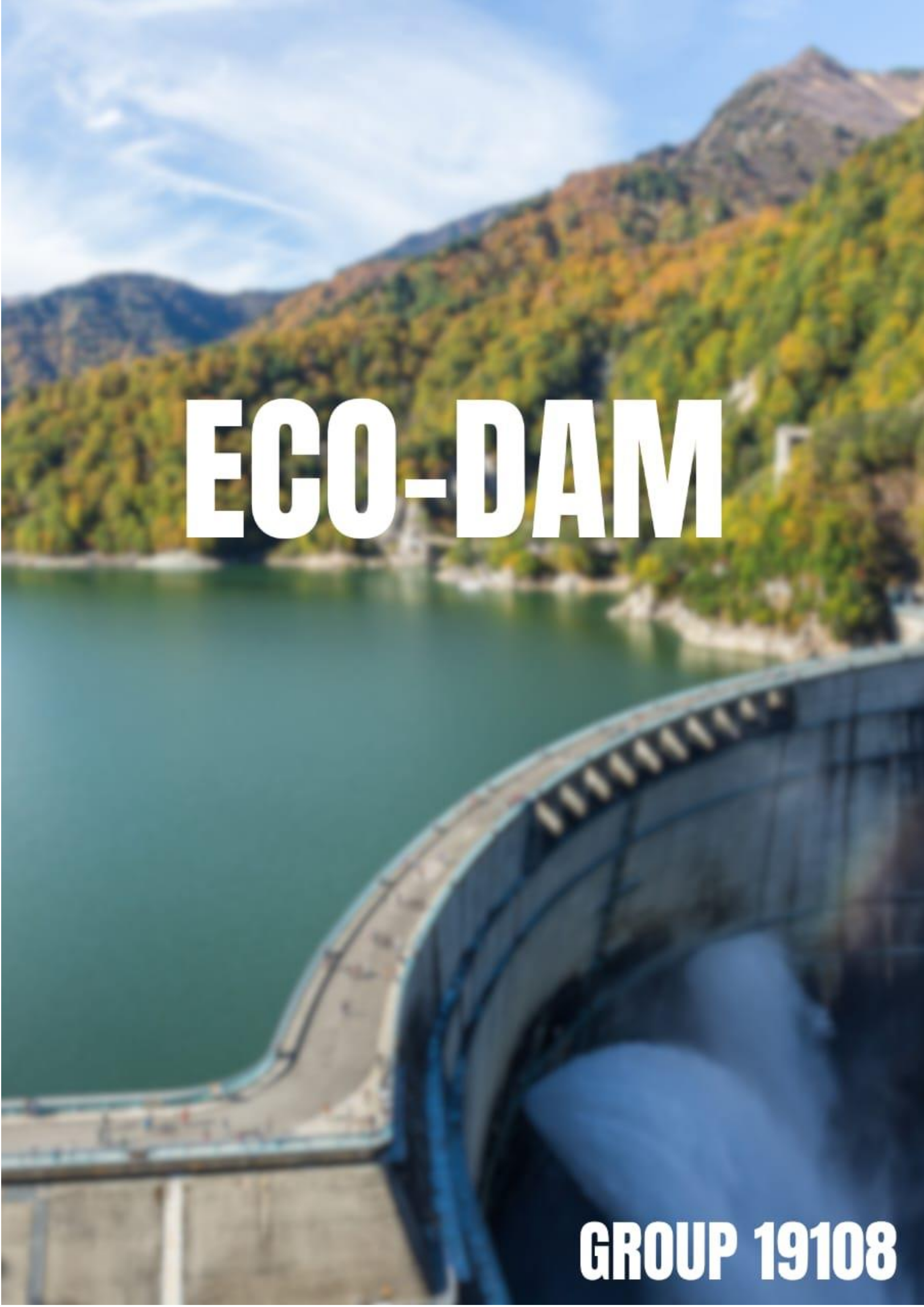
ECO-DAM



GROUP 19108

ECO-DAM

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• Chapter 1

! | present and Justify a Problem and Solution Requirements

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• Egypt Grand Challenges

Present and Justify a Problem and Solution Requirements

Water scarcity

Life is impossible without water. Water is crucial not only for human but for the entire ecosystem. **water Scarcity** makes it extremely difficult for humans and animals to survive. Water is the most critical natural resource necessary for the existence of all living beings.

Figure (1): Water Scarcity

Degrading water quality and making it hazardous to humans or the environment, water pollution happens when undesirable substances—typically chemicals or microorganisms—contaminate a stream, river, lake, ocean, aquifer, or other body of water.

The pervasive issue of water pollution is endangering our well-being. More people are killed annually by unsafe water than by war and all other types of violence put together. Our supplies of drinkable water are limited, though: We can actually access less than 1% of the freshwater on Earth. If nothing is done, the problems will only get worse by 2050, when there will likely be a third more freshwater used globally than there is currently.

Water is essential for economic growth, the health of ecosystems, and life itself. It is the lifeblood of a healthy world and people. However, a global water crisis currently threatens growth, with over 2.3 billion people missing access to safe drinking water and 3.6 billion lacking proper sanitation.

Water insecurity is thought to cost the world economy up to 500$ billion annually. A growing population worsening droughts and flooding brought on by climate change exacerbate the issue. Accelerating change is necessary in order to handle the water situation.

We need to conserve water to contribute to better sources of water thus, the gradual demand on water would decrease and by that point, building a dam can help in conserving the water in addition, providing a better quality of life for citizens. (Unwater, 2015)

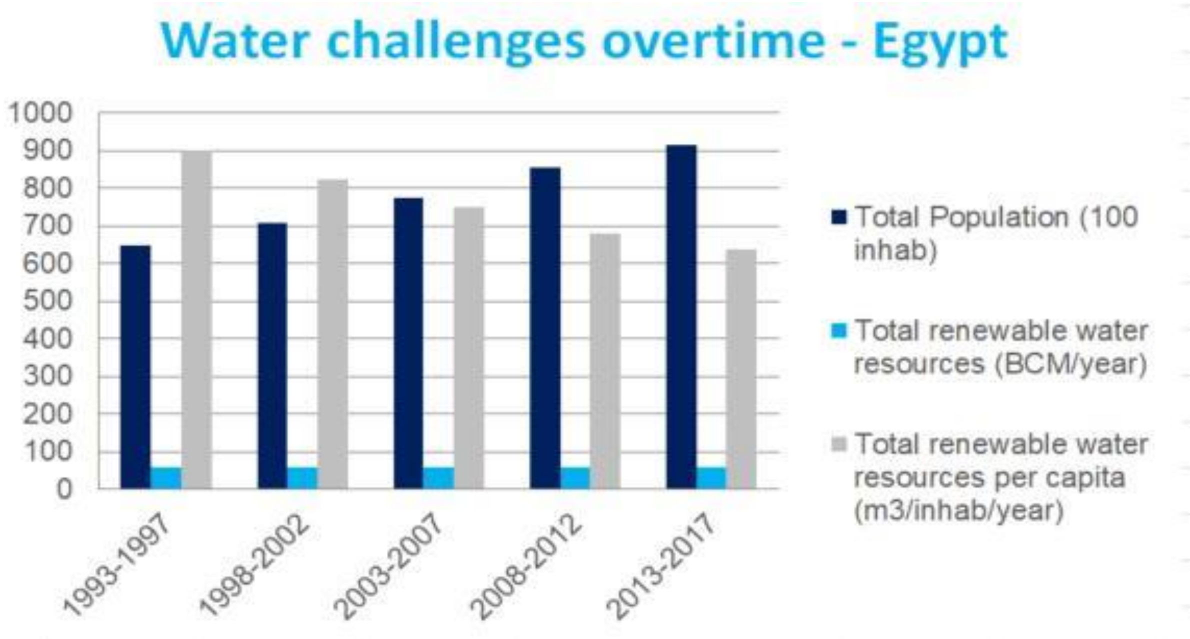


Figure (2): Water challenges Overtime in Egypt index

Urban Congestion

Urban congestion is the dynamic development of urban areas poses increasingly more challenges for the provision of transport services for the population. The concentration of the economic potential and population in the metropolitan areas results in the occurrence of large transport needs, and when these needs are met at the same time, the phenomenon of congestion occurs. Research the relationship between various factors contributing to congestion in urban traffic and the level of congestion in Egypt cities is very important.

Figure (3): Urban Congestion in Egypt

The research has shown that the most statistically significant relationships have occurred in the case of the number of business entities and the number of passenger cars. It can be concluded that the demand side factors are more important in Egypt cities than the supply side factors or perhaps the current transport policy is ineffective. When effectively applied, transport policy instruments can play special role.

These instruments can contribute to reducing congestion in various ways, i.e. by implementing various sub-objectives, which include reducing the need to travel, reducing the use of passenger cars, improving the functioning of public transport and use of the infrastructure. The results of this study can be useful for transport policy makers at central, regional and local levels. The concentration of the economic potential and population in the metropolitan areas results in the occurrence of very large transport needs in a spatially limited area, and when these needs are met at the same time, the congestion occurs. This applies to congestion in respect of both the road network and the vehicles. Significant disproportions between the transport needs and the possibilities of their meeting at the desired level of quality can be seen also in EGYPT cities impact on economic, social, and environment development.

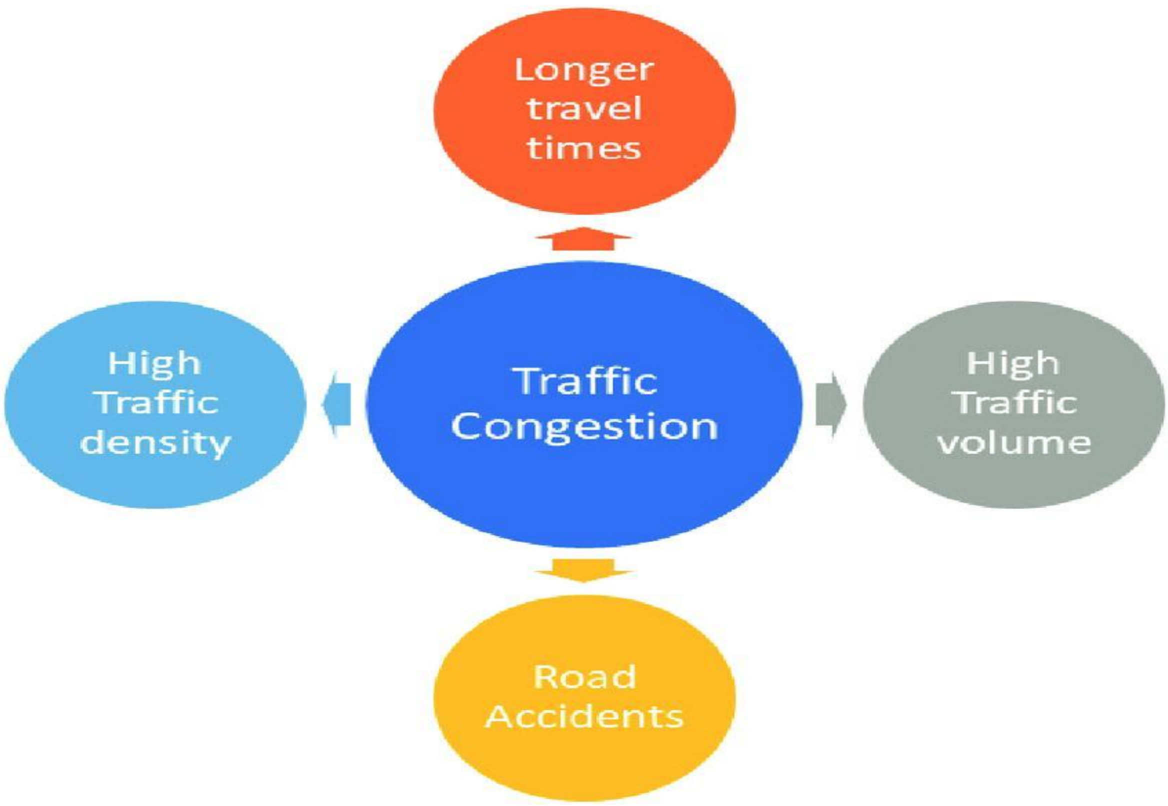


Figure (4): Urban Congestion impacts

From the economic point of view, congestion generates an increase in the costs of transport. The costs of congestion include costs of delays, growing operating costs of vehicles (mainly fuel), emissions of pollutants, as well as costs of stress resulting from disturbances in the vehicle traffic Cairo traffic has gotten worse over the past few year, causing nation to lose a lot of money and its citizen to suffer and Cairo S traffic congestion may cost the city Economy up to 4% of GDP per year. According to a recent study by the world bank title " Cairo traffic congestion "at least 4000 Careens are injured and 1000 careens die each year in traffic related accidents, of which more than half are pedestrians. The same Study claims that the capital S congestion problem costs the country 50 billion EGP a year, which is four percent of EGYPT's GDP (Gross Domestic Product). This is four times the amount lost by cities of the same size the figures are calculating the loss of productivity due to extended travel times and the environment impact of increased vehicle emissions. (Koźlak, 2018)

Recycling Garbage

The way our society handles waste is not only very worrying but is also becoming increasingly dangerous. Analyzing the link between greenhouse gas emissions and landfills, researchers found that landfills produce 20% of all methane emissions caused by human activities, of which Open waste burning accounts for 91% of methane emissions from landfills. Since this is how more than 65% of waste in the United States is disposed of, there are still many threats to our atmosphere and the residents living near these fire pits.

Figure (5): Recycling in Egypt

According to an OECD study, global plastic waste production has doubled in the past 20 years. Most of this waste is processed in landfills, burned or seeped into the environment. Research shows that as incomes and populations increase, laws aimed at stopping plastic waste leaks are not keeping pace. OECD countries produce about half of the world's plastic waste, with annual plastic waste per capita ranging from 221 kg in the United States to 69 kg in Japan and South Korea.

In many developing nations, rising rates of urbanization, population growth, and economic expansion result in an increasing amount of solid garbage being produced. One of Egypt's major issues is the handling of solid waste. Egypt currently produces around 95 million tons of solid garbage annually from a variety of industries. The amount of garbage generated per person varies according on household size and economic status, ranging from 0.2 to 0.6 kg. (Network, E. D, 2023)

Climate Change

Long-term changes in temperature and weather patterns are commonly referred to as **Climate Change**. These changes may be organic, but since 1800, human activities have been the primary cause of Climate Change. This is mainly because burning fossil fuels, such as coal, oil, and gas, releases gases that lead to global warming. (National Geographic, 2023)

Figure (6): Air pollution is a form of climate change.

There are two categories of factors for climate change: **natural** factors, and **human** factors. The climate change's natural factors go back to Long before people existed, the globe experienced periods of warming and cooling. The sun's intensity, volcanic eruptions, and variations in the amounts of naturally existing greenhouse gases are some of the forces that can cause climate change. However, data show that the current rate of global warming—especially since the mid-20th century—is far quicker than in the past, and it can’t be explained by natural factors alone. "These natural causes are still in play today, but their influence is too small, or they occur too slowly to explain the rapid warming seen in recent decades,"(writes NASA)

The climate change's human factors can be represented in these points: **1.** The main cause of emissions produced by humans is the combustion of fossil fuels like coal, oil, and gas for transportation, heat, and electricity. Deforestation releases sequestered (or stored) carbon into the atmosphere, an average of 8.1 billion metric tons of carbon dioxide are released annually by logging, clearcutting, fires, and other kinds of forest degradation: this amounts to more than 20 percent of all carbon dioxide emissions worldwide, leading to global warming. **2.** The usage of fertilizer, which is a major source of nitrous oxide emissions, the raising of livestock (cattle, buffalo, sheep, and goats are big methane emitters) , furthermore landfills sites that increase CH4 Gas , and some industrial processes that create fluorinated gases are other human activities that contribute to air pollution. **3.** Road development and agricultural practices, for example, can alter the earth's reflectivity, causing local warming or cooling. (IEA, 2023)

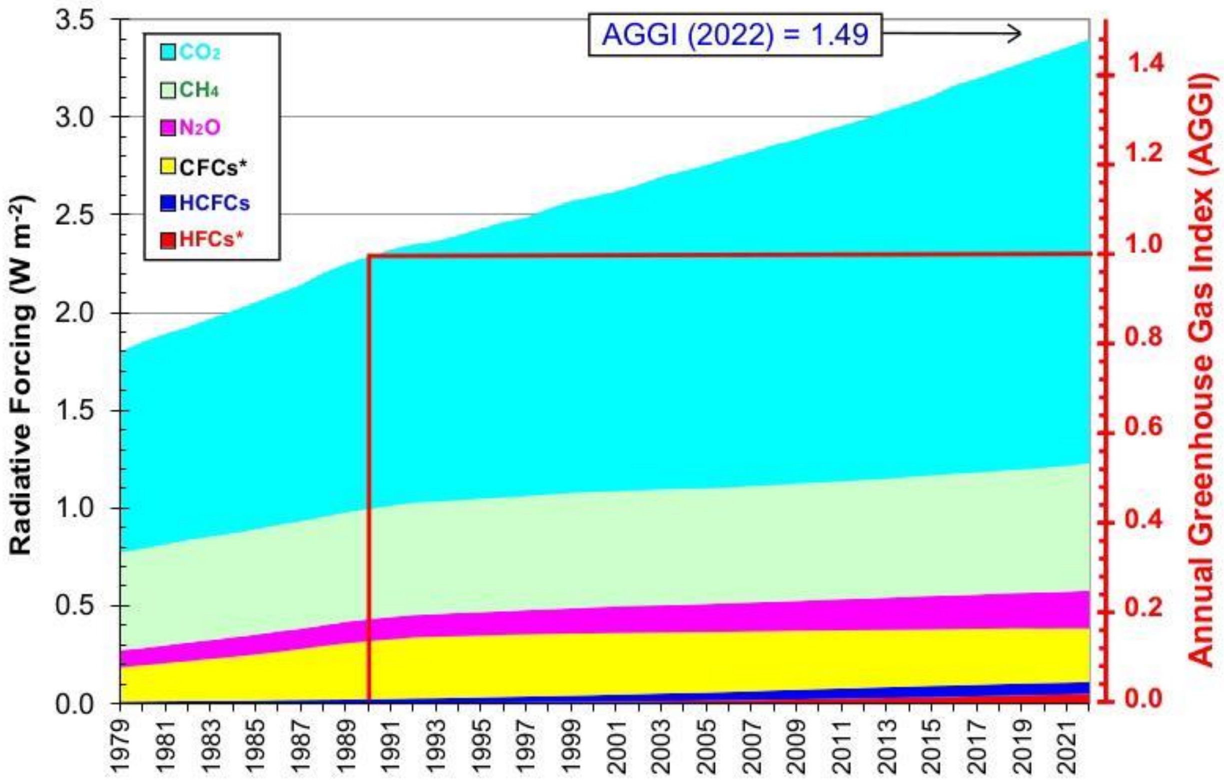


Figure (7): Annual Greenhouse Gases Index (AGGI)

Climate change is causing Egypt's arid climate to face additional environmental stresses, including extreme temperatures, irregular precipitation, elevated sea levels, coastal flooding, shoreline erosion, deteriorating soil salinity, and persistent drought. These impacts will worsen water scarcity, hinder food security, displacing exposed populations, and destabilizing the Egyptian economy.

Figure (8): Alexandria 12 Jan 2023 Flood

UNESCO lists Alexandria as one of several Mediterranean cities that should be tsunami prepared by 2030.

The rising temperatures are predicted to increase by 21°C by the middle of the century and 4.4°C by the close of the century, with areas like South Sina and Aswan being particularly vulnerable. Heat stress is the most immediate impact of atmospheric warming, with heat-related mortality expected to increase by up to 47 times by 2080. This is particularly concerning for lower-income residents in informal settlements, who may lack reliable air conditioning due to reduced government subsidies. Heat-sensitive populations, such as pregnant women, young children, the elderly, and those with chronic health conditions, will also be more vulnerable. Rising temperatures will also affect livestock and crops, resulting in reduced crop yields and decreased milk and meat production. Elevated temperatures will disrupt Egypt's domestic food supply chains, leading to increased water demands and potential food price surges. Additionally, decreased rainfall or irregular precipitation could be detrimental. To address these emerging climate risks and manage communal vulnerabilities, robust climate governance is urgently needed. (Kim & Bourhrous., 2023)

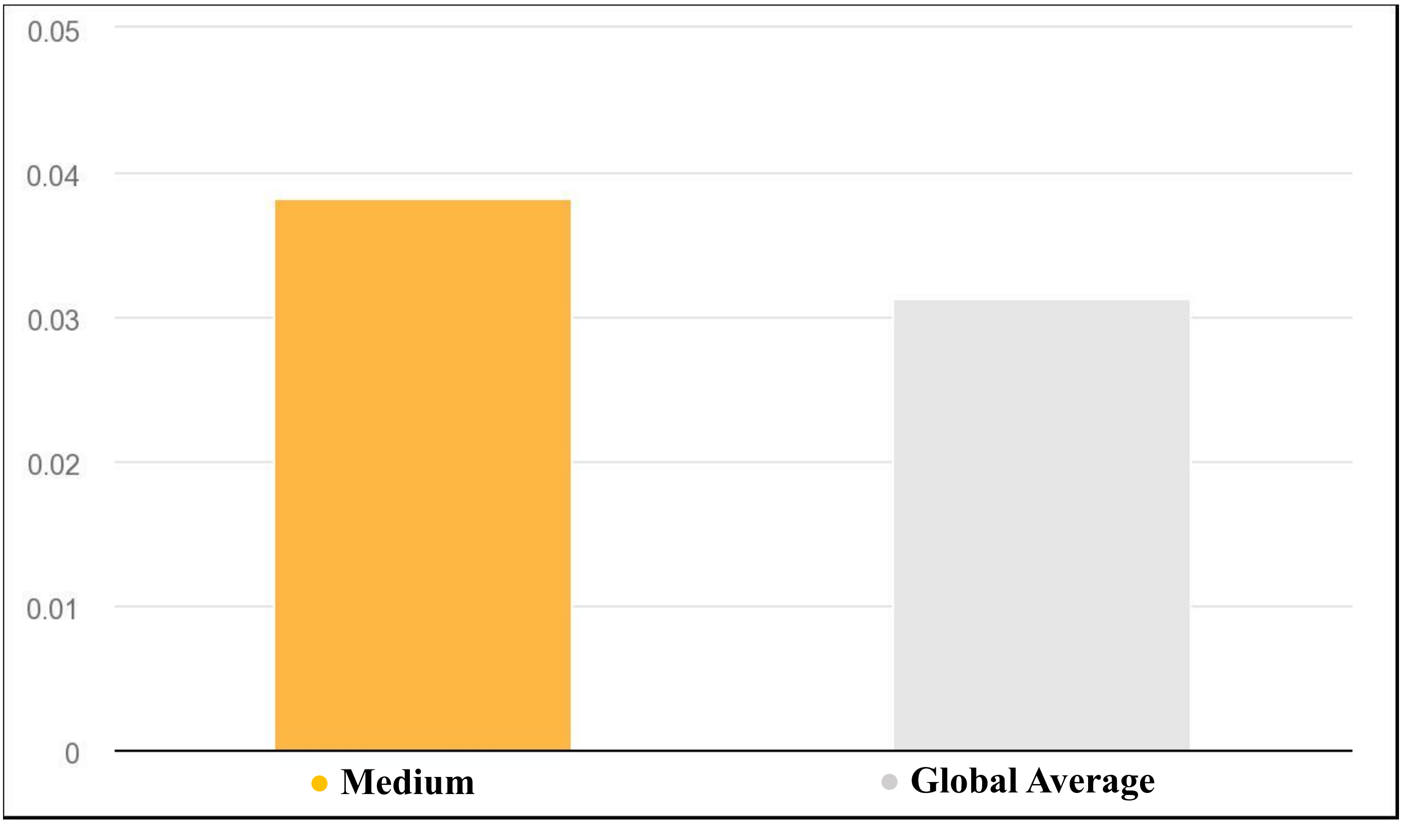


Figure (9): Level of warming in Egypt, 2000-2020

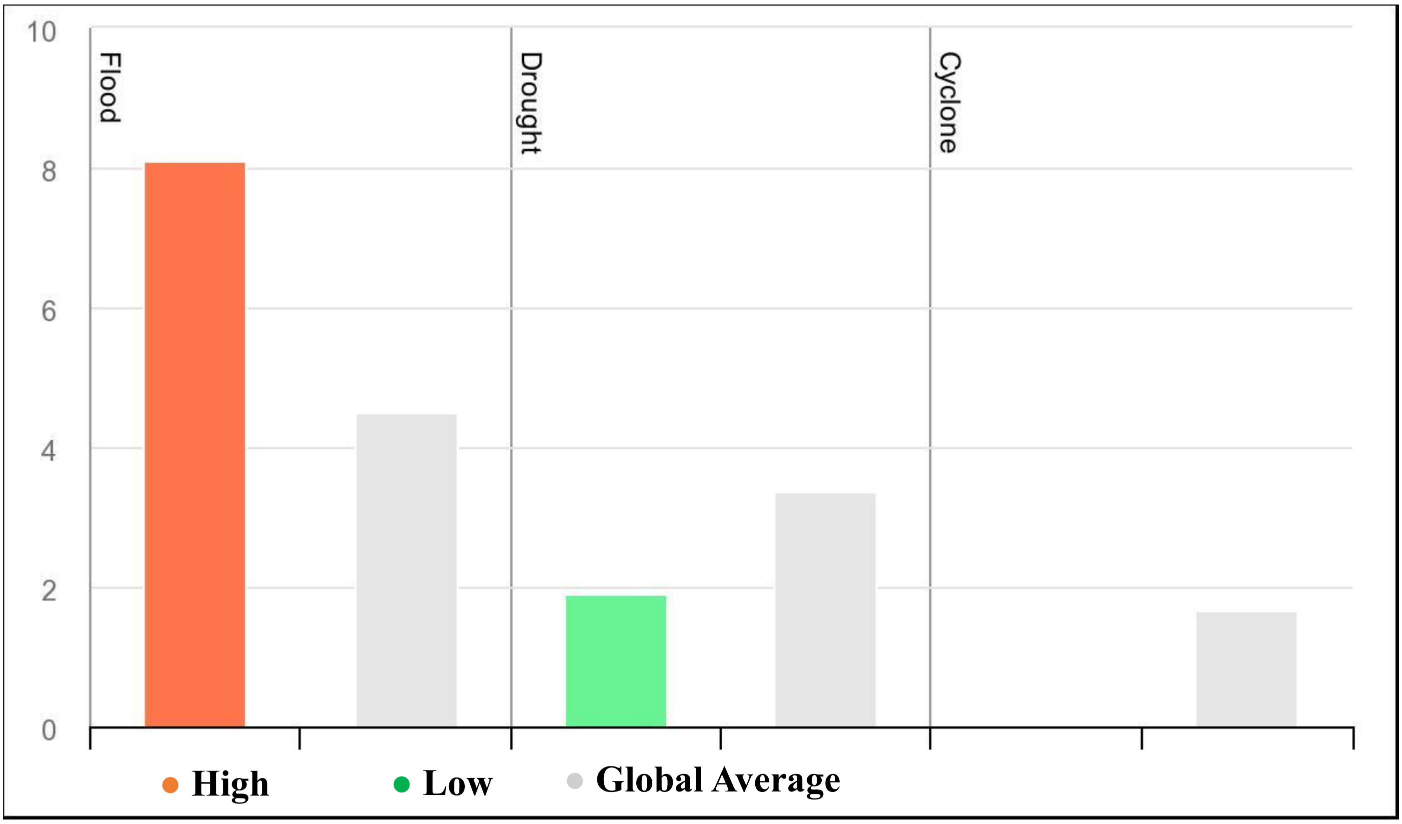


Figure (10): Level of floods, droughts and tropical cyclones in Egypt, 2000-2020

•Problem To Be Solved

Present and Justify a Problem and Solution Requirements

Water scarcity is a serious problem that faces World and Egypt According to UNICEF research, 920 million children worldwide are at risk of water scarcity, highlighting the catastrophic effects of climate change and other environmental dangers on children's well-being.

Figure (11): Water scarcity effect on agricultural production

Seven billion cubic meters of water are lost in Egypt each year, and by 2025, 1.8 billion people would be living in complete water scarcity globally.

Population growth, economic developments efforts, and climate change are the main reasons behind Egypt’s water scarcity. Egypt’s population keeps growing and put more pressure on water resources.

Egypt and the region need to halve the waste water lost, so they can reuse the water and desalination they are effective solutions.

Climate change is disrupting weather patterns, which results in extreme weather events, erratic water availability, increased water scarcity, and contaminated water sources. These effects can have a significant impact on the amount and quality of water that children required to survive. (UNICEF, 2021)

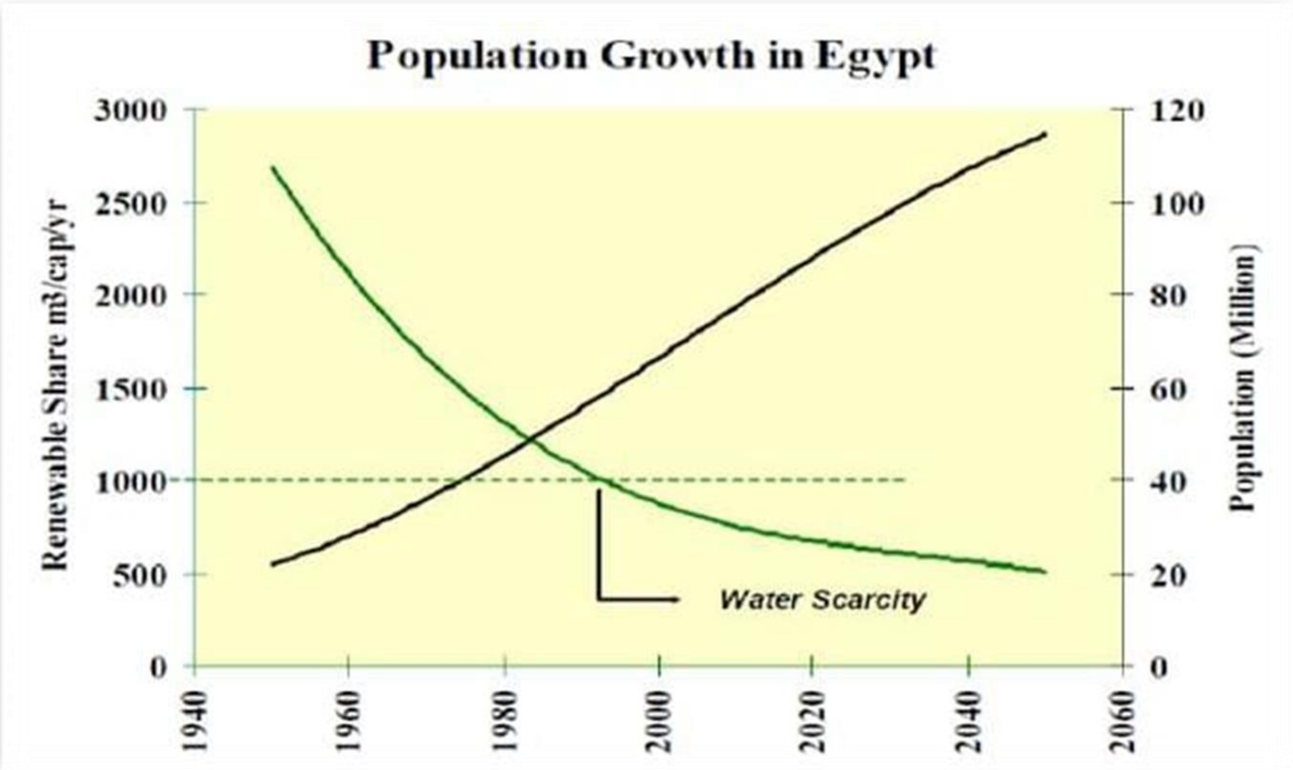


Figure (12): Water scarcity level in Egypt index

➢ If the problem is Solved:

● The water resources will increase, so we will achieve great success in the field of agriculture.

● It will have a good impact on the Egyptian economy and decrease the urban congestion around the Nile.

● Increase production of clean hydroelectric energy instead of non-renewable energy, so we will keep the environment greener.

➢ If the problem isn't Solved:

● As a result of growing water scarcity, Egypt could face growing rates of food hunger and unemployment, which could spark political unrest in the Nile River region.

● People can’t get enough to drink, wash, or feed crops, economic decline may occur.

● Increased human conflicts that consider one of the biggest effects of water shortage, which leads to heightened competition amongst users of water, therefore, millions of lives are at risk.

•Research

Present and Justify a Problem and Solution Requirements

Topics related to the problem.

➢ Water scarcity

The concept of water scarcity is relative. Depending on supply and demand, different amounts of water can be accessed at different times. As demand increases and/or water quantity or quality decreases, water becomes scarcer. Water is a limited resource while demand is increasing. Global population growth and resource-intensive economic growth mean that water resources and infrastructure in many countries are not meeting expectations. (UNICEF, 2021)

There are many problems caused by water scarcity that have negative effects like:

- **Drought**

When there is insufficient rain and a long period of unusually dry weather, it is called drought. For neighboring countries, this can partly lead to a number of problems, such as cable cars and lack of potable water. These impacts can result in devastating social and economic disasters, including famine, physical migration from drought-integrated areas, and war over scarce resources. natural weather patterns are violated, the water cycle is disrupted, leading to dehydration. Storm tracks can become stationary for months or even years due to changes in atmospheric circulation.

Figure (13): Drought is Caused By water scarcity.

patterns. The amount of precipitation a place normally receives can be greatly affected by this outage. The way moisture is.

absorbed in different areas can also be disrupted by changes in wind patterns. Researchers have discovered a relationship between specific climate trends and drought. El Niño is a climate phenomenon characterized by a rise in the temperature of surface waters in the Pacific Ocean around the coast of central South America. In addition to changing storm patterns, these warmer waters are associated with droughts in northeastern South America, Australia and Indonesia. (The IRC, 2023)

- **Agriculture**

Significant droughts in the US and Chile have reduced surface and groundwater supplies and impacted agricultural output.

In addition to impacting crop water requirements, climate change is predicted to increase variability in precipitation and surface water supplies, resulting in a decrease in snowpack and glaciers.

These water issues are predicted to have a significant negative influence on agriculture, a sector that depends heavily on water, eroding the productivity of cattle operations and crops that are irrigated and rain-fed, especially in some nations and areas.

Figure (14): Droughts impacted Agricultural Output

According to an OECD assessment of future hotspots for water risk, in the absence of additional action, Northeast China, Northwest India, and the Southwest United States are expected to be among the most severely affected regions, with potentially significant domestic and global ramifications.

- **Pollution:**

Wastewater carrying pollutants similar as asbestos, lead, mercury, cadmium, arsenic, sulfur, canvases, and petrochemicals is a problem for Egypt's artificial terrain. Industrial polluters continue to contaminate unabatedly in malignancy of legislation proscribing them from doing so over specified thresholds.

unbridled, dirty wastewater from a variety of diligence, including the tanning of leather, the distillation of sugar, the manufacturing of chemicals, the structure accoutrements assiduity, the canning of food, the processing of paper and wood pulp, and the electrical assiduity, is a major cause of habitual ails, high rates of order conditions, and the loss of livelihoods for Egyptian fishers.

The pollution also affects Egypt's 40 impoverished population by placing strain on ecosystem and environmental service and affects also on water scarcity.

Figure (15): Water Pollution

Topics related to the solution

➢ Types of Dams

At the first We didn’t know what to do so we searched and find two types of dams:

- **Arch dam**

All arch dams have a single curved concrete wall. Its convexity is towards the upper side, and it is curved like an arc. The transfer of forces, including water pressure, to the supports is made possible by the bow effect. The cross section of an arch dam is smaller than a gravity dam, but it is still approximately triangular in shape. Arch dams work well in valleys with narrow, steep sides. In order to resist the forces imparted by the bow movement, strong rock masses are required in the slopes. (The British Dam Society (BDS)., 2017)

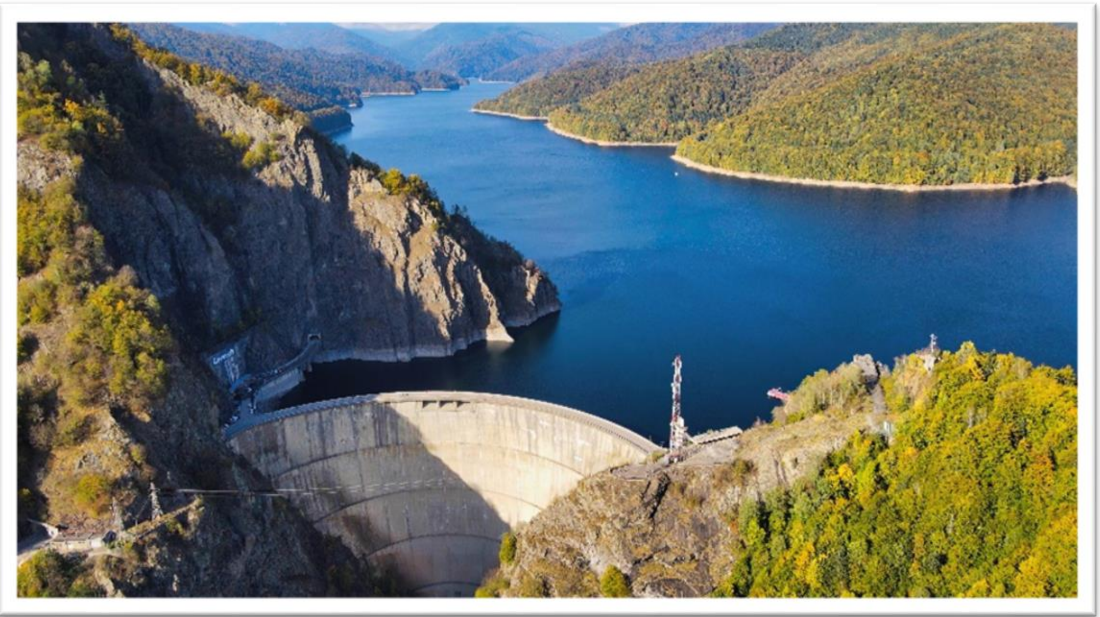


Figure (16): Arch Dam Shape

- **Pros of Arch Dam**

We have investigated the advantages of arch dams and have found that they work best in valleys where the length is relatively short compared to the height. The arch dam section is much smaller than the gravity dam section corresponding to a given height. As a result, arch cavers use fewer and less expensive materials. Also in arch dams, heave pressure problems are minimal due to the significantly narrower base width. In addition, the cantilever movement transfers only a small portion of the weight of the water to the foundation.

- **Cons of Arch Dam**

It calls for advanced model work and specialized labor. In addition, the design of the arch dam is highly specialized. Its construction usually moves slowly. It also requires very strong solid rock supports that can withstand the thrust of the arch.

- **gravity dam**

Solid gravity dam refers to the stiff dam that is built with mass concrete, brick masonry, or stone. Solid gravity dams are defined as those that withstand overturning moments caused solely by their own weight, independent of any external forces like water pressure or slit pressure. Such a dam needs very little upkeep and is incredibly robust and inflexible. (The British Dam Society (BDS)., 2017)

Figure (17): gravity Dam Shape

- **Pros of Gravity Dam**

Since gravity dams have a tendency to slip, these work better in steep valleys. In these dams, excess water can be released by spillways constructed in strategic dam locations or sluices built inside the dam body. These dams can be constructed to the greatest practical height provided they are placed on a solid base. A gravity dam doesn't break all at once. It is possible to foresee their collapse well in advance, preventing loss of life and property. They have the lowest maintenance costs and the highest benefit-to-cost ratio. These are particularly beneficial in areas with a lot of precipitation and snowfall. (Suryakanta., 2015)

- **Cons of Gravity Dam**

We have researched about cons of gravity dams, and we found that They have high initial construction costs. Their construction period is relatively longer. This requires a strong and solid foundation. Once a dam is built, it cannot be raised. In addition, they require manpower to monitor it. (Suryakanta., 2015)

- **Cement**

Cement's central use is to bind together the ingredients of concrete – sand and aggregates. Cement is a glue, acting as a hydraulic binder, meaning it hardens when water is added. Cement itself is a fine powder that is made by first crushing and then heating limestone or chalk, with a few other natural materials, including clay or shale, added. The ground base materials are heated in a rotating kiln to a temperature of up to 1,450 degree C or as hot as volcanic lava. s(GCCA., 2020)

- **Polycarbonate sheet**

Polycarbonate is a versatile, tough plastic used for a variety of applications, from bulletproof windows to compact disks (CDs). The main advantage of this material over other types of plastic is its great strength combined with light weight. While acrylic is 17% stronger than glass, polycarbonate is nearly unbreakable. Bulletproof windows and enclosures as seen inside banks or at drive-throughs are often made of this plastic. Add to this the advantage that it is just 1/3 the weight of acrylic, or 1/6 as heavy as glass, and the only drawback is that it is more expensive than either. (Kayne., 2023)

- **Reinforcing Steel**

Reinforcing bar used in concrete to provide additional strength, as concrete is weak in tension, while steel is strong in both tension and compression. Steel and concrete have similar coefficients of thermal expansion, so a concrete structural member reinforced with steel will experience minimal stress as the temperature changes. It is used in bridges, buildings, skyscrapers, homes, warehouses, and foundations to increase the strength of a concrete structure.

Steel is the product of choice thanks to specific advantages over other materials:

- **Ability to be bent –** Reinforcing steel can be bent after being manufactured. This simplifies the construction and provides for rapid delivery of fabricated materials.

- **Robustness –** Reinforcing steel is robust and able to withstand rigors of construction.

- **Ability to be recycled –** Reinforcing Steel is able to be readily recycled at the end of the structure design life.

- **Compatibility with concrete –** Reinforcing steel does not need to be tied directly to the formwork and does not float in concrete.

- **Availability –** Reinforcing Steel is available in every region of the country. (CRSI., 2023)

- **Polyvinyl chloride**

Polyvinyl chloride (PVC, or vinyl) is used in a variety of applications in the building and construction, health care, electronics, automobile and other sectors, in products ranging from piping and siding, blood bags and tubing, to wire and cable insulation, windshield system components and more. (Chemical Safety Facts. , 2022)

- **Bitumen**

Bitumen is a viscous substance that exists in a liquid to a semi-solid phase. It is a blackish-brown color. And its most important characteristics are:

- It generally consists of asphaltene resin and other petroleum compounds.
- Different formulations of bitumen lead to different properties.
- Bitumen exists in nature and can also be extracted from crude oil. (Zahedi, 2023)

• Other solutions already tried

Present and Justify a Problem and Solution Requirements

• Aswan High Dam

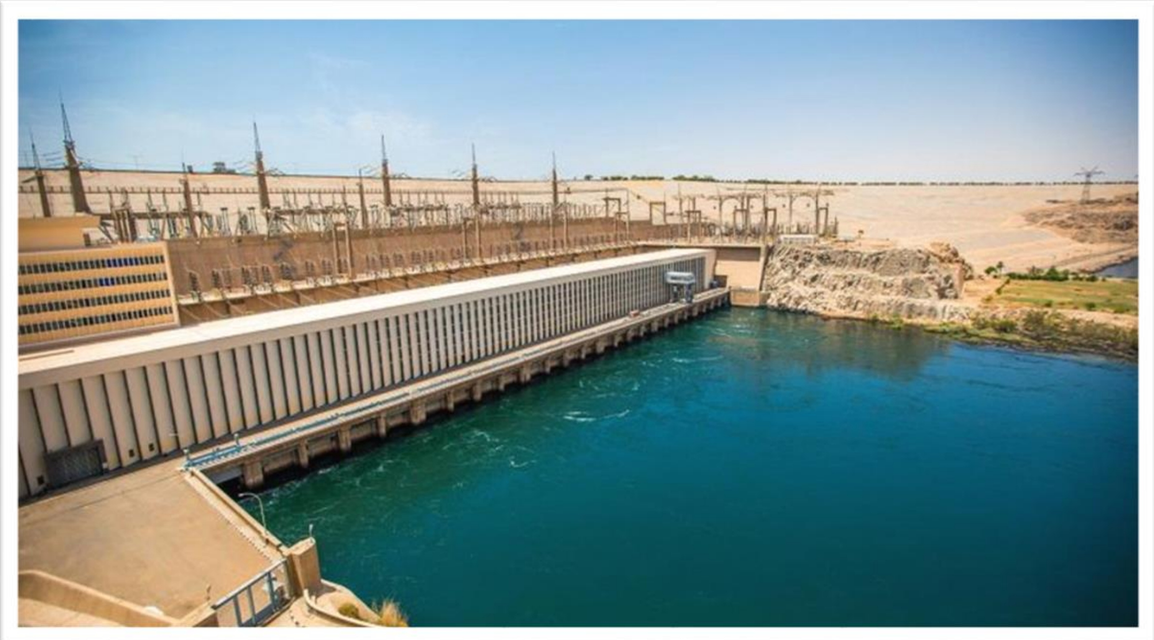


Figure (18): Aswan High Dam

High Dam is considered the greatest and largest engineering project of the twentieth century from an architectural and engineering point of view, superior to other giant global projects.

The High Dam was built to protect Egypt from the high floods that were occurred in Egypt and drowning large areas in it, and to conserve water that was wasted in the Mediterranean.

High Dam was built with good intentions and its construction has indeed become instrumental in the industrialization of Egypt. However, just like in other new developments and changes, there are also consequences. It is just a matter of ensuring the pros outweigh the cons.

As shown in the corresponding image, the dam was built across the Nile in Aswan, Egypt. It is in the southern part of Egypt. The water that was dammed up is called Lake Nasser. Lake Nasser Divided into 2 parts with the majority of it belonging to the Egyptian side at 83% and the rest belonging to the Sudanese territories. Known as Lake Nubia, it rescues many Sudanese migrants who were flooded out of their homes after the great floods of the Nile. (National Environmental Satellite, Data, and Information Service., 2017)

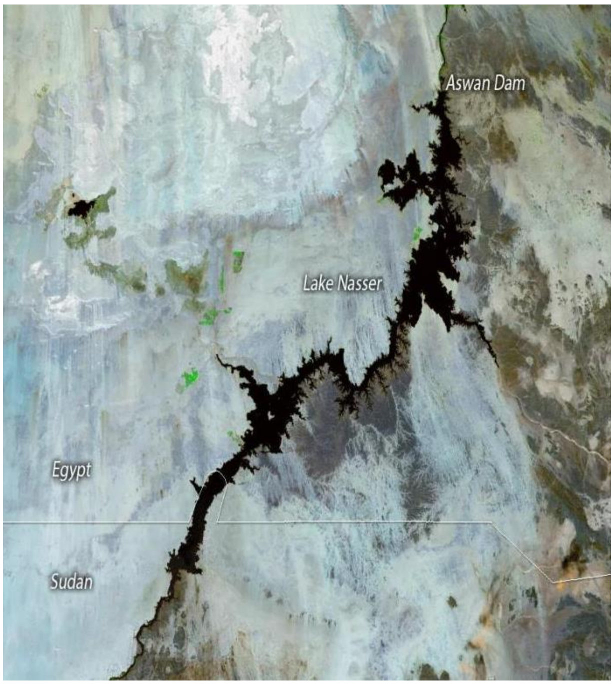


Figure (19): Aswan High Dam image taken by (NOAA/NASA's Suomi NPP satellite's VIIRS instrument)

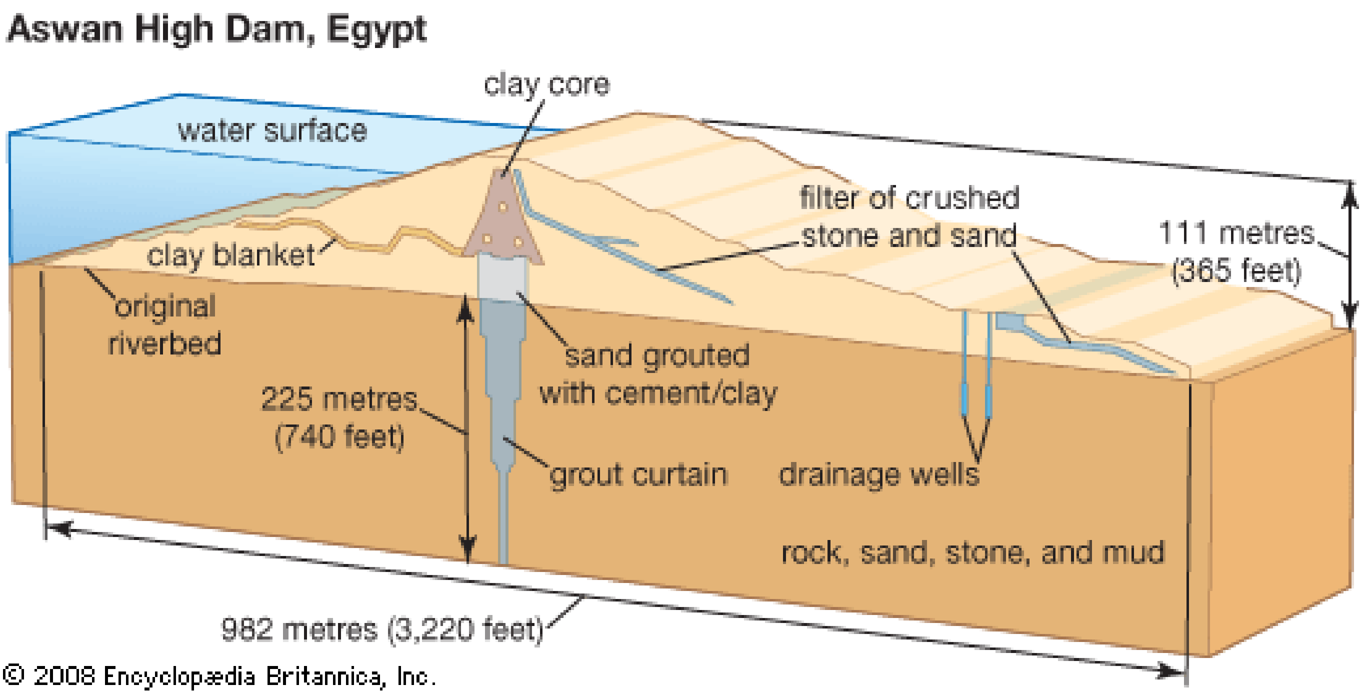


Figure (20): Aswan High Dam Structure

➢ Pros

- A new source for crop irrigation. (Using water that use to go on to the Mediterranean Sea)

- Villages downstream aren’t flooded anymore. (Controls flooding)

- Easier to navigate river because of consistent, controlled flow.

- Hydro-electric power. (Electricity from a clean source)

- Better fishing from the lake that was created from the dam. (Lake Nasser)

➢ Cons

- No more silt replenishment. The silt naturally fertilized the soil. Now farmers must use chemical fertilizers.

- Erosion. (No silt deposit to rebuild the soil)

- Less nutrients going into Mediterranean. (Fishing has dropped in the sea)

- The flooded area was home to 100,000 Nubians. They had to be relocated. (The move added stress, disease, and food shortages in their new location)

• Grand Coulee Dam

Figure (21): Grand Coulee Dam

Grand Coulee Dam, on the Columbia River west of Spokane, Washington, is one of the largest structures ever built by mankind--a mass of concrete standing 550 feet high and 5,223 feet long, or just shy of a mile.

Grand Coulee contains 12 million cubic yards of concrete, or enough to build a highway from Seattle to Miami. More massive than the Great Pyramid of Giza, Grand Coulee is listed by the American Society of Civil Engineers as one of the seven civil engineering wonders of the United States. Grand Coulee's reservoir, Franklin D. Roosevelt Lake, stretches 150 miles north, almost to the Canadian border. (nwcouncil, 2023)

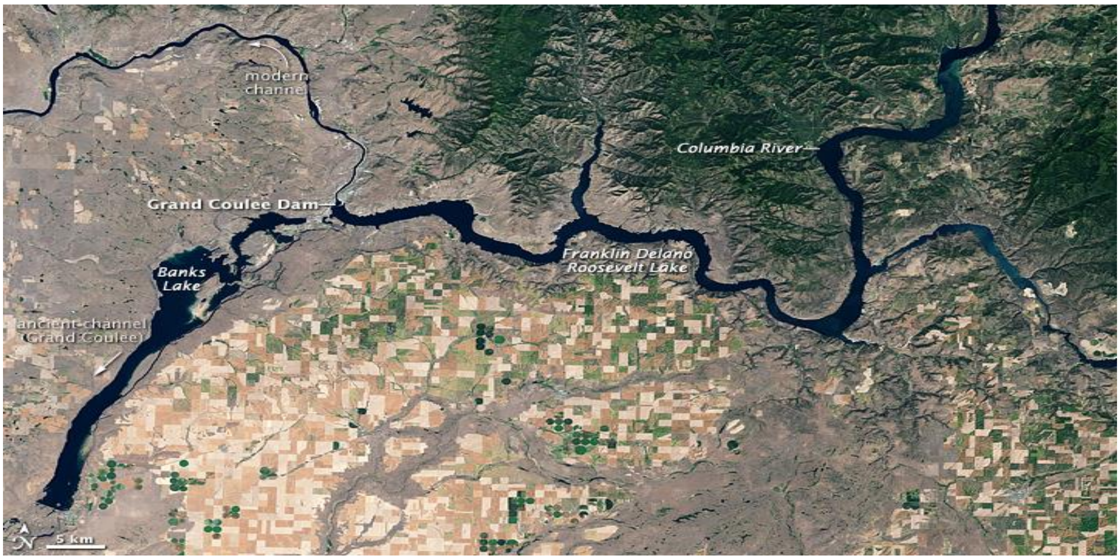


Figure (22): Grand Coulee Dam Location taken by (NOAA/NASA's Suomi NPP satellite's VIIRS instrument)

➢ Pros

- providing a renewable source of clean energy.

- This massive source of energy also helped to decrease costs of electricity in the surrounding areas.

- The Grand Coulee Dam also created many jobs.

- The dam revolutionized the Pacific Northwest and played a key part in attracting people to the area for example, farmers moved onto reclaimed land and used water from the dam's reservoir to irrigate their crops. (The Engines of Our Ingenuity., 2015)

➢ Cons

- The construction of a series of dams on the Columbia River, including the Grand Coulee Dam, has limited the available riverine salmon habitat to 13% of the river. Fall chinook salmon currently use only 85 km of the 2,000 km river as breeding grounds. (National Parks Service., 2017)

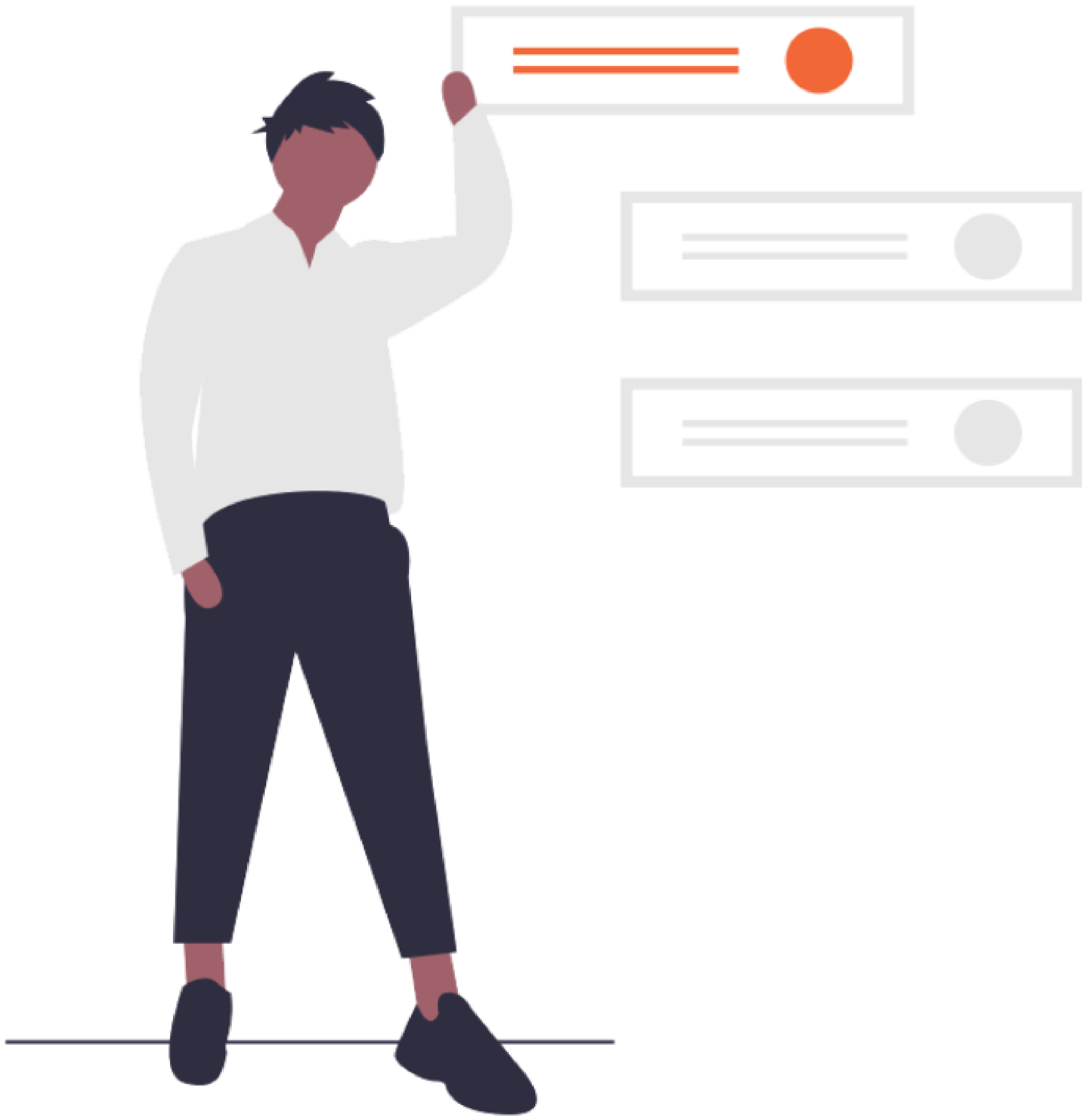
• Chapter 2

Generating and Defending a Solution

I. Solution and Design Requirements

II. Selection of Solution

III. Selection Prototype



• Solution and Design Requirements

Generating and Defending a Solution

To show the success of our solution and prototype, the project should be tested according to some points as a rubric.

The Design Requirements for Our Gravity Dam Prototype:

- the amount of water should be between (50 and 60) liter.
- The height of water (25cm) and the dam (30cm)
- The dam should support a concentrated load in its middle point not less Than (10kg)
- The thickness of the dam in the bottom should be (10cm) and (3cm) at the top.
- The prototype dam should be able to discharge water to both (25%) and (50 %) of the stored water.
- Avoid any bending in the dam components.
- The minimum storage time, during testing the prototype should be at least 2 hrs.
- The dam should be constructed of no more than one manufactured material along with recycled materials or materials from natural resources.
- The maximum diameter of the reinforcing bars should not exceed (3mm) while the maximum length should not exceed (100mm.)
- Reinforcing bars have the same material constraints in that they must be recycled materials or the one manufactured material.

*These design requirements were chosen according to the challenge that we are trying to solve.

• Selection of Solution

Generating and Defending a Solution

Most of the prior solutions were designed to solve the problem of water scarcity that was faced by most countries that turned to building dams. Dams have positive aspects in that they conserve water, help in irrigation, and eliminate water scarcity. Dams have different shapes and requirements.

Shape:

After doing some research about the shape we find that gravity dam the best shape because it saves water for many times. It very strong and does not need to maintenance. Our dam is rectangular shape with a triangle forward and it has container that will save 50 liters of water and it can hold 10 kilogram above it. We will make gate to leak 25% of water and another one to leak 50%, so it must be a strong dam.

Materials:

many of prior solution used materials can be harmful to environment and cannot be used again, so to solve this problem in our project and make it better than the real must made from recycled reinforcing bars, and we will choose materials on some requirements such as:

- choose good type of cement that does not absorb water and waste many water.
- used materials cheaper than the real to encourage engineer to build it.
- being strong and flexible to make the dam structure on best way.
- Not pollute the environment when recycled.

According to these requirements we choose Polycarbonate sheets (C15H16O2), cement (C_3S, C_2S, C_3A, and C_4AF) and Polyvinyl Chloride (C2H3Cl)

• Selection Prototype

Generating and Defending a Solution

During the selection of the prototype, we made sure that it will meet our Design Requirements, use the least amount of volume, and make sure of the constancy of the high efficiency over long periods.

Firstly, to make a good visualization for the prototype design we used sketch up to predict the positive and the negative points before the real construction of the prototype as shown in figure (23) The requirement for the suitable prototype.

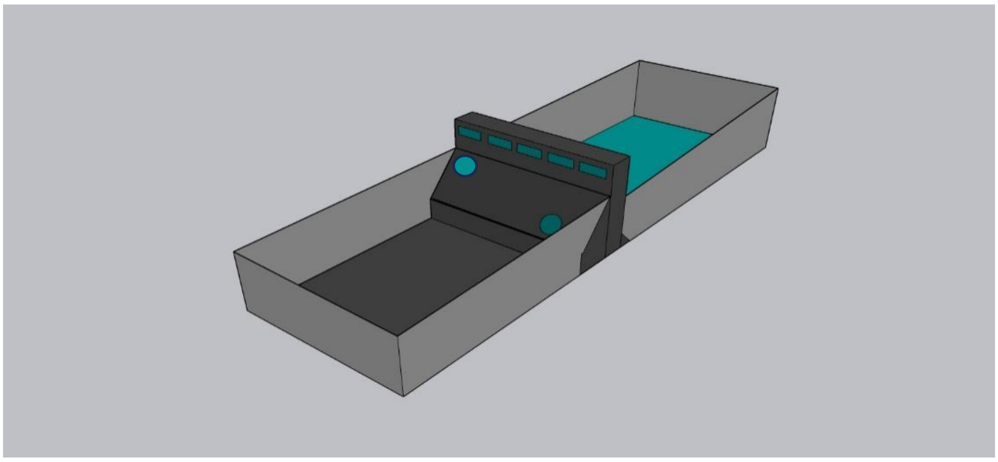


Figure (23): A model of our prototype using Sketch Up

We will build Our gravity dam using Cement (C_3S, C_2S, C_3A, and C_4AF) and recycled reinforcing bars. we will make two gates using polycarbonate sheets ($C15H16O2$) to leak 25% of stored water and another one to leak 50%, and We will use a pipe made of polyvinyl chloride ($C2H3Cl$) to pass water through.

• Chapter 3

Constructing and Testing a Prototype

I. Materials and Methods

II. Test Plan

III. Data Collection

• Materials & Methods

Constructing and Testing a Prototype

• The Materials

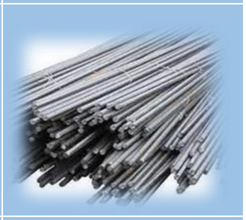
Materials	Amount used	Cost	Source	Usage	Illustration
Cement	20 Kg	60 L. E	building materials shop	Used in building prototype	
Polycarbonate sheets	2 sheets (cm/sheet)	80 L. E	"Recycled" plastic factory	Used in building prototype	
Reinforcing bars	4 Kg	200 L. E	"Recycled" black smith's	Used in building prototype	
Polyvinyl chloride	1 m	70 L. E	plumbing tools shop	Used in building prototype	
Bitumen	4 Kg	60 L. E	Paints shop	Used in building prototype	
Total cost			470L.E		

Table (1): Materials Used in the prototype.

• The Methods

The materials listed in table (1) were utilized to construct the prototype, which is a Gravity Dam depending mainly on a composite of cement with reinforcing bars in its body.

The first phase involved arranging all of the safety procedures, such as donning lab coats and gloves to prevent injury or textile damage, as well as wearing face masks to prevent the inhalation of any dangerous chemicals.

The prototype consists of a group of components :

- Constructing template
- Reinforcing bars
- The composite (matrix)

1. Mold (constructing template)

The mold (Construction template) will be an iron mold modeled in the shape Chosen for the Dam in the form of rectangular shape and a triangle forward. There will be two gates made of polycarbonate sheets ($C_{15}H_{16}O_2$) on a greater height than the other, so that we can release 50% of the stored water using the highest gate, and release 25% of the stored water using the lowest gate.

2. Reinforcing bars

A network of reinforcing was made with the same dimensions of the mold, but it well be smaller than the mold by 1.5 cm in height and width. Each reinforcing bar piece should equal 3mm in diameter and 10cm in length, so the reinforcing parts were forged together to form a reinforcing skeleton for the body of the dam. The reinforcing skeleton will be installed to the mold before adding the matrix.

3. The composite (matrix)

The last component is the matrix, this matrix consists Cement, with sand and gravel to give it the strength that withstand the water's thrust. We will use bitumen (a derivative of petroleum derivatives); to coat the walls of the dam to prevent water leakage. We have chosen bitumen over any other material because it is considered one of the best water-resistant insulating materials, in addition to It does not interact with the properties of water, so it does not change the taste or smell of the water.

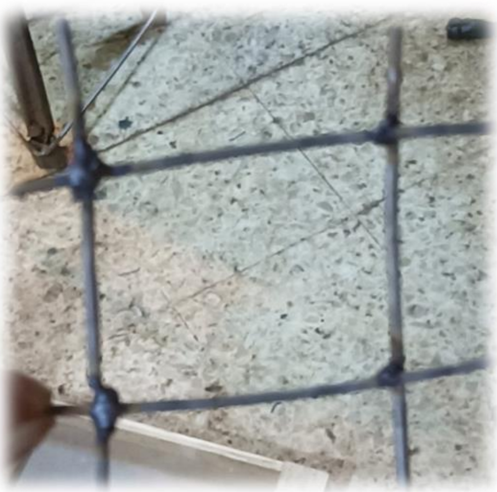


Figure (24): a part of reinforcing bars network

Table (25): photo shows the methods

• The Tools

Tool	Usage	Illustration
pliers	used it to form the reinforcing bars in the shape of dam that was specified.	
Tape meter	To measure the dimensions of the mold, and the dissemination of the reinforcing bars	
Verner caliber	used to measure the thickness of the reinforcing, and the thickness of dam walls.	
Sensitive balance	Used to measure the mass of the used materials such as cement, to get the correct ratios.	
Brush	Used to paint the walls of the dam with bitumen, to prevent water leakage.	

Table (2): Tools Used in the prototype.

• safety procedures

Tools	Usage	Illustration
Lab coats	To protect ourselves from sharp tool	
Gloves	Protect our hands from sharp tools.	
Goggles	To maintain the safety of our eyes from materials dust	
Mask	To protect ourselves from inhaling material dust or the adhesive material	

Table (3): Safety procedures

• Test Plan

Constructing and Testing a Prototype

The prototype was made with high accuracy to suit the design requirements Which are:

- the length of the dam = (48) cm.
- the thickness of bottom = (35) cm.
- the thickness of top = (5,5) cm.
- the capacity of water = (55) liters.
- The height of water (36) cm.
- the height of dam = (40) cm.
- The diameter of the reinforcing bar = (3) mm.
- the length of the reinforcing bars = (10) cm.
- the dam supports a concentrated load in its middle point

more than (10) kg.

we tested these four points:

1. The first step is to measure the dimension of the dam, we used the tape meter to measure the length, width and height which were (35) cm, (48) cm, and (40) cm. (respectively)

2. From design requirements is (the capacity of water will be between (50,60) liters) We achieved this requirement by measuring the volume of water using the graduated cylinder then we find it 55.0 liters.

3. After that we want to measure the flow rate of the water, so we used the stopwatch to measure the time taken by liter of water to come out of the pipe. We find that liters come out from the pipe in minutes, the flow rate in the first gate = $\frac{13.5\ liters}{5\ second}$ = 2.7 L / sec.(0.0027 m^3 / sec) and in the second gate = $\frac{40.5\ liters}{32\ second}$ = 1.27 L / sec (0.0013 m^3 / sec)

4. At the end we want to measure the durability of the dam, so we hung an iron chain over it containing two weights equal to 10 kilograms to make a concentrated load in the middle. And the dam carried 10 kg without any deformation.

   As a result, we achieved the design requirements such as the dam made a flow rate (Liter per minute), and its dimension is (35, 48, 40). The dam supported a concentrated load in its middle point a (10) kg.

• Date Collection

Constructing and Testing a Prototype

First attempt

In the first attempt to build our prototype we fell into some negative points and mistakes, we incorrectly calculated the proportions of the concrete components and increased the proportions of sand and reduced the proportions of cement, which led to the disintegration of the concrete after it was poured and incoherence of the dam. What increased this problem was that we did not paint the wooden mold with an insulating material so that the concrete stuck to the mold walls, and as a result we were unable to remove the dam from the mold. Ideally, part of the prototype collapsed.

Second attempt

In the second attempt we approved some points, and these were results:

➢ **Positive results:**

1. We have corrected the proportions of the components of the concrete, and this led to the cohesion of its parts, its solidity and its endurance.

2. we can fully separate the prototype from its mold because we have painted the mold walls with insulating material.

➢ **Negative results**:

1. We have built gates in wrong places in the dam that did not allow 25% and 50% of water to come out.

2. The water container was too small, as it did not accommodate the required volume of water, estimated at 90 liters.

3. the gates was too weak to withstand with the pressure of the water as it was made of thin plastic.

Third attempt

- **Positive results:**

1. we used a gate made from polycarbonate that can resist the water pressure.

2. the gates disbursed 25% and 50% of water successfully.

3. we make a new container that accommodates the specified amount of water.

4. we have calculated the flow rate and it was in the first gate = $\frac{13.5\ liters}{5\ second}$ = 2.7 L / sec.(0.0027 m^3 / sec) and in the second gate = $\frac{40.5\ liters}{32\ second}$ = 1.27 L / sec (0.0013 m^3 / sec)

Time (sec)	Volume (m^3)
4	0.01
6	0.015
9	0.02
14	0.025
19	0.03
25	0.035
32	0.04
40	0.045
48	0.05
60	0.055

Table (4): water flow rate table

• Chapter 4

Evaluation, Reflection, Recommendations

I. Analysis and Discussion

II. Recommendations

III. Learning Outcomes

IV. List of Sources in APA Format

• Analysis and Discussion

Evaluation, Reflection, Recommendations

Egypt faces a lot of grand challenges: Manage and increase the sources of clean water, Deal with urban congestion, Recycling garbage and wastes for economic and environmental purposes. Reduce the effect of climate change. Each one of these grand challenges forms a large risk. Seven billion cubic meters of water are lost in Egypt each year, and by 2025, 1.8 billion people will be living in complete water scarcity globally. Our research helped us to select the places that have heavy precipitation and Egypt has topographic nature helped it to build many dams in different places (ES.1.01). building a dam helps Egypt to store much clean water and it can produce electricity. Our dam construction included using recyclable materials that are eco-friendly to save the environment.

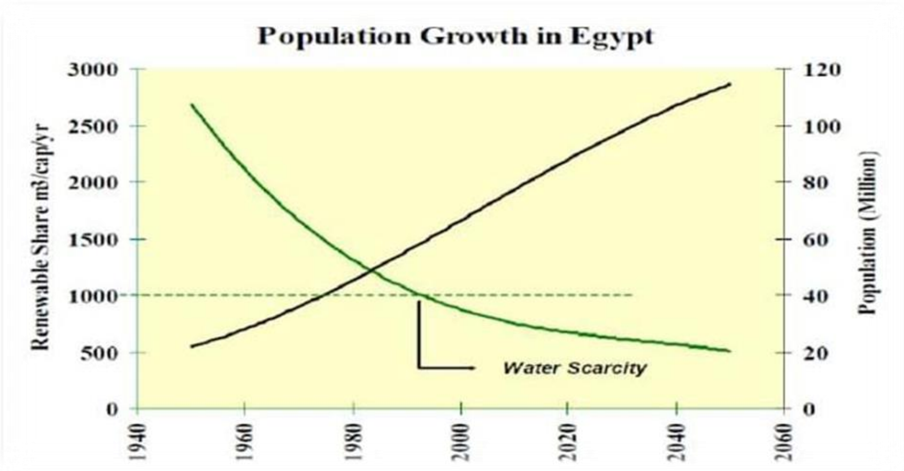


Figure (26): Water scarcity level in Egypt index

The type of dam is a gravity type which has a structure designed to withstand loads by its weight and by its resistance to sliding and over-turning on the foundation which seems to be one of the best choices to store water. It has many advantages it can be constructed to the greatest practical height provided they are placed on a solid base; it doesn't break all at once. It is possible to foresee their collapse well in advance, preventing loss of life and property, it has the lowest maintenance costs and the highest benefit-to-cost ratio, and it is particularly beneficial in areas with a lot of precipitation and snowfall.

This type will be well used in making the solution which is to make a Mold (constructing template) made of wood with dimensions (35 cm in length, 50 cm in width, and 40 cm in height) it measured by vernier calliper (PH.1.01) A network of reinforcing bars was smaller than the Mold by 1.5 cm in each dimension. Each reinforcing bar piece should be 3 mm in diameter and 10 cm in length, so the reinforcing parts were forged together to form a reinforcing skeleton for the body of the dam. The reinforcing skeleton will be installed to the Mold before adding the concrete and pipes.

To calculate the volume of the dam by the following equation (MA.1.05):

The volume of cuboid = 48 *50 *5.5 = 13200 cm^3.

The volume of scalene triangular prism = 0.5 * base* length* height = 0.5* 48* 32*26 = 19968 cm^3.

So, **the volume of the dam = 19968 + 13200 = 33168 cm^3.**

cement, sand, and gravel were used to make the concrete that was used to build the dam (ES.1.03), we used polycarbonate sheet to make the gate we chose it as it is considered a very strong recycled material, we used PVC pipes, we used reinforcing bars pieces to make a reinforcing skeleton to coherence the concrete with each other, and we used a bitumen as it considered a hydrophobic material that insulates the concrete of the dam and water we use a pully to open the gate of the dam (BI.1.03)

In the first attempt, sand and cement were used, both were used to make the concrete needed to build the dam, but the prototype broke down. the proportions of cement and sand were wrong which led to incoherence of the concrete and the disintegration of the dam, what increased this problem was that the wooden Mold wasn’t painted with an insulating material therefore, the concrete stuck to the Mold walls, as a result, the Mold couldn’t be removed Ideally, part of the prototype collapsed, some modifications were made to overcome the negative results of the first trial.

In the second attempt corrected proportions of cement and sand and car oil were used, and new proportions of cement and sand were used to make concrete, and this led to the adhesion of its parts, its solidity, and its endurance. The car oil was painted on the walls of the wooden Mold and this was a perfect choice. After that, the dam came out from the Mold without any collapsing in the dam parts. Another negative result occurred when the container was too small and the gates were too weak as it was made of plastic, the gates were in the wrong places in the dam that did not allow 25% and 50% of water to come out.

In the third attempt, we made some modifications to overcome the negative results that we faced in the second attempt, in the third attempt, a gate made from polycarbonate was used that could resist the water pressure, and the gates disbursed 25% and 50% of water successfully after the position of gates was changed. A new container was made that accommodates the specified amount of water.

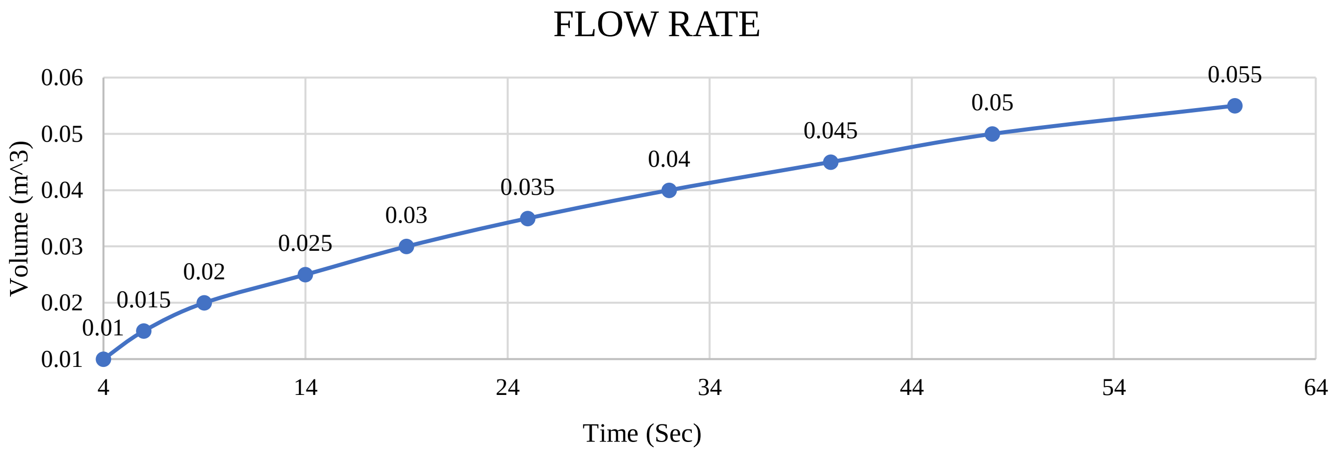


Figure (27): water flow rate graph

The flow rate of water was calculated by observing the amount of water that passes through the two gates per second. The first four seconds the water passed was 10 litres and then at 6 seconds it became 13.5 Liters and here the first gate was successfully drained, and the second gate also was drained. After 32 seconds, 40.5 litres were drained successfully.

so, the flow rate in the first gate = $\frac{13.5\ liters}{5\ second}$ **= 2.7 L / sec.(0.0027 m^3 / sec)**

and in the second gate = $\frac{40.5\ liters}{32\ second}$ **= 1.27 L / sec (0.0013 m^3 / sec)**

at the end all of the water (55 L) in 60 sec. (Serway & Vuille, 2017)

after that we have made an accumulative frequency curve graph represent the flow rate. (MA.1.02) as shown in figure (27).

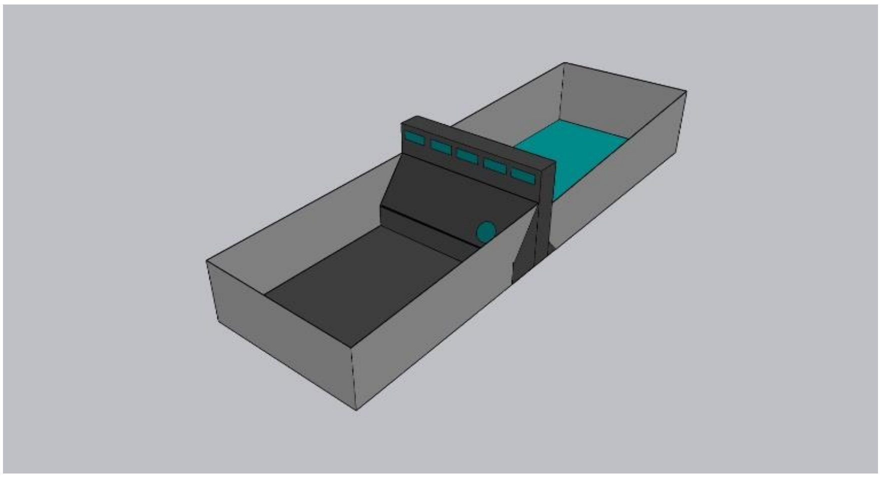


Figure (28): 3D design for the dam

• Recommendation

Evaluation, Reflection, Recommendations

- Make sure the dam's design includes an effective system for draining extra water. The safety of the dam and the areas around it must be guaranteed by this system, which must be able to withstand possible flooding.

- Place smart monitoring devices on the dam to help keep track on the water level, manage the flow, and defend against floods.

- Establishing a system of traffic on the route to make a balance in the traffic.

- Waterproofing cement can be used better than painting the dam with waterproofing materials "we didn't use it because of the budget"

• List of Learning Outcomes

Evaluation, Reflection, Recommendations

Learning Outcome	Application
BI.1.03	We studied at this learning outcome that cell membrane has many structures that help it to work well and separate the cell from the surrounding environment. Cell membrane consists of lipids, protein and carbohydrates. Lipids of cell membrane called phospholipids that consist of tail and head. Head like the water so it called hydrophilic and tail hate water, so it called hydrophobic. Cell membrane consists of phospholipids bilayer so in our dam we will use materials that be hydrophobic to put in the dam and do not affect from water such as hydrophobic cement that doesn't absorb water and bitumen that make insulating layer that prevent water to reach to the dam.
ME.1.02	In this learning outcome we learned more about graphs and how to convert from graph to anther and measure velocity and acceleration so we will measure the flow rate of water and draw a graph(velocity-time) to make it easy to read and show the most accurate details.
MA.1.03	We learned in this learning outcome that we can make similarity between objects so in our dam we will make a similarity between real scale and our dam to keep our dimension right and we can get dimension of in front triangle by cosine and sine law.

CH.1.01	In this learning outcome we learned significant figure that used in approximating to the nearest zero number to make measures easy. We should build our dam on scientific methods to be strong and can't destroy.
PH.1.01	In this learning outcome we learned relative errors that separated into random and systematic errors. In our dam we will measure the length of dam and gate many times and take the mean of these errors to measure length with high accuracy.
PH.1.01	We learned from this learning outcome that every action has reaction opposite in direction and same in the magnitude and each object has a gravitational force (weight). We must measure our dam weight to make sure that our dam doesn't be heavy can moved it from place to another.
E.S.1.02	In this learning outcome we learned much information about minerals and its hardness and cleavage so we will select the best materials that have high hardness and good in building.
ES.1.03	In this learning outcome we studied about Earth materials and its properties because of that, we used limestone can be converted to cement and mixed with sand and gravels to make a strong concrete.
B.I.1.02	In this learning outcome we learned much information about cells, and it structure and the connection between organelles together so in our dam we must select the best materials that mixed together without separation.
EN.V.	We learnt about abbreviations and scientific terms, and it helped us to express our writings in a better way, which helped in making the portfolio and poster clear.

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Evaluation, Reflection, Recommendations

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"Group 19108"