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DEPARTMENT OF CIVIL ENGINEERING

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Department Vision:

To be the leading department providing quality education to develop competent Civil Engineers, Entrepreneurs, and innovators to serve the nation.

Department Mission:

M1- To provide quality technical education.

M2- To prepare competent students for employment.

M3–To focus on developing values and professional skills.

Program Educational Objectives:

- 1. To ensure that graduates will have a mastery of fundamental knowledge, problem solving skills, engineering experimental abilities, and design capabilities necessary for entering civil engineering career and/or graduate school.*
- 2. To incorporate verbal and written communication skills necessary for successful professional practice.*
- 3. Demonstrate knowledge of management principles and engineering techniques for effective project management.*
- 4. To prepare graduates to deal with ethical and professional issues, taking into account the broader societal implications of civil engineer.*

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1. Green Building Technologies and Sustainable Construction

Prathmesh Sonar, Harshali Chavan, TE Civil

As the demand for energy efficiency and environmentally friendly construction grows, green building technologies are shaping the future of the construction industry. The global push for sustainability, along with government regulations and incentives, has led to a boom in eco-friendly construction practices. This article explores the various technologies and materials being adopted in sustainable construction, such as eco-friendly materials, energy-efficient systems, and certifications like LEED (Leadership in Energy and Environmental Design).

Eco-Friendly Materials in Construction

Green building materials play a crucial role in reducing the environmental impact of construction. These materials not only minimize carbon footprints but also improve the energy efficiency of structures. Some of the most commonly used green materials include:

- **Bamboo:** A renewable material that grows rapidly, bamboo has high strength and flexibility, making it ideal for structural use in many buildings.



Fig. bamboo reinforcement

- **Recycled Steel:** This material helps reduce waste in the construction process. Steel is a common element in construction and recycling it significantly reduces environmental damage.

- **Fly Ash Concrete:** Fly ash, a byproduct of coal combustion in power plants, is now commonly used in concrete to enhance its strength and durability while reducing cement usage.



Fig. fly ash

Energy-Efficient Building Design

One of the primary goals of sustainable construction is to reduce energy consumption. This is achieved through:

- **Passive Solar Design:** Buildings designed to optimize the use of sunlight for lighting and heating. Large windows on the south-facing walls allow the structure to absorb heat during the day, reducing the need for artificial heating.
- **High-Efficiency HVAC Systems:** Heating, ventilation, and air conditioning systems are optimized to consume less energy. These systems use energy-efficient components, such as variable speed compressors, heat exchangers, and air purifiers.



LEED Certification

The LEED certification system has become a global standard for evaluating green buildings. It is based on the overall sustainability of a building, including energy efficiency, water conservation, material usage, and the quality of the indoor environment. The LEED process not only ensures that buildings are constructed in an eco-friendly manner but also promotes continuous improvements during operation.

Green building technologies are rapidly evolving, and with innovations like smart buildings and energy-efficient designs, the future of construction is moving towards greater sustainability. These developments not only reduce environmental harm but also save on long-term costs for building owners and developers.

2. Artificial Intelligence and Machine Learning in Civil Engineering

Bhagyashri Patil, Lokesh Vispute, TE Civil

Artificial Intelligence (AI) and Machine Learning (ML) are revolutionizing industries worldwide, and civil engineering is no exception. These technologies are enhancing how civil engineers plan, design, construct, and maintain infrastructure. In civil engineering, AI and ML can help with project management, structural health monitoring, predictive maintenance, and risk assessment, providing a data-driven approach to traditional engineering tasks.

AI in Project Management

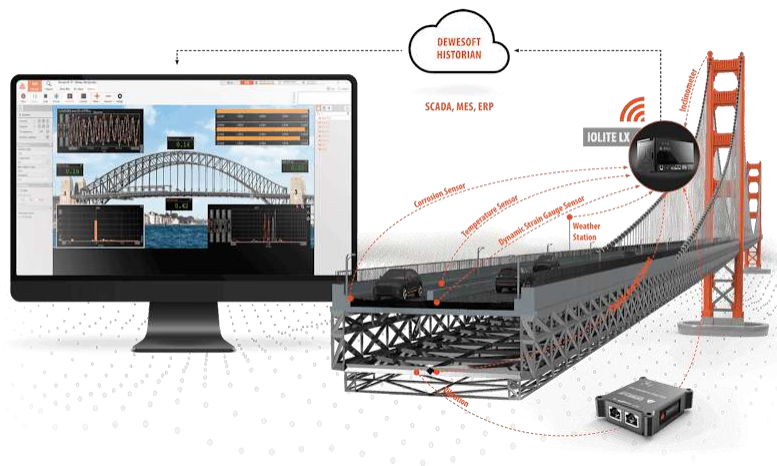
Civil engineering projects often involve large-scale operations, with multiple stakeholders and complex timelines. AI tools can streamline project management by analyzing historical project data to predict risks, optimize

schedules, and allocate resources more efficiently. AI-based software can continuously monitor project progress, detect deviations, and recommend corrective actions to prevent delays and cost overruns.



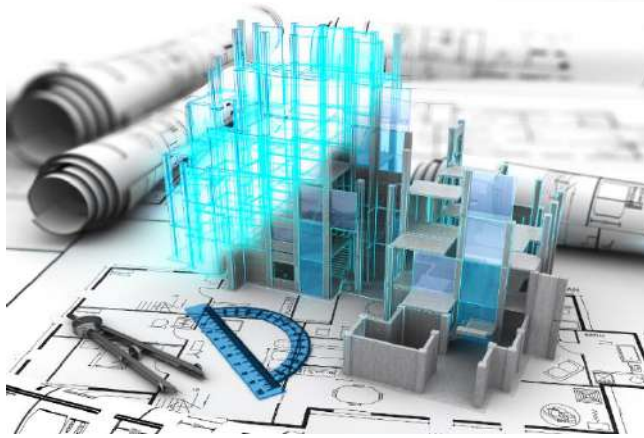
Structural Health Monitoring and Predictive Maintenance

AI and ML are critical in predictive maintenance and structural health monitoring. Sensors embedded in bridges, buildings, and other infrastructure gather data on vibrations, stress, temperature, and other factors that can signal potential failure points. AI algorithms then analyze this data in real-time to predict when maintenance is required, allowing engineers to address issues before they escalate into costly repairs or dangerous structural failures.



AI in BIM (Building Information Modeling)

AI-driven algorithms are also integrated into Building Information Modeling (BIM), where they help optimize design choices, identify construction conflicts, and automate repetitive tasks. AI-enhanced BIM tools assist in simulating building designs to predict energy consumption, optimize structural integrity, and improve overall efficiency.



As AI continues to advance, its role in civil engineering will grow, leading to smarter, more efficient projects and safer infrastructure.

3. Advancements in Seismic Resilient Structures

Pranjal Randhir, Pranav Sonawane, Harshali Patil, Arjun Deore, BE Civil

Seismic resilience in structural design has become increasingly important, especially in regions prone to earthquakes. In recent years, advancements in materials science and engineering technologies have significantly improved the ability of buildings to withstand seismic forces. This article explores the innovative techniques, materials, and case studies that contribute to seismic resilience in modern construction.

Shape-Memory Alloys



Shape-memory alloys (SMAs) are revolutionizing seismic engineering. These smart materials have the unique ability to return to their original shape after deformation, making them ideal for seismic applications. When incorporated into structural elements like beams and joints, SMAs can absorb and dissipate seismic energy, reducing damage during an earthquake.

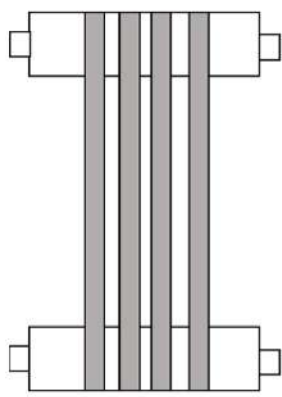
Base Isolation Systems

Base isolation is one of the most effective methods for protecting buildings from seismic forces. In this system, a building's foundation is separated from the ground using flexible bearings, which absorb and dissipate seismic energy. This allows the structure to move independently from the ground, greatly reducing the impact of the earthquake. Buildings in Japan, where seismic activity is frequent, commonly use base isolation systems.

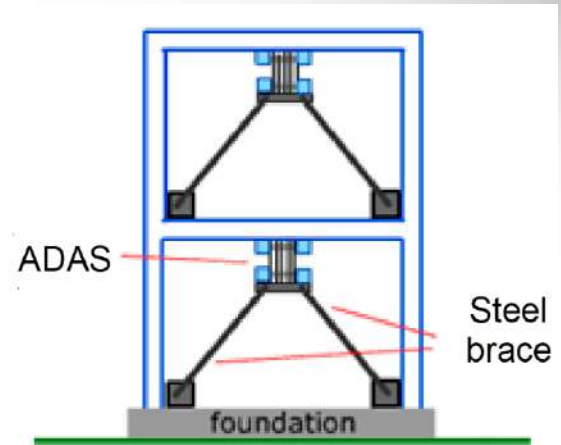
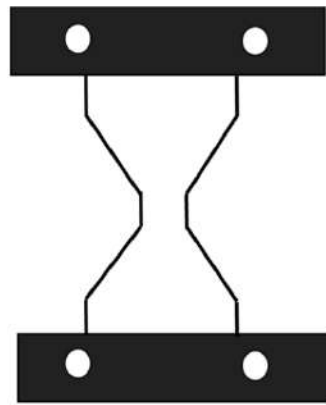


Energy-Dissipating Devices

Innovative energy-dissipating devices, such as dampers, help absorb the energy generated by seismic waves. These devices can be installed in key structural elements like braces or columns. When an earthquake strikes, the dampers reduce the amount of force transmitted to the building's framework, minimizing the risk of collapse.



(a)



(b)

Case studies of earthquake-resistant buildings, like the Tokyo Sky tree in Japan and retrofitting projects in California, demonstrate the effectiveness of these techniques.

4. Water Resource Management in a Changing Climate

Rohit Datir, Aryan Avhad, Aniket Bhoj, SE Civil

Water resource management is becoming a top priority for civil engineers as the effects of climate change intensify. Rising temperatures and shifting precipitation patterns are straining traditional water management systems, prompting the need for innovative solutions to ensure sustainable water use. This article explores the latest advancements in flood control, rainwater harvesting, and smart water management systems.

Flood Control and Resilience

Urbanization, coupled with increased frequency of extreme weather events, has made cities more vulnerable to flooding. New flood management strategies include the construction of permeable pavements and green roofs to absorb rainwater and reduce surface runoff. Additionally, civil engineers are designing floodplain restoration projects, which involve re-establishing natural waterways and wetlands to mitigate flood risks.

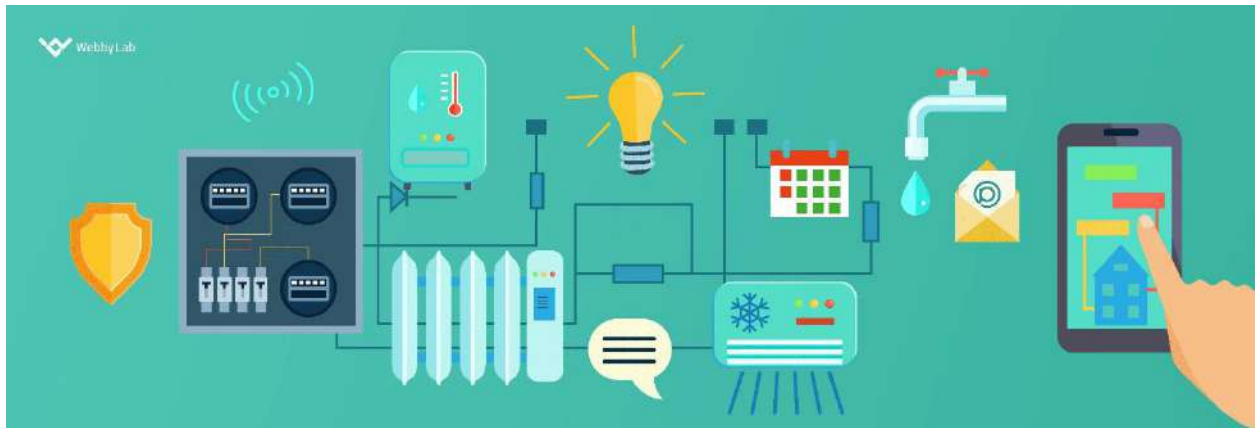
Rainwater Harvesting

Rainwater harvesting systems are an effective way to reduce dependence on centralized water supplies. Advanced rainwater harvesting solutions involve the installation of underground cisterns, where water is collected and

filtered for use in irrigation and sanitation. This practice not only conserves water but also reduces the strain on municipal systems during dry periods.



Smart Water Management with IoT



The integration of IoT (Internet of Things) technologies into water management is revolutionizing the field. Smart sensors are now widely used to monitor water levels, detect leaks, and optimize irrigation systems. These real-time data systems allow engineers to make informed decisions and quickly respond to water-related challenges.

5. 3D Printing and Prefabrication in Construction

Arjun Singh, Pradnya Aher, Pallavi Chaudhari, Leena Ahirrao, BE Civil

The rise of 3D printing and prefabrication technologies is transforming the construction industry. These advancements not only offer a faster and more cost-effective way to build structures but also contribute to sustainability by minimizing material waste and reducing carbon emissions. This article examines the latest innovations in 3D printing and prefabrication for construction.

3D-Printed Buildings

3D printing, also known as additive manufacturing, allows the creation of complex structures layer by layer using a variety of materials such as concrete, plastic, and metal. One of the most exciting developments is the ability to 3D print entire buildings. This technology significantly reduces construction time and cost, particularly for low-cost housing projects. Several pilot projects, such as the 3D-printed homes in the Netherlands and Mexico, are already demonstrating the feasibility of this technology on a large scale.



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Prefabrication and Modular Construction

Prefabrication involves manufacturing building components in a factory and then assembling them on-site. This process enhances efficiency, reduces construction time, and ensures better quality control. Modular construction, a form of prefabrication, allows entire sections of buildings to be manufactured off-site and then fitted together like building blocks. This technique is gaining popularity for high-rise residential buildings and hotels.



By reducing construction waste and improving energy efficiency, these technologies are playing a significant role in making the construction industry more sustainable.

6. Effect of Replacement of Cement by Sugarcane Ash and Biopolymer on Concrete

Isha Bhuse, Apurva Kapadnis- BE Civil

The demand for sustainable construction materials has increased due to the environmental impact of cement production, which contributes significantly to global CO₂ emissions. This study explores the effects of replacing cement with **sugarcane bagasse ash (SCBA)** and **biopolymers** in concrete. SCBA, a byproduct of the sugar industry, is rich in silica and exhibits pozzolanic properties, making it a viable alternative to cement. Biopolymers, derived from natural or synthetic biological sources, improve concrete properties such as cohesion, water retention, and durability. The combination of SCBA and biopolymers in concrete offers a promising solution for sustainable construction.

SCBA, when used as a partial replacement for cement (typically between **5-15%**), enhances compressive strength, reduces permeability, and improves resistance to sulfate attack and chloride penetration. However, excessive SCBA content may negatively impact workability due to its fine particle size and high water absorption. The pozzolanic reaction between SCBA and calcium hydroxide (Ca(OH)₂) released during cement hydration results in additional **calcium silicate hydrate (C-S-H) gel formation**, enhancing strength and durability.

Biopolymers play a crucial role in modifying concrete properties. They act as **water reducers**, improving workability while maintaining strength. Some biopolymers, such as **starch-based, lignin-based, and chitosan-**

based polymers, enhance adhesion between cement particles and improve the **flexural and compressive strength** of concrete. Additionally, biopolymers contribute to reducing shrinkage cracks, increasing resistance to freeze-thaw cycles, and improving resistance to chemical attacks. Their ability to **retain water** helps in prolonged hydration, leading to improved long-term concrete performance.

When combined, SCBA and biopolymers create a **synergistic effect**, improving the mechanical and durability properties of concrete. The key benefits include:

Increased Strength: SCBA's pozzolanic activity, coupled with biopolymer-induced adhesion, leads to improved compressive and flexural strength.

Enhanced Workability: While SCBA alone may reduce workability, biopolymers counteract this by improving water retention and flowability.

Better Durability: The combination results in **lower permeability**, increased resistance to aggressive environmental conditions, and reduced risk of cracks.

Eco-Friendliness: Utilizing **industrial waste (SCBA)** and renewable biopolymers reduces cement consumption and contributes to lower carbon emissions.

Experimental studies have demonstrated that **10% SCBA replacement with 0.5-2% biopolymer content** can improve concrete properties significantly. SCBA enhances **strength and durability**, while biopolymers improve **workability and shrinkage resistance**. However, challenges such as **SCBA variability, workability issues, and the cost of biopolymers** must be addressed to optimize the mix design for large-scale applications.

Future research should focus on advanced **processing techniques for SCBA**, cost-effective **biopolymer formulations**, and their **integration with self-healing and smart concrete technologies**. Large-scale implementation of SCBA and biopolymers in concrete has the potential to **revolutionize the construction industry**, making it more **sustainable, durable, and cost-efficient**.

In conclusion, the partial replacement of cement with **SCBA and biopolymers** presents a **viable, eco-friendly, and efficient alternative** in modern construction. By improving strength, durability, and sustainability, this approach aligns with global efforts to reduce the environmental footprint of the cement and concrete industry.

7. Evaluation of Corrosion Rate of Concrete

Abhishek Sonawane, Imran Pathan- BE Civil

Concrete is a widely used construction material known for its durability and strength. However, one of the major concerns affecting its longevity is **corrosion**, particularly when reinforced with steel. The deterioration of concrete due to corrosion can compromise structural integrity, leading to **higher maintenance costs** and potential

safety risks. This article evaluates the **corrosion rate of concrete**, its causes, influencing factors, and methods for assessment and prevention.

Causes and Factors Affecting Corrosion

Corrosion in concrete structures mainly occurs due to the **ingress of aggressive agents**, such as **chlorides, carbon dioxide, and sulfates**. Some of the primary factors influencing the corrosion rate include:

Chloride Penetration – Common in marine environments and de-icing salts, leading to reinforcement corrosion.

Carbonation – CO₂ from the atmosphere reacts with calcium hydroxide, reducing concrete alkalinity and making steel reinforcement vulnerable to corrosion.

Moisture and Oxygen Availability – The presence of water and oxygen accelerates electrochemical corrosion reactions.

Cracks and Porosity – Higher permeability allows faster ingress of corrosive substances, increasing the corrosion rate.

Methods for Evaluating Corrosion Rate

Various techniques are used to assess the corrosion rate of concrete structures:

Electrochemical Methods:

Half-Cell Potential Test – Measures the probability of corrosion activity in reinforcement steel.

Linear Polarization Resistance (LPR) – Determines the corrosion rate by analyzing the electrical resistance of steel reinforcement.

Gravimetric Analysis: Measures the weight loss of steel reinforcement over time due to corrosion.

Chloride Content Analysis: Determines chloride concentration in concrete to assess corrosion risk.

Carbonation Depth Measurement: Evaluates how far carbonation has progressed within concrete.

Corrosion Prevention and Mitigation

To enhance the durability of concrete structures, several preventive and protective measures are employed:

Use of Corrosion-Resistant Materials – Employing stainless steel or coated reinforcement can reduce corrosion risk.

Waterproofing and Sealers – Applying protective coatings prevents moisture ingress.

Use of Supplementary Cementitious Materials (SCMs) – Fly ash, silica fume, and slag improve concrete durability by reducing permeability.

Cathodic Protection – A technique where a sacrificial anode is used to protect steel reinforcement from corrosion.

Corrosion Inhibitors – Chemical admixtures that slow down the corrosion process.

Conclusion

Corrosion significantly affects the lifespan of concrete structures, making its evaluation and control crucial in civil engineering. By understanding the **factors influencing corrosion, adopting proper assessment methods, and implementing preventive measures**, the durability of concrete structures can be significantly improved. Further research on **advanced materials, smart coatings, and self-healing concrete** can help develop more effective solutions to combat corrosion in the future.

8. Catchment Area Treatment: A Sustainable Approach for Watershed Management

Sakshi Sonawane, Sidhhant Velis- BE Civil

Catchment Area Treatment (CAT) is a comprehensive approach aimed at conserving and rehabilitating watershed areas to ensure the sustainable management of water resources. A catchment area, also known as a drainage basin, is the land region where rainwater collects and flows into rivers, lakes, reservoirs, or other water bodies. Over time, rapid urbanization, deforestation, soil degradation, and climate change have led to increased soil erosion, sedimentation, and declining water availability, affecting both ecosystems and human communities. CAT plays a vital role in mitigating these issues by implementing measures that reduce erosion, enhance groundwater recharge, restore vegetation cover, and improve overall water quality. The core objective of CAT is to maintain the ecological balance of watersheds while ensuring that water resources remain available for agriculture, drinking, industry, and ecosystem sustenance.

Various scientific and engineering-based interventions are used in CAT to protect and improve catchment areas. Afforestation and reforestation help restore degraded lands by increasing tree cover, which stabilizes soil, reduces runoff, and enhances groundwater infiltration. Soil conservation techniques such as contour plowing, terracing, and mulching prevent topsoil loss and retain soil moisture, ensuring better agricultural productivity. Water harvesting structures, including check dams, percolation pits, farm ponds, and gabion structures, play a crucial role in managing surface runoff, reducing water loss, and improving groundwater levels. Gully and ravine treatments such as brushwood dams, vegetative barriers, and check walls help in controlling the formation of deep gullies, which contribute to soil erosion and land degradation. Additionally, sustainable farming practices like agroforestry, organic farming, mixed cropping, and controlled grazing prevent land degradation and ensure long-term agricultural productivity.

The benefits of CAT extend to environmental, economic, and social domains. Environmentally, CAT helps in reducing soil erosion, minimizing sedimentation in reservoirs, improving biodiversity, and enhancing local climatic conditions by increasing green cover. Water resources benefit significantly from CAT interventions as they help increase groundwater recharge, reduce flood risks, and improve water availability for various uses. The

socio-economic advantages of CAT include increased agricultural productivity, improved livelihoods through employment in afforestation and soil conservation projects, and reduced dependency on external water sources. Moreover, CAT helps in improving the resilience of local communities against droughts, floods, and other climate-related challenges by ensuring better land and water management.

Despite its numerous advantages, CAT faces several challenges in large-scale implementation. Lack of awareness and community participation, deforestation, urban encroachments, insufficient funding, and inadequate policy support hinder the effectiveness of CAT programs. Climate change further complicates catchment management by altering rainfall patterns, increasing extreme weather events, and reducing the effectiveness of conventional water conservation techniques. Addressing these challenges requires a collaborative effort from governments, non-governmental organizations (NGOs), researchers, and local communities to develop sustainable and innovative CAT strategies.

To ensure the long-term success of CAT, future efforts should focus on strengthening community engagement, integrating modern technologies such as Geographic Information Systems (GIS) for better watershed monitoring, and promoting policy-level initiatives that support large-scale watershed conservation. The adoption of eco-friendly livelihood practices, better enforcement of land-use policies, and research into climate-resilient soil and water conservation methods will further enhance the effectiveness of CAT programs. By prioritizing catchment area treatment, societies can secure a cleaner and more sustainable water future, promote ecological restoration, and mitigate the adverse effects of environmental degradation, ensuring water security for future generations.

9. Prediction of Evapotranspiration Using WEAP Software

Vikas Ugale, Vedant Khadangale- BE Civil

Evapotranspiration (ET) is a critical component of the **hydrological cycle**, representing the combined loss of water from the Earth's surface due to **evaporation from soil and water bodies** and **transpiration from plants**. Accurate prediction of ET is essential for **water resource management, agricultural planning, and climate change studies**. One of the most effective tools for modeling and predicting ET is the **Water Evaluation and Planning (WEAP) software**, which provides an integrated approach to **water balance analysis, demand forecasting, and climate impact assessment**.

WEAP software estimates ET using **climatic inputs such as temperature, humidity, solar radiation, and wind speed**, along with **land use and vegetation cover data**. It incorporates methods like the **Penman-Monteith equation, FAO-56 model, and empirical water balance approaches** to simulate ET under different scenarios. By integrating **hydrological models, climate projections, and land-use data**, WEAP helps researchers and policymakers understand **how evapotranspiration responds to changing environmental conditions, irrigation practices, and water availability**.

The prediction of ET using WEAP is particularly useful for **watershed management, irrigation optimization, and drought mitigation**. It allows decision-makers to evaluate **different water management strategies, assess the impacts of deforestation or urbanization on ET, and develop climate-resilient water policies**. Additionally, WEAP supports scenario-based simulations, enabling users to compare **historical trends with future projections under different climate and land-use scenarios**.

In conclusion, the **WEAP model serves as a valuable tool for predicting evapotranspiration** and optimizing water resources for sustainable development. By incorporating **real-time climate data, land-use patterns, and hydrological processes**, WEAP enhances the accuracy of ET estimation and aids in **efficient water planning and conservation efforts**. Its ability to model **complex water systems and evaluate multiple management strategies makes it indispensable for researchers, water managers, and policymakers** in addressing global water challenges.

10. Advanced Treatment of River Water for Domestic Use

Om Rajole, Shrushti Musale- BE Civil

The **advanced treatment of river water** for domestic purposes is essential to ensure safe, clean, and potable water for human consumption. River water often contains **suspended solids, bacteria, viruses, organic pollutants, heavy metals, and chemical contaminants** that require effective treatment before use. With increasing water pollution due to industrial discharge, agricultural runoff, and urban waste, **conventional treatment methods are often insufficient**, necessitating the use of **advanced technologies** for water purification.

The **advanced treatment process** typically follows multiple stages to remove contaminants and enhance water quality. Initially, **pre-treatment** methods such as **coagulation, flocculation, and sedimentation** are employed to remove large particles and turbidity. This is followed by **primary treatment** using **sand filtration and activated carbon filtration**, which helps in removing suspended solids and organic compounds. Advanced treatment technologies include **membrane filtration (ultrafiltration, nanofiltration, and reverse osmosis), advanced oxidation processes (AOPs), and UV disinfection**. **Reverse osmosis (RO)** is particularly effective in removing **dissolved salts, heavy metals, and microbial contaminants**, ensuring high-quality potable water. **Ultraviolet (UV) and ozone treatment** play a crucial role in **disinfecting water by eliminating bacteria, viruses, and other pathogens** without the use of chemicals.

Furthermore, **adsorption techniques using activated carbon and ion exchange resins** help in removing **pesticides, organic pollutants, and heavy metals** from river water. In some cases, **biological treatments, such as biofiltration and microbial degradation**, are employed to break down organic matter and enhance water clarity. **Electrocoagulation and nanotechnology-based filters** are also emerging as effective solutions for improving water purification efficiency.

Smart monitoring systems and automation have revolutionized river water treatment, enabling real-time **water quality monitoring and automated control of treatment processes**. These technologies ensure that treated water meets **drinking water quality standards** set by regulatory bodies like the **World Health Organization (WHO) and Environmental Protection Agency (EPA)**.

In conclusion, **advanced river water treatment** is critical for providing safe and sustainable drinking water. By integrating **membrane technologies, advanced oxidation processes, UV and ozone disinfection, and real-time monitoring**, modern water treatment facilities can effectively remove contaminants and ensure high-quality water supply for domestic use. With growing concerns over **climate change, pollution, and water scarcity**, adopting **advanced and sustainable water treatment solutions** is essential for securing **safe and clean drinking water for future generations**.

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