Compendium of Best Practices in Water Management – 3.0

For Prelims: Neeru-Chettu Program, Sujalam Sufalam Jal Abhiyan (Gujarat), Jalyukt Shivar Abhiyan, **Sponge City** Initiative, Sustainable Urban **Water Management,** Sihlanzimvelo Stream Cleaning Project: (South Africa), **Flood Forecasting and Early Warning System** in Kolkata.

For Mains: Water Management Practices and Water Conservation.

Recently, NITI Aayog released 'Compendium of Best Practices in Water Management – 3.0'. This Compendium of Best Practices is a repository of unique and effective water management strategies applied nationally as well as internationally.

- Success stories related to smart infrastructure for efficient irrigation, rejuvenation of lakes and rivers, reuse of wastewater etc are disseminated to stakeholders and practitioners and researchers.

What are Some Policy-Led Interventions in Water Conservation?

Neeru-Chettu Program (Andhra Pradesh)

- **About:**
  - The Neeru-Chettu Program, initiated by the Government of Andhra Pradesh in 2015, was implemented **to improve water conservation and management** in the State with peoples' participation to make the state drought proof.
- **Intervention:**
  - De-silting of minor irrigation tanks and feeder channels.
  - Repairs and renovation of existing water harvesting structures.
  - Construction of check dams, percolation tanks, farm ponds.
  - Arresting the soil erosion by following the ridge to valley approach.
  - Development of cascades i.e. chain of tanks to divert water from surplus basin to deficit basin using latest Geographic Information Systems (GIS) and satellite technology.
  - Encouraging micro irrigation on a large scale and mobile micro irrigation practices in severe water scarce areas.
  - Massive afforestation and soil moisture conservation works and rising of nurseries by the Forest Department.
- **Outcomes:**
  - **Improvement in ground water levels in Rayalaseema region** due to the works taken up under Neeru–Chettu.
  - A total of 126477 structure repaired.
  - 86 Lift irrigation schemes revived.

Sujalam Sufalam Jal Abhiyan (Gujarat)

- **About**:
  - Sujalam Sufalam Jal Sanchay Abhiyan is a water conservation scheme launched by the

Government of Gujarat in 2018.
    - The scheme aims **to deepen and desilt water bodies,** clean and rejuvenate rivers, and construct new water harvesting structures in the state.
- **Outcomes:**
    - Around 13,000 ponds and check-dams desilted and 32 rivers rejuvenated, creating an additional capacity of 11,000 lakh cubic feet to store water when the rain arrives.
    - 6,170 lakes were cleaned and deepened.
    - The water harvesting capacity of the state of Gujarat increased by 42,064 lakh cubic feet in three years (2018-2020).
    - Soil excavated was given to the public free of cost.
- **Intervention**:
    - Deeping of ponds, tanks, check dams and reservoirs. Cleaning of rivers, drains canals, irrigation structures and drinking water sources.
    - Construction of check dams, new ponds, Khet Talavadi, and Van Talav.

Mukhyamantri Jal Swavlamban Abhiyan (Rajasthan)

- **Background:** Rajasthan faces **water scarcity due to its low and erratic rainfall.** The rainfall varies from 100 mm in the west to 900 mm in the southeast, and three out of five years are drought affected. **Most of the rainfall is lost due to runoff,** and the groundwater level is declining. To cope with this problem, water harvesting structures are needed in the watershed area.
- **About:**
    - Mukhyamantri Jal Swavlamban Abhiyan (MJSA) is a water conservation and management scheme launched by the Government of Rajasthan in 2016.
- **Objectives:**
    - Making the village self-sufficient in terms of drinking water.
    - Increase the level of groundwater table and strengthen watershed.
    - Increase the area under irrigation and cultivation through water harvesting & conservation.
- **Intervention:**
    - The scheme aims to harvest and utilize the available runoff water in rural areas by using the Four Waters Concept.
        - The concept involves the **treatment of catchment water, proper utilization of existing water harvesting structures,** renovation of non-functional water harvesting structures, and creation of new water harvesting structures.
    - The scheme also adopts the concept of Water Budgeting in Gram Sabhas, where the water uses and demand for various purposes are determined and planned accordingly.
- **Outcome:**
    - This scheme has resulted in an increase of **4% in groundwater level** that helped agriculture and irrigation.
    - Improved the problem of soil erosion and fertility which resulted in more production.
    - Supplied water to 4.1 million people and 4.5 million animals which decreased the death due to water scarcity.

Drink From Tap Mission (24x7 Water Supply) - Odisha

- **Background:** Urban Odisha faced water supply challenges due to rapid urbanization.
- **About:** The DRINK FROM TAP MISSION is launched by the Odisha government in 2020 to provide safe and continuous drinking water to urban residents.
- **Objectives**:
    - **Drink pure water straight from the Tap:** Conversion of intermittent water supply systems to continuous (24x7) water supply systems
    - Water Supply Management through Community Partnership (**Self Help Groups**) – “Jalsaathi”
    - 100% coverage of households with piped drinking water of good quality as per recommended standards.
    - 100% metering of house connections to eliminate non-revenue water (NRW) due to leakages and wastage for full cost recovery.

- **Interventions:**
  - Employed advanced technology and management techniques in construction and operation.
  - Ensured quality through Third Party Quality Monitoring & **Public Private Partnership (PPP)** Laboratories.
  - Policy interventions: Right to water, simplified connection procedures, community involvement.
  - Relaxed norms for the poor, covered slums under AMRUT, shifted from hand pumps to piped supply.
  - Focused on reducing Non-Revenue Water (NRW) through equipment, training, and infrastructure upgrades.
- **Outcomes:**
  - Achieved 100% household coverage with round-the-clock tap water.
  - Eliminated the need for personal water storage.
  - Removed the need for rooftop tanks and home treatment systems.
  - Metering and billing reduced water leakages and wastage.
  - Swift issue resolution boosted public confidence in WATCO

Kapildhara Yojana (Madhya Pradesh)

- **Year of Implementation:** 2008
- **About:** Kapildhara Yojana is a scheme by Madhya Pradesh to provide irrigation facilities to small and marginal farmers through **MGNREGA.**
- **Objectives:**
  - To support landholders without irrigation facilities and prioritize marginalized communities.
  - To improve crop productivity, intensity, and diversity and generate livelihood sources.
- **Interventions:**
  - Construction of dug wells, farms ponds, check dams, etc. on private lands of beneficiaries.
  - Horticulture development, land reform, and other activities under MGNREGA.
  - Target of constructing 2.5 lakh Kapildhara wells in five years.
- **Outcomes:**
  - More than 3.57 lakh Kapildhara wells were constructed on unirrigated land of poor farmers.
  - Nearly 4.74 lakh hectare area turned into irrigated area.
  - Increased crop variety and income for farmers.

Automation of Irrigation System: Narayanpur Left Bank Canal System system (Karnataka)

- The Government of Karnataka launched a project in 2014 to automate the Narayanpur left canal system, which irrigates a vast area of about 4.5 lakh hectares from the Narayanpur dam on the Krishna river.
- The project involved installing more than 4,000 **automated control and regulating gates, sophisticated software and communication infrastructure,** and solar powered integrated gates to manage the delivery of water to the farmers along the canal network.
- The project also provided irrigation schedules, water demand, water billing, and revenue generation information to the farmers through a dashboard.
- The project **used GIS-based information to monitor the soil health, crops,** water demand and allocation, weather, and contours in the command area.
- The project achieved positive outcomes such as **delivering water to the tail end users, optimizing the water use efficiency and reducing water loss,** increasing the irrigated area and agricultural production, reducing operational costs and maintenance requirements, and enhancing the online water management system.

Jal Samvardhan Yojana (Karnataka)

- In Tumakuru District, Karnataka, the Jala Samvardhane Yojana Sangha (JSYS), a registered society under the Societies Act of Karnataka, has been implementing Jal Samvardhan Yojana since 2002.
  - Traditional tank systems, known as "kere," have been integral to water harvesting

traditions in Karnataka for centuries. These **tank systems have contributed significantly to ecological sustainability,** environmental preservation, and rural livelihoods.

- **Objective:**
  - To create a **conducive environment for sustainable and decentralized tank management systems**, reduce poverty through the development of community-based institutions, and **rehabilitate tanks within the district.**
- **Interventions:**
  - The intervention involves **active participation from Tank Users Groups (TUGs) and includes improvements to tank bunds**, waste weirs, feeder canals, repairs to sluices to prevent water leakages, and desiltation of tank beds to restore their original capacity and enhance groundwater levels.
- **Outcomes:**
  - About 60, 50,716 cum of desolation was done in about 454 tanks helping in recharge of underground water in the open wells and bore wells in the surrounding area.
  - About 1,24,950 local indigenous plant species like **Honge, Neem, Bamboo, Tamarind, Neale, Karijali,** Jatropha, Accacia, etc planted in the foreshore of tank bed

Jalyukt Shivar Abhiyan (Maharashtra)

- Jalyukt Shivar Abhiyan (JSA) is a flagship program of the Maharashtra government launched in 2015-16 to make the state drought-free by 2019.
- JSA aimed **to make 5000 villages water scarcity free every year** by creating and repairing water harvesting structures, increasing groundwater recharge, and promoting efficient water use in farming.
- JSA **used geotagging of water bodies and a mobile application f**or web-based monitoring of the scheme.
- JSA achieved positive outcomes such as **declaring 11,000 villages drought-free,** increasing water storage capacity and agricultural productivity, and recharging groundwater level.

What are the Some of the Best Practices of Watershed Development?

Reversing Salinity in Saurashtra

- Ambuja Cement Foundation (ACF) launched a holistic program in 1998 to address the problem of salinity ingress caused by overexploitation of groundwater and reduced rainfall in the coastal region of Saurashtra.
- ACF implemented various initiatives to increase water harvesting and groundwater recharge, such as building check dams, ponds, canals, and rainwater harvesting systems.
- ACF also promoted drinking water supply infrastructure, modern irrigation technologies, salinity resistant crops, and community participation in water resource management.
- ACF's intervention resulted in significant impacts such as additional water availability, increased agricultural productivity, improved livelihoods, and reduced salinity levels.

What is Watershed?

- A watershed (also called drainage basin/catchment area) is an area of land that drains or "sheds" water into a specific waterbody.
- It is an independent drainage unit for surface water runoff.
- One watershed is separated from another by a natural boundary known as the water divide or the ridge line.
- **Watershed Management** is the process of implementing land use practices and water management practices to protect and improve the quality of the water and other natural resources within a watershed.

Clean and Safe Drinking Water in Odisha

- **Place of Implementation:** Nuapada district in Odisha
- **Background:** Over-extraction of groundwater in Nuapada district of western Odisha has resulted in increased concentrations of natural fluoride in groundwater (as high as 4.95 milligrams per litre). This led to unavailability of clean and safe water in the village.
- Jal Jeevan Mission, implemented by the Government of Odisha in 2019, aimed to address the problem of fluoride contamination in groundwater, which caused health issues like fluorosis and kidney failure among the villagers.
- The mission changed the **source of drinking water from groundwater to surface water, by using the Lower Indira dam and Jonk river dam** as potential sources. The water from the dams was collected, treated, and supplied to the villages through overhead tanks and functional taps.
- The mission achieved **positive outcomes such as potable water in villages, reduction in kidney failure cases by 30%,** provision of field testing kits, formation of Village Water and Sanitation Committees (VWSCs), and capacity-building programmes for the villagers.

Neknampur Lake Restoration (Telangana)

- **Place of Implementation**: Neknampur Lake, Hyderabad (Telangana)
- **Organization**: Dhruvansh organization
- **Year of Implementation:** 2016
- **Background:** Neknampur lake with an area of 25 acres of lake was contaminated with garbage, sewage, water hyacinth, cultural siltation and debris dumping.
    - Encroachment issues plus a legacy garbage dumped place of Manikonda Municipality in Hyderabad became a serious cause of concern.
- **Objective:**
    - Restoration of lake and biodiversity
    - Phytoremediation & **bioremediation** to purify water in lake.
    - Desilting lake
    - Floating treatment wetlands installation & their maintenance at lake.
    - Solar Floating Aerators at lake to make lake energy free.
    - Protection of Pythons, monitor lizards & turtles from poachers.
    - Stopping of Invasive species in lake water like catfish & red-eared terrapin.
    - More than one lakh plantations at the lake which includes native species & medicinal plants.
- **Outcome:**
    - 90% reduction in **Biochemical Oxygen Demand(BOD)** of the lake due to constant maintenance of treatment system.
    - Beautiful lake with no smell or odor though sewage is still coming into lake.
    - Water hyacinth still in lake but never covered the lake.
    - Lake rejuvenation & Community rejuvenation going parallelly.

Watershed Development in Hyderabad to Address Water Scarcity

- **Novartis, a global healthcare company based in Switzerland and National Agro Foundation, a public charitable trust,** launched a watershed development program in 2021 to address water scarcity in five villages near Hyderabad, Telangana.
    - There are two primary sources of water in Hyderabad — the Nagarjuna Sagar reservoir (**River Krishna**) and the Yellampalli reservoir (**River Godavari**).
    - Water levels at both these reservoirs were dangerously low in 2019 affecting the drinking water supply for its 6.8 million residents.
- The program aimed t**o improve drinking water availability and quality, sanitation facilities, livelihood support**, and ecological restoration.
- The program implemented an integrated model of watershed management, inclusive development, and capacity-building for farmers.
- The program achieved significant outcomes such as increasing water availability by 50%-60%, augmenting groundwater table by 10 feet, benefiting around 2000 families, creating additional water storage capacity, harvesting rainwater, and increasing farmer income.

What are the Advantages of Watershed Development Approach?

- Building robust and sustainable structures positively impact year long availability of water.
- Employing modern techniques like microirrigation , mulching raise the irrigation efficiency.
- Community awareness about quality and quantity of water can help in averting risk of water stress.
    - Precautions must be taken to avoid accumulation of silt in dams as it lowers the water holding capacity.
- Shift from rain dependent farming to harvesting and storing rain water through diversion-based farming is required.
- Over extraction of ground water can lead to Fluoride contamination creating health issues.
- Shift in source of water from ground water to surface water in areas which are contaminated with heavy metals is recommended.
- The implementation of Phytoremediation and Bioremediation techniques are effective in biological rejuvenation of lakes.
- The biological restoration of lake can integrate renewable energy options such as solar power within the process.

What are the Examples of Best Practices of Smart Water Infrastructure?

Improving Water Services through Smart Metering in The Republic of Korea

- **About:** Seosan city Government and K-water (Korea Water Resources Corporation) **installed smart water meters in Cha-ri village, a small village in 2016 in South Korea** that faced water losses due to deteriorated pipes and drought situation.
- **Background:** Cha- ri a small village faced several water losses due to deterioration of water pipes. Seosan city has a relatively low rate of non-revenue water, except one of its villages Cha-ri which has a high rate of non-revenue water at 32% in 2015.
    - Due to the drought situation in 2015, it was difficult to identify and reduce water loss in a wide supply area.
- **Objective:** To detect water loss and reduce rate of non-revenue water, leakage from burst pipes and improve customer satisfaction in Cha-ri village.
- **Interventions:** Seosan city and K- Water Installed Smart water meters in region. Created nine sub district metered area systems within two district metered areas.
    - Non-revenue water analysis was conducted on a daily basis to understand and detect leakage. Water monitoring systems were expanded to 12 branches.
    - Customer satisfaction is evaluated by smartphones.
- **Outcome:** The smart water metering system reduced the rate of non-revenue water from 32% to 10%, reduced customer water usage by 55% and the cost by 70% and increased the flexibility in managing service failures.

Using Satellites For Better Irrigation

- **About:** IrriSAT is a weather-based irrigation management app that **uses remote sensing to provide crop water use and information across large spatial scales in Australia.**
    - It was developed by Mr. John Hornbuckle, Jamie Vleeshouwer and Dr. Janelle Montgomery in 2019 using Google Earth Engine.
- **Background:** Traditional methods of collecting data such as manual measurements or ground-based surveys can be time-consuming and labor intensive.
    - Moreover, these irrigation systems may lead to overwatering or under watering of crops.
    - Drought conditions and limited water availability pose additional challenges to agricultural productivity.
    - Weather-based irrigation management systems can help mitigate the impact of drought by adjusting irrigation schedules based on forecasted weather conditions.
- **Intervention:** IrriSAT uses **remote sensing to provide site specific crop water management information** across large spatial scales at fine resolution.
    - Developed using Google Earth Engine, this app delivers crop water use and information to assist in irrigation scheduling and crop productivity benchmarking.
- **Outcome:** IrriSAT users reported **water savings by modifying irrigation timing,** predicting

climate events, identifying poorer performing areas and benchmarking performance of irrigated fields.

Sponge City Initiative: Sustainable Urban Water Management

- **About:** China implemented a Sponge city program in 2014 to adopt nature-based solutions to flooding and improve urban water management.
- **Background:** The People's Republic of China (PRC)'s rapid urbanization resulted in flooding that caused significant human and economic losses, advocating for sustainable approaches like sponge cities for water management.
- **Objectives:**
  - To adopt low impact developments concept which improve effective control of urban peak runoff, and temporarily store, recycle and purify stormwater.
  - To integrate systems of **Blue-Green-Grey infrastructure.**
  - It also focuses on upgrading traditional drainage systems by constructing underground water storage tanks and tunnels and integrating natural water bodies.
- **Interventions:**
  - China has implemented a comprehensive solution. They have combined low impact development methods with grey infrastructures, large scale flood control projects and rehabilitation.
  - Indicators like **control rate of annual runoff volume (CRARV), wastewater reuse rate, rainwater reuse rate, groundwater table,** pluvial flood control and prevention ability were used to identify performance assessment on flood control, aquatic environments, water resources, water security and other aspects.
  - Greenways development for controlling the volume of stormwater runoff.
  - Reconstruction of pervious pavement and pipelines.
  - Artificial wetlands, artificial ponds and artificial soil infiltration are all used to purify and retain rainwater runoff at the end of catchments.
  - Restored riverside wetlands and gentle green slopes along the river to reduce flood risk.
  - Sponge city infrastructure like rain gardens and bioswales integrated with drainage pipe network improvements
- **Outcome:**
  - After implementing the Sponge city program Shenzhen now has a **high-density greenway network that totals over 2,300 kilometers in length,** including green transport corridors, forests, and parks varying in width from under 3 m to over 100 m.
  - Sponge city program **eliminated flooding in six areas, eliminated pollution in seven river branches,** and reduced the urban heat island effect.

Community-based Stormwater Smartgrids: Distributed AI/IoT Rain Harvesting/ Networks for Flood and Drought Resilience

- **About**: In 2015, Raingrid implemented the Stormwater Smartgrid system in Canada to address stormwater management challenges.
- **Background**: Canada is committed to sustainable storm water management as by increasing permeable surfaces through water sensitive urban design like bioswales, rain gardens and permeable paving, they also invest in collecting storm water. At the individual and property level rain tanks are promoted to collect and measure rain water runoff.
  - But there are various problems at property-based rain harvesting and land-based infiltration systems, where **it is difficult to measure storing capacity, if the system is already storing past storm water.**
  - To address this issue Raingrid stormwater Smart grid was developed using Artificial Intelligence and IoT systems.
- **Objective:**
  - Flood Prevention and Weather prediction through **Artificial Intelligence (AI)** and **Internet of Things (IoT)**.
  - Reducing need for piped stormwater management Intervention:
    - RainGrid's Residential Stormwater Smartgrid Utility Technology (RSSUT) is a smart water management technology designed to capture rain runoff from rooftops.
    - The RainGrid system consists of: individual property cisterns, **an artificial**

intelligent cloudbased weather algorithm, localized sensors, and electrically actuated drainage for harvested water reuse either within or exterior to the building envelope.

- A basic RainGrid System offers two stage primary filtration and storage in either above or below ground cisterns.
- Primary goal of taking rooftops offline from the storm sewer system, with a secondary goal of providing harvested water for groundwater recharge, potable or non-potable uses.
- IoT system has sensors for temperature, barometric pressure, and cistern level, and an electrically actuated valve for drainage.

- **Outcomes:**
  - Stormwater Smartgrid system successfully reduces 90% rainwater runoff size of the cistern serving the roof area.
  - Stormwater Smartgrid system is capable of retaining roughly 60% of all urban runoff as system penetration rises from 20-80%.
  - Because of the smart grid innovation, RainGrid was designated by the Water Research Foundation (WRF) Leaders Innovation Forum for Technology (LIFT) as an Intelligent Water System for demonstration adoption and implementation by municipalities and utilities in 2015.

What are the Examples of Wastewater Treatment and Reuse?

Growing Tomatoes without Soil Using Vertical Farming in Hydroponics

- **Place of Implementation**: Port Augusta, South Australia Organization: Sundrop Farms
- **Year of Implementation**: 2016
- **Background:** The **UN's Food and Agricultural Organization** estimates that food production levels need to be increased by 70% from 2007 levels by 2050 to feed a projected world population of 9.7 billion.
  - Due to reduced availability of land for agriculture, efficient farming methods have become a necessity.
- **Objectives:**
  - To produce crops with the help of sea water, without soil in arid regions.
  - To increase water usage efficiency in farms and conserve more water.
  - Use of vertical farming to achieve food security Interventions.
  - A vertical farming hydroponics facility is established to grow tomatoes without soil.
  - The desalination unit produces pure water to irrigate the crops. The heat and carbon dioxide keep the tomatoes in the optimum atmosphere to facilitate year-round photosynthesis.
- **Outcome:**
  - The farm produces one million liters of fresh water every day by desalinating seawater drawn from 3 km away.
  - 7,000 tonnes of tomatoes a year i.e.15% of Australia's total crop was grown in arid land.
  - 1,80,000 of tomatoes were grown hydroponically in stacks without soil.
  - Saving of 2 million liters of diesel and 15,000 tons of CO_2 when compared to traditional farms

Waterless Dyeing Technology in Textile Processing

- Waterless dyeing technology is a new way of dyeing synthetic fabric using carbon dioxide instead of water and chemicals.
- The technology was developed by DELFT University, DyeCoo and Tong Siang Co. and implemented in Taiwan in 2012.
- **Background:**
  - Conventional textile dyeing is highly water intensive. It uses fresh water as solvent generates highly polluted water that must be treated extensively prior to discharge into rivers.
- **Outcome**:
  - The technology has several environmental benefits, such as eliminating chemical solvents,

reducing energy usage by 49%, saving water withdrawals of 8256000 m3 per year, and achieving zero effluent discharge.

Namakkal District of Tamil Nadu became Water Secured

- Namakkal district of Tamil Nadu implemented various water conservation and management initiatives in 2022 to address water scarcity and make it water secure.
- The district constructed **rooftop collection systems, percolation tanks, check dams, farm ponds, recharge shafts** and artificial recharge structures to capture rainwater and replenish the groundwater table.
- The district also r**emoved encroachments along the waterbodies, rejuvenated 49 tanks and 1400 kms of minor streams and rivers,** created sewerage network and cleaned sewerage lines.
- The district used **data acquisition systems to monitor and control water supply networks, detect leaks,** reduce system losses and optimise water distribution.
- As a result of these interventions, Namakkal **became the second best district in India in terms of groundwater availability** and achieved the second place in the Union Jal Shakti Ministry's annual ranking for water conservation and management in 2022.

Reuse of Treated Water in Thermal Power Plant in Nagpur

- In 2015, MahaGenCo and the Nagpur Municipal Corporation (NMC) implemented a wastewater reuse project in Nagpur due to water scarcity caused by the city generating 425 million liters of wastewater daily with a capacity of only 100 million liters.
- The project aimed to address this issue and increase water supply for a thermal power plant while diversifying water sources.
- It included a raw wastewater intake facility, a wastewater treatment plant with secondary and tertiary treatment, a 16.2 km pipeline to the power plant, and a one-day reservoir at the power plant.
- MahaGenCo paid NMC INR 2.03 per cubic meter of raw wastewater.
- As a result, **Nagpur became the first Indian city to reuse over 90% of its wastewater,** benefiting from reduced water transport costs and consistent, cost-effective, high-quality treated wastewater for the power plant.

What are the Advantages of Wastewater Treatment and Reuse Approach?

- Hydroponics in combination with desalination is efficient method of growing crops with reduced fresh water consumption.
- Waterless drying technology in textile industries results in enormous amount of water and energy savings.
- Tertiary treatment of wastewater and its reuse in mining operations presents a financially and environmentally beneficial model.
- Nagpur model of reuse of tertiary treated water to generate steam in thermal power plant is an excellent demonstration of how circular economy can result in lowering the volume of freshwater withdrawal. This model can be adopted by other cities as well.
- Community-driven initiatives are better maintained and demonstrate longevity in terms of resource management.
- In large urban water supply systems, comprehensive monitoring and real-time data procurement ensures control, decision support and sustainable use of water resources.

What are Some of the Best Practices of Climate Resilient Water Management?

What is Climate Resilient Water Management (CRWM) ?

- CRWM is an approach that aims to increase the resilience of water systems to the impacts of climate change and other uncertainties.
- CRWM involves **managing the demand and supply of water resources,** as well as enhancing the adaptive capacity of water users and managers. CRWM also **integrates water management with other aspects of sustainable development, such as disaster risk reduction,**

biodiversity conservation, and social equity.

Flood Forecasting and Early Warning System in Kolkata

- **About:** Kolkata Municipal Corporation (KMC) implemented a Flood Forecasting and Early Warning System (FFEWS) in 2018 with the help of Asian Development Bank (ADB) **to improve the city's flood resilience.**
- **Background:** Kolkata is highly prone to recurring flooding:
  - Urbanization challenges like encroachment of water bodies, inadequate storm water drainage systems, inadequate solid waste management block the tidal channels
  - Deltaic topography and extreme rainfall'
  - Lack of flood preparedness.
  - Flood Forecasting and Early Warning System (FFEWS) is the first comprehensive city level early warning system in India implemented by KMC with the help of ADB.
- **Objective:**
  - To improve flood resilience of the city
  - Monitor and disseminate flood risk data
- **Interventions:**
  - FFEWS uses 400 sensor nodes to monitor and visualize real time data on temperature, air quality, water stagnation and other climate related data in a GIS platform.
  - FFEWS also uses ultrasonic sensors and shopfront sensors to capture real time information on flood and air quality in vulnerable hotspots and commercial areas.
  - FFEWS disseminates warnings to the public through mobile notifications, radio and television broadcasts.
- **Outcomes:** FFEWS has reduced flooding in about 4,800 hectares of the city, reduced traffic congestion, improved urban planning, reduced economic loss and improved flood awareness and safety at community level.

Temporary Flood Water Storage in Agricultural Areas in the Middle Tisza River Basin

- **About:** The Government of Hungary implemented a flood protection strategy for the middle Tisza river basin in 2009 using temporary reservoirs.
- **Background:** River straightening, combined with other factors (sediment accumulation in some river sections, deforestation, land use change) caused continuous increase in peak flood water levels.
  - From the period 1998-2001 four serious flood events took place on the Tisza river with peak water levels, as neither the height of the dikes, nor their strength were adequate. In one flood event dikes were ruptured and protected areas were flooded.
- **Intervention:**
  - Six temporary reservoirs were used for agricultural purposes in normal periods and utilized for temporary water retention during floods.
  - An additional water retention area along the Tisza river was created in 2022. The water retention areas were planned to have a lifetime of over 100 years.
  - A mechanism of economic compensation implemented by the government for remunerating farmers in case of damage to the agricultural soil and yield losses during flood events.
  - Cost-benefit analysis of the selected strategy performed
- **Outcome:**
  - Area utilized for agricultural purposes in normal conditions, is eventually flooded (intentionally and under controlled conditions) and utilized for flood water retention in case of emergency.
  - This system supplemented the dikes to cope with floods with a return period of 100 years or higher.
  - Allowed buffering during extreme precipitation events and reducing flood wave propagation, with consistent beneficial implications for flood risk mitigation.
  - Cost benefit analysis presented a tradeoff between efficiency in risk reduction and

relatively low initial investment costs.

Sihlanzimvelo Stream Cleaning Project (South Africa)

- The Sihlanzimvelo Stream Cleaning Project is an initiative by the eThekwini municipality in Durban, South Africa, in 2011 to **manage flooding and stormwater blockages in the Umhlangane River Catchment.**
    - The project also aims to educate the communities about flood management and environmental issues.
- **Background:** The coastline along eThekwini is vulnerable to flooding and erosion as culverts designed in earlier times did not factor in the debris carried by rivers during storm events.
    - The streams are located in high density, low-income settlements with poor water quality. This poses human health risks and flood associated impacts.
    - Alien and invasive vegetation, accumulation of solid waste increased the amount of silt in rivers causing stormwater blockages.
- **Outcome:**
    - Sihlanzimvelo expanded its reach from 295 km to 525 km, creating clean public spaces for recreation.
    - Around 800 jobs were created, saving millions of rand by preventing damage to road culverts and infrastructure in the city.
    - The maintenance program removed solid waste and alien vegetation in KwaMashu under the Sihlanzimvelo Stream Cleaning Project.

Metropolitan Area Outer Underground Discharge Channel (MAOUDC)

- **About: T**okyo, Japan, built an underground flood defense system called Metropolitan Area Outer Underground Discharge Channel (MAOUDC) in 2005 to **prevent severe floods in Tokyo during the monsoon season.** The system reduces the risk of flooding and its impacts on the city.
- **Intervention:**
    - Underground tunnels works as a function to divert and manage flood water.
    - The system consists of underground tunnels, silos, pumps and tanks that collect, store and divert excess water from rivers to Tokyo Bay.
- **Outcome:**
    - Flood water is successfully stored during extreme rainfall and reduced the risk of water stagnation around the city.
    - The damages resulting from floods have been reduced (halved) in comparison to losses before establishing the defense system.
    - The tunnels are open to tourists and visitors to spread awareness about the importance of disaster management during inactivity.

What are the Advantages of Climate Resilient Water Management Approach?

- In the wake of rising flood events all across India, sustainable flood protection initiatives are required.
- Hungary introduced a cost-effective practice for flood protection in which agricultural land is used as temporary reservoir during flooding for water retention.
- Constructing underground tunnels as practiced in Japan is an innovative measure to divert and manage flood water.
    - The water stored in the storage may be used for domestic supply or can be pumped back into the river when the river water recedes.
- Flood Forecasting and Early Warning System (FFEWS) model implemented in Kolkata can be replicated in other cities.
- Real time monitoring through smart technology is effective in building city’s flood resilience.