Cairo University	**Faculty of Agriculture**
Food Processing Program	**Contemporary International Issues**
Second Term 2025/2026	**Prof. Abbas M. Sharaky**

Contemporary International Issues (FTP 217)

First Term 2025/2026

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Grading

Mid Term Exam (Dec. 15, 2025) …….…..…..	20%
Oral Exam (Dec. 29, 2025) ….............................	10%
Term paper (Dec. 29, 2025)……..…………..…..	20%
Final Exam ………………................................	50%

Course Description:

This course examines the global challenges affecting food production, focusing on current issues (Food Security) that illustrate these challenges. Students will investigate a range of topics including water, energy, and environmental aspects, regional disparities in the ability to meet basic human needs, and protection of the natural environment in an attempt to help students to appreciate the natural resources, to provide them with some historical perspective on the present status of the planetary environment; to give students opportunities to analyze specific environmental quality issues and to familiarize them with the ideas and practices of managing resources and environments according to the principles of sustainable development.

Course Content:

1. **Climate Change:**

   Causes, evidences, greenhouse gases, sea level rise.

2. **Plate tectonics and earthquakes**

   1.1 Plates and Plate Motion

   2.1 Causes of Earthquakes and Seismic Waves

3. **Water Issues:**

   3.1 Water cycle and global water balance

   3.2 Water scarcity

   3.3 Water pollution

   3.4 Water resources in Africa

   3.5 Water resources in the Arab World

   3.6 Water scarcity

   3.7 Water resources in Egypt, Nile, High Dam

4. **Transboundary issues in the Nile Basin:**

   4.1 Water challenges in Ethiopia

   4.2 Ethiopian Renaissance Dam

   4.3 Water Agreements

5. **Desertification issues:**

   5.1 Drought, deforestation, overgrazing, urbanization.

   5.2 Sand dune encroachment.

6. **Energy Resources issues:**

   6.1 Non-renewable energy resources (fossil oil, natural gas, coal, uranium).

   6.2 Renewable energy resources (solar, wind, geothermal, hydroelectricity, biomass, biofuels, nuclear power).

Introduction:

Environment is a complex mixture of many variables including all the physical and biological surroundings and their interactions. Each organism is affected by environmental problems like water scarcity, desertification, global warming, depletion of natural resources, pollution, loss of biodiversity, etc.

More than at any other time in history, the future of humankind is being shaped by issues that are beyond any one nation's ability to solve. Climate variation (change), coronavirus, financial instability, terrorism, waves of migrants and refugees, water scarcities, lack of energy and disappearing fisheries—all of these are examples of global issues whose solution requires cooperation among nations. Each issue seems at first to be connected to the next. Some common features soon become apparent:

- Each issue affects a large number of people on different sides of national boundaries.
- Each issue is one of significant concern, directly or indirectly, to all or most of the countries of the world, often as evidenced by a major U.N. declaration or the holding of a global conference on the issue.
- Each issue has implications that require a global regulatory approach; no one government has the power or the authority to impose a solution, and market forces alone will not solve the problem.
- Global environmental issues: Harmful aspects of human activity on the biophysical environment. As such, they relate to the anthropogenic effects on the natural environment, which are loosely divided into causes, effects and mitigation.

The 10 Most Significant Environmental Issues:

1. Water Scarcity

Causes: Destruction of water resources, Global warming, Deforestation, Decrease in rain water.

2. Energy Scarcity

Causes: Great dependence on traditional energy sources, slow growth for renewable energy technology, over use of energy sources (exploitation).

3. Pollution

Air pollution

Light pollution, Visual pollution, Noise pollution, Ozone depletion.

Soil pollution

Soil erosion, Soil contamination, Soil salination

Water pollution

Acid rain, Agricultural runoff, Groundwater contamination, Marine pollution

Oil spills, Wastewater.

4. Global Warming

As a result of over deforestation and emission of excess amount of oxides of carbon from power plants and vehicles there has been formed a greenhouse effect around the Earth. Global warming would leads to water scarcity and extinction of several living organisms.

5. Desertification

Root causes of desertification have been identified as population growth and climate change which contribute to the nature and extent of environmental stress.

6. Climate Change, Sea level Rise, Flood, Drought

Causes: global warning, over exploitation of minerals and resources, pollution of water bodies. Deforestation, reduction in water absorption capacity of soil, heavy rainfall.

7. Food Scarcity

Causes: population explosion, conversion of green farm areas to concrete farms, diet style. About 800 million people do not get enough food to eat. Eliminating hunger is thus one of the most fundamental challenges facing humanity.

8. Earthquakes

Causes: Dams, uncontrolled stone mining, nuclear experiments.

9. Infectious Diseases and Carcinogens and mutation

Causes: Radiation, ozone layer depletion, nuclear reactor explosions, mobile towers.

10. Over population

Global Climate Change

Global climate change is one of the most important environmental issues facing the world today. **Climate** is the average of weather over many years of hundreds, thousands, even millions across large regions, even the entire planet. The difference between weather and climate is a measure of time. **Weather** is the changes of the climatic elements in the atmosphere over a short period of time (minutes to months) in just one place. Climate is what you expect, weather is what you get. Climate can be measured quantitatively by calculating the long term averages of different **climate elements** such as temperature, humidity, atmospheric pressure, wind, and precipitation.

Factors affecting climate:

1. **Latitude**:

   Latitude, or how far one is from the equator. Places nearer the equator receive more sunlight and are much warmer than places nearer poles. This temperature difference between low and high latitudes drives the general circulation of the atmosphere, transferring heat away from the equator towards the poles.

2. **Terrain (shape of the land):**

   a. Mountains and plateaus are exposed to the cooler temperatures of higher altitudes

   b. Mountainous regions block the flow of air masses, which rise to pass over the higher terrain. The rising air is cooled, which causes condensation of water vapor, and precipitation. This being the case, one side of a mountain, the windward side, will often have more precipitation and vegetation; the leeward side is often drier. Mountains receive more rainfall than low lying areas.

   Cloud droplets and/or ice crystals are too small and too light to fall to the ground as precipitation. The ice, to grow large enough to fall as precipitation.

   c. Mountains divert the course of the prevailing winds.

   d. Topographical features such as narrow canyons channel and amplify winds.

e. Vegetation cover decreases temperature and CO_2. Just as climate determines the types of vegetation in a given region, to a certain extent vegetation can contribute to a region's weather. Hot and wet climates in the tropics, for instance, develop rainforests; the more trees and plants there are, the more water vapor in the atmosphere and the moister and cooler the area. Places with large forest resources receive a lot of rain so the climate is Tropical monsoon or moderate, whereas places with sand and bare rocks are extreme hot and dry.
f. Oases have lower temperature than the surrounding deserts.

3. **Altitude (height from sea level):**

Altitude, or how high one is above sea level. the higher the elevation, the colder the climate. This happens because as altitude increases, air becomes thinner and is less able to absorb and retain heat. That is why snow on the top of some mountains all year round. Normally, temperature changes by 1°C in every 165 m height. Temperature decreases when we ascend higher and vice-versa. Lower altitude has dust, vapor and heat absorbing gases like carbon dioxide making the climate at lower altitude warm.

4. **Water bodies (oceans, seas, lakes, rivers, ..) and their currents:**

a. Coastal areas are cooler and wetter than inland areas.
b. Ocean currents can increase or reduce temperatures.
c. Winds that blow from the sea often bring rain to the coast and dry weather to inland areas.
d. El Niño, which affects wind and rainfall patterns. It is Spanish for 'the Boy Child' because it comes about the time of the celebration of the birth of the Christ Child.
e. Land heats more quickly than water, but water holds heat longer. Proximity to water moderates the climate, while inland climates are harsher. Those living near the water will experience breezy, moist weather, when the warm air from the land

meets the cooler air from the water and rises, making for a windy climate with precipitation. The further inland one goes, the drier the climate in most regions.

5. **Earth's tilt**:

   Earth's axis is tilted at 23.5 degrees, we have seasons. One hemisphere leans toward the sun half the year while the other leans away, and then the situation reverses. Though the climates of the Earth's regions (tropical, temperate, or polar) remain the same no matter the season, the weather is affected.

6. **Winds**

   If winds have been blown from a hot area they will raise temperatures. If winds have been blown from cold areas they will lower temperatures. In Egypt, winds originating from the north tend to be cold whereas those from the southwest bring worm air.

7. **Soil and rocks**

   The quality of soil affects the climatic feature of a place. Sandy area reflects the solar radiation and makes the climate warm. Alluvial soil contains biotic elements and stores solar radiation. This makes the climate of such regions cool. Hard rocks increase temperature.

Human influence

1. Deforestation: The number of trees being cut down reduce the amount of carbon dioxide that is taken up by forests. Trees take in carbon dioxide and produce oxygen. A reduction in trees will therefore have increased the amount of carbon dioxide in the atmosphere.
2. The Industrial Revolution, starting at the end of the 19th Century, has had a huge effect on climate.
3. The invention of the motor engine and the increased burning of fossil fuels have increased the amount of carbon dioxide (a greenhouse gas - more on that later) in the atmosphere.

Causes of Climate Change

The climate has changed many times in the long history of earth, but always in response to a global force. The changes can be caused by processes internal to the Earth, external forces (e.g. variations in sunlight intensity) or, more recently, human activities. The strongest force driving climate change right now is the increasing carbon dioxide (CO_2) from the burning of fossil fuels, which is trapping more heat from leaving earth's atmosphere.

1. Changes in the Earth's orbit

The Earth's orbit around the Sun is an ellipse, not a circle but the ellipse changes shape. Sometimes it is almost circular and the Earth stays approximately the same distance from the Sun as it progresses around its orbit. At other times the ellipse is more pronounced so that the Earth moves closer and further away from the sun as it orbits. When the Earth is closer to the sun our climate is warmer.

2. Orientation of the Earth's axis of rotation

The Earth showing angle of axis of rotation (Fig. 1). When the angle increases the summers become warmer and the winters become colder. The Earth rotates around an axis (imagine a line that joins the north and south poles) but the Earth's axis is not upright, it leans at an angle. This angle changes with time and over about 41,000 years it moves from 22.1 degrees to 24.5 degrees and back again.

Fig. 1 Earth rotation

3. Greenhouse gases (GHG) in the atmosphere (Global Warming)

The gases that contribute most to the Earth's greenhouse effect are: water vapor, carbon dioxide, nitrous oxide, methane and ozone (Fig. 2). Of these, water vapor makes the greatest contribution to the greenhouse effect because there is more of it. These gases trap solar radiation (electromagnetic radiation emitted by the Sun) in the Earth's atmosphere, making the climate warmer.

Carbon dioxide (CO_2) is produced any time something is burned. It is the most common GHG, constituting by some measures almost 64% of total long-term GHGs.

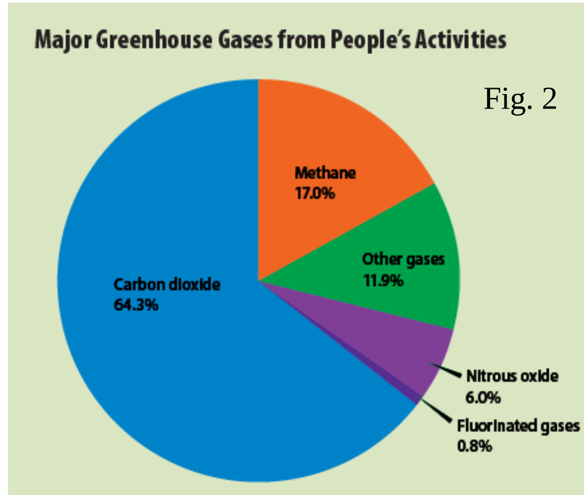

Fig. 2

Methane (CH_4) is produced in many combustion processes and also by anaerobic decomposition, for example, in flooded rice paddies, pig and cow stomachs, and pig manure ponds.

Nitrous oxide (laughing gas), NO/N_2O or simply NO_x is a byproduct of fertilizer production and use, other industrial processes and the combustion of certain materials.

There are many natural causes of climate change, but recently we have become concerned with the effect mankind's pollution of the atmosphere may be having on the global climate. The Sun, which is the Earth's only external form of heat, emits solar radiation mainly in the form of shortwave visible and ultraviolet (UV) energy. As this radiation travels toward the Earth, 25% of it is absorbed by the atmosphere and 25% is reflected by the clouds back into space. The remaining radiation travels unimpeded to the Earth and heats its surface. The Earth releases a lot of energy it has received from the Sun back to space. However, the Earth is much cooler than the Sun, so the energy re-emitted from the Earth's surface is much weaker, in the form of invisible long wave infrared (IR) radiation, sometimes called heat.

Greenhouse gases like water vapor, carbon dioxide, methane and nitrous oxide trap the infrared radiation released by the Earth's surface (Fig. 3). The atmosphere acts like the glass in a greenhouse, allowing much of the short wave solar radiation to travel through unimpeded, but trapping a lot of the long wave heat energy trying to escape back to space. This process makes the temperature rise in the atmosphere just as it does in the greenhouse.

This is the Earth's natural greenhouse effect and keeps the Earth 33°C warmer than it would be without an atmosphere, at an average 15°C. In contrast, the moon, which has no atmosphere, has an average surface temperature of -18°C. During the last 200 years mankind has been releasing extra quantities of greenhouse gases which are trapping more heat in the atmosphere. Over the same time period the climate of the Earth has warmed, and many scientists now accept that there is a direct link between the man-made enhancement of the greenhouse effect and global warming.

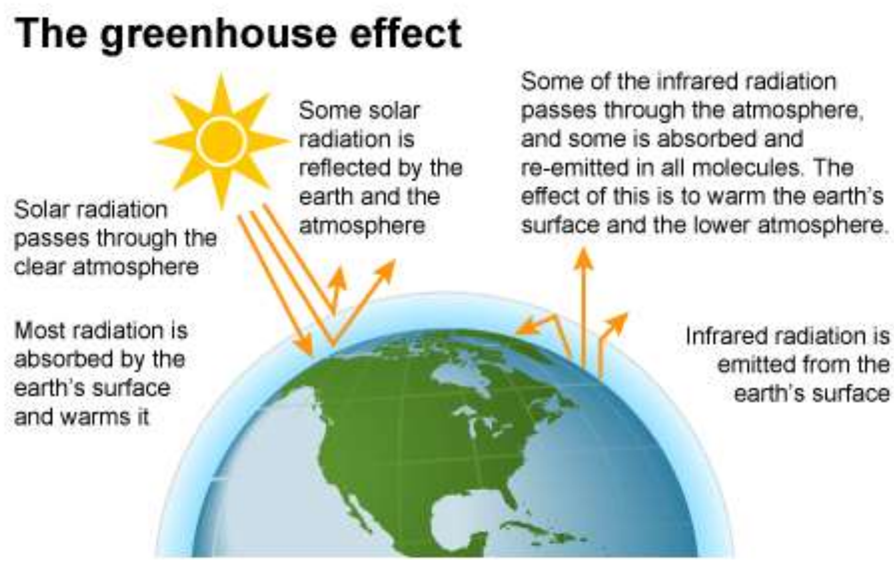

Figure (3): The greenhouse effect.

4. Plate tectonics and volcanic eruptions

The lithosphere is fragmented into fourteen major tectonic plates. Convergent boundaries form between two plates that are moving toward one another. The edge of one plate plunges into asthenosphere beneath leading edge of second (overriding) plate (Fig. 4). The subducted plate melts to generate magma, which rises upwards

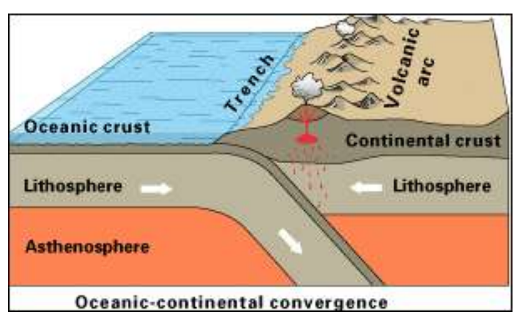

Figure (4): Plate tectonics

into the overriding plate. Some magma accumulates in magma chambers (plutons) in the overriding plate, where it crystallizes into plutonic rocks.

Some magma erupts on the Earth's surface, where it crystallizes into volcanic rocks. Subduction boundaries are characterized by several physiographic features, including chain of volcanic mountains (and subterranean plutons) that parallels the oceanic trench: volcanic arc: land-locked arc (e.g., Andes), and island arc: sea-bound arc (e.g., Japan).

5. Volcanoes

Volcanoes can impact climate change. Volcanoes affect the climate through the gases and dust particles thrown into the atmosphere during eruptions. The effect of the volcanic gases and dust may warm or cool the Earth's surface, depending on how sunlight interacts with the volcanic material. During major explosive eruptions huge amounts of volcanic gas, aerosol droplets, and ash are injected into the stratosphere. Injected ash falls rapidly from the stratosphere -- most of it is removed within several days to weeks -- and has little impact on climate change. But volcanic gases like sulfur dioxide (SO_2) can cause global cooling, while volcanic carbon dioxide (CO_2), a greenhouse gas, has the potential to promote global warming (Fig. 5). The most significant climate impacts from volcanic eruptions come from the conversion of SO_2 to sulfuric acid (H_2SO_4), which condenses rapidly in the stratosphere to form fine sulfate aerosols that increase the reflection of radiation from the Sun back into space, cooling the Earth's lower atmosphere or troposphere.

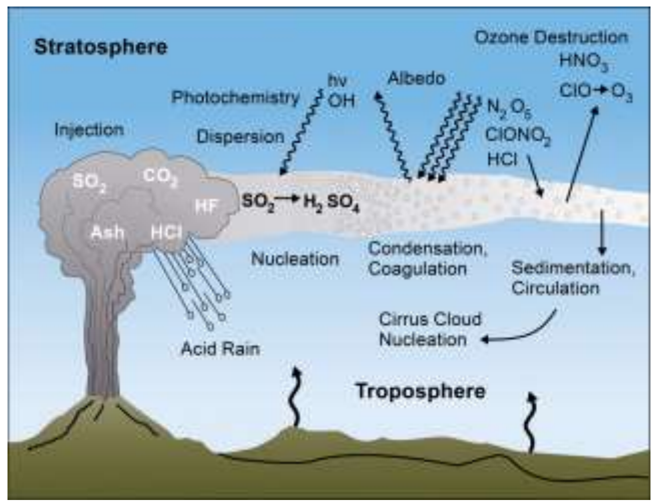

Fig. 5. Volcanic gases.

Do the Earth's volcanoes emit more CO_2 than human activities? No.

The CO_2 released in contemporary volcanic eruptions has never caused detectable global warming of the atmosphere. In 2010, human activities were responsible for a projected 35 billion metric tons (gigatons) of CO_2 emissions. All studies to date of global volcanic carbon dioxide emissions indicate that present-day subaerial and submarine volcanoes release less than a percent of the CO_2 released currently by human activities. While it has been proposed that intense volcanic release of CO_2 in the deep geologic past did cause global warming, and possibly some mass extinctions, this is a topic of scientific debate at present.

However, there have been times during Earth history when intense volcanism has significantly increased the amount of CO_2 in the atmosphere and caused global warming.

6. Vegetation coverage on the land

On a global scale, patterns of vegetation and climate are closely correlated. Vegetation absorbs carbon dioxide and this can buffer some of the effects of global warming.

7. Meteorite impacts

Meteorite impacts have contributed to climate change in the geological past. Large impacts can cause a range of effects that include dust and aerosols being ejected high into the atmosphere that prevent sunlight from getting through. These materials insulate the Earth from solar radiation and cause global temperatures to fall. After the dust and aerosols fall back to Earth, the greenhouse gases (CO_2, water and methane), caused by the interaction of the impactor and its 'target rocks', remain in the atmosphere and can cause global temperatures to increase.

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What evidence do we have of climate change?

1. Temperatures are rising.
2. Melting Glaciers. Rapid sea ice loss climate change
3. Snow and rainfall patterns are shifting.
4. Rising the atmospheric CO_2 levels.
5. Extreme climate events – like heavy rainstorms, river flooding, worsening drought, and record high temperatures – are already happening.
6. The global mean sea level rising over the 20th century was 1.7 ± 0.2 mm/yr. This rate increased to 3.2 ± 0.4 mm/yr since 1990, mostly because of increased thermal expansion and land ice contributions.
7. Ocean Acidification: The average pH of ocean surface waters has fallen by about 0.1 units, from about 8.2 to 8.1 (total scale) since 1765.

What are the most important sources of GHGs and black carbon?

Fossil fuel and related uses of coal and petroleum are the most important sources of GHGs and black carbon (power generation, industry, transportation, buildings) (Fig. 6).

Agriculture is the second most important source (animals – cows and pigs), feed production, chemical intensive food production, and flooded paddy rice production, as well as deforestation driven by the desire to expand cultivated areas.

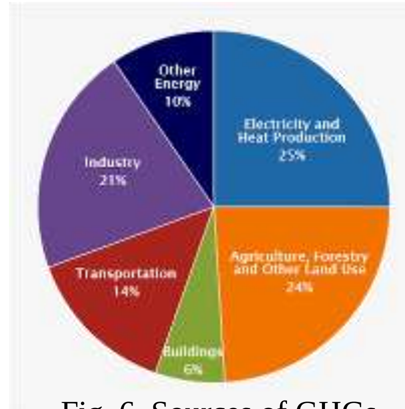


Fig. 6. Sources of GHGs

Why do glaciers melt? Causes

The rising temperature of the Earth has been responsible for melting glaciers throughout history. The main causes behind glacial melting:

- ***CO_2 emissions*****:** the atmospheric concentration of ***CO_2*** and other greenhouse gases (GHGs) produced by industry, transport, deforestation and burning fossil fuels, amongst other human activities, warm the planet and cause glaciers to melt.
- ***Ocean warming*****:** oceans absorb 90% of the Earth's warmth, and this fact affects the melting of marine glaciers, which are mostly located near the poles.

What is the difference between sea ice and glaciers?

A glacier is an accumulation of ice and snow that slowly flows over land. Greenland and Antarctica are home to most of the world's glacial ice, which are 3,000 meters and 4,500 meters thick, respectively. Sea ice forms and melts strictly in the ocean whereas glaciers are formed on land. When glaciers melt, because that water is stored on land, the runoff significantly increases the amount of water in the ocean, contributing to global sea level rise. Sea ice, on the other hand, is often compared to ice cubes in a glass of water: when it melts, it does not directly change the level of water in the glass. Glacial ice is 91% in Antarctica, and 8% in Greenland. If they were to melt, global sea level would rise approximately 70 meters. Some glaciers form at high elevations.

- , Negm, A.M. (ed.), The Nile Delta, Volume 55, pp. 33–62, The Handbook of Environmental Chemistry, The Nile Delta, Springer, Berlin, Heidelberg., 55, pp. 33-62. https://doi.org/10.1007/978-3-319-95600-8

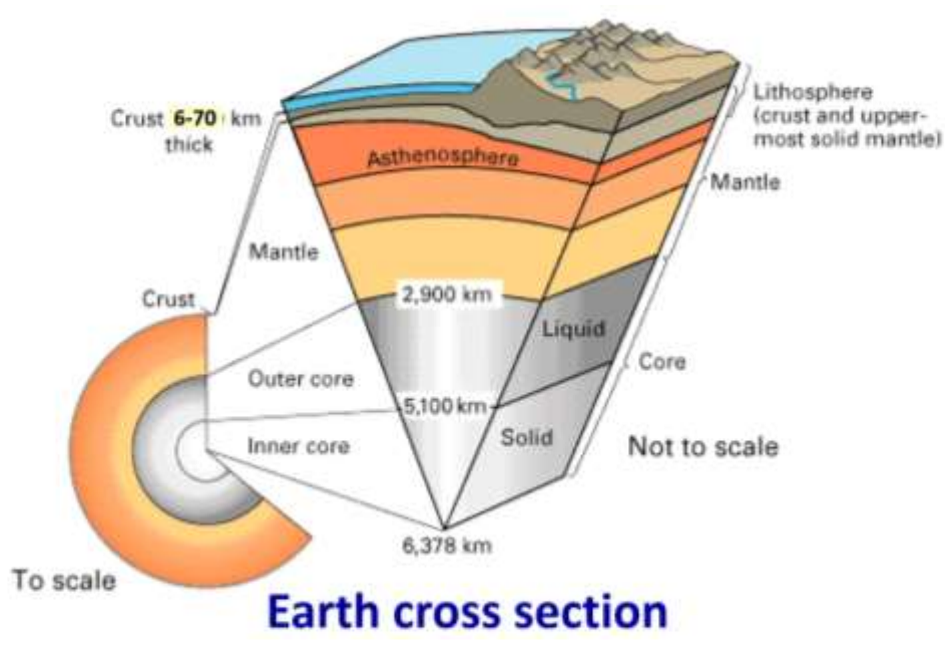
PLATE TECTONICS

Internal structure of earth:

The Earth can be divided into three main divisions based on chemical composition and physical characteristics.

1. **The crust** is the outside layer of the earth and is made of solid rock, mostly basalt and granite. There are two types of crust; oceanic and continental.
    a. Oceanic crust is denser and thinner and mainly composed of basalt.
    b. Continental crust is less dense, thicker, and mainly composed of granite.
2. **The mantle** lies below the crust and is up to 2900 km thick. It consists of hot, dense, iron and magnesium-rich solid rock. The crust and the upper part of the mantle make up the lithosphere, which is broken into plates, both large and small.
3. **The core** is the center of the earth and is made up of two parts: the liquid outer core and solid inner core. The outer core is made of nickel, iron and molten rock.

The crust and the uppermost part of the mantle are relatively rigid. Collectively, they make up the **lithosphere** that is broken into a series of **tectonic plates**. These plates are able to move very slowly across the hotter and partially molten underlying material that deforms by flowing and is referred to as the **asthenosphere**.



The lithosphere is broken into 7 large, and 5 smaller rigid pieces called plates (Fig. 7). The major plates are the African, North American, South American, Eurasian, Australian, Antarctic, and Pacific plates. Several minor plates also exist, including the Arabian, Nazca, and Philippines plates.

The plates are all moving in different directions and at different speeds (from 2 cm to 10 cm/year) in relationship to each other. The place where the two plates meet is called a ***plate boundary***. Boundaries have different names depending on how the two plates are moving in relationship to each other. The boundaries of these plates, where they move against each other, are sites of intense geologic activity, such as earthquakes, volcanoes, and mountain building.

What are tectonic plates?

Tectonic plates are gigantic pieces of the Earth's crust and uppermost mantle. They are made up of oceanic crust and continental crust. Earthquakes occur around mid-ocean ridges and the large faults which mark the edges of the plates.

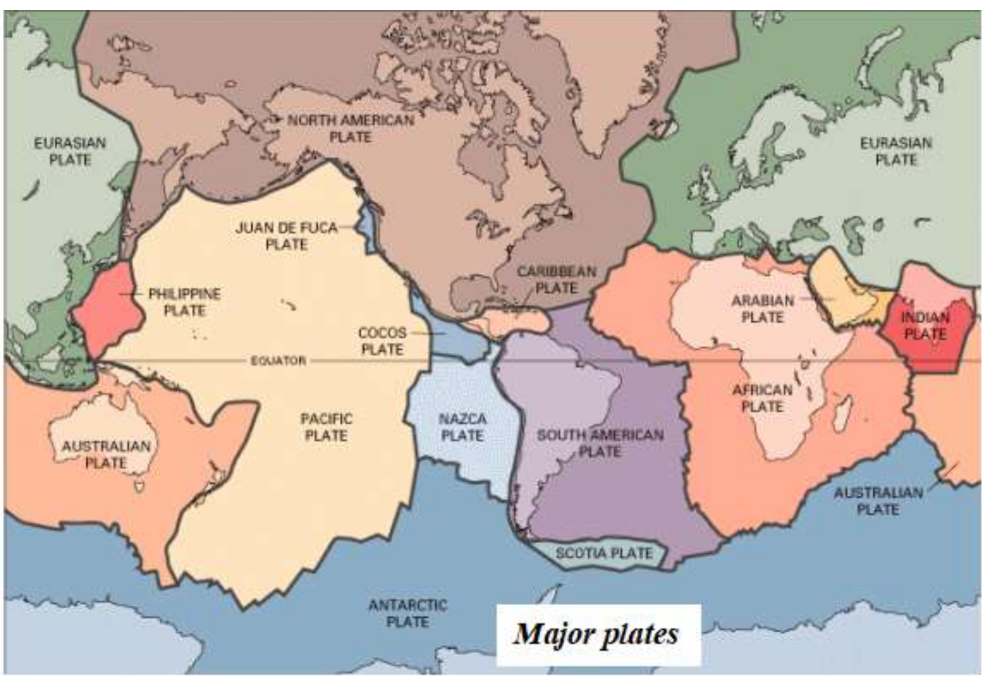


Figure (7): Earth's plates

What is the Ring of Fire?

The Ring of Fire is in the Pacific Ocean. It is made up of a string of volcanoes, deep ocean trenches, and high mountain ranges having mineral deposits. It is the site of earthquakes around the edges of the Pacific Ocean. The countries closest to and most at risk from activity in the Ring of Fire are the western United States, Chile, Japan and Pacific Ocean Island nations, including the Solomon Islands. Other countries potentially impacted because they are located within the Pacific Ring of Fire are Indonesia, New Zealand, Papa New Guinea, Canada, Guatemala, Russia, Peru, Mexico, and Antarctica.

The "Ring of Fire" also called the Circum-Pacific belt, is the zone of earthquakes surrounding the Pacific Ocean — about 90% of the world's earthquakes occur there. About 75% of the world's volcanoes can be labeled Ring of Fire volcanoes, as they have occurred in or near the Ring of Fire. The next most seismic region (5-6% of earthquakes) is the Alpide belt (extends from Mediterranean region, eastward through Turkey, Iran, and northern India).

What is a tectonic plate boundary?

A tectonic plate boundary is the border between two plates. The tectonic plates slowly and constantly move but in many different directions. Some are moving toward each other, some are moving apart, and some are grinding past each other. Tectonic plate boundaries are grouped into three main types based on the different movements.

<u>Types of plate boundaries:</u>

Three types of plate boundaries are defined on the basis of their relative directions of movement (Fig. 8):

1. Convergent boundaries (crashing - subduction):

Convergent boundaries form between two plates that are moving toward one another. The edge of one plate plunges into asthenosphere beneath leading edge of second (overriding) plate. The subducted plate melts to generate magma, which rises upwards into the overriding plate. Some magma accumulates in magma chambers (plutons) in the overriding plate, where it crystallizes into plutonic rocks. Some magma erupts on the Earth's surface, where it crystallizes into volcanic rocks.

2. Divergent boundaries (pulling apart)

Divergent boundaries are the sites of the creation of new oceanic crust by volcanism: magma (molten rock) rises upwards out of the asthenosphere into widening gap (spreading center) between two diverging plates ***magma*** erupts (as ***lava***) from volcanoes and fissures, crystallizes into volcanic rocks. Spreading centers are marked by continental rift valleys, ocean basins, mid-ocean ridges**.** Two converging plate edges collide head-on, but there is no subduction.

3. Transform boundaries (sideswiping):

Transform boundaries form between two plates that are moving in parallel but opposite directions Plates are moving past one another in parallel but opposite directions.

Example: ***North and East Anatolian*** faults, Turkey and ***San Andreas*** Fault, USA, which separates the Pacific plate (moving northwest) and the North American plate (moving south). The average rate of motion across the San Andreas Fault Zone during the past 3 million years is 56 mm/yr. This is about the same rate at which your fingernails grow. Assuming this rate continues, Los Angeles and San Francisco will be adjacent to one another in approximately 15 million years.

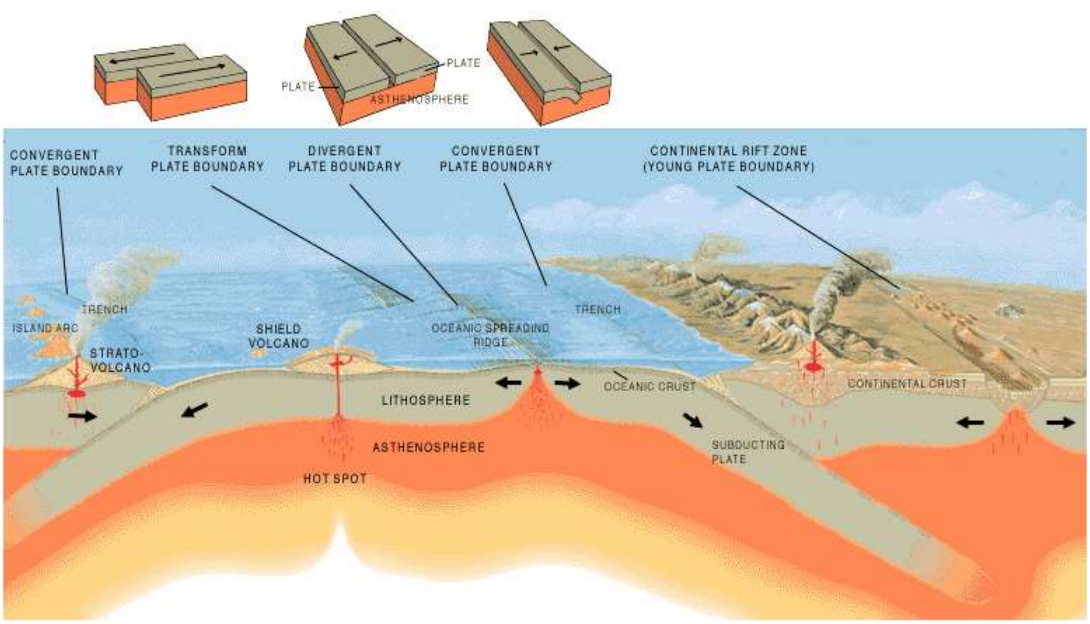


Figure (8) *The three types of plate boundaries*

EARTHQUAKES

An earthquake is a sudden, rapid shaking of a region of the earth's surface caused by the breaking and shifting of rock beneath the earth's surface. Technically, a train or a large truck that rumbles down the street is causing a mini-earthquake. On average, our planet is subjected to nearly 1000 earthquakes every day.

It's important to be aware of what to do during an earthquake. Most of the injuries that occur during earthquakes are due to falling walls, shattering glass, or falling furniture, not from the actual movement of the earth itself.

Rock can deform only so far before it breaks. When a rock breaks, waves of energy are released and sent out through the Earth, which is called **seismic waves**.

The point beneath the Earth's surface where the rocks break and move is called the **focus** of the earthquake. The focus is the underground point of origin of an earthquake. Directly above the focus, on the Earth's surface, is the **epicente**r. Earthquake waves reach the epicenter first. During an earthquake, the most violent shaking is found at the epicenter.

The location of an earthquake is commonly described by the geographic position of its epicenter and by its focal depth. The **focal depth** of an earthquake is the depth from the Earth's surface to the focus. Earthquakes with focal depths from the surface to about 70 km are classified as ***shallow***. Earthquakes with focal depths from 70 to 300 km are classified as ***intermediate***. The focus of ***deep*** earthquakes may reach depths of more than 700 km. The focuses of most earthquakes are concentrated in the crust and upper mantle. The depth to the center of the Earth's core is about 6,370 km, so event the deepest earthquakes originate in relatively shallow parts of the Earth's interior.

What is the distribution of earthquakes?

Most earthquakes occur in narrow belts along the boundaries of crustal plates. They mainly occur around the Pacific Ring of Fire, along the Mid-Atlantic Ridge, in the Himalayan Region, and continental rift zones like East Africa. Less than 10% of all earthquakes occur within plate interiors.

Seismic waves and measuring earthquakes

The vibrations produced by earthquakes are detected, recorded, and measured by instruments called **seismographs**. The zig-zag line made by a seismograph, called a "**seismogram**, (Fig. 9)" reflects the changing intensity of the vibrations by responding to the motion of the ground surface beneath the instrument. From the data expressed in seismograms, scientists can determine the time, the epicenter, the focal depth, and the type of faulting of an earthquake and can estimate how much energy was released.

Types of seismic waves:

1. Body Waves: Body waves move through the inner part of the earth. There are two main types of body waves (Fig. 10):

(a) **P waves** (primary) are sometimes called **compressional waves** or primary waves or push-pull waves and they are transmitted (propagated by movements of the mater in the Earth parallel to the direction in which the wave is moving). Material expands and contracts in volume and particles move back and forth in the path of the wave. P-waves are essentially sound waves and ***travel through solids, liquids or gases***. They have the *highest velocity* of all seismic waves and thus will reach all seismographs first. The velocity of the P waves depends on the elastic properties of the rock through which they travel.

(b) **S waves** (Secondary) are also called **shear waves**, **secondary waves**. They propagate by movements of the Earth perpendicular to the path of the wave. S-waves travel slower than P-waves, so they will reach a seismograph after the P-wave.

S waves travel with a velocity that depends only on the rigidity and density of the material through which they travel. Different rocks have different physical characteristics (such as how compressible they are and how they respond to shear stresses) and therefore different P and S wave velocities. ***S-waves can travel only through solids***, because only solids have rigidity. S-waves cannot travel through liquids or gases.

2. Surface Waves: Surface waves travel over the surface of the earth. They are sometimes called long waves, or simply L waves. They are responsible for most of the damage associated with earthquakes, because they cause the most intense vibrations.

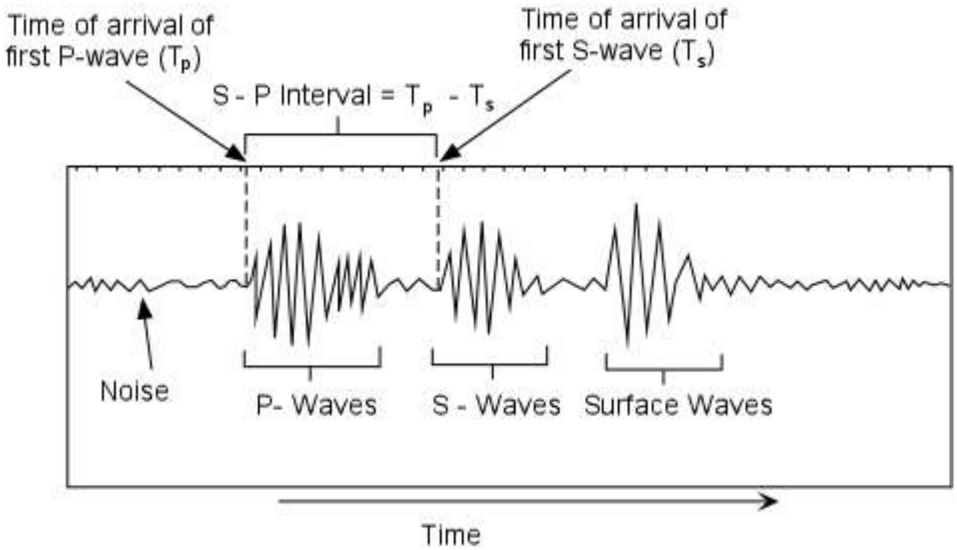


Figure (9): Seismogram

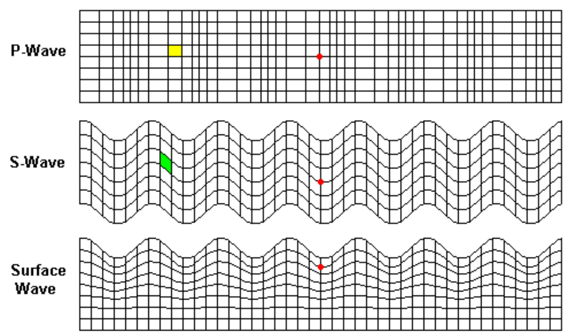


Figure (10): Seismic waves.

Surface waves behave like S-waves in that they cause up and down and side to side movement as they pass, but they *travel slower than S-waves* and *cause the damage* in large earthquakes. L waves are the slowest moving of all waves, so the most intense shaking usually comes at the end of an earthquake.

Shallow-focus earthquakes (<70 km) are most common; they account for 85% of total quake energy released. Intermediate- (70-300 km, 12%) and deep- (>300 km, 3%) focus quakes are rare because most deep rocks flow in a ductile manner when stressed or deformed; they are unable to store and suddenly release energy as brittle surface rocks do.

Measuring Earthquakes:

1. **The magnitude:**

The magnitude of an earthquake, usually expressed by the **Richter scale**, is a measure of the amplitude of the seismic waves. The moment magnitude of an earthquake is a measure of the amount of energy released - an amount that can be estimated from seismograph readings.

Richter Magnitude represents roughly 32 fold increase in the amount of energy released. Thus, a magnitude 7 earthquake releases 32 times more energy than a magnitude 6 earthquake. A magnitude 8 earthquake releases 32 x 32 or 1000 times more energy than a magnitude 6 earthquake. A quake of magnitude 2 is the smallest quake normally felt by people. Earthquakes with a Richter value of 6 or more are commonly considered major; great earthquakes have magnitude of 8 or more on the Richter scale (Fig. 11). Earthquakes of large magnitude do not necessarily cause the most intense surface effects.

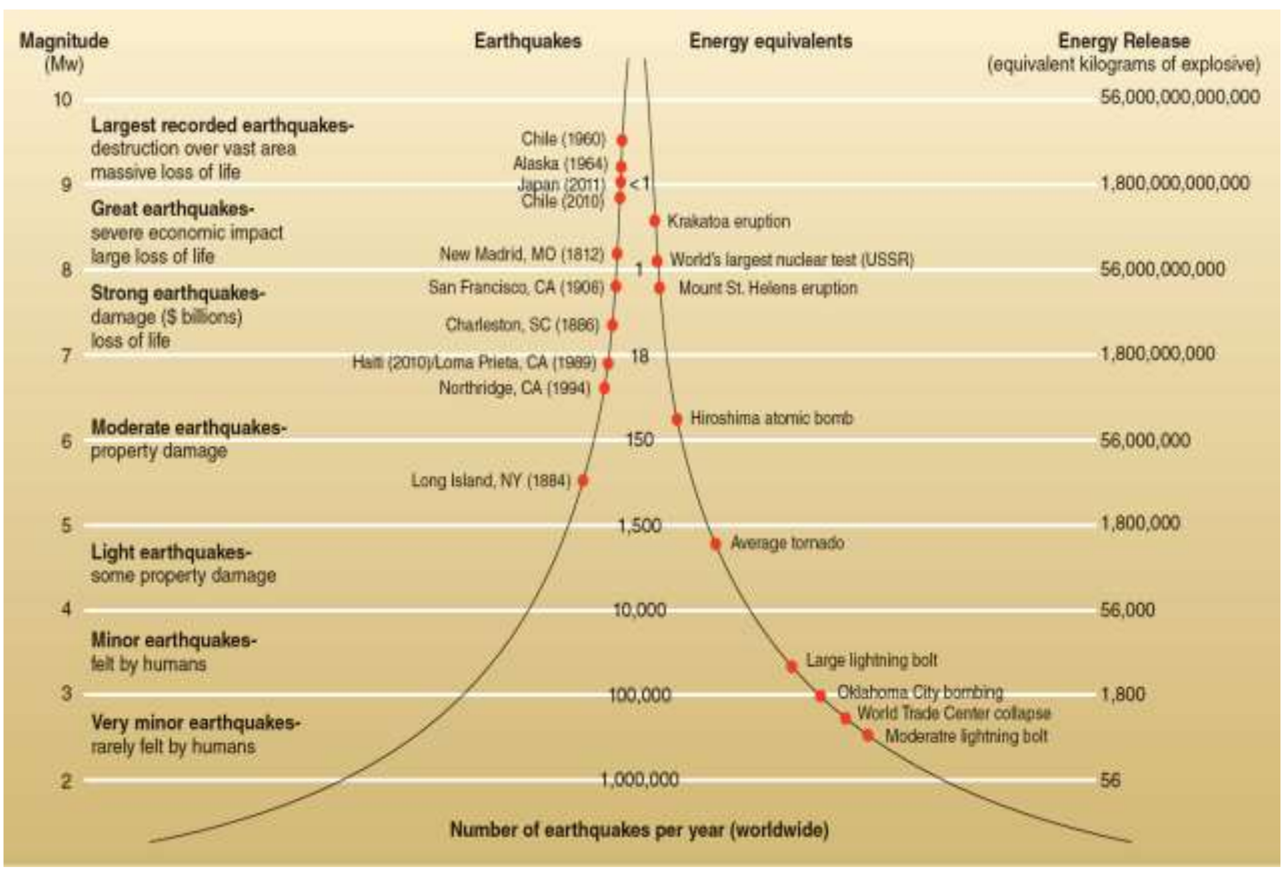


Figure (11): The actual energy released in earthquakes of varying magnitudes.

2. **The intensity**:

Intensity of the earthquake is as expressed by the **Modified Mercalli Scale** that is a subjective measure describing how strong a shock was felt at a particular location. An earthquake's destructiveness depends on many factors. In addition to magnitude and the local geologic conditions, these factors include the focal depth, the distance from the epicenter, and the design of buildings and other structures. The extent of damage also depends on the density of population and construction in the area shaken by the quake.

Tsunamis:

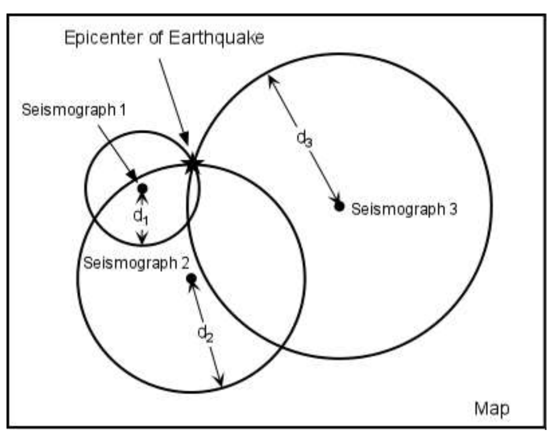
Tsunamis (Japan's dread "huge wave") are giant ocean waves caused by an earthquake released beneath the ocean floor, and can rapidly travel across oceans. The wave speeds can reach 960 km/hour and may be 15 meters high or higher by the time they reach the shore. Tsunamis can cause damage thousands of kilometers away on the other side of the ocean.

Location of Earthquakes:

In order to determine the location of an earthquake, we need to have recorded a seismograph of the earthquake from at least three seismographic stations at different distances from the epicenter of the quake (Fig. 12). In addition, we need one further piece of information - that is the time it takes for P-waves and S-waves to travel through the Earth and arrive at a seismographic station. From the seismographs at each station one determines the S-P interval (the difference in the time of arrival of the first S-wave and the time of arrival of the first P-wave. Note that on the travel time curves, the S-P interval increases with increasing distance from the epicenter.

Thus the S-P interval tells us the distance to the epicenter from the seismographic station where the earthquake was recorded. Thus at each station we can draw a circle on a map that has a radius

(Fig. 12): Location of Earthquakes.



Major Seismic Hazard Zones

Pacific Ring of Fire:

Revered as the most prolific seismic belt on Earth, the Pacific Ring of Fire spans the vast expanse from the western coast of North America, traversing South America, Japan, Southeast Asia, and Oceania (Fig. 13). Characterized by intense tectonic activity along the Pacific Plate's boundaries.

Mediterranean and Middle East:

The collision of the African and Eurasian plates engenders significant seismicity across the Mediterranean and Middle Eastern regions. From Turkey and Greece in the west to Iran and Pakistan in the east, this zone witnesses recurrent earthquakes, underscoring the geological intricacies shaping the landscape.

Himalayas:

Nestled amidst the majestic peaks of the Himalayan range, this seismically active region bears witness to the relentless convergence of the Indian and Eurasian plates.

Alaska:

Situated at the juncture of the Pacific and North American plates, Alaska emerges as a crucible of seismic activity within the United States. Subduction zones and transform faults delineate the state's geological fabric, fostering a landscape rife with seismic hazards.

Western United States:

San Andreas Fault, a boundary separating the Pacific and North American plates.

This region experiences a spectrum of seismic phenomena, ranging from small tremors to catastrophic earthquakes.

South America:

The western coast of South America bears witness to relentless subduction processes, as the Nazca Plate plunges beneath the South American Plate. Seismicity along this volatile boundary engenders significant earthquakes and shaping the landscape.

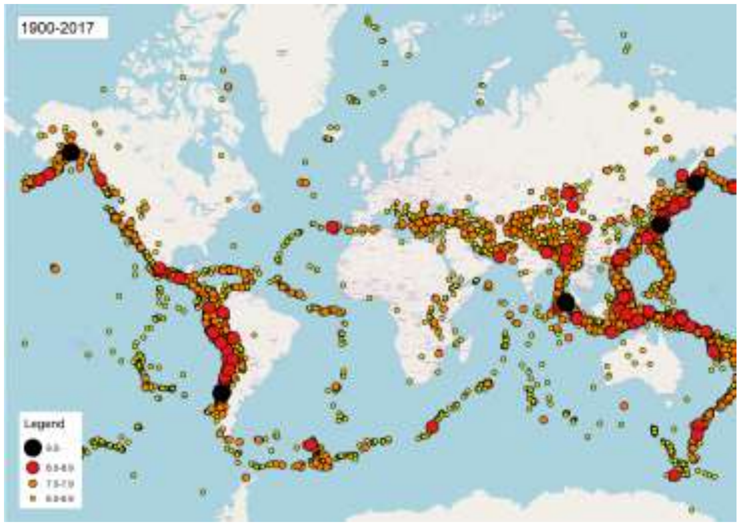


Fig. (13): Seismicity of the world (1900 -2017).

Earthquake activity is highest along the two spreading axes in the Red-Sea and the Gulf of Aden, which joins into the main Ethiopian Rift through the Afar triple-junction. Further to the south along the eastern branch, epicenter distribution is more diffuse than along the western branch where a concentration of epicenters follows the rift structures starting from southern Sudan to southern Malawi.

Earthquakes in Egypt:

EGYPT has a historical record of earthquake activity extending over the past 4,800 years. In addition to the magnitude 5.8 Dahshour earthquake of 12 October 1992, which damaged over 1,000 schools and killed over 541 and injured over 6,000 people. Egypt is usually affected by some earthquakes occur in the plate boundaries at Cyprus and Crete islands

The AD 365 Ammianus tsunami in Alexandria, Egypt

On the morning of 21 July, AD 365, the Eastern Mediterranean was shaken by an earthquake that is generally believed to be the strongest recorded earthquake in the Mediterranean (>8.5). It originated west Crete, Greece, and was followed by a tsunami that hit the Mediterranean coastlines, particularly Libya, Alexandria, and the Nile Delta, killing thousands. The sea was driven back and withdrew from the land, then it returned back with big noise.

The 365 Crete earthquake occurred on 21 July 365 in the Eastern Mediterranean, with an assumed epicentre near Crete. The earthquake had a magnitude of or higher. The earthquake was followed by a tsunami which devastated the

Water Issues

Origin of ocean water:

As Earth formed in a cloud of gas and dust more than 4.5 billion years ago. The ocean formed from the escape of water vapor and other gases from the molten rocks of the Earth to the atmosphere surrounding the cooling planet. After the Earth's surface had cooled to a temperature below the boiling point of water, rain began to fall—and continued to fall for centuries. As the water drained into the great hollows in the Earth's surface, the primeval ocean came into existence. The forces of gravity prevented the water from leaving the planet.

The hydrologic (water) cycle

There is water in the atmosphere, rivers, & lakes. It moves around and around the water cycle. Water changes state between liquid, gas and solid. The water cycle is how water travels around the world (Fig. 14). The water cycle on earth will never run out.

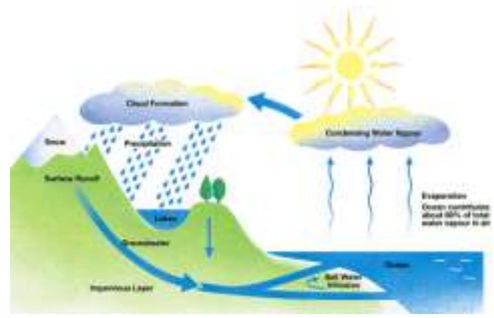


Figure (14): Water Cycle

The water cycle is a conceptual model that describes the storage and movement of water between the biosphere, atmosphere, lithosphere, and the hydrosphere. Water on this planet can be stored in any one of the following reservoirs: The hydrological cycle consists of a collection of reservoirs (each having a particular mass of water substance) and movement (fluxes, measured in units of mass or volume per unit time) of water substance between these reservoirs.

The following are reservoirs of the global hydrological cycle:

1. Global oceans
2. Ice masses
3. Antarctic ice sheet, Greenland ice sheet, Mountain glaciers, Arctic ice, Sea ice
4. Continental seasonal snow
5. Surface fresh water: Lakes, Rivers, Marshes and wetlands
6. Subsurface water: Soil moisture, Permafrost, Groundwater

7. Biospheric water
8. Atmospheric water vapor
9. Clouds: Liquid, Ice

Water moves from one reservoir to another by way of processes such as evaporation, condensation, precipitation, deposition, runoff, infiltration, sublimation, transpiration, melting and groundwater flow (Fig.14).

Precipitation:

All moisture from the atmosphere, rain, snow, hail and sleet come from clouds that move around the world. When clouds rise over mountain ranges, they cool, becoming so saturated with water that begins to fall as rain, snow or hail, depending on the temperature of the surrounding air.

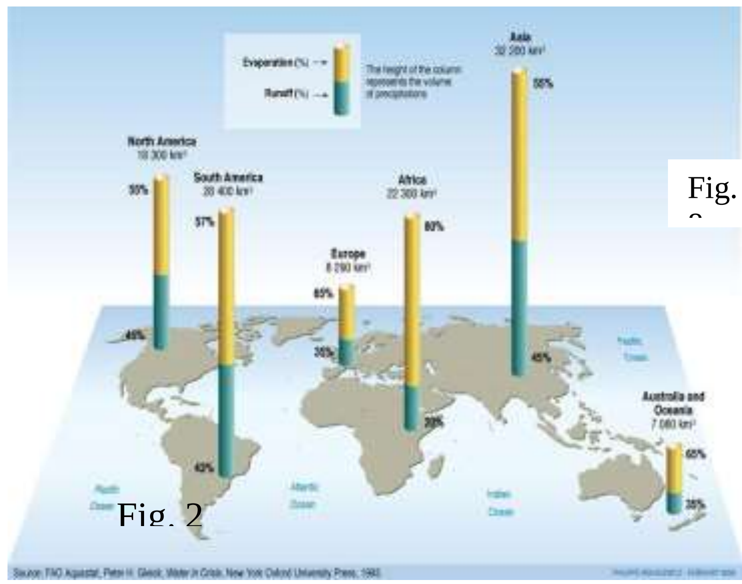


Figure (15): World precipitation, runoff and

Evaporation:

Evaporation occurs when water goes from the liquid to the vapor state. As water is heated by the sun, the surface of it's molecule becomes sufficiently energized invisible vapor in the atmosphere. The oceans supply most of the evaporated water found in the atmosphere. It is estimated that each year about 502,800 km^3 of water evaporates over the oceans and seas, 90% of which (458,000 km^3) returns directly to the oceans through precipitation, while the remainder (44,800 km^3) falls over landmasses where climatological factors induce the formation of precipitation. The resulting imbalance between rates of evaporation and precipitation over land and ocean is corrected by runoff and groundwater flow to the oceans. The rate of evaporation depends mainly on: 1) the temperature of the air and the water body,

2) the absolute humidity of the air above the free surface of the water body, and 3) the wind speed: high winds keeps absolute humidity low, and stirs up the free surface.

Africa receives considerable inputs of solar heat and radiation because it has large share of its area in the tropics. About 80% of the rainfall water is lost by evaporation (Fig. 15).

Transpiration: All the water that could enter the air from plant leaves by a process called transpiration. The term ***evapotranspiration*** is used for the total water loss from a basin from evaporation and transpiration combined.

Condensation: Condensation is a process by which air masses are cooled. As water vapor rises, it cools and eventually condenses, usually on tiny particles of dust in the air. The normal lapse rate is about 0.7ºC /100 m of elevation change. When water condenses it becomes a liquid again or turns directly into a solid (ice, hail or snow). These water particles then collect and form clouds.

Runoff occurs when precipitation rate exceeds infiltration capacity at a given time. It is visible flow of water in rivers, creeks and lakes as the water stored in the basin drains out. Tropical regions exhibit greater river runoff volumes. The Amazon carries 15% of all the water returning to the world's oceans, while the Congo- carries 33% of the river flow in Africa.

Infiltration is a process by which water from precipitation or snow melt moves from the surface downwards into the soil and rocks through cracks, joints and pores until it reaches the water table where it becomes groundwater. It is driven by gravity and pressure ($P_{pore} \leq P_{atmosphere}$) pores until it reaches the water table where it becomes groundwater. It is driven by gravity and pressure ($P_{pore} \leq P_{atmosphere}$).

Groundwater: Subterranean water is held in cracks and pore spaces. Depending on the geology, the groundwater can flow to support streams. It can also be tapped by wells. Some groundwater is very old and may have been there for thousands of years.

The endless circulation of water from the atmosphere to the earth and its return to the atmosphere through condensation, precipitation, evaporation and transpiration is called the hydrologic cycle.

GLOBAL WATER BUDGET:

The global water resources are estimated as follow: The total volume of water on Earth is about 1.4 billion km^3 (Table 1). The volume of freshwater resources is about 35 million km^3, or about 2.5% of the total volume. About 27 million km^3 (76.65% of the global freshwater) occur in the form of ***ice*** and permanent snow cover in mountainous regions, the Antarctic and Arctic regions. Groundwater represents about 22.76% of the global freshwater.

What makes water saline?

Salinity refers to the amount of total dissolved solids (TDS) in the water and is frequently measured by electrical conductivity (EC), as ions dissolved in water conduct electricity and actual TDS analyses are expensive to conduct.

Saline water contains significant amounts (referred to as "concentrations") of dissolved salts (Table 1). In this case, the concentration is the amount (by weight) of salt in water, as expressed in "parts per million" (ppm). If water has a concentration of 10,000 ppm of dissolved salts, then one percent of the weight of the water comes from dissolved salts (1 ppm = 1%). The rivers transport dissolved salts from eroded rocks after rainfall to the oceans. The concentration of salts in oceans increases with increasing evaporation with time. Waters with higher TDS concentrations will be relatively conductive. TDS is measured in parts per million or mg/L and EC is measured in micro-Siemens per centimeter (μS/cm).

Parameters for saline water:

Freshwater (Drinking water)	Less than 1,000 ppm
Freshwater (Slightly saline)	From 1,000 ppm to less than 3,000 ppm
Moderately saline water (Brackish)	From 3,000 ppm to less than 10,000 ppm
Highly saline water (Seawater)	From 10,000 ppm to less than 50,000 ppm
Brine water	More than 50,000 ppm

Ocean water contains about 35,000 ppm of salt, Dead Sea contains 330,000 ppm.

Nile River at Cairo contains about 300 ppm.

Dissolved Salts in Sea Water

Table 1: Typical salts dissolved in sea water

Component	**Mass** ***(gram/kg_{water})*** ***at °C***
Pure water	965.31
Chlorine	19.10
Sodium	10.62
Magnesium	1.28
Sulfur	2.66
Calcium	0.40
Potassium	0.38
Minor constituents	0.24
Trace constituents	0.01
SUM	1000.00

The **atmosphere** holds about 0.04%. The annual precipitation for the earth is more than 30 times the atmosphere's total capacity to hold water, indicating the rapid recycling of water that must occur between the earth's surface and the atmosphere. Freshwater **lakes** and **rivers** contain an estimated 105,000 km^3 (0.3% of the world's freshwater) (Table 2).

Table 2. Distribution of the world water supply

Reservoir	Volume million Million km^3	% Total	% of freshwater
Oceans	1,360	97. 5	
Ice Caps and Glaciers	25	1.8	71.293
Groundwater	10	0.7	28.517
Lakes	0.1	0.007	0.285
Atmosphere	0.013	0.001	0.037
Streams and Rivers	0.002	0.0001	0.006
Total	1,395		

The surface freshwater is stored in streams, rivers and lakes only comprise 0.0001% of all water in the earth system. The largest store of water is the ***oceans*** that contain about 1,365 million km^3 (97.5% of the earth's water) of salty water.

Africa contains about 4,050 km^3/yr (9% of the world's total freshwater resources). These resources are distributed unevenly across Africa. They are concentrated in the central and western regions of the continent, where rainfall ranges from moderate to abundant. Democratic Republic of Congo is the wettest country in Africa. It contains 935 km^3/yr (about 25% of all of Africa's annual internal renewable water resources). By contrast, the driest country, Mauritania, has just 0.4 km^3/yr (0.01% of Africa’s total).

Africa is home to some of the planet's largest desert regions, including the vast Sahara (the world's biggest desert), which spans the midsection of North Africa; the Horn Desert in the east; and the Kalahari and Namib deserts of Southern Africa. All told, approximately two-thirds of Africa is classified as desert or arid. It is the most tropical of all the continents with over 75% of its area falling between 23 °N and °S.

Water scarcity

The population growth will lead to the increase in water use and withdrawals for personal (drinking and hygiene), industrial (production of goods) and agricultural (irrigation and livestock) use. Consequently the water availability will decline. Water scarcity is the lack of sufficient water resources to satisfy the demand in a certain country, region or town.

Such a relationship between water use and water availability is called the ***water stress index*** that is a tool used by the United Nations (UN). and other organizations to define whether the water stress is likely to appear in some region.

Water Stress Indicator is based on the measure of renewable water availability per capita per year within the country or region (Table 3).

Water scarcity is among the main problems to be faced by many societies and the World in the 21st Century. Water scarcity is commonly defined as a situation when annual renewable freshwater availability in a country or in a region is below 1000 m^3/person/year. However, many regions in the World experience much more severe scarcity, living with less than 500 m^3/person/year, which could be considered severe water scarcity.

Table (3) Water Stress Indicator

Index (m^3/capita/year)	**Class**
>2,500	No stress
1,700 - 2,500	Vulnerable
1,000 - 1,700	Stress
500 - 1,000	Chronic Scarcity
<500	Absolute or Severe Scarcity

Limitations of water stress evaluation

1. The indicator ignores the differences in water demand between the countries determined by the climate and culture, etc.
2. It omits the seasonal water availability variations.
3. The indicator disregards the water quality or water accessibility.
4. It also does not take into account the non-renewable groundwater and artificial water sources such as desalination plants that increase the amount of available water.
5. It ignores poor water management.

<u>Water stress index (WSI) in Egypt</u>

Water stress index (WSI) is the annual amount of available renewable freshwater per person per year.

In Egypt (2021):

- Population in 2024 = ~107 million
- Annual freshwater resources in Egypt:
    - Nile: 55.5 km^3
    - Rainfall: about 1.0 km^3

Total annual water budget = 56.5 km^3 = 56,500 million m^3

- Annual water per capita = Annual water budget / Population

= 56,500 / 107 = **523.4 m^3/person/ year**

~ 523 m^3/capita/year

Causes for water scarcity:

Annual renewable freshwater availability of less than 1,000 m^3 per person is defined by as water scarcity that may result from a range of phenomena. These may be produced by natural causes, may be induced by human activities, or may result from the interaction of both.

1. Natural:
    a. Climate factors (temperature, evaporation, rainfall (intensity, variability in time and space).

b. Geologic factors (topography, rock types, soil, fractures, ..).
c. Vegetation cover.

2. Human influences:

a. Pollution and contamination degrade the water quality and lead to water unavailability for many uses.
b. Population growth
c. Poor water management.

The arid environments

Aridity is usually expressed as a function of rainfall and temperature. A useful "representation" of aridity is the following climatic aridity index: p/ETP Where:

P is the mean value of annual precipitation,

ETP is the mean annual potential evapotranspiration calculated by method of Penman, taking into account atmospheric humidity, solar radiation, and wind.

1- **<u>The hyper-arid zone</u>** (arid index 0.03)

The hyper-arid zone comprises dryland areas without vegetation, with the exception of a few scattered shrubs. True nomadic pastoralism is frequently practiced. Annual rainfall is low, rarely exceeding 100 millimeters. The rains are infrequent and irregular, sometimes with no rain during long periods of several years. Average rainfall in Egypt is 50 mm/year. The northern Africa is arid and hyper-arid (Fig. 3).

2- **<u>The arid zone</u>** (arid index 0.03-0.20):

The arid zone is characterized by pastoralizm and no farming except with irrigation. For the most part, the native vegetation is sparse, being comprised of annual and perennial grasses and other herbaceous vegetation, and shrubs and small trees. There is high rainfall variability, with annual amounts ranging between 100 and 300 mm (Fig. 16).

Fig. 16.
Aridity zones.

3- **<u>The semi-arid zone</u>** (arid index 0.20-0.50):

The semi-arid zone can support rain-fed agriculture with more or less sustained levels of production. Sedentary livestock production also occurs. Native vegetation is represented by a variety of species, such as grasses and grass-like plants, fortes and half-shrubs, and shrubs and trees. Annual precipitation varies from 300-600 to 700-800 millimeters, with summer rains, and from 200-250 to 450-500 millimeters with winter rains.

4- **Sub-humid zone** (arid index 0.50-0.75):

5- **Humid zone (**arid index >0.75)

When the rainy season lasts more than ten months per year, it creates a **humid climate**, in which more water falls than can evaporate.

In arid climates annual precipitation ranges 0–200 mm and in semi-arid climates it ranges 200–500 mm. In the first, most rainfall (70% or more) is used as evaporation and evapotranspiration, less than 30% becomes runoff, and groundwater recharge is generally negligible. In semiarid climates the rainfall converted into runoff is about the same, groundwater recharge increases to near 20% and real evaporation and evapotranspiration then average around 50% (UNESCO 2006).

Pollution

Pollution means any solid, liquid or gaseous substance present in such concentration as may be, or tend to be, hazardous or detrimental to the environment. **Pollutants**, the components of pollution, can be either foreign substances or naturally occurring contaminants. Environmental pollution is a worldwide problem and this is scrambled with the unsustainable human activities, resulting in substantial human health problems. Human activities and natural forces are the main reasons of pollution.

Classification of Pollution

Environmental pollution is classified into various categories. The major categories of pollution are list in the following table:

Category	Pollutants	Health effects
Air pollution	Smoke, dust, toxic substances (SOx, NOx), CFCs, ozone, PAN, etc.	Respiratory infection, bronchitis, asthma, heart disease
Water pollution	Industrial and sewage wastewater, wastewater, pesticide, fertiliser, detergents, heavy metals, etc.	Deoxygenation of water bodies, noxious odours, poisoning, disease like cholera
Soil pollution	Chemicals used in agriculture, pesticides, petroleum hydrocarbons, arsenic, lead and other heavy metals, human and animal waste, etc.	Congenital disorders, poisoning
Radioactive pollution	Radiation (X-ray), radionuclides (strontium-90, iodine-129, cesium-137 and different other isotopes)	Damage DNA, eye cataract, cancer
Noise pollution	Machines in factories, transportation systems, motor vehicles, aircrafts, trains, late-night commercial operations, etc.	Headaches, hearing loss, cardiovascular effects, depression, discomfort, impaired development

Air Pollution

Air pollution is a result of industrial and certain domestic activities. An ever increasing use of fossil fuels in power plants, industries, transportation, mining, construction of buildings, and stone quarries had led to air pollution. It may be defined as the introduction of particulates and chemicals into the atmosphere in such concentration that may be directly and indirectly injurious to human health or other living organisms, plants or interferes with the normal environmental processes.

Air Pollutants

The most common air pollutants are sulfur oxides (SO_2, SO_3); nitrogen oxides (NO_2, NO_3); carbon monoxide (CO) produced by industry and motor vehicles; carbon dioxide (CO_2) from burning of fossils fuels; volatile organic compounds like methane; chlorofluorocarbon (CFC); ozone (O_3); ammonia (NH_3); particulate matter or fine dust, metals, odors; etc.

Effects of Air Pollution

Air pollution is a significant risk factor for the environment and a number of health conditions. It is responsible for global warming, ozone depletion and acid rain. It primarily affects the body's respiratory system and the cardiovascular system causing respiratory infections, asthma, bronchitis, heart disease, stroke and lung cancer.

Sources and Pollutants

Agricultural runoff laden with excess fertilizers and pesticides, industrial effluents with toxic chemical substances (e.g. detergents, heavy metals) and sewage water with human and animal wastes and pathogens pollute our water bodies thoroughly. Natural sources of water pollution are soil erosion, leaching of minerals from rocks and decaying of organic matter. Rivers, lakes, seas, oceans, estuaries and ground water sources may be polluted by point or non-point sources.

Soil Pollution

Soil is formed by weathering of rocks. It is the most important abiotic factor that holds most advantageous microbes and supports life of plants that rely on it for their nutrition, water supply and mineral supply.

Human activities lead to degradation of soil, water and air. Soil degradation causes decline in soil productivity through adverse change in nutrient status, structural stability, concentration of solutes, etc.

Effects of Soil Pollution

Soil pollution has direct effect on all life forms of aquatic and terrestrial habitat. When soil pollutants runs off into rivers and lakes, it may kill the fishes, plants and other aquatic organisms. Soil pollutants impair soil stability due to which it does not support growth of crops in field, and toxic soil particle may have harmful effect on human health.

Water Pollution

Water pollution is the result of contamination of water bodies (e.g. lakes, rivers, oceans and groundwater). Any physical, chemical or biological change in waterbodies that adversely affects living organisms or makes water unsuitable for desired uses can be considered as water pollution. This form of environmental degradation occurs when pollutants are directly or indirectly discharged into water bodies without adequate treatment to remove harmful compounds.

Water pollution is caused by a variety of human activities such as industrial, agricultural and domestic. It affects the health and quality of soils and vegetation.

Types of pollution based on the sources:

1. Point Source Pollution

Point source pollution is pollution caused from a stationary location or fixed facility where pollutants are discharged, any single identifiable source of pollution. Examples are oil spill from ship, smoke/effluent discharge from a factory, etc.

2. Non-point Source Pollution

Non-point source pollution comes from diffuse sources (i.e. without a single point of origin or not introduced into a receiving stream from a specific outlet). It is the type of pollution that cannot be easily tracked back to its source. Examples are agriculture, forestry, urban, mining and construction activities. Non-point source pollution does not always immediately destroy habitats at one time but usually over longer periods of time. The examples are fertilizers, pesticides, animal waste, etc.

The main causes of water pollution:

I. Human causes:

1. **Municipal Pollutants**
2. **Agricultural Pollutants**
    - Nutrients (phosphorus and nitrogen)
    - Pesticide

II. Natural causes:

1. Desertification (Sand and dust storms)
2. Flooding
3. Volcanoes
4. Tsunami and Earthquakes (fires,
5. Erosion
6. Mass wasting (rockfall)
7. Hurricanes and Tornadoes (thunderstorms)
8. Acid rains
9. Sea-water intrusion
10. Wildfires
11. Ocean currents
12. Heat (springs)
13. Meteorite impact

1. Wildfires (How Do Wildfires Impact Water Quality?)

Wildfires pose a substantial risk to water supplies because they can lead to severe flooding, erosion, and delivery of sediments, nutrients (nitrate, ammonia, phosphate) from build-up of ash, soil erosion, fire debris, chemicals used to fight the fire, heavy metals and toxins into streams, rivers, lakes, and reservoirs. When water flow increases, it accelerates the river-bank erosion.

What causes wildfires?

- Natural phenomena

a. Lightning strikes on trees or dry vegetations.
b. Volcanic related phenomena, such as eruptions or geothermal activity.
c. Sparks from rockfalls.
d. Spontaneous combustion (self-heating or autoignition, increase in temperature due to exothermic internal reactions). Microbiological activity (bacteria) that ferments the hay, creating ethanol.

- Human activities especially in dry and windy conditions (90% in USA):

a. Campfires
b. Discarded cigarette butts
c. Burning debris (yard waste, agricultural residue, or trash).
d. Equipment sparks from machinery, power lines, railroads or vehicles.
e. Human settlements near forests

Los Angoles, California Fire 2025

Since January 7, 2025, a series of destructive wildfires have affected the Los Angeles metropolitan area and surrounding regions. As of January 31, 2025, two fires remain active, which include the Palisades Fire, and the Eaton Fire.

The combination of dry and low humidity conditions in Southern California has had less than 10% of average rainfall since Oct. 1 2024 and powerful offshore winds (160 km/h; 45 m/s) called “Santa Ana” that hit the region prompted a series of ferocious wildfires erupted on Jan. 7, 2025. The fire is extended across the Los Angeles area, killing at least 29 people, destroying or damageing more than 18,000 thousands of structures, and forcing more than 200,000 to evacuate.

Freshwater Resources in Africa

Significant features of water resources in Africa:

1. Low rainfall, most African countries also experience extremes of rainfall (periodic flooding or drought).
2. High evaporation (80%).
3. The extremely low runoff in relation to precipitation, in which the renewable water resources constitute only about 20% of the total rainfall.
4. Uneven water distribution, where great temporal and spatial variability of rainfall in Africa. The western Africa and central Africa have significantly greater precipitation than northern Africa, the Horn of Africa and southern Africa.
5. Water pollution in Africa is common.
6. Mismanagement of water resources in Africa. Water uses (90% in agriculture, 10% domestic and industrial). Some countries cultivate of crops of high water requirements such as rice, sugarcane and banana, which need more water than crops like millet or sorghum).
7. Irrigation in some countries (Egypt and Sudan) is an ancient flood irrigation method.
8. Non-renewable groundwater in most of the Northern African aquifers.
9. Overgrowth population in Africa forms excess demand of water.
10. The deterioration of water quality (pollution), salinization, and reduction of the yield of the heavily exploited aquifers.
11. Climate change affects some African regions (drought and rainfall changes).
12. There are some conflicts and political water tension of the transboundary surface and groundwater resources in Africa. Some of the main transboundary rivers are the Nile River (Sudan and Egypt), Congo River, Senegal River (Mauritania), the Juba and Shebilli rivers (Somalia).

Freshwater Resources in the Arab Region

The definition of **freshwater** is water containing less than 1000 milligrams per liter of dissolved solids, most often salt. It occurs in the form of stream flow, groundwater, soil moisture, or atmospheric water vapor.

Water resources, although globally abundant, are distributed in pronounced uneven patterns throughout the globe. Global renewable surface and groundwater resources amount for an average annual share of 6185 m^3/capita for year 2015.

More than 85% of the Arab Region is classified as arid and hyper-arid, receiving an average annual rainfall of less than 250 mm. The average annual precipitation for the Arab nations is 156 mm/year. Total rainfall is km^3 1488. More than 75% of the limited precipitation received by the region is evaporated indicating the highest aridity in the world.

The Arab Region annual renewable freshwater availability is 300 km^3, from which 54% of is originated from outside the region.

Fossil groundwater has been extensively tapped in the desert areas. A total of about 30 km^3/year of non-renewable and non-conventional water supplies are being produced.

Water challenges in the Arab World

1. Low rainfall (1488 km^3/year). The annual renewable surface water is **300 km^3** (0.67% of the world), although the Arab region forms 5.8% of the world population and 9.2% of the land surface.
2. High evaporation (80% of the rainfall).
3. Non-renewable groundwater.
4. Uneven water distribution (spatial and temporal):
    a. Three countries (Egypt, Sudan and Iraq) have more than 65% of the Arab water.
    b. Short rainfall season in winter.
5. Mostly deserts (flat and dry).
6. Overgrowth population (2.37%/year). It is increased from 262 million in 1997 to 390 in 2015. It has 769 m^3/capita in 2015 (world average is 6185 m^3/year/kapita).

7. Water Mismanagement:
    a. Water uses (81% in agriculture, 13% domestic and 6% industrial)
    b. Types of crops (cultivation of high water requirement plants such as rice, sugarcane and banana, which need more water than crops like millet or sorghum).
    c. Using ancient flood irrigation method.
8. The deterioration of water quality (pollution), salinization, and reduction of the yield of the heavily exploited aquifers.
9. Climate change (drought and rainfall changes).
10. The conflicts of the transboundary surface and groundwater resources. More than 54% of the available actual renewable water resources are being generated outside the Arab Region. The main transboundary rivers are the Nile River (Sudan and Egypt), Senegal River (Mauritania), the Juba and Shebilli rivers (Somalia), the Tigris and Euphrates (Syria and Iraq).

Irrigation Water Requirement of Crops

Water requirement of crops is defined as "the amount of water required by a crop in its whole production period”. It includes evaporation and other unavoidable wastes. Usually water requirement for crop is expressed in water depth per unit area. The amount of water taken by crops varies considerably (Table 4).

Table 4. Water requirement of different crops.

Crop	Water Requirement (mm)
Sugarcane	1500-2500
Rice	900-2500
Banana	1200-2200
Citrus	900-1200
Cotton	700-1300
Pineapple	700-1000
Tomato	600-800
Grape	500-1200
Maize	500-800
Potato	500-700
Groundnut	500-700
Wheat	450-650
Soybean	450-700
Sorghum	450-650
Chillies	500
Cabbage	380-500
Onion	350-550
Pea	350-500
Sunflower	350-500
Gingelly	350-400
Bean	300-500

RIVERS

Introduction

The total volume of water on Earth is about 1.4 billion km^3. The volume of freshwater resources is about 35 million km^3, or about 2.5% of the total volume. Freshwater ecosystems in rivers, lakes, and wetlands contain just a fraction—one-hundredth of 1 percent—of the Earth's water (i.e. 0.0001%) and occupy less than 1% of the Earth's surface (Watson et al. 1996; McAllister et al. 1997). There are about 263 international river basins covering 45.3% (~231,059,898 km^2) of the land surface area of the Earth.

River Basin?

A ***river basin*** is the portion of land drained by a river and its tributaries. It encompasses the entire land surface dissected and drained by many streams and creeks that flow downhill into one another, and eventually into the main river.

Watershed

A watershed is simply the area of land that catches rain and snow and drains or seeps into a marsh, stream, river, lake or groundwater.

What is the difference between a River Basin and a Watershed?

Both river basins and watersheds are areas of land that drain to a particular water body, such as a lake, stream, river or estuary. In a river basin, all the water drains to a large river. The term watershed is used to describe a smaller area of land that drains to a smaller stream, lake or wetland. There are many smaller watersheds within a river basin.

River discharge (Q) is the volume of water moving down a stream or river per unit of time, commonly expressed in cubic meter per second (m^3/s). In general, river discharge is computed by multiplying the area of water in a channel cross section by the average velocity of the water in that cross section (Fig. 17):

Discharge = area x velocity

= (width x depth) x velocity

Q = W x D x V

Q = river discharge (m^3/sec)

W = average width (m)

D = average depth (m)

V = velocity of water (m/sec)

Average annual discharge of the Nile River at Aswan is 84 billion m^3.

Average annual discharge of the Congo River is 1300 billion m^3 (15 times the Nile).

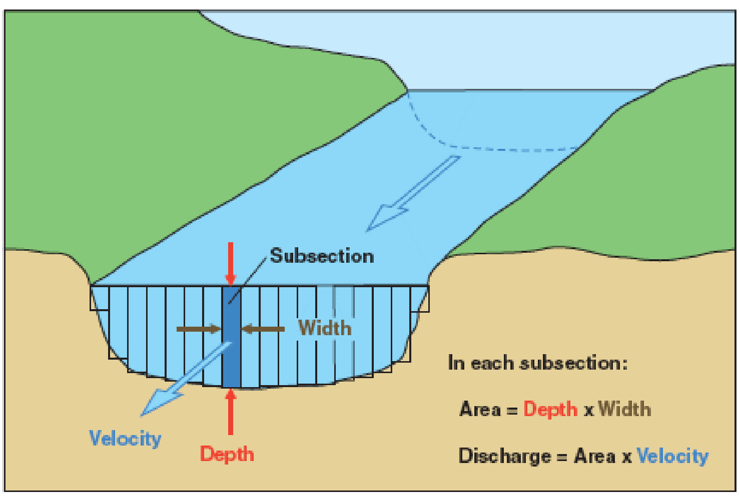


Figure (17): River discharge.

MAJOR RIVERS IN AFRICA

There are 261 international rivers, covering almost one half of the total land surface of the globe. Africa contains half a dozen of global significance watersheds. The northeast quadrant of the continent is home to the Nile River, the longest river in the world at approximately 7,000 km. Other major river basins include the Congo River in central Africa, the Niger River in western Africa, the Zambezi River in southeastern Africa, and Orange River in southern Africa (Fig. 18).

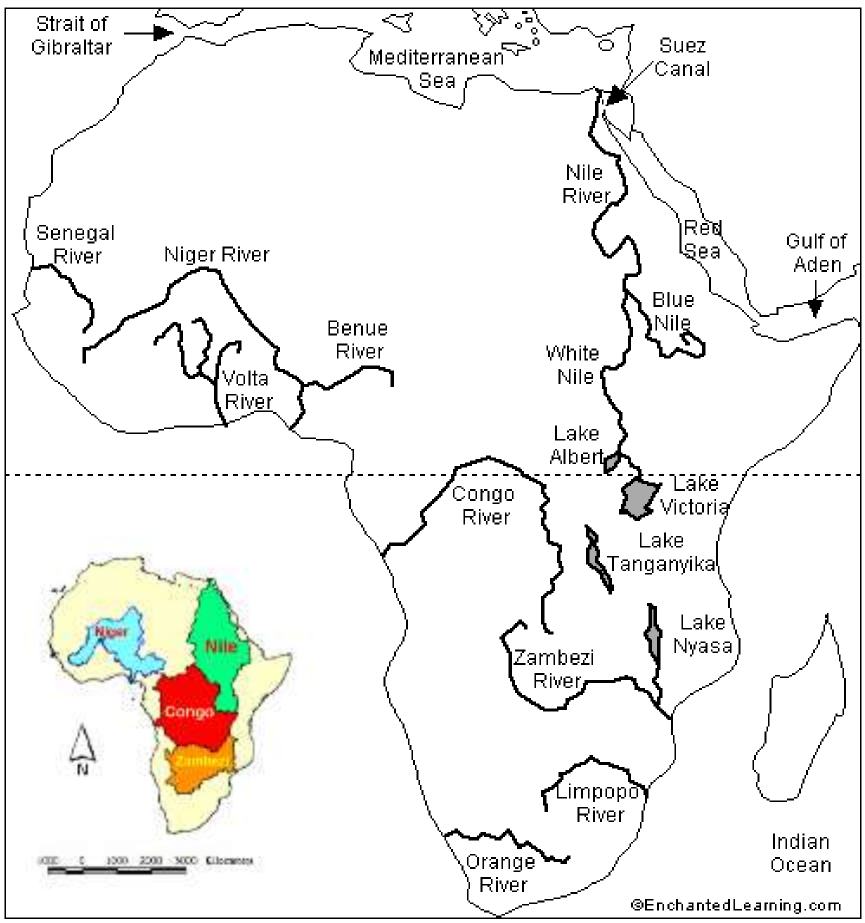


Figure (18): Major rivers in Africa.

Water Resources in Egypt

The actual resources currently available for use in Egypt are 55.5 km^3/yr, and 0.5 km^3/yr effective rainfall on the northern strip of the Delta, non-renewable groundwater for Western Desert and Sinai, while water requirements for different sectors are in the order of 80 km^3/yr. The gap between the needs and availability of water is about 24 km^3/yr. This gap is overcome by recycling.

The Nile River

The Nile is the longest river in the world with a length of 6,695 km from the headwaters of the Kagera River in Rwanda in the south, to the Egyptian delta on the Mediterranean coast in the north.

The Nile has a drainage area of about 3.2 million km^2. It is nearly 10% of the landmass of the African continent, covering parts of 11 countries. They are (from south to north) Rwanda, Burundi, Tanzania, Uganda, Kenya, DR Congo, Ethiopia, Eritrea, South Sudan, Sudan, and Egypt (Fig. 6).

Sources of the Nile:

It has two main tributaries:

1. **Ethiopian sources** originating in the highlands of Ethiopia.

   a) The Blue Nile, with its source in the Ethiopian highlands.

   b) Atbara (Tekeze)

   c) Baro-Akobbo-Sobat

2. **Equatorial Plateau of East Africa**, The White Nile, originating from the headstreams of which flows into Lake Victoria, and Lake Victoria with the surface area of 66,700 km^2 is the world's second largest freshwater lake after Lake Superior in North America. The equatorial water flows to South Sudan and forms Bahr el Jebel.

The two principal branches of the Nile - the White Nile and the Blue Nile join at Khartoum to form the main Nile. The average of the annual Nile flow (discharge) is 84 km^3 at Aswan.

About 85% of the Nile water comes from Ethiopian highlands, 15% flows from the Equatorial sources (Fig. 12 and Table 5).

The Blue Nile

The Blue Nile flows about 1,400 km from Lake Tana to Khartoum, where the Blue Nile and White Nile join to form the main Nile. It provides the Nile by 50 billion m^3 annually (about 60%) (Table 4). It stretches nearly 850 km between Lake Tana and the Sudano-Ethiopian border, with a fall of 1300 m; the grades are steeper in the plateau region, and flatter along the low lands. The Blue Nile River (also called Abbay River in Ethiopia) exits from the south east of Lake Tana and flows south and then westwards cutting a deep gorge towards the western part of Ethiopia. More than 95% of the transported sediments (clay) carried by the Nile originates in Ethiopia, from the Blue Nile, Atbara, and Sobat, and small tributaries.

The White Nile:

The White Nile Sub-basin originates at the confluence of Bahr el Jebel River and Baro-Akobo-Sobat River above Malakal, South Sudan (Figs. 19 and 20). The Bahr el Jebel extends from the mountains of Burundi and Rwanda the Equatorial Lakes. A number of tributaries from Burundi and Rwanda eventually flow into the Kagera River, over Rusumu Falls and into Lake Victoria. The Victoria Nile flows out of the Northern end of Lake Victoria over the Owen Falls Dam and then into Lake Kyoga.

From there the river drops from the Rift Valley at its peak to Lake Albert where it is reinforced by water from Lake George and Lake Edward and flows out of the Lake Plateau as the Albert Nile. At the border of Uganda at Nimule it becomes the Bahr el Jebel or the Upper Nile. Tributaries flowing into the upper White Nile (Bahr el Jebel) in southern Sudan also contribute water to the White Nile, although approximately half of the water flowing into the Sudd downstream is lost to evaporation and overflow into the extensive wetlands of this region.

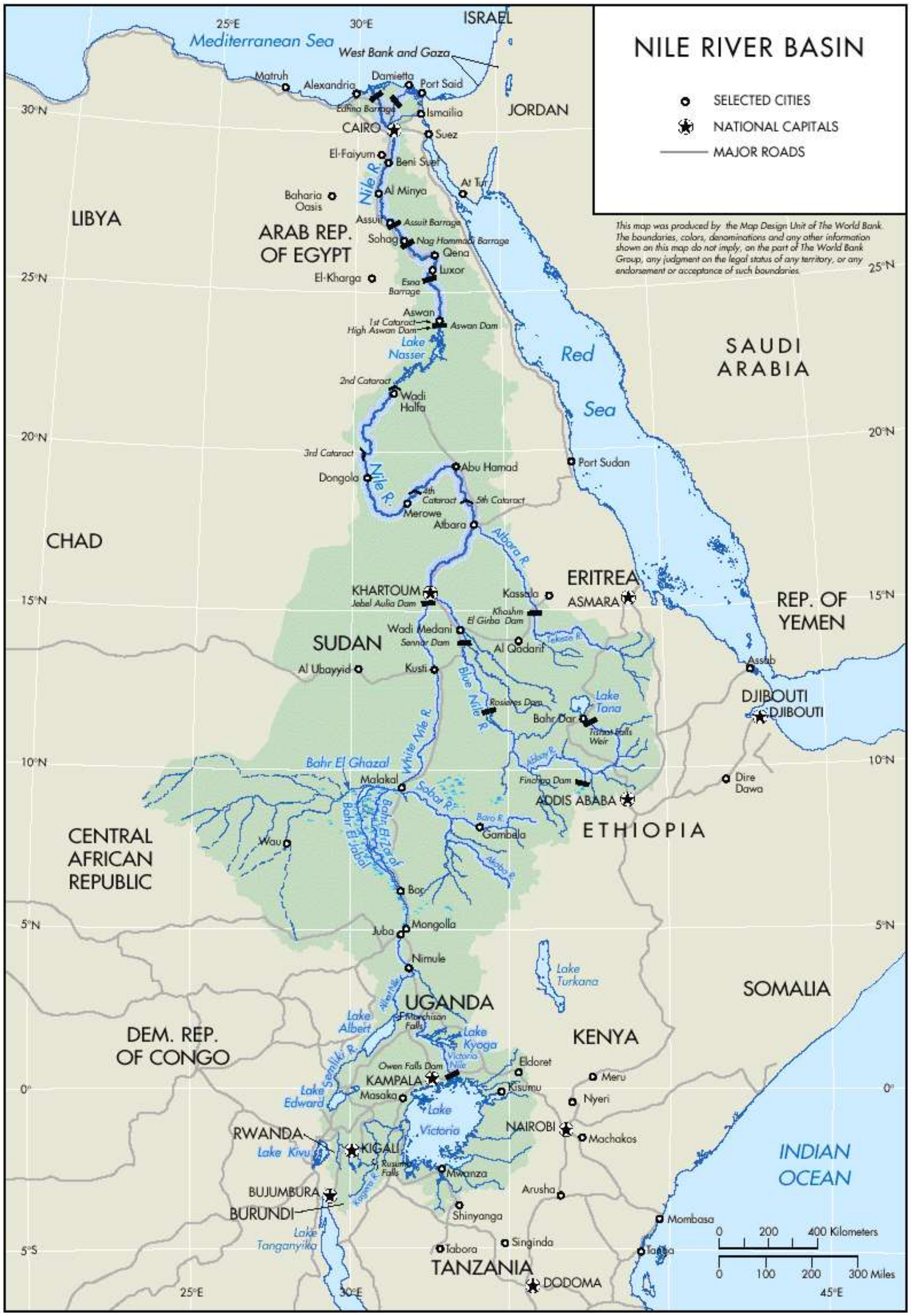


Figure (19): Nile Basin.

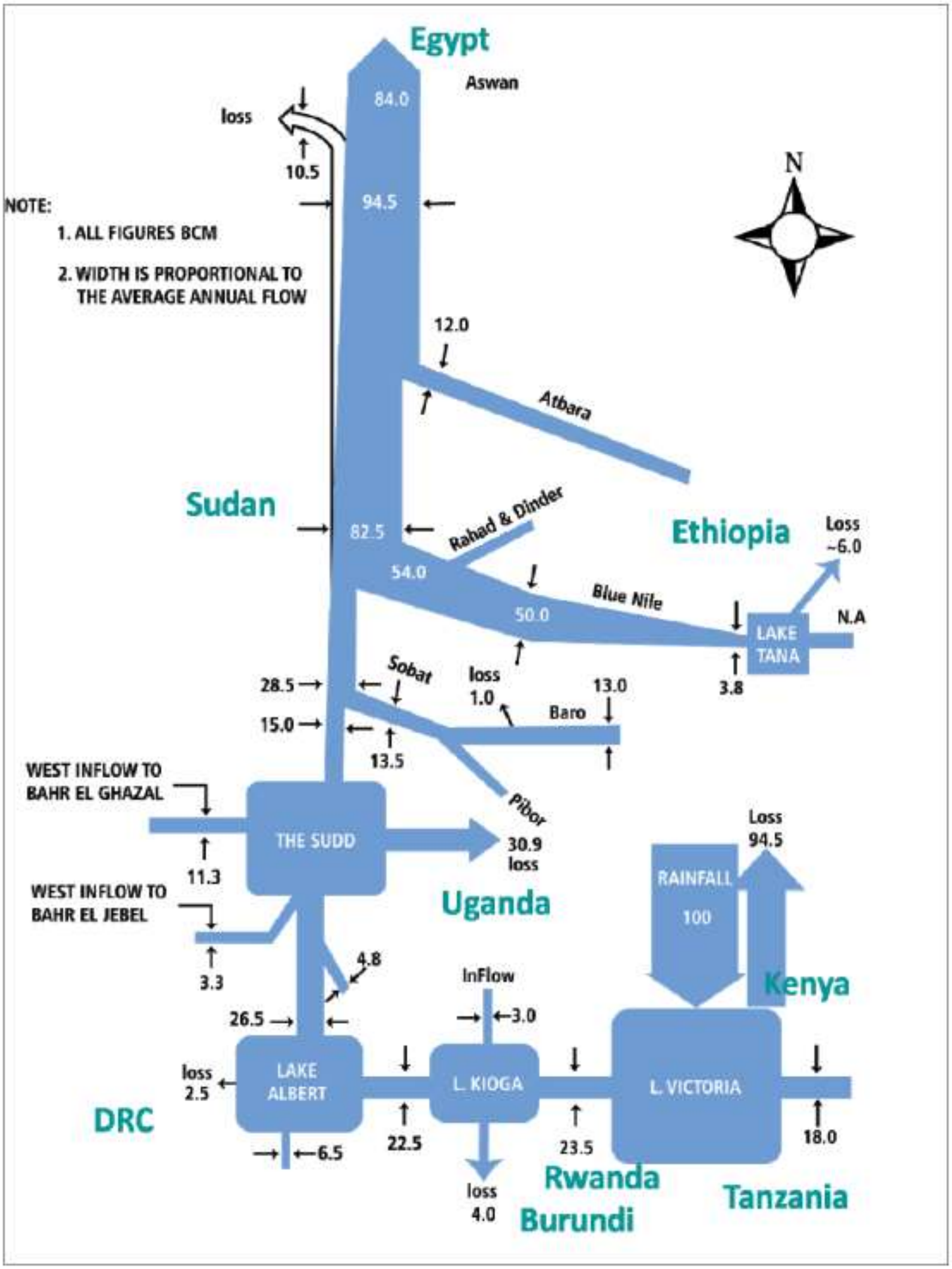


Figure (20): Schematic of the Nile River Flow Fluxes.

Table 5. Contribution of the main Nile sources

Source	River	Water share km^3 at Aswan	%
Ethiopian Highlands	Blue Nile	50	60%
	Atbara (Tekeze)	10	12%
	Baro-Akobbo-Sobat	11	13%
Equatorial Plateau	Lake Victoria - Bahr el Jebel	13	15%
Total		**84**	**100%**

Victoria Lake

Lake Victoria– the largest of the Nile Equatorial Lakes. It is ’s surface area is about 66,700 km^2 and occupies a large proportion of the entire sub-basin. Three countries Kenya (6%), Tanzania (51 %) and Uganda (43%) share the lake shoreline, and six countries share the basin: Burundi, DRC, Kenya, Rwanda, Tanzania and Uganda.

Lake Victoria, 1,134 m above sea level, is by far the largest lake (66,700 km^2) in Africa, and the second largest freshwater lake in the world. Annual water inflow into Lake Victoria through the main tributaries is about 18 km^3. It also receives about 100 km^3/year from direct rainfall. Therefore, it has the most fresh water in Africa in terms of low TDS. Similar to most of the African continent, the annual evaporation rate is about 80%. The net annual outflow from the lake through the Upper Victoria Nile is 23.5 km^3. The concentration of the metal content (salinity) of the Nile River increases with distance from the Aswan High Dam to the north due washing the surface rocks and the human activities. The average salinity of the Nile in Egypt is much greater than that of Victoria.

The Atbara River

The Atbara River is the last major tributary of the River Nile, and converges with it about 320 km downstream of Khartoum. The Nile River experiences massive fluctuations throughout the year, with 80% of the annual discharge occurring between August and October. Prior to construction of the Aswan High Dam, the flow was not reliable throughout the year, and was not abundant during the long, hot and dry summer months, when it is especially critical to Egyptian agriculture. This inhibited the development of the river in many ways.

The Baro-Akobo-Sobat River

The Baro-Akobo-Sobat River includes the discharge from two tributaries: the Baro and Akobo River from the Ethiopian Highlands and the Pibor River from southern Sudan and northern Uganda. Most of the runoff develops in the mountains and foothills of Ethiopia.

The Bahr el Jebel River

Exiting Lake Albert, the river flows north into Sudan and is known as the Bahr el Jebel. The Bahr El Jebel Sub-basin is the most complex of the Nile reaches due to having many seasonal inflows. Below the Sudan-Uganda border, the river receives seasonal flow from torrential streams before entering the Sudd, south of Mongalla. The Sudd is a region of permanent swamps and seasonal wetlands, within which approximately half of the Bahr el Jebel flow is lost to evaporation due to its large surface area and high rate of evaporation as well as overbank spillage; in fact, less than half the water entering the Sudd flows out to the White Nile.

Efforts to attempt to prevent water loss within the Sudd can be dated back to 1900 when the Under Secretary of State for the Egyptian Public Works Department stated the need to reduce water lost in the vast swamps.

Jonglei Canal, South Sudan

Construction of the Jonglei Canal, initiated in 1978 but discontinued in 1983 due to civil conflict, could lead to additional change in the Sudd ecosystem if completed; to date, 240 km of the planned 360 km canal length has been completed. Diversion of water around the Sudd could reduce the area of seasonally flooded grasslands, impact the distribution of other vegetation types, eliminate critical habitat, and displace thousands of Nubians from their homeland.

Grand Ethiopian Renaissance Dam (GERD)

Historical Background

The U.S Bureau of Reclamation carried out a substantial hydrological work on the Blue Nile Basin from 1956 to 1964, the time of constructing the Egyptian High Dam (1960-1970). It proposed 26 water projects in the Blue Nile basin. Four of them are located on the main river and other 22 are located on the tributaries. The Renaissance Dam is one of the four major projects (Fig. 21).

The Blue Nile is an international river, flowing from Ethiopia to Sudan and Egypt. The average annual flow at the Sudan border is 50 billion m^3 per annum.

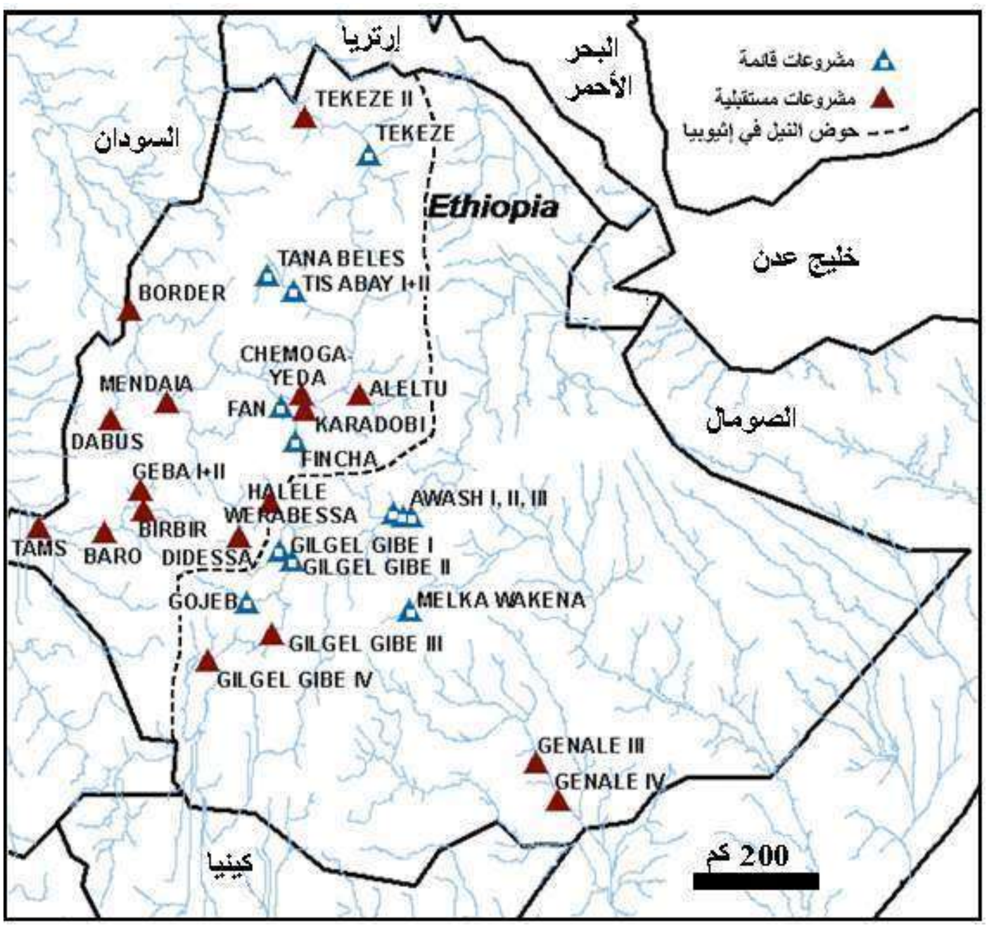


Figure (21): Water projects in Ethiopia.

Location:

The Grand Ethiopian Renaissance Dam (GERD) is being built on the Blue Nile River in North western Ethiopia, a few Kilometers from the Ethio– Sudan common border (5 – 15 km) at elevation 550 m above sea level. The site is approximately 445 km North West of Addis Ababa.

The Blue Nile valley slopes from the river gorge in the Ethiopian highlands (>2,000 m above seal level) to the lowland desert in Sudan. It is heavily laden with silt and brown in color. This silt results from heavy erosion in the Ethiopian highlands.

Names	**Storage capacity (km^3)**
1. Border Dam (1964 – Feb. 26, 2011) **:** 84.5 m high	11.1
2. Project X, Feb. 26, 2011. **:** 90 m high	14-17
3. Grand Ethiopian Millennium Dam (April 2, 2011) **:** 145 m high	62
4. Grand Ethiopian Renaissance Dam (GERD) (April 15, 2011) sometimes referred to as Hidase Dam.	67 to 74

Structure of the Dam:

The dam is to be 145 m high and 1,780 m long. The reservoir will have the capacity to hold up to 74 km^3 of water, which occupies more than 2,000 km^2. A curved saddle dam, supporting the dam and reservoir, will be a 5 km long and 50 m tall. The size of the reservoir is about half of the size of Lake Aswan Dam, which holds 162 km^3 at its peak (182 m above sea level).

Electricity

The powerhouses are to be located one on the Right bank and one on the Left bank of the river and will accommodate ten and five Francis Turbine Units respectively, each with an installed generating capacity of 350 MW. That is:

15 x 350 MW = 5,250 MW total installed capacity.

A concrete lined Gated Spillway and a 5 km long, 50 m high Saddle Dam, both located on the Left Bank.

Upgrade: On March 27, 2012; the government announced a revision of the design. Thus, the total installed capacity of the dam will accommodate 16 turbines 375 MW installed capacity. Ten turbines will be on the left bank, while another six turbines on the right bank. 16 turbines X 375 MW=6,000 MW will be the total installed capacity of the dam. They increased in 2017 to be 6,450 MW.

Project life span:

The dam was scheduled to start delivering electricity in September 2014, when 2 turbine units (thus, 750 MW) become operational. It is postponed to Sep. 2020. The project completion was scheduled for September 2017. It is expected to be completed in 2022.

Cost estimate and financing:

The total cost is estimated at 78 billion birr (3.350 Bln Euros or 4.8 Bln USD) and is to be covered by government budget. It will exceed 8 Bln USD.

Purpose/Use:

The dam will ‘mostly’ be used for generating hydroelectric power.

Advantages
Grand Renaissance Dam

1. **Clean renewable energy production 5,250-6,000 MW.**
2. **Irrigation (250,000 Acres) in the dry season.**
3. **Navigation.**
4. **Sediment manage. and life span for Sudan-Egypt's dams.**
5. **Minimizing the evaporation.**
6. **Flood control.**
7. **Reducing water load at the High Dam Lake.**
8. **Water flow all year in Sudan.**

Disadvantages of the Grand Renaissance Dam

1. High cost US $4.5 billions (> US $ 8 billions.
2. Loss of agricultural (250,000 Acres), grazing and forest lands.
3. People displacement (30,000 capita).
4. Loss of the dead storage (5-25 km^3) ➔12 km^3 and 1-2 km^3 /yr.
5. Low power generation in the High Dam.
6. Partial control of Ethiopia to water flowing to Sudan & Egypt.
7. Flooding of some mining areas (Au, Fe, Cu, Pt, building stones, ...
8. Short life span (30 years at 400 Mm^3/yr sediments from 50 km^3.
9. Decreasing soil fertile in Sudan.
10. Increasing of earthquakes in the storage area.
11. Political conflicts with downstream countries.
12. increase the transmission of malaria.
13. Failure risk (Tsunami-like flooding).

General Principles of International Water Law

International custom is one source of international law, with the others being international conventions and the general principles of law.

1. Principle of Equitable and Reasonable Utilization**:**
   It aims to balance the uses and protect the interests of all riparian states of a transboundary watercourse**.** The precise definition of its normative content in detail, and thus its application, remain difficult in practice.
2. Equitable and Reasonable Utilization:
   It implies that a state is not free to unilaterally increase its use of the watercourse simply by virtue of the absence of any protest by another riparian state
3. Obligation Not to Cause Significant Harm
4. Obligation to Protect International Watercourses and Their Ecosystems
5. Obligation to Cooperate
6. Obligation of Notification and Related Obligations
7. Obligation to Consult
8. Obligation to Exchange Data and Information

Desertification

What is desertification?

Desertification is recognized as ***"a process of land degradation in arid, semi-arid, and dry sub-humid areas that is the result of several factors, including human activities and climate variation".*** (UNCCD, 1999).

Desertification *is a process in which some of the productive lands change into desert or non productive lands.*
It is most likely to occur in areas where rainfall is scarce.

Desertification is a worldwide phenomenon estimated to affect 40 million km^2 or approximately one-third of the Earth's surface area and >1 billion people in over 110 countries.

Desertification is especially important problem in Africa. Two-thirds of the continent is desert or dry lands, and 74% of its agricultural dry lands are already seriously or moderately degraded.

Root causes of desertification have been identified as population growth and climate change which contribute to the nature and extent of environmental stress. Environmental stress represents both environmental degradation and scarcity of natural renewable resource.

What are the major causes of desertification?

There are many factors that trigger desertification, including the unpredictable effects of drought, fragile soils and geological erosion, livestock pressures, nutrient mining, growing populations, … etc.

I. CLIMATIC VARIATIONS:

High and sustained temperatures lasting for months with infrequent and irregular rainfall, leads to drought with the effect that vegetation has difficulty growing. This natural phenomenon occurs when rainfall is less than the average recorded levels. As a result, severe hydrological imbalances jeopardize production systems.

II. HUMAN ACTIVITIES:

Over-exploitation of natural resources represents the most immediate causes for desertification.

1. **Overcultivation** exhausts the soil. Farmers are clearing average land, and using it which takes away the richness in the soil. Unsustainable agricultural practices especially under the intensive and frequent cultivation, which resulted in salinity, water-logging, depletion of soil fertility and excessive use of pesticides, fertilizers as well the inappropriate time and machines of tillage which led to problems of physical and chemical desertification, e.g. compaction, pollution … etc.
2. **Overgrazing** removes the vegetation cover that protects it from erosion. It was not as large of a problem long ago because animals would move in response to rainfall. People would move with the animals so it prevented overgrazing in such areas. Now, humans have a steady food supply so they do not have to move about. Therefore, people use fences to keep their animals in one place which causes overgrazing.
3. **Deforestation** destroys the trees that bind the soil to the land. Destruction of plants in dry regions is causing desertification to occur. People are cutting down tress to use them as a source of fuel. Once all these trees are cut down there is nothing to protect the soil. Therefore, it turns to dust and is blown away by the wind
4. **Poorly drained irrigation** systems turn croplands salty. Poor water management due to the inefficiency of traditional irrigation system, inadequate drainage networks and overabstracting of groundwater with consequent sea water intrusion in the coastal areas.

5. **Urbanization on a fertile cultivated lands** such as urban encroachment on the Nile Delta. The loss of prime agricultural lands to illegal urban encroachment is about 1 million acre.

The effects of desertification

1. Soil becomes less usable.

   The soil can be blown away by wind or washed away rain. Nutrients in the soil can be removed by wind or water. Salt can build up in the soil which makes it harder for plant growth.
2. Vegetation is lacked or damaged.

   Loosened soil may bury plants or leave their roots exposed. Also, when overgrazing occurs, plant species may be lost.
3. Famine

   Places that have war and poverty are most likely to have famine occur. Drought and poor land management contribute to famine.
4. Food loss

   The soil is not suited for growing food; therefore the amount of food being made will decline. If the population is growing, this will cause economic problems and starvation.
5. People near Affected Areas

   Desertification can cause flooding, poor water quality, dust storms, and pollution. All of these effects can hurt people living near an affected region.

Desertification in Egypt

Egypt as located in the arid and hyper arid zones, it severely affected by various types and forms of desertification, the major consequences of desertification in Egypt include:

• 16% of the total cultivated lands were lost due to urbanization.

• More than 30% of the irrigation farmlands are salt affected.

• Pollution as a result of excessive use of fertilizers and pesticides, the use of industrial and agricultural drainage water in irrigation and the lack of adequate sanitation in the rural areas, has led to serious impacts on public health and environmental risk.

• Some 45% of the total range lands areas (4 million ha) are severely degraded.

• Sand dunes cover about 16% of the total country area.

About 5% of such dunes are active and seriously affected the cultivated lands in the vicinities of Nile Valley and delta and High Dam Lake.

World Energy Issues

Energy is involved in all life cycles, and it is essential in agriculture as much as in all other productive activities. An elementary food chain already shows the need for energy: crops need energy from solar radiation to grow, harvesting needs energy from the human body in work, and cooking needs energy from biomass in a fire. The food, in its turn, provides the human body with energy.

The world's energy resources can be divided into **fossil fuel**, **nuclear fuel and renewable resources**. Secure, reliable, affordable, clean and equitable energy supply is fundamental to global economic growth and human development and presents huge challenges for us all. Energy demand will continue to increase.

I. Renewable Energy:

Renewable resources are available each year, unlike non-renewable resources, which are eventually depleted. A simple comparison is a coal mine and a forest. While the forest could be depleted, if it is managed it represents a continuous supply of energy, vs. the coal mine, which once has been exhausted is gone.

Most of earth's available energy resources are renewable resources. Renewable resources account for more than 93 percent of total U.S. energy reserves.

Biomass: We distinguish between: woody biomass (stems, branches, shrubs, hedges, twigs), non-woody biomass (stalks, leaves, grass, etc.), and crop residues (bagasse, husks, stalks, shells, cobs, etc.). The energy is converted through combustion (burning), gasification (transformation into gas) or anaerobic digestion (biogas production). Combustion and gasification ideally require dry biomass, whereas anaerobic digestion can very well take wet biomass. Fuel preparations can include chopping, mixing, drying, carbonising (i.e. charcoal making) and briqueting (i.e. densification of residues of crops and other biomass).

Dung from animals, and human excreta. The energy is converted through direct combustion or through anaerobic digestion.

Animate energy: This is the energy which can be delivered by human beings and animals by doing work.

Solar radiation: i.e. energy from the sun. We distinguish between direct beam radiation and diffuse (reflected) radiation. Direct radiation is only collected when the collector faces the sun. Diffuse radiation is less intense, but comes from all directions, and is also present on a cloudy day. Solar energy can be converted through thermal solar devices (generating heat) or through photovoltaic cells (generating electricity). Direct beam solar devices (whether thermal or photovoltaic) would need a tracking mechanism to have the device continuously facing the sun.

Hydro resources, i.e. energy from water reservoirs and streams. We distinguish between: lakes with storage dams, natural heads (waterfalls), weirs, and run-of-river systems. Hydro energy can be converted by waterwheels or hydro turbines.

Wind energy, i.e. energy from wind. Wind machines can be designed either for electricity generating or for water lifting (for irrigation and drinking water).

Geothermal energy is the energy contained in the form of heat in the earth. A distinction is made between tectonic plates (in volcanic areas) and geopressed reservoirs (could be anywhere). Geothermal energy is, strictly speaking, non-renewable, but the amount of heat in the earth is so large that for practical reasons geothermal energy is generally ranked with the renewable energy. Geothermal energy can only be tapped at places where high earth temperatures come close to the earth's surface.

II. Non-renewable Energy:

Fossil fuels, like coal, oil and natural gas. Unlike the previous energy sources, the fossil energy sources are non-renewable.

Nuclear power is currently non-renewable as it depends on mined uranium. In the future we may be able to use readily available hydrogen as a fuel, making it renewable.

Energy in Africa

Africa is well endowed with renewable and non-renewable energy resources that far exceed its energy demand requirements for the next century. But paradoxically, most African countries are characterized by energy poverty and poor energy access, a reflection of their low income and general state of economic under development. In Africa, energy use per capita is very low, compared to other regions of the world.

Energy resources in Africa

Africa is the world's second largest and second most populous continent, its landmass of 30.3 million km², an area equivalent to the United States of America, Europe, Australia, Brazil and Japan combined. Africa is the house of 1,419 million people (2022) in 54 countries of various sizes, socio-cultural entities, and resource endowments, including fossil and renewable energy resources. Most of these energy resources are yet to be exploited, and that is a reason why the continent is the lowest consumer of energy. It has been estimated that Africa's energy resource endowments with respect to the world totals are in the following order of magnitude: Oil 9.5%, Coal 5.6%, Natural Gas 8.0%.

Africa's uranium deposits, estimated at over 600 kilo tons, are among the largest in the world. South Africa, Namibia and Niger Republic are currently ranked among the 10 leading global producers of uranium, which is the main fuel for nuclear energy production.

Africa also hosts in its Western, Central and Eastern regions some of the largest river courses of our world. These are the Nile, Congo, Niger, Volta and Zambezi river systems. This makes Africa's hydroelectric potentials most attractive, especially as a renewable energy source. The hydroelectric potentials of the Democratic Republic of Congo (DRC) alone, is estimated to be sufficient for over 300 percent of current Africa energy consumption. Indeed, some parts of Europe are already thinking of subscribing to cheap hydroelectric power imports from the DRC.

Africa also has tremendous solar energy potentials, because of the proximity of a greater bulk of its land mass to the equator. At this privileged center of the earth's location, Africa has most of its land mass exposed to nothing less than 325 days of strong sunlight.

The most striking feature of the African energy situation is over-consumption of low-grade traditional energy sources (fuel wood, charcoal and non-woody biomass), on the one hand, and under-consumption of high-quality modern fuels (coal, Liquefied Petroleum Gas (LPG), natural gas, NRSE) on the other.

Africa accounts for 3% of world energy consumption – the lowest per capita modern energy consumption in the world (50% of world average).On the other hand, Africa has the highest share of biomass in total energy consumption in the world (59% of total energy consumed).

Africa is a diverse continent. There is considerable variation in energy consumption among the different regions and countries. For example, the share of biomass energy in total energy exceeds 81% in Africa compared to only 4.1% in North Africa and 16.5% in Southern Africa. Southern Africa and North Africa have high levels of modern energy consumption, while SSA countries continue to rely heavily on biomass and traditional energy. This heavy reliance on traditional energy sources means a low level of energy efficiency; heavy deforestation and biodiversity loss; greater health hazards due to indoor air pollution; and reduced capacity to mitigate climate changes.

In 2020, 938 MW of hydropower capacity was put into operation across the African continent. Hydropower accounts for 16% of the total electricity share and is expected to increase to more than 23% by 2040.

Nuclear Energy

Nuclear energy is a form of energy released from the nucleus, the core of atoms, made up of protons and neutrons. This source of energy can be produced in two ways:

nuclear fission – when nuclei of atoms split into several parts – or

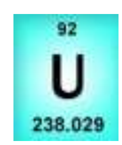
nuclear fusion – when nuclei fuse together.

Nuclear reactors use Uranium as their fuel source. Uranium is found in trace amounts around the globe, with a concentration of ~2 parts per million (ppm) in the crust.

How does nuclear energy work?

In nuclear fission a particle is fired at an atom to split it into two smaller atoms (and some additional neutrons). The neutrons released hit other atoms, causing them to divide and release more neutrons. This is called a chain reaction and the whole process creates masses of heat. A nuclear reactor then transfers this heat energy to water, turning it into pressurised steam. This steam is then released through turbines, turning the steam's heat energy into kinetic energy that turns electrical generators to produce electricity. A nuclear reactor, or power plant, is a series of machines that can control nuclear fission to produce electricity. The fuel that nuclear reactors use to produce nuclear fission is pellets of the element uranium.

What is an isotope?



All matter is made of atoms, which in turn are made up of protons, neutrons and electrons. The number of protons is what gives atoms their chemical properties, setting apart the variou s chemical elements. Atoms have equal numbers of protons and electrons. The heavy metal Uranium ($^{234-238}U$) is a slightly radioactive metal, and it has 92 protons, while oxygen has 8. However, the same element can have different numbers of neutrons, forming versions of the element called isotopes. Uranium is 18.7 times as dense as water. Hydrogen, the lightest element, has three naturally occurring isotopes, denoted ^{1}H (abundance 99.9855%), ^{2}H (0.0145%), and ^{3}H (trace). Oxygen has three stable isotopes: ^{16}O (99.63%), ^{17}O (0.0375%) and ^{18}O (0.1995).

Uranium has three naturally occurring isotopes: Uranium-238 (^{238}U), Uranium-235 (^{235}U), and Uranium-234 (^{234}U). The ^{238}U is the most abundant throughout the Earth's crust, making up about 99.3% of natural uranium, 0.71% for U-235, and 0.0055% for U-234.

The ^{235}U and ^{238}U are chemically identical, but differ in their physical properties, notably their mass. The nucleus of the ^{235}U atom contains 92 protons and 143 neutrons, giving an atomic mass of 235 units. The ^{238}U nucleus also has 92 protons but has 146 neutrons – three more than U-235 – and therefore has a mass of 238 units.

The ^{235}U isotope is extremely important, since it is the most efficiently undergoes fission when bombarded with thermal neutrons (meaning it can sustain a nuclear chain reaction). For this reason, ^{235}U is the principally used fuel in nuclear reactors and uranium-based fission-type nuclear weapons.

What is Fusion, and Why Is It So Difficult to Achieve?

Nuclear fusion is the process by which two light atomic nuclei combine to form a single heavier one while releasing massive amounts of energy. The nuclei need to collide with each other at very high temperatures exceeding ten million degrees Celsius in the Sun, to enable them to overcome their mutual electrical repulsion.

The amount of energy produced from fusion is very large — four times as much as nuclear fission reactions.

What is uranium enrichment?

The 1.27% difference in mass between ^{235}U and ^{238}U allows the isotopes to be separated and makes it possible to increase or "enrich" the percentage of ^{235}U while removing ^{238}U. Enrichment is currently done with centrifuges that exploit the fact that ^{238}U is about 1.27% heavier than ^{235}U. They take uranium (in gas form) and use rotors to spin it at 50,000 to 70,000 rotations per minute. The heavier ^{238}U moves to the edges of the centrifuge, leaving the ^{235}U in the middle. This is only so effective, so the spinning process is done over and over again, building up the percentage of the ^{235}U.

Most civilian nuclear reactors use “low enriched uranium” that’s been enriched to between 3% and 5%. This means that 3–5% of the total uranium in the sample is now ^{235}U. That’s enough to sustain a chain reaction and make electricity.

What level of enrichment do nuclear weapons need?

To get an explosive chain reaction, ^{235}U needs to be concentrated significantly more than the levels we use in nuclear reactors for making power or medicines. Technically, a nuclear weapon can be made with as little as 20% ^{235}U (known as “highly enriched uranium”), but the more the uranium is enriched, the smaller and lighter the weapon can be. Countries with nuclear weapons tend to use about 90% enriched, “weapons-grade” uranium. Highly enriched uranium (20% ^{235}U) is used for research reactors.

The impacts of a nuclear explosion:

The impacts of a nuclear explosion depend on many factors, including the design of the weapon (fission or fusion) and its yield; whether the detonation takes place in the air (and at what altitude), on the surface, underground, or underwater; the meteorological and environmental conditions; and whether the target is urban, rural, or military. Approximately 85% of the explosive energy produces air blast (and shock) and thermal radiation (heat). The remaining 15% is released as initial radiation.

- Thermal radiation—light and heat capable of causing skin burns and eye injuries and starting fires of combustible material at considerable distances.

- Emission of nuclear radiation, which may be separated into initial radiation and residual radiation. Initial radiation, consists of **gamma** rays, **beta** particles (free electrons) and a small proportion of **alpha** particles. They have harmful effects in living organisms, a hazard that persists over considerable distances because of their ability to penetrate most structures. Residual radiation that is emitted more than one minute after the detonation.

Is nuclear energy renewable?

Nuclear fuels, such as the element uranium, are not considered renewable as they are a finite material mined from the ground and can only be found in certain locations. But nuclear power stations use a miniscule amount of fuel to generate the same amount of electricity that a coal or gas power station would (e.g., 1 kg of uranium contains the same amount of energy as 100,000 kg of oil, or 2.7 million kg of coal).

Why is uranium used to produce nuclear energy?

Uranium is the fuel most widely used to produce nuclear energy because:

1- uranium atoms split apart relatively easily.

2- Uranium is a very common element, found in rocks all over the world.

What are the benefits of nuclear energy?

1. The amount of electricity produced in a nuclear power station is equivalent to that produced by a fossil fuelled power station.
2. Clean Energy Source, with lower greenhouse gases (H_2O, CO_2, CH_4).
3. Many countries (France, 80%) produce electricity from nuclear power (57).
4. It is an economic alternative to fossil fuel power stations (cheap).
5. Nuclear reactors can be manufactured small enough to power ships and submarines.
6. Powerful and efficient 1 kg U = 100,000 kg of oil
7. Reliable (dependable) less maintenance for longer stretches before refueling (1.5-2 years).
8. Low fuel cost.
9. Long uranium supply (hundreds of years)
10. Easy transportation (small size).
11. Unlike many renewable energy sources, power from nuclear energy can be generated 24 hours a day and isn't dependent on the weather.
12. Long lifespan: Nuclear power stations are now certified for 80 years of operation – far longer than a gas- or coal-fired power stations (40 years).

Challenges of Nuclear Energy

1. Nuclear power is a controversial method of electricity.
2. Commercial nuclear power is sometimes viewed by the general public as a dangerous based on three global nuclear accidents:
   - Chernobyl , Russia 1986 (30 people killed and over 100,000 evacuated).
   - Three Mile Island, Pennsylvania, USA 1978;

- 6 reactors of Fukushima, Japan 2011.

3. Dangerous of radioactive waste produced.
4. High cost of storing and monitoring the radioactive waste.
5. Nuclear powered ships and submarines pose a danger to marine life and the environment
6. Concerns of people living near nuclear radioactive leaks.
7. Weaponization or nuclear-bomb building.

History of the nuclear energy in Egypt:

The first Egyptian nuclear plant for peaceful purposes is the long-awaited dream for more than 70 years. President Gamal Abdel Nasser was the first to knock the door of nuclear future, and enthusiastically sought to let Egypt join the nuclear club. In 1955, the "Atomic Energy Commission" was formed and chaired by President Nasser, and in July 1956 Egypt and the former Soviet Union signed a bilateral agreement on cooperation in the atomic energy affairs and its applications.

In September 1956, Egypt and former Soviet Union signed a contract for establishing the first nuclear research reactor in Anshas City with a capacity of 2 MW. In 1957, the "Atomic Energy Commission" became the "Atomic Energy Corporation" while Anshas reactor started work in 1961. On November 19, 2015, President Abdel-Fattah El-Sisi and Russian President Vladimir Putin signed an agreement for construction of Dabaa plant.

El Dabaa, Egypt

Egypt is currently constructing the first nuclear energy plant which will be located in El Dabaa, Matrouh Governorate. The plant will have four Water-Water Energetic Reactor (VVER)-1200 reactors, each with a generating capacity of 1,200 megawatt (MW), with a total 4,800 MW. Egypt started construction the first unit in July 2022. All four reactors are expected to be operational by 2030. The project will cost US$28.75 billion of which Russia will finance 85% as a state loan of US$25 billion. El Dabaa is a 60-km town in Matrouh Governorate, Egypt, about 320 km northwest of Cairo. This location is close to the Med.

Sea water, which can be used for cooling nuclear plants, and far from the earthquakes belt and residential blocks.

Nuclear Non-Proliferation Treaty (NPT):

Because nuclear fuel can be used to create nuclear weapons as well as nuclear reactors, only nations that are part of the Nuclear Non-Proliferation Treaty (NPT) are allowed to import uranium or plutonium, another nuclear fuel. The treaty promotes the peaceful use of nuclear fuel, as well as limiting the spread of nuclear weapons. The treaty, agreement of July 1, 1968, signed by the United Kingdom, the United States, the Soviet Union, and 59 other states, under which the three major signatories, which possessed nuclear weapons, agreed not to assist other states in obtaining or producing them. The treaty became effective in March 1970 and was to remain so for a 25-year period. Additional countries later ratified the treaty; as of 2007 only three countries (**India, Israel, and Pakistan**) have refused to sign the treaty, and one country (**North Korea**) has signed and then withdrawn from the treaty. The treaty was extended indefinitely and without conditions in 1995 by a consensus vote of 174 countries at the United Nations headquarters in New York City.

Article I:

Nuclear-weapon states pledge not to transfer nuclear weapons or other nuclear explosive devices to any recipient or in any way assist, encourage or induce any non-nuclear-weapon state in the manufacture or acquisition of a nuclear weapon.

Article II:

Non-nuclear-weapon states pledge not to acquire or exercise control over nuclear weapons or other nuclear explosive devices and not to seek or receive assistance in the manufacture of such devices.

Article III:

Non-nuclear-weapon states pledge to accept IAEA safeguards to verify that their nuclear activities serve only peaceful purposes.

The objective of the treaty is to halt the spread of nuclear weapons-making capability, guarantee the right of all members to develop nuclear energy for peaceful ends and - for the original five nuclear weapons powers - to phase out their arsenals. The treaty defines nuclear-armed states as those that manufactured and exploded a nuclear weapon or other nuclear device prior to January 1, 1967. They are the ***United States, Britain, France, China and Russia***, which assumed rights and obligations from the former Soviet Union. Those five nations are the permanent members of the U.N. Security Council. A total of 191 countries are party to the NPT. Two non-signatories, India and Pakistan, developed nuclear weapons in 1998. Another, Israel, is widely assumed to have a nuclear arsenal but has not confirmed or denied it publicly. North Korea withdrew from the treaty in 2003.

The Non-Proliferation Treaty is uniquely unequal, as it obliges nonnuclear states to forgo development of nuclear weapons while allowing the established nuclear states to keep theirs. Nevertheless, it has been accepted because, especially at the time of signing, most nonnuclear states had neither the capacity nor the inclination to follow the nuclear path, and they were well aware of the dangers of proliferation for their security.

Why did Israel and US America bomb Iran in 13-24 June 2025?

Iran has been a non-nuclear-weapon signatory to the NPT since 1970. It has a uranium enrichment program that it says is for peaceful purposes, not developing weapons, but Western powers and Israel suspect it intends to develop the means to make atomic bombs.

According to the International Atomic Energy Agency (IAEA), Iran has enriched large quantities of uranium to 60%. It's actually easier to go from an enrichment of 60% to 90% than it is to get to that initial 60%. That's because there's less and less ^{235}U to get rid of. On June 22, 2025, the United States Air Force and Navy attacked three nuclear facilities in Iran as part of the Iran–Israel war.

United States strikes on Iranian nuclear sites (Iran)