UGRC 144
Science and Technology in Our Lives/Geohazards

Flood and Flood Hazards

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The key topics to be covered in the session are as follows:

- Topic One – The Hydrologic Cycle
- Topic Two – Streams Systems and their Features
- Topic Three – Flooding: Consequence and Development of Floodplains
- Topic Four – Factors Governing Flood Severity
- Topic Five – Flood Characteristics
- Topic Six - Effects of Development on Flood Hazards
- Topic Seven - Hazards Associated with Floods
- Topic Eight - Strategies for Reducing Flood Hazards
The Hydrologic Cycle

• The hydrosphere includes all the water at and near the surface of the earth. All the water in the hydrosphere is caught up in the hydrological

Precipitation

• The hydrologic cycle begins with precipitation in the form of snow or rain, representing the initial input into the hydrologic system.
The Hydrologic Cycle

Evapotranspiration

- A fraction of the precipitation is returned to the atmosphere by two processes;
  - **Evaporation**, driven by solar energy, is the physical conversion of some of the precipitation to water vapour that is returned to the local atmosphere.
  - **Plant Transpiration** is the process by which plants release water into the atmosphere.
Surface Runoff

- The runoff tends to move toward sinks or temporary storage locations such as:
  - streams/rivers
  - Lakes
  - Wetlands
  - the ocean

- The runoff fraction is a major factor leading to river flooding.
The Hydrologic Cycle

Infiltration

• A fraction of the precipitation moves down into the ground, and infiltrate into the regolith in the subsurface.

  – **Unsaturated Zone**: the upper part of the regolith in which the pore spaces of the rock/soil is partially filled with air and partly with water.

  – **Saturated Zone**: this is the zone between the base of the unsaturated zone and an impermeable rock below, within which water accumulates.
The Hydrologic Cycle

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Streams Systems and their Features

• A stream is body of flowing water confined within a channel, regardless of size. It flows downhill through local topographic lows, carrying away water over the earth’s surface.

• In addition to that, the size of a stream is influenced by the following factors:
  – climate, including the amount of precipitation and evaporation
  – vegetation or lack of it
  – the underlying geology
Importance of Streams

• Streams are a major source of water and transportation for the world's human population.

• They carry billions of tons of sediment to lower elevations, and thus are one of the main transporting mediums in the production of sedimentary rocks.

• Streams are sources of water for consumption, agriculture, and industry.

• Streams are also used to generate hydroelectric power, just like what we have at Akosombo, Akuse, and Bui in Ghana.
Flooding: Consequence and Development of Floodplains

• Large volumes of water flowing in streams often lead to flooding, and flooding is one of the more common and costly types of natural disasters.

• The over flow of a streams banks due to higher discharge is termed flood.

• Flood occurs when a stream runs out of its confines and submerges surrounding areas.
Flooding: Consequence and Development of Floodplains

- A majority of stream floods are linked to precipitation.
- When rainfalls or snow melts, some of the water infiltrates or sinks into the ground. It may then percolate through soil and rock at greater depths.
Factors Governing Flood Severity

The factors that govern flood severity are as follows;

• **Role of Precipitation**
  
  – If there is exceptional precipitation, the subsurface is not able to absorb all the water because precipitation intensity is higher than infiltration rate into the ground
  
  – If this happens over a prolong period, there is gradual build up of large volumes of water on the surface of the earth, and could lead to flooding.
  
  – If the amount of water flowing in to one area is greater than the capacity of the system to hold it within natural confines, it will result is a flood.
Factors Governing Flood Severity

The factors that govern flood severity are as follows;

• **Dam & Levee Failures**
  
  – Dams occur as both natural and human constructed features. Natural dams are created by volcanic events through lava flows and pyroclastic flows, landslides, or blockage by ice.
  
  – Human-constructed dams are built for water storage, generation of electrical power, and flood control.
  
  – All types of dams may fail with the sudden release of water into the downstream drainage.
Factors Governing Flood Severity

The factors that govern flood severity are as follows;

• **Porosity and permeability of the underlying rock**
  
  – A very porous and permeable soil allows a great deal of water to sink in relatively fast.
  
  – If the soil is less permeable or is covered by artificial structures, the proportion of water that runs off over the surface increases.
  
  – Once saturated with water, any additional moisture is necessarily forced to become part of the surface runoff.
Factors Governing Flood Severity

The factors that govern flood severity are as follows;

• **Topography**
  
  – The steeper the terrain, the more readily water will runoff over the surface and the less it tends to sink into the soil.
  
  – Water that infiltrates the soil tends to flow down gradient and may in time, also reaches the stream.
  
  – The more gradually the water reaches the stream, the better the chances that the stream discharge will be adequate to carry the water away without flooding.
Factors Governing Flood Severity

The factors that govern flood severity are as follows;

• **Vegetation**
  
  – Vegetation may reduce flood hazards in many ways. The plants may simply provide physical barrier to surface runoff, decreasing its velocity, and thus slowing the rate at which water reaches a stream.

  – Also plant roots loosen the soil and tend to maintain or increase infiltration. Plants also absorb water, using some to grow.

  – Thus, vegetation can be critical to preventing soil erosion.
Flood Characteristics

• During a flood, the water level of a stream is higher than usual, and its velocity and discharge also increases as the greater mass of water is pulled down by gravity.

• The elevation of the water at any point is termed the stage of the stream.

• A stream is at flood stage when the stream stage exceeds bank height.
Flood Characteristics

- **Upstream floods** are floods that affect only small localized areas (streams draining small basins). They are caused by sudden, locally intense rainstorms and by events like dam failure.

- **Downstream floods** are floods that affect large stream systems and large drainage basins. They result from prolonged heavy rains over a broad area or from extensive regional snowmelt.
Effects of Development on Flood Hazards

• Floods are normally caused by one or a combination of the following activities and processes;
  – Materials used to cover the ground when cities are built, such as roads asphalt and concrete, are relatively impermeable and greatly reduce infiltration.
  – Buildings in a floodplain also can increase flood heights. The buildings block the original river channel and occupy volume that water formally could fill, and a give discharge corresponding to a higher water level
Effects of Development on Flood Hazards

- Both farming and urbanization also disturb the land, by removing natural vegetation, and expose the soil to erosion.

- Indiscriminate dumping of garbage and other solid materials into drains impede the flow of water.

- It is also common to observe drains that have experienced siltation, where silt- and sand-sized particles settle in the drains, and subsequently reducing its volume.
Hazards Associated with Floods

- **Primary effects** of flooding include:
  - injury,
  - loss of life, and damage caused by swift currents,
  - debris and sediment transported to farms,
  - Destruction of homes, building, railroads, roads, bridges
  - Damage to urban communication and supply systems.
Hazards Associated with Floods

• **Secondary effects** may include;
  – short-term pollution of rivers,
  – hunger and disease, and
  – displacement of persons who have lost their homes.

• In addition, fires may be caused by cuts in electrical circuits or gas mains broken by flooding and associated erosion.
Strategies for Reducing Flood Hazards

1. Restrictive Zoning and “Flood proofing”

- This involves the identification of an area threatened by floods of different recurrence intervals.

- Once this is done, the land might best be restricted to land uses not involving much building.

2. Channelization

- This refers to the modification of a stream channel itself intended to increase the velocity of water or volume of the channel, or both.
3. Retention Ponds and Diversion Channels

- The ponds are large basins that trap some of the surface runoff, keeping it from flowing immediately into the stream.
- Diversion channels come into play as the water level in streams rises.
- The channels are used to redirect some of the water flow into areas adjacent to the stream where flooding will cause minimal damage.
4. Levees – These are raised banks along a stream channel.

5. Construction of Flood-Control Dams and Reservoirs

6. Removal of waterweeds, garbage and other obstacles that block the drains and prevent free flow of water
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