G10-1-Dam

(Group: 17103)

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Chapter1: present and justify the problem and solution requirements.

Egypt grand challenges

There are lots of challenges that we face here in Egypt. The best way for facing any challenge or a problem have steps and the most important step for that is gaining knowledge about this problem.

To face any problem, you have to study it well and know about all of its points well so searching about the problem is the best way to start getting knowledge.

Here in Egypt, there are lots of challenges that we face, but scientist have chosen 11 one of these challenges that must be faced and defeated here in Egypt:

- Deal with exponential population growth
- Reduce pollution.
- Work to eradicate public health issues.
- Improve the use of alternative energies.
- Reduce urban congestion.
- Improve use of arid areas
- Increase industrial base for Egypt.
- Improve sources of clean water
- Increase opportunities for Egyptians to stay and work in Egypt.
- Recycle and retain garbage for recycling.
- Improve the use of alternative energy.

Increase the sources of clean water.

Water is the secret of the life, the ancient Egyptian civilization started around the biggest source of clean water "the Nile River", water takes an important part in every field in Egypt, such as: agriculture, Animal husbandry, industry, drinking, as it attracts people to live near to it. Although, Egypt faced in the last few years an unusual shortage of water because of climate change and other factors, so, we really need to increase the sources of clean water to cover the needs of water in Egypt.

There are a lot of desert areas in Egypt, such as the western and eastern deserts in Egypt, which is a large area of desert have no water, no plants, no people living in it.

These large areas in Egypt are useless for us, although we can use it in many ways and get a lot of benefits from it.

The Egyptians only live in 8% of the Egyptian land, so that causes a lot of problems like urban congestion.

The secret to get benefits from these large areas is to provide water there. And that requires to increase the sources of clean water in Egypt.

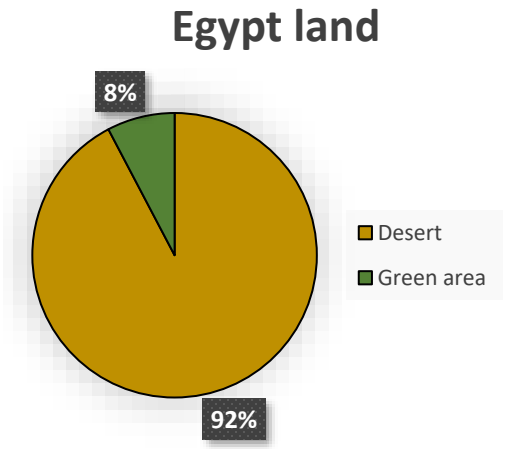


Figure 1 (shwos the desert area to the green area in Egypt)

Figure 2 (shows the shortage of water in some areas)

Egypt suffers from a water shortage of 30 billion cubic meters, it requires 110 billion cubic meters to cover its needs. However, Egypt only gets 80 billion cubic meters, 55.5 billion cubic meters come from the Nile. (**As shown in figure 2**)

Egypt is facing an annual water deficit of around seven billion cubic meters and the country could run out of water by 2025.

The shortage of water in Egypt causes problems in a lot of fields like farming. Farming depends on the availability of water, and it is one of the most important

fields in Egypt. It produces 11% of the Egyptian EDP and employs 1 in 4 people in Egypt.

Increasing the sources of clean water is necessary for us now. That will fix the problem of water shortage and cover the needs of water in Egypt, and save us from the annual water deficit. That also fixes more serious problems like desertification which is in 92% of Egypt land.

Deal with urban congestion

Urban congestion in Egypt is a major problem caused by overpopulation, insufficient infrastructure, and increased car ownership. It manifests in traffic jams, higher air pollution, and a reduced quality of life. The government is taking steps to address it, but more needs to be done to improve the situation.

Figure 3

Egypt is one of the most crowded countries, the number of people in it is increasing a year after another especially in its capital Cairo, which is known as the Greater Cairo Metropolitan Area (GCMA) (**As shown in figure 4**)

Cairo is the most crowded place in Egypt. It contains more than 19 million inhabitants and the scientist expect an increase in this number by 2027 to reach 24 million (**As shown in figure 3**). Cairo contains the fifth of the population of Egypt.

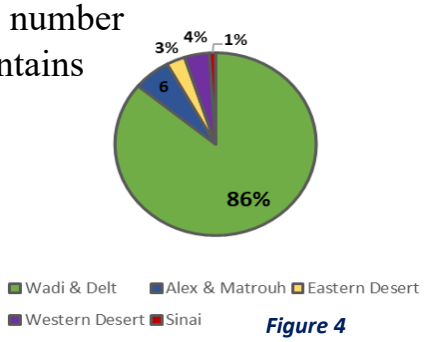


Figure 4

Despite Egypt's large area, the population is concentrated in Cairo, which its area is 3,085 km².

The area of Egypt is 1.002 million km², which is a very huge space that Can handle a lot of residents, but the most

people are concentrated in Cairo and in Nile River Delta. Number of births in Egypt in 2020 is 2,193,000 people.

This huge Urban congestion leads to lots of problems as the huge traffic (**As shown in figure 3**) in the streets which leads to:

1- Economic costs: Traffic congestion costs Egypt an estimated EGP 50 billion (US$8 billion) per year, or about 4% of its GDP. This is due to wasted fuel, lost productivity, and increased travel times.

2- Environmental costs: Traffic congestion is a major source of air pollution in Egypt. Because of the harmful gases emitted from the cars and factories. This can lead to respiratory problems, heart disease, and other health problems.

3- Social costs: Traffic congestion can make it difficult and stressful to get around, which can reduce people's quality of life. It can also lead to social isolation and increased crime rates.

All that leads to the waste of time and burn of more fuel which increases the air pollution and increases the price of transportation and causes lots of other problems as increasing the risk of accidents and traffic-related injuries.

So, we have to do lots of things to reduce these harmful effects as:

1- Investing in public transportation: Public transportation is a more efficient and environmentally friendly way to travel than private cars. The Egyptian government should invest in expanding and improving public transportation services, such as the metro and bus systems.

2- Discouraging car ownership: The Egyptian government can discourage car ownership by making it more expensive to own and operate a car. This can be done through taxes, parking fees, and other measures.

By that we can reduce the effect of the Urban congestion, but to stop it we have to find the core of the problem and to take some steps to end it.

There are many different reasons for why people prefer staying in Cairo more than any other place in Egypt but now I want to speak specially about one of the most important points from my point.

it's about the Availability of services, especially the availability of fresh drinking water but now in these days Egypt suffers from shortage of water due to the big

increase of number of people and their huge need of water so we should all think with a creative method for finding a solution for this huge problem.

Recycled garbage and wastes for economic and environmental purposes.

***Figure 5** : (recycling wastes)*

Recycling is the process of converting waste accoutrements into new accoutrements and objects. It can be used for plastic, wood, and other recycled things.

In Egypt, there is a lack of recycling, and it causes a lot of problems to Egypt, like climate change and pollution. Otherwise, the Egyptians do not understand the risks of the lack of recycling and its causes.

We all buy water bottles, soda bottles, and other plastic bottles, but we do not recycle most of them. There are one million plastic bottles bought every single minute, all over the world, and there is up to 5 trillion plastic bags are used around the world every year. In general, half of the plastics produced are designed for sole use purposes and after they are used, they will be thrown away and not even recycled. Most of Egyptians keep plastic bottles (**as shown in figure 6**) and use them many times and that causes health issues.

Figure 6 (shows thrown blastic bottels causes pollusion and health issues)

Only 60% of the waste produced in Egypt is managed by formal, as well as informal waste collection, disposal, or recycling operations while the rest is thrown on megacity thoroughfares or at illegal landforms.

A big bit of the waste is released undressed into conduits, gutters thoroughfares, and open areas which causes anxiety on water, soil, and air.

Wastes in Egypt have two ways to remove them. It can be reclaimed, or it can be burnt. Burning rubbish has a lot of disadvantages. One of them is pollution.

In Africa, Egypt is counted as the third most populated country, and it has 120 million people. Egypt faces a big problem which is waste operation. waste operation is the mismanagement of rubbish. Every time, Egypt generates fairly 30 million tons of agrarian waste and six million tons of artificial waste.

In 2016, around 21.7 million tons of city's solid waste were generated, driven by population growth, and changing patterns of consumption, waste generation is predicted to increase at a rate of 3.4 per time.

To conclude, recycling is extremely important and the lack of it causes a lot of conspicuous problems in Egypt.

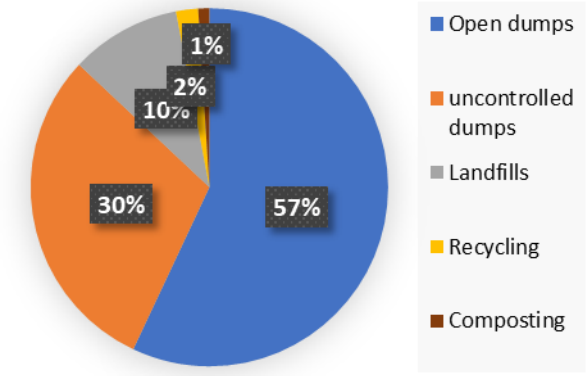
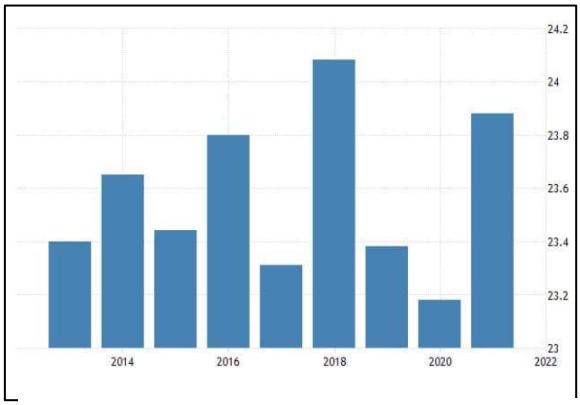


Figure 7

Reduce the effect of climate change.



Graph 1 *(shows the average increase in the temperature in summer)*

Climate change is a long-term shift in global or regional climate patterns problem with many branches as it can be floods, global warming, severe storms, droughts. Those problems can produce another problem such as rising in sea level as when the temperature increases the ocean expand due to melting of the ice of the two poles or it can lead to extinct in a lot of animals or plants as when the climate change the

natural of habitat change and that decreases the biodiversity. The climate change have a serious impact on Egypt like increase in temperature as since 2000 to 2020 increased from 21.8° c to 23.4° c average annual (**as shown in Graph 1**) temperature and in summer the average increased from 28° c to 30.4° c1 and expected to increase the temperature by ratio 0.6 c° in summer and 0.4 c° in rest of the year and that impact on Egypt water resources as it makes a scarcity in water and decrease of the agriculture crops as it expected to decrease about 10 precent of crops in 2050 due to the decrease in rainfall and there are a lot of diseases spread more and more with increase of temperature like heart disease, stroke, high blood pressure, cancer and chronic respiratory diseases.

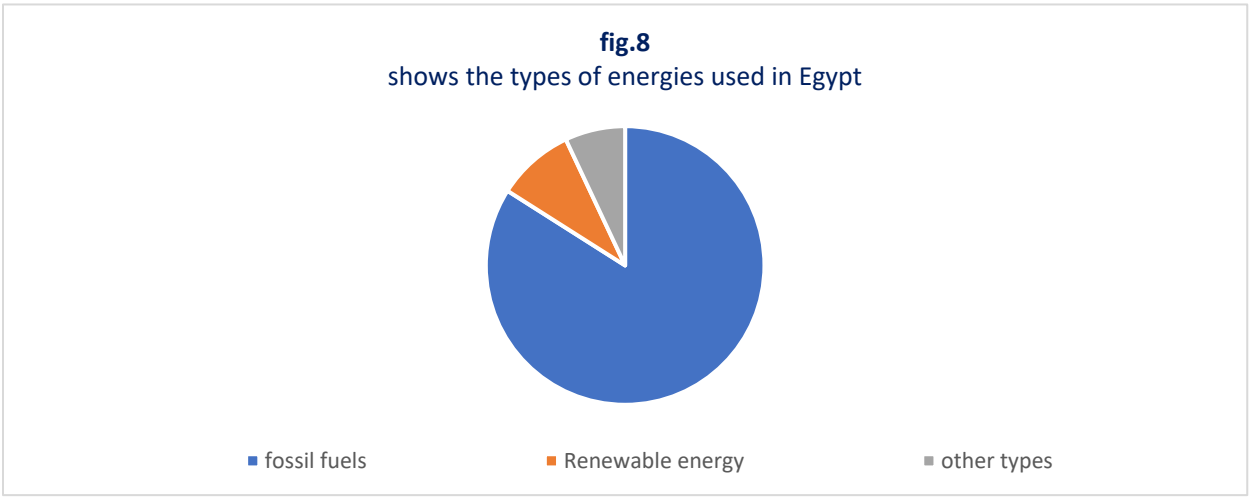
From the reasons that increase the temperature are using the renewable power like burning fossil fuels (**as shown in fig.8**) as fuel accounts for 36% of the total energy consumption in Egypt and renewable energy takes just 6%.

Floods in Egypt have a lot of places that concentrate at such Alexandria, Nile Delta, coast of red sea, Port said and Sinai.

The floods in Egypt is a serious problem as it caused about one thousand deaths in the past 20 years and damage up to 10% of the agriculture production per year and the number of people affected by floods in Egypt from 2016 to 2022 was 3800000 people and the country had to do repairs amounting to $1.028 billion and that affection can be injuries or deaths especially among the children and the elderly , waterborne diseases such as cholera and diarrhea , food insecurity as it can destroy the crops or kill the livestock , a lot of people lose their homes during the floods and that make them homeless . In addition to the physical impacts, there are emotional impacts due to the losses of their lovers and their homes or fear and anxiety due to the horrible experience with floods. Floods affect on an important field like agriculture as it in 2021 about 200,000 acres damaged and cause losses about one billion dollars and in 2017 about 1 million acres damaged and made losses over 2 billion dollars.

The Egypt ministry of environment announced that at 2100 about 10% of Egypt lands would disappear due to the rising in sea level. The world health organization made a study that the deaths related to heat would increase by percentage of 100% by 2100.

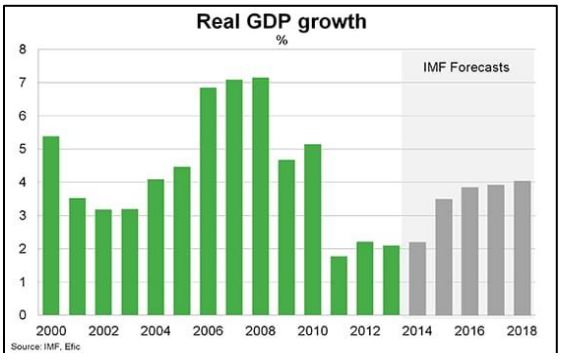
fig.8
shows the types of energies used in Egypt



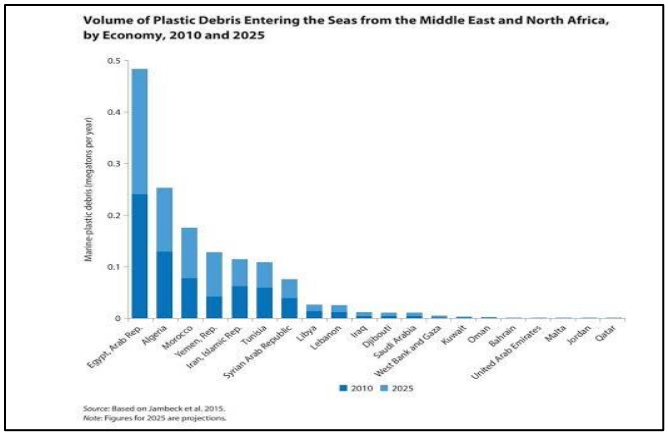
Reduce pollution.

There are a lot of serious problems that face Egypt. One of these dangerous problems is pollution.

Pollution is a big problem that Egypt faces for decades, especially in large cities in Egypt such as, Cairo, Giza, Alex, and Qalubiya. Pollution has significant effect on health, economy, environment of Egypt. The economic cost of pollution on health in



Graph 2



Graph 3

the Greater Cairo (Cairo - Giza - Qalubiya) is about 1.4% of Egypt's GDP (Gross Domestic Product). (**as shown in Graph 2**)

There are a lot of types of pollution in Egypt such as, water pollution, soil pollution, and air pollution.

Pollution contributes to climate change, acid rain and reduce visibility.

The main factor of household air pollution is burning many things for example, wood, fossil fuels, plastic, etc. There are around 3800000 people died because of air pollution each year. The majority of these deaths occur in the developing world. Of the 195 countries, 98 countries (Egypt one of them) increased the percentage households with access to clean - burning fuels to more than 85%. There are 3 billion people still use solid fuels and open fires for lighting, cooking, and heating.

There are many sources and things that cause pollution in Egypt such as burning fossil fuels, automobile exhaust which makes air pollution and dirty water. (**as shown in figure 9**)

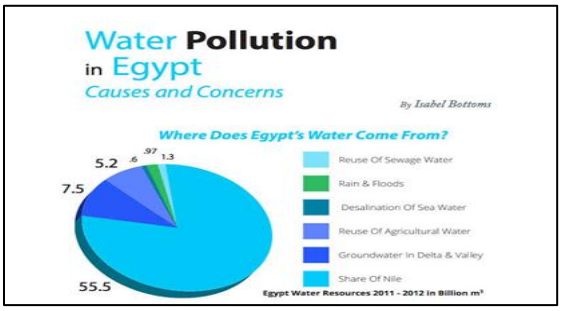


Figure 9

Egypt is 27 of 117 countries on the air pollution index during 2021, but the most interesting that Cairo of the 126 at the world of the World Cities in the air pollution ratio of 47.4 micrograms.

We should do many things to solve these problems such as, using recycled materials such as paper, bottles, plastic, glass, metal and leather instead of burning them, using sustainable energy sources such as, solar energy and wind energy, etc.

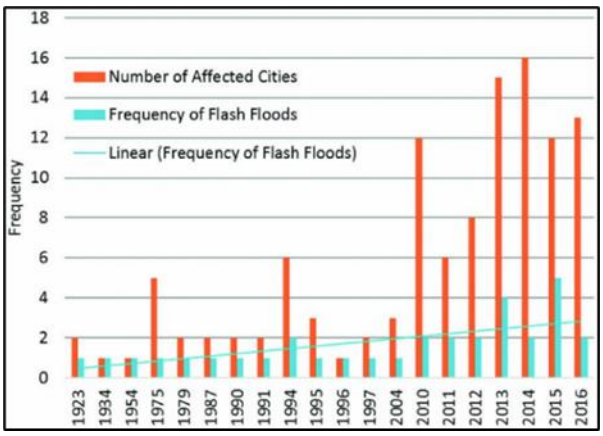
Among the reasons for pollution in Egypt, as amount of pollution, we breathe in relying on some elements for example, access to clean power and energy for heating and cooking all the time of the day.

To conclude, we should cooperate to solve this dangerous problem well.

Problem to be solved.

The problem that must be solved in the capstone of this semester is reducing the flooding.

Floods are an extremely dangerous problem that faces all countries around the world, especially Egypt.



Graph 4

Floods are natural disasters that occur when the water overflows land. Floods can have many reasons, for example, heavy rains, tsunamis, snowmelt, and coastal storms.

Floods can have positive or negative effects on the environment and people. Positive effects of floods such as floods can deposit fertile soil on farmlands, recharge the groundwater, and create wetlands. Negative effects of floods such as, they can destroy a lot of things such as buildings, crops, and lives of the human. Also, they can spread diseases. (**as shown in graph 4**)

According to (the OECD) Organization for Economic Collaboration and Development, floods cause more than $40 billion in damage worldwide, especially in Egypt annually.

Egypt has suffered from floods for decades. In Upper Egypt, there are heavy rains that can cause a lot of floods that damage everything.

Governorates in Egypt are vulnerable to rising Nile levels and have begun to take precautionary measures, namely, Behera, Kafr El Sheikh, and Damietta.

These governorates may face floods. However, the level of floods was low from 2000 to 2021 according to the International Energy Agency, but Egypt is still facing floods.

For example, in 1994 there was a flood in Egypt in Asyut. This flood happened because of a strong weather wave and the amount of rain reached an

unprecedented level; The intensity and length of the precipitation caused a violent torrent over the western mountain there, which led to a very heavy flow of water.

This wave was ranked as the most powerful wave of harsh weather to hit Egypt in the last 50 years. This flood killed 600 people. Most of them are from Asyut.

Egypt is an acidic country and receives a little annual precipitation. The Most of rains fall along the coast, with exceedingly excessive amounts of rainfall received in Alexandria approximately 200mm precipitation per year.

From 2000 to 2020 the level of floods in Egypt was incredibly low with a score of 0.9 out of 10 according to the (IRI) Inform Risk Index. This is lower than the global average of 3.5. However, this does not mean that floods are not a severe problem in Egypt, and they can still have devastating impacts on vulnerable areas and communities.

Figure 10 (flood discharges in red sea)

The most vulnerable region to floods in Egypt is the Sinai Peninsula, which is a desert place that receives little rainfall, but when it does, it causes flash floods that are sudden and destructive.

Studies by Cools et al develop an early warning system for flash floods in the Sinai Peninsula and will be tested based on the best available information.

To conclude, floods in Egypt are an extremely dangerous problem that must be solved.

The major positives if the problem is solved:

1. The number of people who died due the floods would decrease.

2. Lots of houses will not be destroyed. Floods destroy the houses of people and people do not find a house to live in, so if the problem of floods is solved there will be fewer people who would face homelessness.

3. Due to decreasing in the number of floods the pollution in various area would decrease as the floods works as a transporter for the wastage of factories or the garbage of the dumps.

4. The cities will be attractive. When the floods come out, they destroy everything, so if there are fewer floods, we will be able to make the city attractive without fearing a flood.

The major negatives if the problem isn't solved:

1. Increase in the case of homelessness as the floods are a destructive that tend to destroy everything in its way.

2. Destroying the infrastructure of the countries which would cut off the electricity, internet and means of transportation.

3. Different services will be destroyed like schools and hospitals

4. Depression, anxiety and post-traumatic stress disorder (PTSD) would spread through the people who faced the various impacts of floods.

5. The economy of the countries would be affected in a bad way as the country would be forced to re-build everything that had destroyed.

6. the spread of diseases such as cholera would increase as the floods play as transporter for those disease that tend to be transferred through water.

Research

Topics related to the problem:-

- **Climate change**
- **Health problems.**
- **Displacement of people**
- **Environmental problems**

1-Climate change:

The climate change has a lot of impacts that sometime can be significant and dreadful, one of those things that had harmful influence on our life is floods have a bunch of things that could make a such awful disaster to happen like the melting of ice on the top of mountain due to global warming or any reason that can increase the temperature it also can happen due to over raining on a specific area like valleys. the main problem of floods not the floods but it about its followed problems for example displacement of people, loses in people and life, etc.

2-Health problems:

There are two types of disease based on the way of translation from person to another, the first type is infection diseases and that type rely on vectors to translate the disease from a host to another, the second type is non-infection diseases that don't need anything to connect it with its host except genes from parent or bad health style. The floods can spread infectious diseases by conducting the pollutants such as sewage industrial pollutants with source of water drinking those pollutants can include virus or bacteria that effect on humans' health by getting effected after drinking pollutant water.

3-Displacement of people:

The floods make no chance for people to continue leaving in their houses if those houses are inside the flood impact zone and that could lead to a lot of problems for example financial problems as the government of the countries had to bear the cost of repairs of the building or the various facilities and in the case of the countries of weak economy the destruction of buildings by floods can lead to the cases of homelessness

4-Environmental problems:

Even if the floods are a natural problem but it had a lot of environmental problems as it can destroy a whole eco-system in a lot of areas by Elimination of a type of plant or make the animals or birds migrate to better environment. the floods also can pollute the environment by transferring the pollution materials from factory sites or garbage dump to clean places. for the agriculture field, the floods can cause soil erosion as when the wave of floods pass through crops it could take the top soil away which is rich in nutrients.

Topics related to solution:-

- **The flow rate**
- **The dimension's determination**

1-The flow rate:

To measure the volume flow rate of the water from the dam we used the volume of quantity of water coming out of the gates of the dam in specific period of time.

Q_v = volume / Δ time = area * velocity

So, we can increase the speed of the water coming from the gates of the dam by decreasing the area of the gate by which the water moves through, since $Q_v = A*v$

So, at constant flow rate when the surface area of the gate decreases the velocity of the discharging of water will increase

or by increasing the pressure of the water by building the dam's gates deeper in the reservoir because as we get down in the water the pressure increases.

2-The dimension's determination:

To measure the dimensions, we choose a valley that have the amount of rains that we need and the soil in it will not affect the dam's and minimize the dimensions of the real dam by a minimizing scale by which the dimensions of the dam meats the design requirements.

After that we have to test the dimensions of the dam to be safe for constructing the dam so the dam was tested by two tests which are the sliding test: by which we test the force of the dam against the force of water that prevents it from sliding because if the pushing force of water by dividing the all weight of the dam by the force of water.

The second test is the turning over test: by which we measure the ability of the dam to turn over because the force of the dam or the decrease in the weight of the dam.

Prior solutions

1.Birkets dam

Birkets dam is located 20 km away from the city of Siliana in Tunisia. This dam was completed in 1964 with a height of 53 meters and a storge capacity of 260 million cubic meters.

History:

The Birkets Dam has helped to significantly reduce the risk of flooding in Siliana from water of rains. Before the dam was built, the city of Siliana was flooded an average of five times per year by the Oued Siliana River. Since the dam was built, the city of Siliana has not been flooded once.

Figure 11 (Birkets dam)

This is because the dam helps to control the flow of water in the river. During periods of heavy rains.

* In 1963, before the dam was built, the city of Siliana was flooded by the Oued Siliana River causing an estimated EGP 10 million (US$1.6 million) in damage.
* In 1965, after the dam was built, the city of Siliana was hit by a similar rainstorm, but the dam was able to store the excess water and release it slowly over time, preventing the river from overflowing its banks and flooding the city.
* In 1970, the city of Siliana was again hit by a heavy rainstorm, but the dam was once again able to prevent the river from flooding the city.

This dam was built for lots of reasons as:

1- **irrigation:** This dam provides irrigation in Tunisia with a huge amount of water which is about 20,000 hectares which increases the agricultural productivity and solve a massive problem for this land since Tunisia is considered an arid country with limited resources of water

2- **Drinking water:** The birkets dam provides the city of Siliana with pure drinking water

3- **Flood control:** Tunisia faces lots of floods especially in winter, the birkets dam helps in facing these floods by storing the excess water, which protects the community from damage.

4- **Hydropower generation:** This dam also generates hydropower which helps the country and it's a clean source of energy that doesn't pollute the environment.

And after building this dam it became one of the most tourist attractions places in Tunisia so it increases the economy in the country.

The location

In choosing the location you must be very accurate and this dam's location was chosen for many reasons as:

1- **topography:** the dam is located in a narrow valley with step sides, and this is good for the dam construction as it provides it a strong foundation and helps in creating a huge reservoir.

2- **Infrastructure:** The dam is located near existing roads and power lines, that made easy transportation for construction materials and equipment to the site. The dam is also located near the city of Siliana, which is a major agricultural and industrial center. This makes it convenient to distribute the water and electricity generated by the dam.

Details about the dam

• Height: 53 meters (174 ft)
• Crest length: 350 meters (1,150 ft)
• Reservoir surface area: 1,100 hectares (2,700 acres)
• Reservoir storage capacity: 260 million cubic meters (8.3 billion cubic feet)
• Type: Earth-fill dam
• Completed: 1964
• Primary purpose: Irrigation

This dam was created by a French and an Italian company, and its building began in 1961 and it was ended in 1964 and it was built using the rolled earthfall method, which involves compacting layers of soil to create a watertight barrier.

The Birkets Dam is a complex engineering structure that uses a variety of building materials to be created safe and reliable. The dam's engineers carefully chosen the right materials for each part of the dam to ensure that the dam would meet all of its design requirements.

And from lots of materials the main components for manufacturing this dam are:

- **Rocks:** Rocks are used to reinforce the dam and to protect it from erosion. Rocks are also used to build the dam's spillway, which is a channel that allows excess water to flow out of the reservoir.

- **Concrete:** Concrete is used to build the dam's powerhouse, which houses the turbines that generate hydropower. Concrete is also used to build the dam's control tower, which is used to monitor and operate the dam.

- **Steel:** Steel is used to reinforce the dam and to build the dam's gates and valves. Steel is also used to build the dam's penstocks, which are pipes that carry water from the reservoir to the turbines in the powerhouse.

The mechanism of its work:

The Birkets Dam works by collecting rainwater and storing it in a large reservoir. The reservoir is created by a large earthen dam that spans the Siliana River. The dam has a height of 53 meters and a crest length of 350 meters. The reservoir has a surface area of 1,100 hectares and a storage capacity of 260 million cubic meters.

The description of its work during rain event:

- Rainwater falls on the catchment area of the dam.
- The rainwater flows into the reservoir through the Siliana River and its tributaries.
- The water in the reservoir rises as more rainwater flows in.
- When the water in the reservoir reaches a certain level, it flows over the spillway.
- The spillway releases the excess water from the reservoir to prevent it from overflowing.
- The water that flows over the spillway is discharged back into the Siliana River downstream of the dam.

And like everything in our world this dam has pros and cons that we have to focus on them

Its advantages:

• The dam helps to create jobs in the agricultural, tourism, and energy sectors.

• The dam helps to support local businesses and industries.

• The dam helps to improve the quality of life for people in the region by providing them with access to water, electricity, and other amenities.

• The dam helps to protect the environment by reducing erosion and flooding.

• The dam helps to conserve water resources.

• The dam helps to promote sustainable development in the region.

Its disadvantages:

• The dam is vulnerable to sedimentation, which can reduce its storage capacity over time.

• The dam is also vulnerable to drought, which could impact its ability to supply water to irrigation and drinking water users.

• The construction of the dam displaced some people from their homes.

• The dam also had some negative impacts on the environment, such as the loss of some wildlife and vegetation.

2.The Three Gorges dam

• **Location:** Sandouping Town, Yiling District, Yichang, Hubei province, China,
• **started working:** 2009
• **Dimensions:**
- Length: 2,335 meters (7,660 feet)
- Width (base): 115 meters (377 feet)
- Width (crest): 40 meters (131 feet)
- Height: 181 meters (594 feet)

• **storge capacity:**
• **Reservoir:**
- Surface area: 1,045 square kilometers (403 square miles)
- Storage capacity: 39.3 cubic kilometers (31.9 billion acre-feet)

• **Type:** Concrete gravity dam
• **Primary purpose:**
• **Cost:** 22 billion dollars

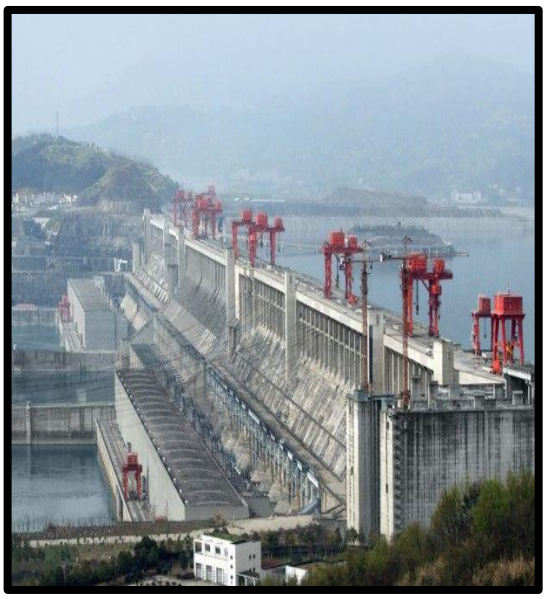


Fig.12 (The Three Gorges Dam)

Reason of building:

• water supply

• floods control

• Navigation

Advantages:

• Hydroelectric power: It generates electricity that enough for million houses as it generates about 100-110 terawatt-hours (TWh)

• Water supply: The dam provides water for irrigation, drinking, and industrial use.

• Navigation: It created a channel for large ships

• Flood control: The dam protects the people who live near to the Yangtze River from the horrible floods

• Water supply: The dam provides water for irrigation, drinking, and industrial use.

Fig.13

• Reduced greenhouse gas emissions: Hydroelectric power is a clean source of energy and doesn't emit greenhouse gases

Disadvantages:

• Greenhouse effect: the dam emits a large amount of greenhouse gases

• Polluting water: As it makes the sewage and industrial wastes to accumulate

• Displacement of people: A millions of people had to leave their houses that placed at the flooded area of reservoir

The location was chosen by some factors:

• **Topography:** The site is located in a narrow gorge, which is surrounded at the end of both sides by high mountains. This natural constriction of the river channel made it possible to build a dam that is relatively short in length, but very high.

• **Infrastructure:** The place of building the dam was already relativity developed as it had roads, power lines, railways that helped in construction process

Materials of building:

• **Concrete:** The concrete was made from locally-sourced sand, gravel, and cement (28 million cubic meters)

• **Steel:** The steel was produced in steel mills across China (463,000 metric tons of steel)

• **Earth and rock:** The earth and rock were excavated from the dam site and surrounding areas (103 million cubic meters)

The description of its work during collecting water:

1. Water flows downstream towards the Three Gorges Dam

2. It is gradually slowed down by the dam's massive structure

3. This allows the water to settle and deposit any sediment it is carrying

4. The cleaner water then flows through the dam's turbines, generating hydroelectric power

To be the best in something, you must learn from previous experiences, whether successful or unsuccessful, in order to learn from the mistakes, they made and benefits from their strength.

3.The Kariba dam

- location:

The Kariba dam is in the Zambezi River between Zimbabwe & Zambia.

History:

Figure 14 (Kariba dam)

Before the dam: Before building the Kariba dam, the area around the Zambezi River suffered from a lot of flood discharges, which had many bad impacts on the area and the people living near to it.
One of these floods is the flood that happened in 1958. This flood was a very massive flood. The flood happened during the construction of the Kariba dam, so it caused a lot of losses to the company working on building the dam and cost them a lot.
The government of the two countries (Zambia & Zimbabwe) at this time were improving their economies, and they were starting to depend on industry on their economies. Although they depended on fossils to generate electricity, which is much more expensive and unreliable. So, they needed to find another source of electricity.
After the dam:
The dam helped a lot with the problem of the flooding and decreased the floods in the area.
The dam also helped with the problem of the electricity, the dam produced enough electricity for the two countries to carry forward their progress in industry and improving their economies.
The dam had also some bad impacts in the area like displacing the people and causing environmental problems.

- started working:

Zambia and Zimbabwe crated a company to control the dam and started working in building it in 1959.

- Completed:

The company finished building the dam and started generate electric from it in 1982.

- Dimensions:

- heigh: 128 meters.
- long: 579 meters.

- storge capacity:

The reservoir of the dam can restore **185km³** of water**.**

- Reservoir:

This dam creates a reservoir behind it called the Kariba Lake, which is the biggest man-made lake in the world. (**As shown in figure 15)**

Figure 15 (Kariba dam reservoir)

- surface area: **185 km^3**
- storage capacity: **5580 Km^2**

- Type:

The dam is designed as an **Arch Dam**.

- Primary purpose:

it was built to generate electricity for Zambia and Zimbabwe.

- Reason of building:

• generate hydroelectric power: the dam generates power that is used to cover the needs of electric in Zambia and Zimbabwe.

•control foods: the dam is used to control the flow of Zambezi River.

- Advantages:

- ❖ It provides 1626 megawatt of power that helps to cover the needs of electricity in Zambia and Zimbabwe.
- ❖ It helped reducing the flood discharges in the river.

- The water stored in the reservoir of the dam is used in irrigation and farmlands.

Figure 16

- Disadvantages:

- The dam has made an environmental and social problems.
- The dam displaced about 57 thousand of Tongan people from their home.
- The dam caused some health issues for the people in the area.

- The location was chosen by some factors:

It is built in the Zambeze river, this area was facing a lot of flood discharges, so the dam, was built there to saves people from flood discharges, and use these floods to generate electric.

Topography: the dam was built in a narrow valley in the Zambezi River which is suitable to build an arch dam.

-Materials of building:

Concrete: this dam is an arch dam, the arch dams design doesn't need a lot of material, and needs a strong material to give it hardness, so concrete is a suitable material for this dam,

- The description of its work during collecting water:

When the Zambezi River flow, the dam collects the flow water from the Zambezi River in the Kariba Lake behind it, the dam uses the flow water also in generating hydroelectric power.

4.Al-Masry dam

Location: Wadi Al-Arish, North Sinai, Egypt

History:

Figure 17

Before the El Masry Dam was built, the city of El Arish and the surrounding area were frequently flooded, the flood caused widespread damage to the city, including the destruction of homes and businesses.

The El Masry Dam has helped to significantly reduce the risk of flooding in El Arish. Since the dam was built, there have been no major floods in the city.

Here are some specific numbers that illustrate the impact of the El Masry Dam on flooding in El Arish:

- Before the dam:

- The average annual number of floods in El Arish was 5.
- The average annual damage caused by floods in El Arish was EGP 10 million (US$1.6 million).

- After the dam:

- The average annual number of floods in El Arish has decreased to 0.
- The average annual damage caused by floods in El Arish has decreased to EGP 0.

These numbers show that the El Masry Dam has had a significant impact on reducing the risk of flooding in El Arish. The dam has helped to protect the city from flooding and has saved the city millions of dollars in flood damage.

Started working: 1979.

Dimensions:

* Length: 400 meters

* Width: 290 meters

* Depth: 62 meters

* Height: 62 meters

Storage capacity: 450 million cubic meters

Reservoir:

* Surface area: 9.5 square kilometers

* Storage capacity: 450 million cubic meters

Type: Gravity dam

Completed: 1979

Primary Purpose: Flood control, irrigation, and water supply

The mechanism:

The Al-Masry Dam works by storing water from the Wadi Al-Arish during the winter months when rainfall is heaviest. The dam's reservoir can hold up to 450 million cubic meters of water. This water is then released gradually throughout the year to meet the needs of irrigation, drinking water, and flood control.

When the reservoir is full, the dam's gates are closed to prevent the water from flowing downstream. The dam also has a spillway, which releases excess water from the reservoir in a controlled manner.

The water stored in the reservoir is used for three main purposes:

* Irrigation: The water is released into a network of canals and ditches to irrigate crops in the surrounding area.

* Drinking water: The water is pumped to a treatment plant and then distributed to the local population through a network of pipes.

* Flood control: When heavy rains cause the Wadi Al-Arish to flood, the gates are closed to prevent the floodwaters from reaching the populated areas downstream.

Reason of building:

- To protect the Sinai Peninsula from flooding.
- To provide water for irrigation and drinking water to the local population.
- To boost the local economy by creating jobs and supporting agriculture.
- To help to reduce Egypt's reliance on imported food.
- To provide a recreational area for locals and tourists.

Advantages:

- ❖ Protects the Sinai Peninsula from flooding.
- ❖ Provides water for irrigation and drinking water to the local population.
- ❖ Boosts the local economy by creating jobs and supporting agriculture.
- ❖ Helps to reduce Egypt's reliance on imported food.
- ❖ Provides a recreational area for locals and tourists.

Disadvantages:

- ❖ Siltation: The dam's reservoir is gradually filling with silt, which reduces its capacity and efficiency.
- ❖ Climate change: Climate change is expected to lead to more extreme weather events, such as heavy rainfall and droughts. This could put the dam under additional stress.
- ❖ Population growth: The population of North Sinai is growing rapidly, which is increasing the water demand.

The location was chosen by some factors:

* Topography: The Al-Masry Dam is in a narrow valley, which is ideal for building a dam. The narrow valley also helps to reduce the amount of land that is inundated when the reservoir is full.

* Infrastructure: The Al-Masry Dam is located near a major road and railway line, which makes it easy to transport materials and equipment to the dam site.

Materials of building:

* Concrete: The Al-Masry Dam is made of concrete. Concrete is a strong and durable material that is well-suited for building dams.

The description of its work while collecting water:

1. When it rains, water flows down the Wadi Al-Arish and into the dam's reservoir.

2. The dam's sluice gates are closed to prevent the water from flowing downstream.

3. The water level in the reservoir rises.

4. When the reservoir is full, the dam's spillway opens to release excess water in a controlled manner.

5. The water is then stored in the reservoir until it is needed for irrigation, drinking water, or flood control.

Figure 18

Additional information:

- The Al-Masry Dam is one of the largest dams in Egypt.
- The dam is a popular tourist destination, and visitors can take boat tours of the reservoir.
- The dam is also home to a variety of fish species, and fishing is a popular activity in the area.
- The dam has created over 10,000 jobs in the construction, agriculture, and tourism sectors.
- The dam has increased agricultural production in North Sinai by over 50%.
- The dam has helped to reduce poverty in North Sinai by over 20%.
- The dam has increased the value of land in North Sinai by over 30%.

Chapter 2: Generating and defining the solution.

Solution and design requirements

In this semester we should build dam that must have:

Sustainability for the dam is very important due to the effectiveness, applicability, and accuracy.

Design and solution requirements are needed for any project, especially in our project to determine what should be applied in project, what properties and characteristics it should have for the project.

Solution and design requirements:

- **Sustainability:**

dam has a significant impact on the society and our environment. They can also help control floods and protect downstream community.

Figure 19

Dams can be constructed and designed in a lot of sustainable ways to clear their social and environmental impacts.

- Managing reservoir water levels to protect downstream impacts.
- Monitoring reservoir sediment to maintain water quality and reservoir capacity.
- Shooting water from the reservoirs in a way that minimizes downstream impacts.

- **Low cost:**

The cost of the solution is very important element to evaluate the quality of the solution and efficiency because of that the prices of are what distinguish solutions that are working on the same problem and the same function, so good solution must have an affordable cost which meets the solution demands.

Figure 20

- **Availability:**

The prototype's sustainability, safety, cost, and efficiency are all determined by the availability of recycled materials used to construct the solution therefore a good solution must be available.

Figure 21

- **Flexibility:**

The flexibility of the solution is how the solution could be used in different areas and places and have the same efficiency.

Figure 22

- **Efficiency:**

For the dam to be efficient, it must produce output that is better than its input in many manners. Efficiency means to achieve a goal in project with the least amount of effort, money even time as long as this goal is effective and provides the best performance that it should do.

Figure 23

Design requirements:

❖ **Dimensions estimation:**

- Target stored capacity of dam between a minimum of 50 and maximum of 60 liters.
- The minimum height of stored water is 25 centimeters.
- The minimum height of the dam is 30 centimeters.
- The thickness of the dam in the bottom should not be less than 10 centimeters, but in the top should be not less than 3 centimeters.
- The prototype dam should be able to discharge water to both 25% and 75% of stored water target amount.
- The minimum storage time, of the maximum designed capacity, during testing prototype should be at least 2 hours.
- All the materials are recycled materials except one manufactured material.

Selection of solution

Egypt suffers from the problem of flooding, so achieving the goal of avoiding and blocking these floods is necessary. Our solution for this problem at this semester is to use the dam as the main idea to block floods. Several ways could achieve our goal. However, there were some limits while searching for a good solution as it has to be efficient, available, and easy to apply in Egypt.

Dam will solve the problem of flooding by storing excess during heavy rains and releasing it slowly and in a controlled manner over time. This helps to reduce the peak flow of the river, which is the main cause of flooding.

In addition to flood control, dams also provide other benefits, including:

- Storing water for irrigation, drinking water, and other purposes
- Hydropower generation
- Recreation opportunities
- Habitat for fish and other wildlife

After understanding the problem well and getting a whole idea about the dam with the help of the prior solutions. We chose the gravity dam as the main dam to solve the problem and the buttress dam as the spare dam.

Gravity dam:

A gravity dam is a type of dam that depends on its own weight and the force of gravity to withstand horizontal water pressure. They are typically constructed of concrete or stone masonry and are used to create reservoirs by crossing rivers or streams. Gravity dams are one of the most popular and oldest forms of dams, and they are well-known for their stability and endurance. (**as shown in figure 24**)

Figure 24

primary benefits of gravity dams:

• Massive Size: Gravity dams are often quite thick and heavy, which aids in their resistance to water forces.

• Broad base: The base of a gravity dam is frequently much wider than the top, which aids in its stability and prevents it from toppling or falling.

• Tapered shape: The walls of a gravity dam taper towards the top, distributing the dam's weight more equally.

• Foundation: To withstand the weight of gravity dams, a solid foundation is required.

Buttress dam:

A buttress dam, also known as a hollow dam, is a form of dam with a solid, water-tight upstream side that is supported at intervals on the downstream side by a series of buttresses (supports). We chose the buttress dam because it is a robust dam that blocks floods and retains water. (**as shown in figure 25**)

Figure 25

Primary benefits of buttress dams:

• Buttresses: Buttresses are thick, reinforced concrete structures erected on the dam's downstream side. They are placed along the dam's length to help distribute water pressure and offset horizontal stresses.

• Crest: The dam's crest is the upper surface that keeps back the water. It is usually a flat surface with a carefully planned elevation to withstand water pressure and prevent overtopping.

• Foundation: A buttress dam, like any other dam, needs on a strong and stable foundation to support the weight of the dam construction and withstand uplift forces.

Where to build the dams:

Figure 26

We chose Wadi El-Hamamat for building both the gravity dam and the buttress dam. Wadi El-Hamamat is an ancient quarry and trading route in Egypt's Eastern Desert (as shown in figure 26). For thousands of years, it was utilized to extract rich materials such as gold, turquoise, and greywacke. The valley is also rich in rock art and inscriptions, which provide unique insights into ancient Egyptian culture and history.

We chose it since it has numerous advantages, such as:

1.Narrow gorge: A narrow gorge provides a strong foundation for a dam while also reducing the quantity of material required to construct it.

2.Rock type: Wadi El-Hamamat's bedrock.

3.Rock type: The bedrock of Wadi El-Hamamat is solid and stable, making it a good candidate for dam support.

4.Water availability: The Wadi El-Hamamat area provides a consistent source of water, which is required for hydroelectric power generation.

Its dimensions:

Length = 243.23 meters

Width = 145.94 meters

Height = 175.128 meters

These dimensions are chosen after many tests which are:

Sliding over test

1. we determine the weight of the dam (by multiplying the area and the density of the material that the dam is mainly made of which is concrete)

2. and the water force inside the reservoir

by which the ratio between them must be more than or equal to 1.5

overturning test

3. by which we measure the probability of falling of the dam being over because of its instability or error in choosing its dimensions.

The spillway gate:

It is a structure used for a variety of purposes, such as managing the flow of water over or around a dam or other hydraulic structure. Spillway gates are primarily used to regulate reservoir water levels or to prevent flooding downstream of a dam. They can also be used to discharge extra water during high flow periods, such as during a flood.

Figure 27

Types of spillway gate:

There are many different types of spillway gates, but some of the most common include:

1. Radial gates: These gates open and close by rotating on a vertical axis. They are frequently utilized on dams with limited space.

2. Vertical lift gates: These gates are vertically raised and lowered. They are frequently employed on dams where precise water level control is necessary.3.Tainter gates: These gates are curved plates that pivot along a horizontal axis. They are frequently employed on dams where a significant volume of water must be discharged quickly.

Figure 28

4. Pneumatic gates: These gates open and close by inflating and deflating with air. They

are frequently employed on minor dams or in isolated areas when power is unavailable.

There are many different types of spillway gates, but we picked Tainter gates for our dam prototype because they are commonly used on dams when a big amount of water must be discharged swiftly.

The sluice gate:

Sluice gates are designed and used to meet the special needs of rainwater collection and storage. Rainwater gathering dams are built to capture and store rainfall for a variety of uses, including agricultural irrigation, groundwater recharge, and local water supply. Sluice gates in such dams would be used to govern the discharge of stored rainwater based on user and natural environment needs.

Figure 29

Considerations for sluice gates:

- Water release regulation: Sluice gates are used to restrict the outflow of rainwater from the dam. This rule ensures that water is released in a controlled manner to suit local water demands while causing no harm.

- Irrigation: Sluice gates in agricultural applications can be modified to discharge water for irrigation during dry periods. This assists farmers in optimizing their water use for agricultural cultivation.

- Groundwater recharge: The controlled flow of rainwater through sluice gates can aid in groundwater recharge, particularly in areas where subsurface water is depleted.

- home water supply: Sluice gates can be used to release water for local communities or small-scale home water supply systems, ensuring that stored rainfall is extracted in a sustainable and controlled manner.

- Sediment management: Sluice gates can be used to control sediment transport depending on the design and location of the dam. Controlled releases can aid in the prevention of sediment building in the dam, hence ensuring long-term storage capacity.
- Environmental considerations: Sluice gate operations must be carefully managed to minimize any negative environmental repercussions downstream. Considerations for aquatic ecosystems, water quality, and habitat protection are all part of this.

- Emergency spillway: An emergency spillway with sluice gates may be installed as a safety element to handle excess rainwater and prevent overtopping during extreme weather occurrences.

- Maintenance: Sluice gates must be inspected and maintained on a regular basis to ensure proper operation. This includes inspecting the structure for structural integrity, cleaning off trash, and lubricating moving parts.

The difference between the spillway gate and the sluice gate:

While both spillway gates and sluice gates are used to manage waterflow, the fundamental difference is in their duties and positions. A spillway gate is related with a spillway and is primarily concerned with dam safety during high-flow events, whereas a sluice gate is a broader word for gates that control waterflow in various water management systems.

Selection of prototype

To construct a small prototype of the solution, it needs to represent some functions that the dam in large scale does. Which is: storing water, recharging 25% of water, recharging 75% of water and recharging the exceeded water.

To represent these functions in smaller scale, we had chosen the minimization scale to be 486.46%. Which produces the following dimensions.

The prototype with a minimization scale of (486.46):

Reservoir dimensions:

- Length equals 50 cm.
- Width equals 30 cm.
- Height equals 36 cm.
- To store 54 liters of water.

The dam structure dimensions:

- Thickness at base = 24cm
- Thickness of crest = 12cm
- Height of dam: 40cm
- Heigh of water = 36cm

Discharging water:

There are 3 main sluice gates at the dam to discharge the water:

- Height: 27 cm, discharges 25% of the water
- height 9 cm, discharges 75% of the water

The mechanism of opening the gates of the dam:

In our prototype we had two gates , the both are the same in the way of opening as you just had to turn the circled hand of the pipes in the clockwise and in the anti-clockwise to close.

Discharging the exceeded water:

One of the important things that must be considered is to deal with the exceeded water. So, the dam will have a spillway gate that discharges the exceeded water.

The mechanism of opening the spillway gates:

The mechanism of getting rid of the exceed water is by using sided spillway by which water would slide from a tunnel next to the dam to prevent the erosion of the dam if we built in spill way.

The maximum height of water in reservoir is 36 cm and we will construct it at that height to get rid of the exceed water that coming from the unexpected rate of floods and the spillway will transfer the water from the upstream to downstream.

The volume of flow rate:

The flow rate is the speed by which a quantity of water gets out of the dam through the gate.

The spillway will be with diameter of 3 cm.

The flow rate at the 25 % gate is 8.82*10^-4.

•By decreasing the area of the gate which the water will get out of, the speed of the water increases, so the time of discharging of water decreases.

•The volume of flow rate is the division of the volume of water and the time ***Or*** Multiplication of the area and, the velocity of water which is (height * gravity * square root 2)

Chapter 3: Constructing and testing a prototype.

Materials and methods

Table 1 *(shows the materials that we used to construct the dam)*

Item	Description	Cost	Quantity	Source of purchase	Image
Cetorex grout	A type of cement that is waterproof and quick to dry	3 L.E	64 kg	CMB	
Reinforcing bars	Metallic bars	Recycled	9 meters	Painting shops	
Water stopcock	Used to be gate	20 L.E	2 pieces	Plumber shop	
Bucket	A small plastic bucket	Recycled	1	Plastic factory	

Wooden sheets	Wood sheets that are used for the mold	150 L.E	100x50 cm	A carpenter	

Methods:

First, it was started by determining the way that will be used to build the prototype. It was found that is important to build a mold to pour the materials in it, to shape the prototype. The mold was made by recycled wooden sheets and counting its dimensions to design it. Then, we started building the prototype, Plastic sheets were first put in the bottom of the mold to prevent the mixture from sticking, and a base of wood under the plastic sheets to avoid any leak in the mold. Then a mixture of cetorex grout, gravel, and water was made. First, we put the reinforcing bars and set them vertically in the mold, so it is harder. Then, the gravel was added to the cetorex grout while stirring them, so it is evenly distributed. Then, the water was added to the cetorex grout -with ratio 1 milliliter of water for each 10 grams of cetorex grout- while stirring quickly, so it is mixed and converted to concrete. After it is mixed, the mixture is put in the mold, and then it is left to dry, and it took a whole day to dry.

Safety precautions:

To take care while making the prototype and the safety precautions we took to be safe. First, the coats were worn to make sure we do not get hurt of the materials we use. Then, the gloves were dressed to do not get hurt of the wood and the nails and stirring the materials. Also, the masks and the glasses were worn while cutting the wood as the dimensions we wanted.

Test plan

In testing our prototype, we had to examine the effincey and the dimensions of our prototype.

So there were three main tests we had to do which are:

First, The dimensions test: any mistake in the dams dimensions during constructing it will cause us lose for the all prototype so we had to be very accurate in testing our prototype's dimensions, we had to take into consideration that the concrete expands after it dries so we tested our dimensions a day after letting the dam to insure that it had dried, we measured the dimensions of the dam by a measuring tape many times to insure that there isn't any errors and insure that it suits the design requirements

And the results was:

- The height of the dam : 40 ± 1.2 cm
- The width of the dam : 50 ± 1.2 cm
- The thickness at the base of the dam : 24 ± 0.6 cm
- The thickness at the crest of the dam: 12 ± 0.4 cm
- The length of the slope side of the dam : 36 ± 0.3 cm
- The length of the part over the slopped side : 6 ± 0.2 cm
- The length of the angle of the slopped part : 69 degrees ± 1 degree

After that we have tested the dimensions of the dam to be safe for constructing the dam so

the dam was tested by two tests which are:-

1-The sliding test:

By which we test the force of the dam against the force of water that prevents it from sliding because if the pushing force of water by dividing the all weight of the dam by the force of water .

so we measure the all weight weight of the dam by multiplying the area of the part of the dam by the density of the material by which the dam is made of by the the gravity

and we calculate the force of the weight of water by multiplying the density of water by the area of the part of the water facing the dam and thee force of the water Is always concentrated by a triangular shape and the force of this triangle of force is concentrated at it's center by which the force is dividing the triangle into 3 parts by which the force of the lower part is equal to the two upper parts.

And the measure must be more than 1.5

2-The turning over test:

By which we measure the ability of the dam to turn over because the force of the dam or the decrease in the weight of the dam

By which we calculate the

We devide the stability momentum (S.M) of the dam by the over turning momentum (O.T.M) and this measure must be less than 3 and more than 2

(S.M) Equals the sum force of each part of the dam * the distance between the center of the force and the toe of the dam

(O.T.M) Equals the pressure of the water on the dam equals the area of the triangle of force of water facing the dam * the distance between the center of force of this tringle and the toe of the dam.

And after that we also checked the dimensions of the reservoir by which there mustn't be any mistake in them to store the certain capacity of water, which is 54 liters to suit the design requairments.

- The length of the reservoir: 30 ± 0.334 cm
- The width of the reservoir: 50 ± 0.492 cm

- The height of the reservoir: 40 ± 0.1 cm

and we checked the chosen place for our gates to insure that the quantity of water will get out from its chosen place :

as the two gates were built one at dimension 27 cm of the dam to discharge 25 % of the water in the dam

and another one at height 9 cm of the dam to discharge 75 % of the water inside the dam

and the spill way is a side spill way which is built as an tunnel in the container at height 36 cm to discharge the whole capacity of water .

Second, the ability of the crossroad to resist a load of 10 kg or more We tested the strength of the dam at it's crest and its resistance of falling by putting a weight of 10 kg on the middle of the dam's crest and it loaded it and after more testing with different weights we concluded that our dam could resist putting a mass of 50 kg or more on it's crest .

Third, the flow rate: for testing the flow rate of water in the dam gates we used a bucket to collect water getting out of the gate and we took a graduated cylinder from the chemistry lab to measure the volume of the quantity of water we collected, and a stopwatch to calculate the time by which water got out of the gates

And since Q_v = volume / Δ time

So to calculate the flow rate we divided the volume of water we calculated and the time by which it passed through the gate.

In our first trial we had chosen to discharge the quantity of 25% of the water in the dam which is 13.5 liters, and we determined it's discharging time 57 seconds

After that we discharged 75 % of the dam which is 40.5 liters and determined it's time 240 seconds

And after calculation of the flow rate of both of them and because of the similarity in the surface area of all the gates of the dam

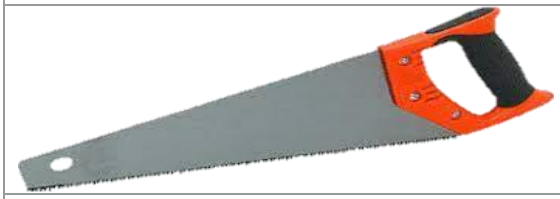
We found that the speed of discharging of water in the second gate, which is deeper is higher due to the increase in the pressure as we go deeper.

Forth, we tested the ability of the dam to store the maximum amount of water without any leakage in water or effect in the dam structure, so we put 54 liters of water in the dam for 2 hour and observed the change in the quantity of water in the 2 hour and found that there was no change or leakage in the amount of water.

Data collection

Building and constructing the dam required a lot of measurement and building instruments, such as:

table 2 (shows the instruments used on measuring and constructing)

	**Measure tape:** It was used to draw the dam dimensions on the wooden sheets to be cut. And it was used to measure the dam dimensions after building. Also, it was used to measure the error in the measurement.
	**Vernier calliper:** It was used to measure some objects in the dam such as the diameter of the water pipes and the water stopcock.
	**Jig saw:** It was used in the fab lap to cut the wooden sheets that was used to make the Mold.
	**Hand saw:** It was used to cut the water pipes.
	**Drilling machine:** It was used to pore the wooden sheets, so we can connect the parts with Plastic zippers.

It was supposed to cut the wooden sheets with the dimensions that we determined perfectly, but there was a measurement error that occurred while drawing the lines in the wooden sheets and while cutting them by the jig saw.

Table 3 *(shows the error on the dimensions of the dam)*

Measurement	Supposed to be	Measurement after error
Heigh	40 cm.	40.2 cm
width	50 cm.	49.9 cm.
Thickness at the bottom	24cm	24 cm.
Thickness at the top	11cm	11.09 cm.
The sloped part	36 cm.	35.9 cm.
The part over the sloped part	6 cm.	6.1 cm.

After constructing the dam, we did test plan to try it, we stored water behind it in the reservoir, and we calculated the flow rate for both the gates. And there are the results:

The flow rate for the first gate that discharges 25% of the water (27 Liters):

Table 4 (shows the flow rate for the first sluice gate that discharges 75% of the water)

Heigh of water	Time	Volume of water	Average flow rate
Between 28 and 24 cm.	34 seconds	6 Liters	0.176 Liters/second
Between 24 and 20 cm.	37 seconds	6 Liters	0.162 Liters/second
Between 20 and 16 cm.	43 seconds	6 Liters	0.140 Liters/second
Between 16 and 12 cm.	69 seconds	6 Liters	0.08 Liters/second

Chapter 4: Evaluation, Reflection, Recommendations.

Analysis and discussion

According to the previous results taken from the test plan, the design requirements was achieved where it was represented by the resistance of prototype on the exposure to loads causes. These results were achieved due to scientific reasons.

The dam should solve a lot of grand challenges which are urban congestion, flash floods, recycled wastes and garbage, pollution, increasing shortage of clean water. The dam should solve flash floods, especially. To solve this problem in wadi El-Hamamat which suffers from flash floods. We must use materials can load and resist the water that comes from flash floods, for this reason, using cetorex grout is required form us which has chemical formula (Na2sio3) sodium metasilicate. the density of cetorex grout as a (powder) which is 1.95 ± 0.05 kg/ L and 2.30 ± 0.05 kg/ L.

For the efficiency of the dam, the dam produces output that is better than its input in many ways. Efficiency = output / input

Figure 30

Input: The total amount of work or energy used.

Output: The amount of useful work or energy produced

As for estimating the dimensions, the materials of the prototype were chosen to

fit with requirement and after their dimensions were measured using a tape

measure, we found that they meet the design requirement as they were:

A. Length of the dam = 50 ± 1 cm

B. Width of the dam = 30 ± 1 cm

C. Height of the dam = 36 ± 1 cm

D. Thickness of the dam at bottom (base) = 24 ± 0.3 cm

E. Thickness of the dam top (crest) = 12 ± 0.4 cm

F. The spill way will be with diameter = 3 ± 0.1 cm

Recommendations for our solution

By decreasing the area of the gates and increasing the pressure due to putting the gates deeply in water the speed of the water getting out of it will increase so we can put a turbine in front of the flow of water and generate electricity due to the high velocity of water.

Figure 31 *(A motor that can be used)*

In large scale, the mechanical way to open the gates, won't be suitable, and it needs motors to be opened, and we recommend to use motors that word by solar energy which is a sustainable resource, so we can solve the problem of pollution that we are facing in our grand challenges. (**As shown in figures 31, 32**)

Figure 32 *(a battery that can be charged by the sun)*

We can also reduce money because the valley that we have chosen to construct our dam in is rich with materials that we can use so we can reduce the budget of transportation of the materials

Recommendations for our prototype:

Because of our design requirements we had to use reinforcing bars with maximum height 100mm and maximum thickness 3mm so that made our prototype weaker so it 'd be better if we increase the thickness and height of the reinforcing bars to

increase its strength. And I recommend also using the laser cutter in the fab lab to cut the dimensions of our mold accurately and prevent any error.

Learning outcomes

Math.1.01:

We use it to calculate the slope of the dam and the angle by using trigonometric functions.

Math.1.02:

Also, we use Lo2 in math to collect the data by making bar charts, graphs, and histograms.

Math.1.04

The concept of similarity of polygons in geometry can be beneficial in building a prototype in several ways:

1. Scaling: Similar polygons have proportional side lengths. By understanding the concept of similarity, you can scale down or up the dimensions of a prototype while maintaining the same shape. This allows you to create prototypes of different sizes based on a single design.

2. Design Iterations: When working on a prototype, you may need to make multiple iterations to refine the design. By leveraging the concept of similarity, you can create variations of the prototype by adjusting the dimensions while preserving the overall shape and proportions. This enables you to explore different possibilities and optimize the design.

3. Material Optimization: Similar polygons have proportional areas. By applying the concept of similarity, you can estimate the material requirements for the prototype. If you have a known prototype with specific dimensions and material usage, you can use similarity to calculate the material needed for different sizes of the prototype, potentially reducing waste and optimizing resources.

4. Testing and Validation: Similar polygons can exhibit similar properties and behaviors. By creating a prototype based on a similar polygon, you can leverage existing knowledge about the properties and behaviors of the original shape. This allows you to make initial assumptions about the prototype's performance, conduct

preliminary testing, and validate the design concept before investing in further development.

Geo.1.01:

We use Lo1 in geology. We use the Engineering geology branch and this branch help us to build our dam. we use hydrogeology branch because this branch studies the distribution and movement of groundwater. we also use petrology branch because this branch studies the origin, composition, and structure of rocks.

Geo.1.05:

we use Lo5 in geology which represents sedimentary rocks. We chose Lo5 that studies sedimentary rock because wadi El-Hamamat that we build the dam in it, because it has sedimentary rocks, like sandstone, mudstone, and limestone. **(As shown in figure 33)**

Figure 33

Bio.1.02:

In biology, we use Lo2 because we benefit from the structure of cell membrane. The structure of our dam is very similar to the structure of cell membrane such as, the similarity between external shape of the dam and strength of phospholipid bilayers in cell membrane such as, layers. The dam has 2 layers as in phospholipid bilayer. Also, the gates of dam which regulate the movement of water in it like channel protein can regulate the movement of charged ions like sodium, potassium, chloride, and calcium across the cell membrane.

PH.1.01

In physics, we use Lo1 Physics in estimating dimensions by applying the measurement errors concept

-absolute error (Δx) = |real value (x_o)-measured value(x)|

-relative error = $\Delta x/x$

and help us also to determine the diameter of the gate by using micrometer. Also, we use lo2 physics which helps us to balance the dam by applying dynamic equilibrium concept.

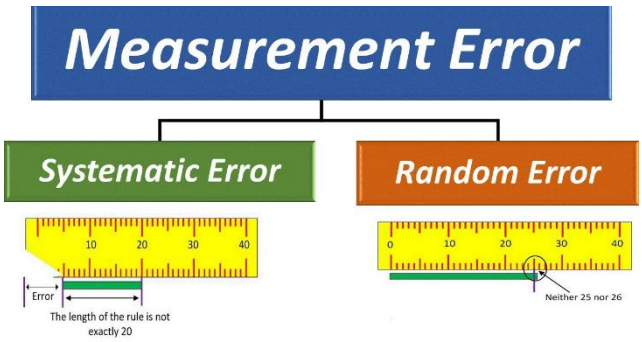


***Figure 34** (shows the types of error)*

PH.1.02

We use Lo2 in physics because the water has gravitational force and the gravity pulls water downwards, creating pressure on the dam's foundation and walls. Also this force needs to be counteracted by the dam's weight and the strength of its materials to prevent it from collapsing.

CS.1.01

In computer science, we also use Lo1 in computer science which helps us to use SketchUp program to design the dam in it with its dimensions. **As shown in figure 35**

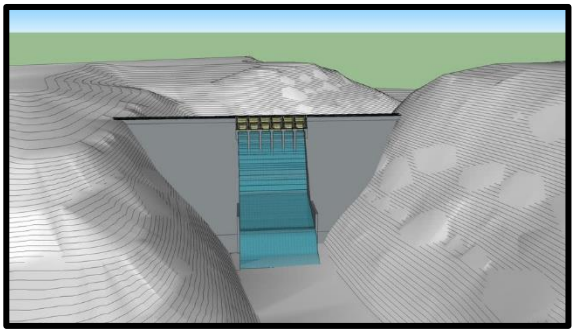


***Figure 35**(shows 3D design for a dam)*

CH.1.01

In chemistry, we use Lo1 in chemistry which gives us the scientific method to build the. The scientific method looks like EDP (Engineering design process) steps. We can use scientific methods by following some consecutive steps which are:

1. Making observation.
2. Ask a question.
3. Making hypothesis.
4. Test the hypothesis.
5. Analyzing results.
6. Drawing conclusion.
7. Communicating results. **(as shown in figure 36).**

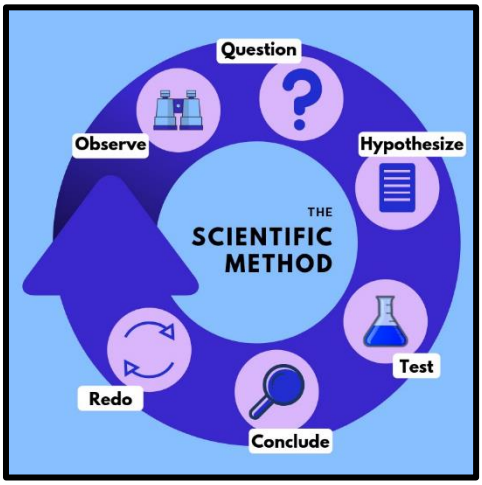


***Figure 36** (shows the steps of scientific method)*

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