WATER RESOURCES SYSTEMS

MANAGEMENT OF FLOODS

(A) CAUSES OF FLOODS:-

1. General Causes

Floods are caused by many factors or a combination of any of these generally prolonged heavy rainfall (locally concentrated or throughout a catchment area), highly accelerated snowmelt, severe winds over water, unusual high tides, tsunamis, or failure of dams, levees, retention ponds, or other structures that retained the water. Flooding can be exacerbated by increased amounts of impervious surface or by other natural hazards such as wildfires, which reduce the supply of vegetation that can absorb rainfall.

Periodic floods occur on many rivers, forming a surrounding region known as the flood plain.

During times of rain, some of the water is retained in ponds or soil, some is absorbed by grass and vegetation, some evaporates, and the rest travels over the land as surface runoff. Floods occur when ponds, lakes, riverbeds, soil, and vegetation cannot absorb all the water. This has been exacerbated by human activities such as draining wetlands that naturally store large amounts of water and building paved surfaces that do not absorb any water. Water then runs off the land in quantities that cannot be carried within stream channels or retained in natural ponds, lakes, and man-made reservoirs. About 30 percent of all precipitation becomes runoff and that amount might be increased by water from melting snow. River flooding is often caused by heavy rain, sometimes increased by melting snow. A flood that rises rapidly, with little or no warning, is called a flash flood. Flash floods usually result from intense rainfall over a relatively small area, or if the area was already saturated from previous precipitation.

2. Severe winds over water

Even when rainfall is relatively light, the shorelines of lakes and bays can be flooded by severe winds—such as during hurricanes—that blow water into the shore areas.

3. Unusual high tides

Coastal areas are sometimes flooded by unusually high tides, such as spring tides, especially when compounded by high winds and storm surges.

(B) Effects of floods

Flooding has many impacts. It damages property and endangers the lives of humans and other species. Rapid water runoff causes soil erosion and large sediment deposition elsewhere (such as further downstream or down a coast). The spawning grounds for fish and other wildlife habitats can become polluted or completely destroyed. Some prolonged high floods can delay traffic in areas which lack elevated roadways. Floods can interfere with drainage and economical use of lands, such as interfering with farming. Structural damage can occur in bridge abutments, bank lines, sewer lines, and other structures within floodways. Waterway navigation and hydroelectric power are often impaired. Financial losses due to floods are typically millions of dollars each year.

(C) Benefits of flooding

There are many disruptive effects of flooding on human settlements and economic activities. However, flooding can bring benefits, such as making soil more fertile and providing nutrients in which in many ways it is deficient. Periodic flooding was essential to the well-being of ancient communities along the Tigris-Euphrates Rivers, the Nile River, the Indus River, the Ganges and the Yellow River, among others. The viability for hydrologically based renewable sources of energy is higher in flood-prone regions.

(D) Detection of floods

This is the method used for remote sensing the disasters. Detection of disasters such as floods, earthquakes, and explosions are quite complex in previous days and range of detection is inappropriate. But, it came to possibilities by using Multi temporal visualization of Synthetic Aperture Radar (SAR) images. But to obtain the good SAR images perfect spatial registration and very precise calibration are necessary to specify changes that have occurred. Calibration of SAR is very complex and also a sensitive problem. Possibly errors may occur after calibration that involves data fusion and visualization process. Traditional image pre-processing cannot be used here due to the on-Gaussian of radar back scattering, but a processing method called "cross calibration/normalization" is used to solve this problem. The application generates a single disaster image called "fast-ready disaster map" from multi temporal SAR images. These maps are generated without user interaction and helps in providing immediate first aid to the people. This process also provides image enhancement and comparison between numerous images using data fusion and visualization process. This proposed processing includes filtering, histogram truncation and equalization steps. The process also helps in identifying the permanent waters and other classes by combined composition of pre-disaster and post-disaster images into a color image for better identity.

(E) Methods of flood management by :-

Some methods of flood control have been practiced since ancient times. These methods include planting vegetation to retain extra water, terracing hillsides to slow flow downhill, and the construction of floodways (man-made channels to divert floodwater). Other techniques include the construction of levees, lakes, dams, reservoirs, retention ponds to hold extra water during times of flooding.

Dams

Many dams and their associated reservoirs are designed completely or partially to aid in flood protection and control. Many large dams have flood-control reservations in which the level of a reservoir must be kept below a certain elevation before the onset of the rainy/summer melt season to allow a certain amount of space in which floodwaters can fill. Other beneficial uses of dam created reservoirs include hydroelectric power generation, water conservation, and recreation. Reservoir and dam construction and design is based upon standards, typically set out by the government. In the United States, dam and reservoir design is regulated by the US Army Corps of Engineers (USACE). Design of a dam and reservoir follows guidelines set by the USACE and covers topics such as design flow rates in consideration to meteorological, topographic, stream flow, and soil data for the watershed above the structure.

The term dry dam refers to a dam that serves purely for flood control without any conservation storage (e.g. Mount Morris Dam, Seven Oaks Dam).

Diversion canals

Floods can be controlled by redirecting excess water to purpose-built canals or floodways, which in turn divert the water to temporary holding ponds or other bodies of water where there is a lower risk or impact to flooding. Examples of flood control channels include the Red River Floodway that protects the City of Winnipeg (Canada) and the Manggahan Floodway that protects the City of Manila (Philippines).

Floodplains and groundwater replenishment

Excess water can be used for groundwater replenishment by diversion onto land that can absorb the water. This technique can reduce the impact of later droughts by using the ground as a natural reservoir. It is being used in California, where orchards and vineyards can be flooded without damaging crops, or in other places wilderness areas have been re-engineered to act as floodplains.

River defenses

In many countries, rivers are prone to floods and are often carefully managed. Defenses such as levees, bunds, reservoirs, and weirs are used to prevent rivers from bursting their banks.

A weir, also known as a lowhead dam, is most often used to create millponds, but on the Humber River in Toronto, a weir was built near Raymore Drive to prevent a recurrence of the flood damage caused by Hurricane Hazel in October 1954.

The Leeds flood alleviation scheme uses movable weirs which are lowered during periods of high water to reduce the chances of flooding upstream. Two such weirs, the first in the UK, were installed on the River Aire in October 2017 at Crown Point, Leeds city centre and Knostrop. The Knostrop weir was operated during the 2019 England floods. They are designed to reduce potential flood levels by up to one metre.

Coastal defenses

Coastal flooding has been addressed with coastal defences, such as sea walls, beach nourishment, and barrier islands.

Tide gates are used in conjunction with dykes and culverts. They can be placed at the mouth of streams or small rivers, where an estuary begins or where tributary streams, or drainage ditches connect to sloughs. Tide gates close during incoming tides to prevent tidal waters from moving upland, and open during outgoing tides to allow waters to drain out via the culvert and into the estuary side of the dike. The opening and closing of the gates is driven by a difference in water level on either side of the gate.

Self-closing flood barrier

The self-closing flood barrier (SCFB) is a flood defense system designed to protect people and property from inland waterway floods caused by heavy rainfall, gales or rapid melting snow. The SCFB can be built to protect residential properties and whole communities, as well as industrial or other strategic areas. The barrier system is constantly ready to deploy in a flood situation, it can be installed in any length and uses the rising flood water to deploy

Temporary perimeter barriers

When permanent defenses fail, emergency measures such as sandbags or inflatable impermeable sacks are used.

In 1988, a method of using water to control flooding was discovered. This was accomplished by containing 2 parallel tubes within a third outer tube. When filled, this structure formed a non-rolling wall of water that can control 80 percent of its height in external water depth, with dry ground behind it. Eight foot tall water filled barriers were used to surround Fort Calhoun Nuclear Generating Station during the 2011 Missouri River Flooding. Instead of trucking in sandbag material for a flood, stacking it, then trucking it out to a hazmat disposal site, flood control can be accomplished by using the on site water. However, these are not fool proof. A 8 feet (2.4 m) high 2,000 feet (610 m) long water filled rubber flood berm that surrounded portions of the plant was punctured by a skid-steer loader and it collapsed flooding a portion of the facility.

In 1999, a group of Norwegian engineers patented a transportable, removable, and reusable flood barrier which uses the water's weight against itself. This removable flood panels protect cities and public utilities.

Resilience

Buildings and other urban infrastructure can be designed so that even if a flood does happen, the city can recover quickly and costs are minimized. For example, homes can be put on stilts, electrical and HVAC equipment can be put on the roof instead of in the basement, and subway entrances and tunnels can have built-in movable water barriers. New York City began a substantial effort to plan and build for flood resilience after Hurricane Sandy.

Strategic retreat

One way of reducing the damage caused by flooding is to remove buildings from flood-prone areas, leaving them as parks or returning them to wilderness. Floodplain buyout programs have been operated in places like New Jersey (both before and after Hurricane Sandy), Charlotte, North Carolina, and Missouri.

Case Study----------------------

The Living Breakwaters initiative is the result of an Obama-era competition for innovative designs to prevent further flooding in coastal communities during harsh weather conditions.

In October 2012, Hurricane Sandy hit the east coast of the United States causing more than $65 billion in damages and economic loss. One of the areas that got hit hardest was Staten Island's South Shore where the beach community of Tottenville saw sixteen-foot waves that destroyed homes and killed two residents (Dejean).

In response to the devastation, the Department of Housing and Urban Development created the Hurricane Sandy Rebuilding Task Force to develop “implementable solutions to the region’s most complex needs (Hurricane Sandy Design Competition).” Shortly after its formation, the task force introduced Rebuild by Design, a competition that promised a total of $920 million from the Community Block Disaster Recovery program for the winners to implement their plans (Tottenville Shoreline Protection Project). Ten teams submitted designs and six of them were eventually awarded funding for their respective projects.

One winning design was the Living Breakwaters initiative proposed by landscape architect Kate Orff. Her firm, SCAPE, envisioned what Orff describes as a “living piece of infrastructure” including a barrier that protrudes from the water and houses an oyster reef (Dejean). SCAPE's green infrastructure solution will be implemented in three stages beginning in Tottenville, subsequently expanding to the surrounding areas, and to be completed in 2021 (Melcher). The plan aims to protect the South Shore of Staten Island from future storm damage, employing oysters to purify the water and restore the coastline. They claim that the breakwaters will protect the coastline from the intense storm conditions caused by climate change and the wave protection will reduce erosion which has greatly contributed to habitat loss in the area (Dejean).

The living breakwaters, however, are not going to exist in an isolated system. SCAPE's design is a part of a layered approach that includes partnerships with the Billion Oyster Project and the Tottenville Shoreline Protection Project, a separately funded project to build similar shoreline protection structures. In addition, part of the Living Breakwaters project's funding is allocated for establishing a “learning hub” to inform local communities about the benefits of oysters and protecting the shoreline ecosystem (Hurricane Sandy Design Competition). This information hopes to encourage residents of Tottenville the surrounding areas to practice sustainable habits, prevent pollution, and continue to engage with the project in the future.