Department of Civil Engineering
National Institute of Technology-Srinagar

MTech 3rd Semester (Water Resources Engineering)

Course Title:-Environmental Impact Assessment of Civil Engineering Projects(EIACEP)

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CHAPTER-1 PAGE-1

LECTURE-1 (L1)

Need for Water Resources Development projects

India sustains nearly 17 per cent of the world's population but has only four per cent of global water resources. About 50 per cent of annual precipitation is received in just about 15 days in a year, which is not being brought to productive use due to limited storage capacity of 36 per cent of utilizable resources (252 BCM out of 690 BCM). Leakage and inefficiencies in the water supply system waste nearly 30 per cent of usable water. The ground water level is declining at the rate of 10 cm per year. Over 70 per cent of surface water and ground water resources are contaminated. All this is leading towards a water scarce situation in many parts of the country.India has undertaken considerable investments for:-

Infrastructure development of large dams, storage structures,and canal networks to meet the country's water and agricultural needs, particularly in support of technology-based interventions to improve production of food grains, pulses, oilseeds, and vegetables. This is evident from the huge increase in budgetary allocation from the 11th Five-Year Plan compared to the 12th.
Five-Year Plan in irrigation including Watershed Development (from Rs 243,497 crore to Rs 504,371 crore) and Drinking Water and Sanitation sector (from Rs 120,774 crore to Rs 254,952 crore). This step has helped in achieving food and

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water security to a large extent, but in many areas of less plentiful surface water, the increasing use of water in agriculture and a growing population has led to higher and potentially unsustainable extraction of ground water for irrigation and domestic needs.

The estimated 'Water Gap' for India by the 2030 is an alarming 50 percent. The water supply and demand gap in India in various river basins is depicted as percentage of demand in the year 2030. India is now in a situation where some tough decisions regarding competing uses of water need to be taken.

The country is also facing the potential threat of climate change, which may have complex implications on the pattern of availability of water resources including changes in pattern and intensity of rainfall and glacial melt resulting in altered river flows, changes in ground water recharge, more intense floods, severe droughts in many parts of the country, salt water intrusion in coastal aquifers, and a number of water quality issues. Water being vital for equitable growth and development of a country, food security,livelihoods, and public health are at stake. Access to safe water has a direct bearing on productivity and health of human and animal populations. The public health implications of unsafe water are enormous and unacceptable.

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Types of water resources

While water covers approximately 71 percent of Earth's surface, only three percent is suitable for human consumption. People can not access most of this water, because it is frozen in polar ice caps or beneath the planet's surface. Available sources for water are derived largely from developments including the recycling and conservation of available water resources, and techniques, such as filtration, which make water potable.

(1)Oceans

Oceans cover most of the Earth, and contain about 97 percent of the water on the planet. This water has a high salt content and is unfit for human use. With the depletion of scarce freshwater sources, methods for removing salt from ocean water, including desalination or distillation, have not been cost-effective. Although untreated sea water is not suitable for human consumption, oceans remain a valuable resource, because they provide food, recreation, oil and a transportation route for trade.

(2)Rivers and Streams

Rivers and streams cover the globe and run through every nation, providing drinking water and recreational areas for swimming, boating and fishing. Rainfall and melting snow continually replenish these waterways. However, weather patterns impact water depth. Severe droughts dry rivers up, while too much rainfall can cause flooding when the water overflows a river's banks. Because rivers and streams cross national boundaries, water rights remain a topic of political debate and conflict.

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(3)Lakes

Lakes are natural or man-made depressions on the surface of land that hold water. Natural lakes occur due to geological processes, such as weathering and erosion. Man-made lakes, also called reservoirs, occur when people dam up rivers and streams or divert the flow of these waterways in order to contain a large amount of water in one area. Lakes provide an energy source for generating electricity, offer recreational areas for swimming and fishing and provide a source of drinking water for many communities. Rainfall replenishes lake water; however, this water is vulnerable to pollution.

(4)Groundwater

Water seeps into the ground from surface run-off and precipitation. As the water enters the ground, part of it clings to plant roots and particles of soil and becomes trapped, creating a water table. Aquifers beneath the water table collect the seeping water, which is called groundwater. According to the United States Geological Survey, or USGS, approximately 50 percent of Americans use ground water for drinking and other household uses. People collect this water by drilling or digging wells that pump the water from below the water table to the surface.

LECTURE-2 (L2)

Some major Multipurpose projects in India

There are several important Water Projects in India that were built as multi-purpose projects, with the aim of not only providing water to the towns and cities but also to generate Hydel-power. With the advent of the 20th century, a new era of developing water projects for generating Hydro-electricity in India began on a modest scale.

After Independence there has been a sharp burst in developing hydro-electricity in various parts of the country. From this time, India has been engrossed in projected economic activities to attain self-sufficiency and improve the quality of living of its citizens. Amongst the various actions that followed for this intention, dealing with water resources has been one of the primary aims and therefore, developing water projects in a larger scale gained importance.

To control the twin problems of flood and famine and also to generate Hydro-electricity in a larger scale developing and maintaining water projects in India became a prime concern. Although the main aim for developing the water projects in India was indeed to generate Hydro electric power; however, providing power to the cottage industries, medium and major industries also became an imperative part of the objective of the water projects in India.

In the year 1902, India witnessed the first Hydel-power house on the **River Kaveri** in Sivasamudram, Karnataka. However, it was just the beginning and almost immediately Tata Hydroelectric Scheme in the Western Ghats of Maharashtra, to furnish power to Mumbai, was established. **Pykara** was marked as the first water power station in Tamil Nadu.

Water Projects in India followed even in the Northern part of the country and **Mandi Power House was** the first one, developed in the Himalayan region. The next one in the pipeline was the **Upper Ganga Canal Hydroelectric Grid System.**

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The water projects of India are also the part of the several multi purpose projects. One of the illustrious water projects in India is the **Rihand Project**. This is the largest man made lake in India, on the fringes of Madhya Pradesh and Uttar Pradesh. Its capacity is 300 mw each year.

The **Koyna** Project in Maharashtra is another important water project in India and is constructed on an east flowing tributary of the River Krishna. A dam on the Koyna Riverhas been built only to ferry waters through a tunnel to the western slopes of the Ghats. Its capacity is 880 mw and it provides power to the Mumbai-Pune industrial region.

The **Sharavathy Project**, another important water project in India is located in the Jog Falls in Karnataka. Its total capacity is 891 mw. It serves the Bengaluru industrial region and also furnishes the states of Goa and Tamil Nadu.

The **Saharigiri Project** in Kerala, **The Balimela Project** in Orissa and the **Sala**l Project for Hydro-electricity in Jammu and Kashmir are other important water projects in India.

In addition to these power projects, India has also built a gigantic Hydel power project in Bhutan at **Chukha**, which was financed by India. The excess energy is brought by India for its use in the north-eastern parts of the country, including West Bengal. The National Hydroelectric Power Corporation Ltd, (NHPC) was established in 1975. It has added 2133 mw raw Hydel power since then. These encompass- Chamera Stage I, Uri, Salal Stage I, Baira-Siul, Loktok, Tanakpur.

With the evolution and development of technology, and with the growing demand for water and energy, along with the growing Indian population, more such Water Projects in India are being planned by the government.

LECTURE--3 (L3)

Importance of Water and its Resources in India

India being an agricultural country, water has served as the most important resource for agriculture. Next to China, India has second largest acreage of irrigated land in the world. In a monsoon country with a characteristic dry season and variability of rainfall, man's ingenuity has long been exercised to reduce his dependence on nature.

The story of water is the story of Indian civilization, indeed, all civilizations. Fifty centuries ago the Mohenjo-Daro civilization of Indus Valley enjoyed the benefits of well-designed water supply and even public swimming pools and baths.

Modern civilization has increased the importance of water as a resource. Economic progress of India is not only tied with agricultural development, but also with industrial development for which she requires hydel power, water for industry, and for domestic use in the ever-growing urban settlement.

Different types of fishes and other animals live in the sea-water. Another wealth of the sea is minerals. Among them sodium chloride or edible salt, Ilmenite, Monazite, Manganese Nodule, and Magnesium are the most important. Sea is also a very important source of gas, petroleum and renewable energy resources.Given below are the various uses of water

* Water in Agriculture

Water plays the most important role in agriculture. Agriculture is impossible without irrigation throughout the crop season. Irrigation ensures proper plant growth.

* Water for Municipal use

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Lifestyle of the inhabitants and their economic conditions affect the water use within the home in different parts of the country. Municipal; demand includes water for domestic purposes, commercial uses, street washing, lawn and garden irrigation, fire protection.

*** Water in the domestic sector** is generally used for drinking, washing toilets, lawn sprinkling, and food preparation etc.

*** Balancing the ecosystem**

Water is not only important for human beings but also plays an important role to balance the entire ecosystem by various ways:

* By its presence in the **atmosphere** it absorbs the Sun's heat.

The rain water scours the hills and carries the sediments into rivers, valleys etc.
Percolating water into rock crusts takes part in the formation of mineral deposits.
In Polar Regions, water in the form of the caps influences climatic and geographical changes.

* **Water for industries**

Water is used in huge quantities in the industries like steel industry, chemicals, fertilizers, textiles, cement, electricity, petrochemicals and paper. Mining, food etc. these industries require water for following or the other reasons:

Cooling.
Generation of power.
Cleaning purposes.
Fire protection.
Air conditioning.

L-3

* **Water for power**

* Thermal power plants also requires large volume of water for the purpose of cooling
and disposal of fly ash. Water is used in thermal power generation.

* **Water for Navigation**

Water ways are important medium of transportation. Transport by water ways is cheaper as compared to by road and railway. The main waterways exist in the Ganga in the eastern region and Brahmaputra in the north-eastern region, which account for more than 60 per cent of the traffic.

* **Water for fish, wildlife and recreation**

Fish, wildlife and recreation facilities play an important role in nation's life and adequate water supplies for their continued development and important. Swimming, boating, fishing is the important outdoor recreational activities which are impossible without water.

LECTURE 4 + 5 (L4-L5)

Habitat assessment

The evaluation of habitat in bio monitoring surveys is a vital component for fully understanding factors that are influencing the health and biological integrity of an aquatic community. The interplay between watershed physiographic features and anthropogenic land use characteristics will play a large role in determining the composition and quality of habitat that is available to resident aquatic communities. The condition of the habitat at a biomonitoring station is evaluated using different physical parameters, varying slightly for high, mid, and low gradient streams. Each of these parameters is numerically scored after visual observation of the stream reach. The numerical scores for all parameters are then summed and the value obtained places the stream within a category of one of the following categories.

Habitat Assessment :-The poor category ranges from one to five, the marginal category six through ten, suboptimal category eleven through fifteen, and the optimal category ranges from sixteen to twenty.

Each biologist in the field (minimum of four) conducts their own assessment of each individual habitat parameter. This is followed by open discussion until agreement is reached on the overall condition of the habitat. In this manner, a semi-quantitative and standardized approach to assessing the habitat is best reached through professional judgment.

By looking at individual habitat assessment parameters, one can obtain important information regarding community structure and health and often identify leading causes of degraded conditions. Habitat assessment data can also be interpreted by summing the twelve habitat parameter scores for an overall assessment value; 161-200: optimal, 101-160: suboptimal, 51-100: marginal, <51: poor. These assessment values are used when assessing a site's attainable biological condition based on a local reference station.

L4-L5

Habitat charactericts that are evaluated:-

(a) Available Cover: This evaluation includes the relative quantity of natural resources in the stream, such as cobble (riffles), large rocks, fallen trees, logs and branches, undercut banks, available refugia, feeding, or sites for spawning and nursery functions of aquatic life

(b) Embeddedness:(High Gradient Only) the degree that voids between dominant substrates found within riffle run habitats are filled with smaller sized particles is termed as
embeddedness. As these voids become filled, important microhabitats for benthic dwelling insects and fish are eliminated, and the ecological health and integrity of the
area is compromised. In addition to the loss of microhabitat, the substrates ability to entrap coarse particulates such as leaves and other riparian generated detritus is also reduced, resulting in the loss of important food resources for many locally dwelling organisms.

(c) Pool Substrate Characterization: (Low Gradient Only) Evaluates the type and condition of bottom substrates found in pools. Firmer sediment types like gravel, sand and rooted aquatic plants provide support for a more diverse group of organisms than a pool that is dominated by mud, bedrock, and no plants. Additionally, a stream that has a uniform substrate in its pool will not support as many types of organisms than a stream that has a variety of substrate types.

(d) Velocity/Depth Regimes:(High Gradient Only) There are basically four types of velocity/depth regimes possible in a river system; deep and slow moving, deep and fast moving, shallow and slow moving, and shallow and fast moving. The more of these velocity/depth regimes that are present in a river or stream, the more varied the habitat and the more amenable to supporting a diverse aquatic community. In larger river systems where only one of these regimes may be commonly present, (i.e. deep and slow moving) a different habitat assessment form is used so that the water body is not assessed negatively for naturally occurring conditions.

L4-L5

(e) Pool Variability: (Low Gradient Only) This rates the overall mixture of pool types found in streams, according to size and depth. There are 4 basic types of pools are large-shallow, large-deep, small-shallow, and small-deep. A stream will support a wide variety if aquatic species. Rivers with low sinuosity (few bends) and monotonous pool characteristics do not have sufficient quantities and types of habitat to support a diverse aquatic community.

(f) Sediment Deposition: Sediment deposition can be caused from increased stream velocities resulting from alteration of the stream channel. Increased stream velocities accelerate the erosion process, increasing suspended materials and bed load sediments (those particles that bounce along the bottom), which are then deposited in lower velocity areas of the water body. Increasing sediment loads and subsequent deposition into other reaches often results in the covering and encapsulation of coarser streambed materials or the filling of interstitial spaces between the larger substrates that previously provided important habitat for fish and aquatic insects.

(g) Channel Flow Status: This parameter represents the degree to which the channel is filled with water. It provides an assessment of the temporal variability of streamflow in the channel and can be related to the suitability of the habitat for inhabitance by fish and aquatic insects. Factors such as hydropower, drinking water diversions, flood control structures, and urban development can precipitate highly varying seasonal and non-seasonal flow regimes which can reduce the amount of available habitat, or alter its characteristics as to be unsuitable for use by the naturally occurring biological community.

(h) Channel Alteration: Channel alteration is an assessment of the degree of diversion from the natural course of the water body by man-made structures and/or activities. This includes rip-rap stream banks, bridge abutments, dredging, concrete channelization, etc.

These structures and activities often degrade habitat by increasing stream velocities and decreasing food sources and protective cover. Elimination of streambank vegetation, undercutting of banks, removal of snags, and smothering or elimination of bottom substrates and detritus are all results of channel alteration. Depositional and erosional areas within the river system are often increased or decreased as a result of channel alteration, causing shifts in the structure of the naturally occurring community.

(i) (Bank Vegetative Protection) Riffle Frequency: (High Gradient Only) Riffle habitat is considered to be the in-stream geomorphic feature that provides the most optimal habitat conditions and reflects the balance between erosional and depositional characteristics in the water body. Five to seven stream widths between each recurring riffle area are considered to be optimal.

(j) Channel Sinuosity: (Low Gradient Only) Evaluates the meandering or sinuosity of the stream. A high degree of sinuosity provides for diverse habitat and fauna, and the stream is better able to handle surges when the stream fluctuates as a result of storms. The absorption of this energy by bends protects the stream from excessive erosion and flooding and provides for refugia for benthic invertebrates and fish during storm events.
Bank Stability: Unstable banks, while naturally occurring under some conditions, usually alludes to highly fluctuating flows and the inability of the riparian habitat to recover from frequently occurring hydrologic stresses. Poor bank stability increases turbidity and depositional/erosional areas. It can also elevate in-stream water temperatures, and cause community shifts from pollutant sensitive aquatic species to pollutant tolerant ones. Poor streamside bank conditions usually coincide with poor in-stream habitat.

LECTURE-6 (L6)

(k)Vegetative ZoneBank Vegetative Protection: Stream side vegetation is one of the principal factors which protects the streambank from erosional processes, provides shade and protective cover for aquatic life, and provides a significant food source to in-stream biota. The density and types of vegetation present are indicative of the sensitivity of the water body to potential changes in streamflow and its susceptibility to erosion and sedimentation.

(l) Riparian Vegetative Zone Width: This habitat quality parameter assesses the width of naturally occurring vegetation between the water body and the area of man-made land uses in order to determine the riparian zones ability to "buffer" detrimental influxes into the water body. The wider the buffer zone, the greater the ability of the riparian zone to mitigate pollutants. A width of approximately eighteen meters is considered optimal; additional widths will in most cases not result in additional protection or attenuation of pollutants.

narrow channel Habitat

L-6

open Habital

forest Habitat