ഏപ്രിൽ 2025

അമൃത്

വാർത്താ പത്രിക

ലക്കം 2

Atal Mission for Rejuvenation and Urban Transformation

Azadi Ka Amrit Mahotsav

അമൃത് 2.0 പദ്ധതിയിൽ ഉൾപ്പെടുത്തി നവീകരിച്ച കണ്ണൂരിലെ വലിയ കുളം

അമൃത് 2.0 പദ്ധതിയിൽ ഉൾപ്പെടുത്തി നവീകരിച്ച കണ്ണൂരിലെ ചെട്ടിയാർ കുളം

അമൃത് വാർത്താ പത്രിക

ഏപ്രിൽ 2025 | പുസ്തകം 4 | ലക്കം 1

എഡിറ്റോറിയൽ

കേരളത്തിലെ നഗരങ്ങളുടെ നഗര നയവുമായി ബന്ധപ്പെട്ട് നവകേരള അർബൻ പോളിസി കമ്മീഷന്റെ അവസാന സിറ്റിംഗ് നടത്തി. ഇതിലൂടെ വന്ന ആശയങ്ങൾ ക്രോഡീകരിച്ച് പുതിയ നവ കേരള നയം പ്രസിദ്ധീകരിക്കുന്നതിലൂടെ പുതിയ നവ കേരളം കെട്ടിപടുക്കാൻ സാധിക്കട്ടെ എന്ന് ആശംസിക്കുന്നു. കേന്ദ്ര സർക്കാർ അമൃതിലൂടെ നടപ്പാക്കിയ റിഫോം ഇൻസെന്റീവ് പദ്ധതിയുടെ ഭാഗമായി 92 നഗരസഭകളിലെയും വിലയിരുത്തലുകൾ സമർപ്പിക്കുവാൻ സാധിച്ചു. ഇതിനായി പ്രവർത്തിച്ച നഗരസഭാ ഉദ്യോഗസ്ഥരെയും അമൃതിലെ എക്സ്പർട്ടുകളെയും പ്രത്യേകം അഭിനന്ദിക്കുന്നു. പുതിയ കേന്ദ്ര ബജറ്റ് പ്രഖ്യാപനങ്ങളുടെ ഭാഗമായി 'അർബൻ ചലഞ്ച് ഫണ്ട്' എങ്ങനെ കേരളത്തിൽ വിനിയോഗിക്കാമെന്നത് വരുന്ന മാസങ്ങളിൽ നമുക്ക് ഒന്നുചേർന്ന് തീരുമാനിക്കേണ്ടതുണ്ട്.

പുതിയ ഫണ്ട് വിതരണ സമ്പ്രദായമായ എസ്.എൻ.എ. സ്പർശ് മുഖാന്തിരം ആദ്യ മദർ സാംഗ്ഷൻ വഴി ലഭിച്ച ഫണ്ട് വിനിയോഗിക്കാൻ നമുക്ക് സാധിച്ചത് ഏവരുടെയും ഒറ്റക്കെട്ടായ പ്രവർത്തനഫലമായാണ്. ഇതിനായി പ്രവർത്തിച്ച സ്റ്റേറ്റ് മിഷൻ മാനേജ്മെന്റ് യൂണിറ്റിലെയും, സിറ്റി മിഷൻ മാനേജ്മെന്റ് യൂണിറ്റിലെയും, നഗരസഭ, ധനകാര്യ വകുപ്പ്, തദ്ദേശ സ്വയംഭരണ വകുപ്പ്, ട്രഷറി വകുപ്പ് എന്നിവിടങ്ങളിലെയും മുഴുവൻ ജീവനക്കാരെയും അഭിനന്ദിക്കുന്നു. ഇതിലൂടെ 117 കോടിയോളം രൂപ നമുക്ക് വിതരണം ചെയ്യുവാൻ സാധിച്ചു. അതുപോലെ സംസ്ഥാന തദ്ദേശ സ്വയംഭരണ വകുപ്പിന്റെ നേതൃത്വത്തിൽ നടക്കുന്ന 'വൃത്തി 2025' ലൂടെ മലിനീകരണവുമായി ബന്ധപ്പെട്ട് കേരളം നേരിടുന്ന വെല്ലുവിളികളുടെ പരിഹാരമാർഗ്ഗങ്ങൾ നമ്മൾ ചർച്ച ചെയ്യുന്നതിലൂടെ ഉരുത്തിരിയുന്ന ആശയങ്ങൾ നമ്മൾക്ക് നടപ്പിലാക്കുവാൻ സാധിക്കട്ടെ എന്നും ആശംസിക്കുന്നു. ഇതിലൂടെ നടക്കുന്ന നമ്മുടെ മോഡൽ പ്രോജക്ടുകൾ നൂതന ആശയങ്ങൾ എന്നിവ മറ്റുള്ളവരിലേയ്ക്കും എത്തിക്കുന്നതിനായി സംഘടിപ്പിക്കുന്ന പ്രദർശനങ്ങളിലൂടെ സാധിക്കട്ടെ എന്ന് ആശംസിക്കുന്നു.

മിഷൻ ഡയറക്ടർ

തദ്ദേശസ്വയംഭരണ വകുപ്പ്
കേരള സർക്കാർ

ചീഫ് എഡിറ്റർ
സൂരജ് ഷാജി ഐ.എ.എസ്സ്
മിഷൻ ഡയറക്ടർ

എഡിറ്റർ
മുരളി കൊച്ചുകൃഷ്ണൻ
എൻവിയോൺമെന്റ് എക്പർട്ട് കം
ഹൈഡ്രോ ജിയോളജിസ്റ്റ്

അസിസ്റ്റന്റ് എഡിറ്റർ
സാവിയോ സജി ഇ.ആർ.

സ്റ്റേറ്റ് മിഷൻ മാനേജ്മെന്റ് യൂണിറ്റ് (അമൃത്)
നാലാം നില, മീനാക്ഷിപ്ലാസാ,
ആർടെക് ബിൽഡിംഗ്,
ഗവ. ആശുപത്രിക്ക് എതിർവശം,
തൈയ്ക്കാട്, തിരുവനന്തപുരം - 695014
ഫോൺ നം. : +91-471-2323856,
ഫാക്സ് : +91-471-2322857
വെബ്സൈറ്റ് : www.amrutkerala.org
ഇമെയിൽ : smmukerala@gmail.com

(സ്വകാര്യ വിതരണത്തിന് മാത്രം)

ബഹു. കേന്ദ്ര നഗരകാര്യ വകുപ്പ് മന്ത്രി ശ്രീ. മനോഹർ ലാൽ ഖട്ടറുമായി ബഹു. തദ്ദേശ സ്വയംഭരണ വകുപ്പ് മന്ത്രി ശ്രീ. എം.ബി. രാജേഷ് ചർച്ച നടത്തി

അമൃത് വാർത്താ പത്രിക

ഏപ്രിൽ 2025

ഉള്ളടക്കം

അമൃത് 2.0 പദ്ധതിയിൽ ഉൾപ്പെടുത്തി തൃശ്ശൂർ കോർപ്പറേഷനിൽ നവീകരിച്ച പുത്തൻകുളം


Press Meet
ERALA URBAN POLICY COMMISSION
REPORT 2025
LSGD


ENTRY
EXIT

കേരള അർബൻ പോളിസി കമ്മീഷൻ അന്തിമ റിപ്പോർട്ട് ബഹു. മുഖ്യമന്ത്രിയ്ക്ക് സമർപ്പിച്ചു

നവ കേരള നഗര നയത്തിന്റെ ഭാഗമായി സംസ്ഥാന സർക്കാർ രൂപീകരിച്ച കേരള അർബൻ പോളിസി കമ്മീഷൻ അന്തിമ റിപ്പോർട്ട് ബഹു. മുഖ്യമന്ത്രിയ്ക്ക് സമർപ്പിച്ചു. അന്തിമ റിപ്പോർട്ട് തയ്യാറാക്കി അംഗീകരിക്കുന്നതിന്റെ ഭാഗമായി തിരുവനന്തപുരത്ത് വച്ച് കമ്മീഷന്റെ സമ്പൂർണ്ണ യോഗം നടന്നു. നഗരവത്ക്കരണ രംഗത്ത് സംസ്ഥാനം നേരിടുന്ന വിവിധങ്ങളായ പ്രശ്നങ്ങളെയും അവയുടെ പരിഹാരങ്ങളെയും സംബന്ധിച്ച് സമഗ്രമായ ചർച്ചകളും പ്രഭാഷണങ്ങളും യോഗത്തിന്റെ ഭാഗമായി സംഘടിപ്പിച്ചിരുന്നു. അർബൻ പോളിസി കമ്മീഷൻ മെമ്പർ സെക്രട്ടറിയും തദ്ദേശ സ്വയംഭരണ വകുപ്പ് പ്രിൻസിപ്പൽ സെക്രട്ടറിയുമായ ഡോ. ഷർമിള മേരി ജോസഫ് ഐ.എ.എസ്. കമ്മീഷനംഗങ്ങളെ യോഗത്തിലേയ്ക്ക് ഔപചാരികമായി സ്വാഗതം ചെയ്തു. സുസ്ഥിര നഗര വികസനത്തിലധിഷ്ഠിതമായി അടിസ്ഥാന ഭൗതീക വികസന സൗകര്യങ്ങൾ ആസൂത്രണം ചെയ്യുവാനായി കമ്മീഷൻ സ്വീകരിച്ച നടപടികളും നയരൂപീകരണത്തിന്റെ ഭാഗമായി വിവിധ യോഗങ്ങൾ നടത്തിയതും അതിന്റെ തുടർച്ചയായി നടത്തിയ പ്രവർത്തനങ്ങളും പ്രിൻസിപ്പൽ സെക്രട്ടറി യോഗത്തിൽ വിശദീകരിച്ചു.

തദ്ദേശ സ്വയംഭരണ വകുപ്പ് മന്ത്രി ശ്രീ. എം.ബി. രാജേഷ് യോഗത്തിൽ പങ്കെടുത്ത് കമ്മീഷന്റെ പ്രവർത്തനങ്ങൾ വിലയിരുത്തി. പുതിയ നഗര നയത്തിൽ തദ്ദേശ സ്വയംഭരണ സ്ഥാപനങ്ങളുടെ വികേന്ദ്രീകൃത സ്വഭാവം ശക്തിപ്പെടുത്തുന്ന രീതിയിലുള്ള നിർദ്ദേശങ്ങളും, തദ്ദേശ സ്ഥാപനങ്ങൾക്ക് വിഭവശേഷി വിനിയോഗിച്ച് സ്വയം വരുമാനം കണ്ടെത്താനും ത്വരിതഗതിയിൽ നഗരവത്ക്കരണം നടക്കുമ്പോൾ കേരളത്തിന്റെ സാമൂഹിക സുരക്ഷാ സംവിധാനങ്ങളെ നിലനിർത്തുന്നതിനും മുന്നോട്ടു കൊണ്ടുപോകുന്നതിനുമുള്ള നിർദ്ദേശങ്ങളും നഗര നയത്തിൽ ഉൾപ്പെടുത്തിയിട്ടുണ്ടെന്ന് മന്ത്രി പറഞ്ഞു.

അർബൻ പോളിസി കമ്മീഷൻ ചെയർമാൻ ഡോ. എം. സതീഷ്കുമാർ കമ്മീഷൻ നടത്തിയ പ്രവർത്തനങ്ങളെ കുറിച്ച് അവലോകനം നടത്തി കൈവരിച്ച നേട്ടങ്ങൾ യോഗത്തിൽ വിവരിച്ചു. നയരൂപീകരണത്തിനാധാരമായി രൂപപ്പെടുത്തിയ ആശയങ്ങളിലധിഷ്ഠിതമായ പഠന പുരോഗതി സംബന്ധിച്ചുള്ള ചർച്ചകളും പ്രസന്റേഷനും യോഗത്തിന്റെ ഭാഗമായി നടന്നു. .

ചീഫ് സെക്രട്ടറി ശ്രീമതി ശാരദാ മുരളീധരൻ യോഗത്തിൽ പങ്കെടുത്തു. നഗര നയ രൂപീകരിണവുമായി ബന്ധപ്പെട്ടുള്ള നിർദ്ദേശങ്ങളും അഭിപ്രായങ്ങളും യോഗത്തെ അറിയിച്ചു. കമ്മീഷൻ ചെയർമാൻ ഡോ. എം. സതീഷ് കുമാർ, സീനിയർ അസോ സിയേറ്റ് പ്രൊഫസർ, ക്വീൻസ് ഇന്ത്യാ അക്കാഡമി, യുണൈറ്റഡ് കിംഗ്ഡം, അഡ്വ. എം. അനിൽ കുമാർ, മേയർ, കൊച്ചി., ഡോ. ഇ. നാരായണൻ, കൺസൾട്ടന്റ്, വേൾഡ് ബാങ്ക്., ഡോ. ഷർമിള മേരി ജോസഫ് ഐ.എ.എസ്., പ്രിൻസിപ്പൽ സെക്രട്ടറി തദ്ദേശ സ്വയംഭരണ വകുപ്പ്., പ്രൊഫ. ഡോ. ജാനകി നായർ, എം. കൃഷ്ണദാസ്, ചെയർമാൻ, ചേംബർ ഓഫ് മുനിസിപ്പൽ ചെയർമാൻ, ശ്രീ. വി. സുരേഷ്, മുൻ ചീഫ് മാനേജിംഗ് ഡയറക്ടർ, ഹഡ്കോ, പ്രൊഫ. ഡോ. വൈ.വി.എൻ. കൃഷ്ണമൂർത്തി, പ്രൊഫ. ഡോ. കെ.എസ്. ജയിംസ്, പ്രൊഫ. ഡോ. കെ.ടി. രവീന്ദ്രൻ, പ്രൊഫ. ഡോ. അശോക് കുമാർ, ശ്രീ. ഹിതേഷ് വൈദ്യ, ശ്രീ. ടിക്കേന്ദർ സിംഗ് പൻവാർ എന്നിവരാണ് കമ്മീഷൻ അംഗങ്ങൾ.

തദ്ദേശ സ്വയംഭരണ വകുപ്പിന്റെ നവീകരിച്ച വെബ്സൈറ്റ് ബഹു. തദ്ദേശ സ്വയംഭരണ വകുപ്പ് മന്ത്രി ലോഞ്ച് ചെയ്തു

തദ്ദേശ സ്വയംഭരണ വകുപ്പിന്റെ നവീകരിച്ച വെബ്സൈറ്റ് ബഹു. തദ്ദേശ സ്വയംഭരണ വകുപ്പ് മന്ത്രി ശ്രീ.എം.ബി. രാജേഷ് ലോഞ്ച് ചെയ്തു. തദ്ദേശ സ്ഥാപനങ്ങളിലേയ്ക്ക് വരാതെ തന്നെ എല്ലാ സേവനങ്ങളും പൊതുജനങ്ങളുടെ വിരൽത്തുമ്പിൽ ലഭ്യമാക്കുന്ന സുവർണ്ണ കാലഘട്ടത്തിലേയ്ക്ക് തദ്ദേശ സ്വയംഭരണ വകുപ്പ് മുന്നേറുകയാണെന്ന് മന്ത്രി ഉദ്ഘാടന പ്രസംഗത്തിൽ പറഞ്ഞു. കൂടാതെ തദ്ദേശ സ്ഥാപനങ്ങളിലെ അഴിമതി സംബന്ധിച്ച പരാതികൾ അറിയിക്കുന്നതിന് ആരംഭിച്ച സിംഗിൾ വാട്സ് ആപ്പ് നമ്പർ (807 806 60 60) സേവനവും മന്ത്രി ഉദ്ഘാടനം ചെയ്തു.

VIJAYAKUMAR M.K.
Urban Infrastructure cum Water Expert
State Mission Management Unit, AMRUT

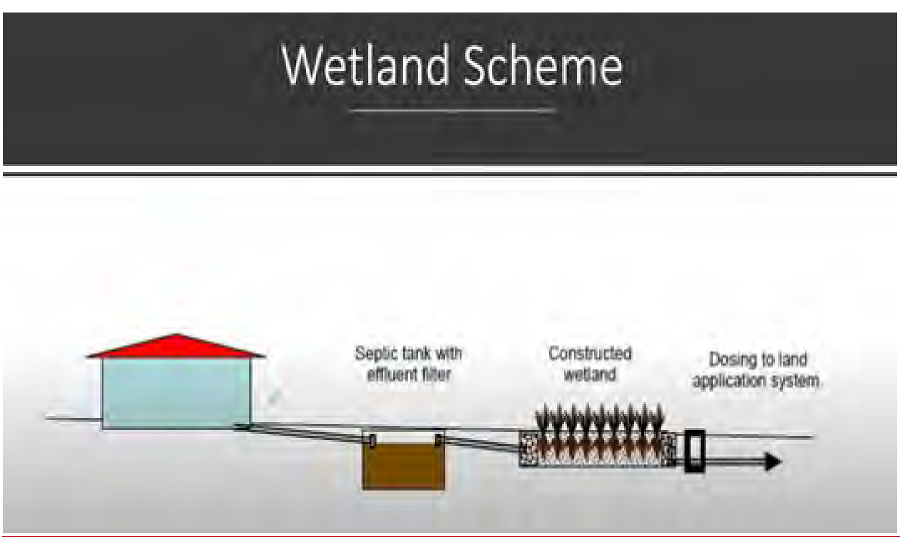
Constructed Wetlands for Wastewater Treatment in Kerala: Sustainable Solutions for Rural and Urban Areas

Introduction:

Kerala is facing significant water pollution challenges due to rapid population growth, industrialization, and urbanization, especially in urban centers like Thiruvananthapuram. The quality of water is a critical issue as it directly affects public health. Access to clean, potable water is essential for the well-being of the population.

To address this, low-cost, natural treatment methods like Constructed Wetlands (CW) offer a viable solution. CW systems, which can be implemented in hospitals, universities, and communities, are more affordable than large, expensive technologies in terms of construction, operation, and maintenance. They provide a sustainable, eco-friendly, and cost-effective approach to wastewater treatment.

Constructed Wetlands use natural processes to treat wastewater. A CW system consists of a shallow basin filled with filter material like sand or gravel, and planted with vegetation that can tolerate saturated conditions. Wastewater flows over or through the substrate, and the treated water is discharged through a structure that controls the water level. CWs replicate natural wetland processes in a controlled environment.



Wastewater from the sewer is first treated in a septic tank or anaerobic baffle reactor. The effluent is then transported through pipelines and applied to a basin via an inlet arrangement. It flows over (free water surface – FWS CW) or through filter media (sand and gravel) under gravity (subsurface flow – SSF CW), moving horizontally or vertically. The filter media supports vegetation which facilitates treatment through aerobic and anaerobic zones. The basin is sloped and lined with an impermeable material to prevent wastewater infiltration. The treated water is collected at the outlet and can be used for gardening, or discharged into the river.

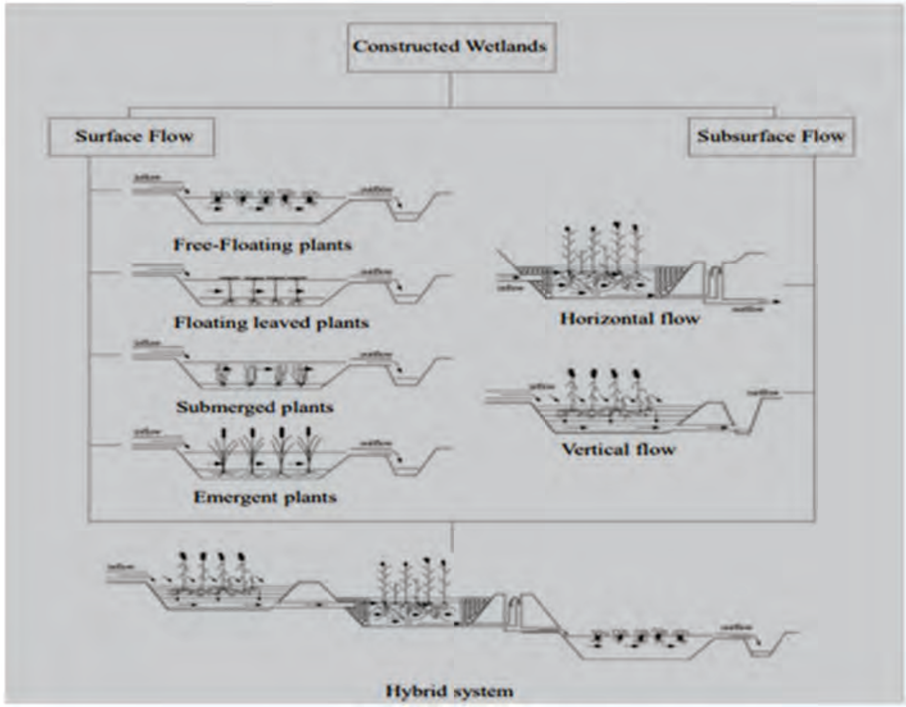
Vegetation in CWs plays a vital role in supporting microbial growth and filtration. Pollutants are removed through physical, chemical, and biological processes. Wastewater is first treated in a septic tank or anaerobic baffle reactor. Any remaining suspended solids are removed in the wetland by filtration and sedimentation. Microbial growth breaks down soluble organic compounds, both aerobically (with oxygen) and anaerobically (without oxygen). Oxygen for aerobic degradation is supplied by diffusion from the atmosphere or through oxygen leakage from plant roots, though the latter is minimal.

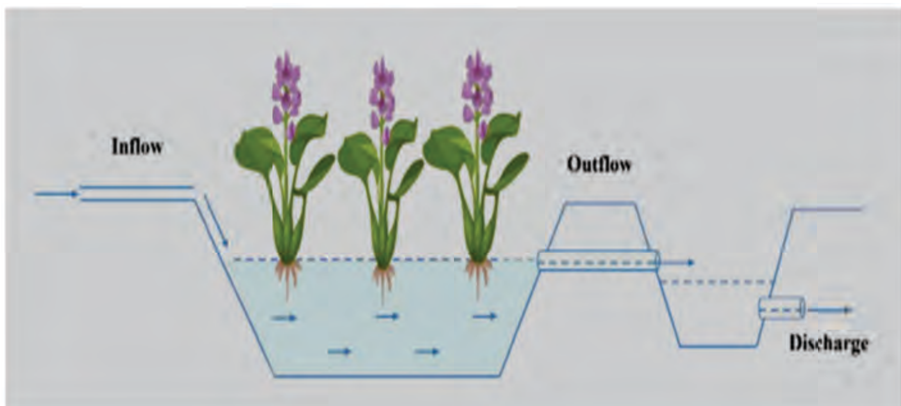
Phosphorus removal in constructed wetlands occurs through mechanisms such as adsorption, complexation, precipitation, plant uptake, and biotic assimilation. For nitrogen, removal processes include volatilization, ammonification, nitrification/denitrification, plant uptake, and matrix adsorption, with microbial nitrification/denitrification being the dominant mechanism. Ammonia is converted to nitrate by nitrifying bacteria in aerobic zones, while denitrifying bacteria convert nitrates to dinitrogen gas in anoxic and anaerobic zones.

Metal removal in CWs involves sedimentation, filtration, adsorption, complexation, precipitation, cation exchange, plant uptake, and microbial oxidation. Adsorption refers to the binding of metal ions to plant or substrate surfaces, while bacteria facilitate the precipitation of metal oxides and sulphides. Certain wetland species are also capable of directly taking up metals.

Types of Constructed Wetlands. Constructed wetlands are classified into surface/free water surface flow and subsurface flow systems. Free Water Surface (FWS) wetlands have water flowing above the media bed and are densely planted. Subsurface flow wetlands are divided into Vertical Flow (VF) and Horizontal Flow (HF) based on water flow direction. VF and HF wetlands are generally used for secondary treatment, as they are not suitable for primary treatment due to the risk of clogging.

Free water surface constructed wetlands (FWS CWs): FWSCWs consist of shallow basins where wastewater flows across the surface, requiring a significant amount of land. However, this design can result in unpleasant odours, potential waterborne diseases, and aesthetic problems. Due to these challenges, as well as concerns regarding hygiene and reduced treatment efficiency, it is recommended to avoid using FWS CWs for sewage wastewater treatment. Instead, sewage treatment in India mainly focuses on Vertical Flow Constructed Wetlands (VFCWs), Horizontal Flow Constructed Wetlands (HFCWs), hybrid systems, and aerated constructed wetlands (CWs).

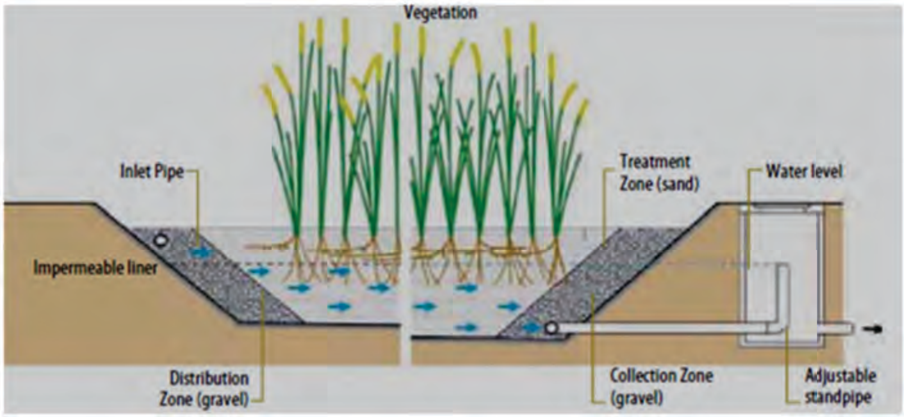




Free Water Surface Constructed Wetlands

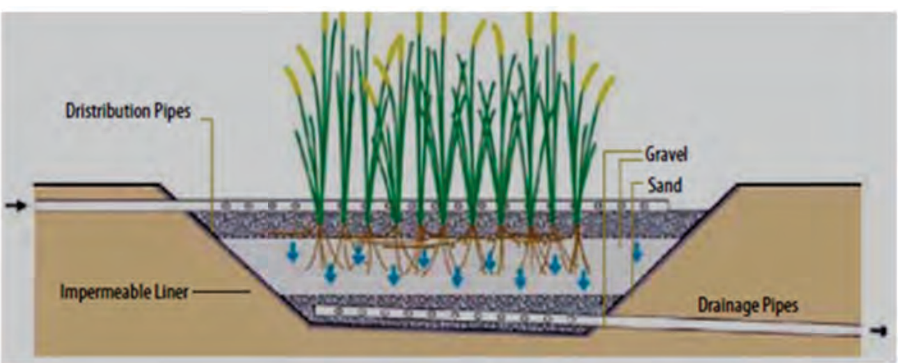
Horizontal Flow (HF): In a Horizontal Flow Wetland (HF CW), wastewater enters through the inlet and gradually moves horizontally through a porous substrate beneath the surface. During this process, the wastewater passes through a combination of aerobic, anoxic, and anaerobic zones. Aerobic zones develop around plant roots, which release oxygen into the substrate, while microbial degradation and physical/chemical processes occur as the wastewater interacts with these zones. HF CW systems are highly effective at removing organic pollutants such as Total Suspended Solids (TSS), Biochemical Oxygen Demand (BOD (5 day period)), and Chemical Oxygen Demand (COD). However, due to limited oxygen transfer, the removal of nutrients, particularly nitrogen, is less efficient, although some nitrate removal can still take place. Phosphorus removal in HF CW is generally limited, as the media used (such as crushed stones or pea gravel) has low quantities of iron (Fe), aluminium (Al), or calcium (Ca), which are necessary for phosphorus sorption and precipitation.

HF CW systems are commonly used for secondary or tertiary treatment, and it is essential to have effective primary treatment to remove particulate matter before wastewater enters the wetland system. This prevents clogging of the wetland filter beds. HF CW systems are employed for treating a variety of wastewater types, including domestic sewage, municipal wastewater, industrial effluents, agricultural runoff, and landfill leachate



Horizontal Flow Constructed Wetland.

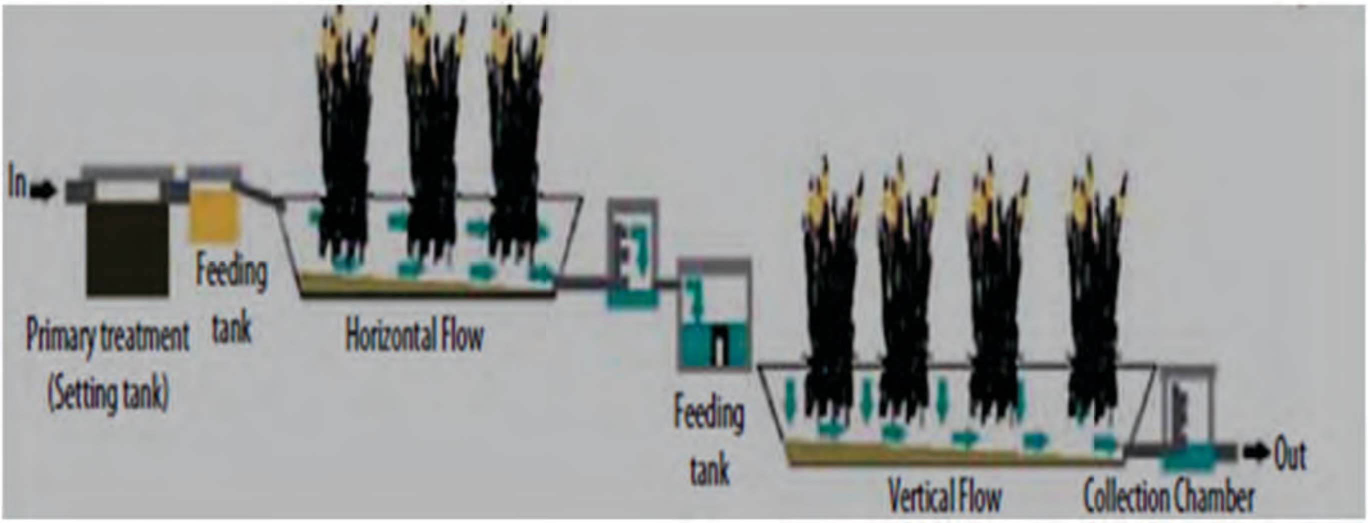
Vertical Flow (VF): A VF CW consists of a flat bed of sand or gravel topped with additional media and vegetation. Wastewater is introduced at the top and gradually filters down through the bed, where it is collected by a drainage system at the base. VF wetlands typically operate with intermittent flooding, where large doses of water are applied and allowed to drain, enabling air to refill the bed. This intermittent dosing enhances oxygen transfer, which promotes nitrification. Compared to HF CWs, VF CWs are smaller and offer better oxygen transfer, which allows for more efficient nitrification. They also effectively remove BOD5, COD, and pathogens.



Vertical Flow Constructed Wetland

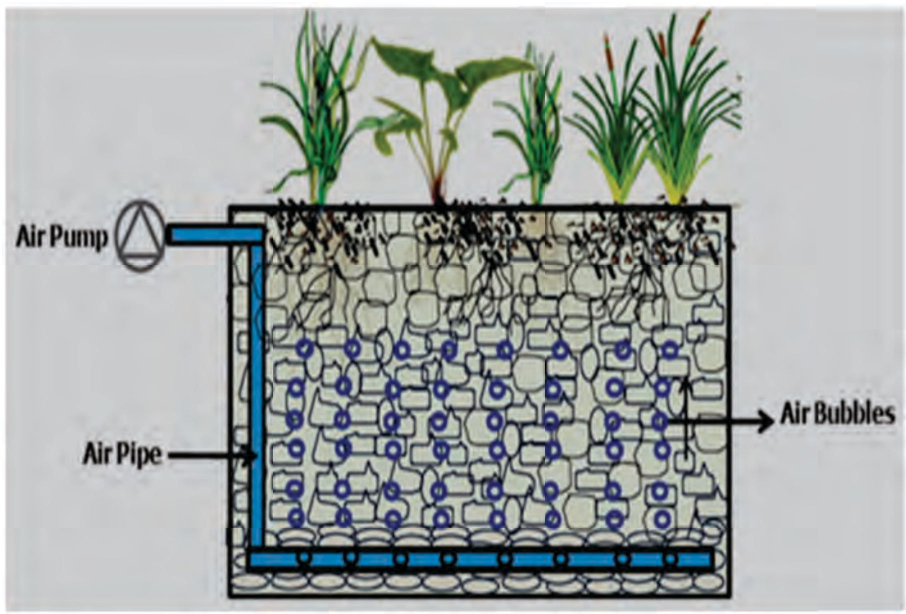
Like HF CWs, VF CWs require effective primary treatment to remove suspended particles and prevent clogging of the filter media. VF CWs are typically used for domestic and municipal wastewater treatment, although they have also been successfully applied to treat various other types of wastewater, including composting leachate, refinery effluent, airport runoff, and dairy effluent.

Hybrid Wetlands: Horizontal Flow (HF) wetlands are effective at removing BOD5 and TSS in secondary wastewater treatment but have limited capacity for nitrification due to restricted oxygen transfer. This has led to increased interest in Vertical Flow (VF) wetlands, which offer better oxygen transfer and require less space than HF wetlands. However, VF wetlands are less efficient at solids removal and can become clogged if the media is poorly selected. As a result, hybrid wetlands—combining the strengths of both HF and VF systems—have gained popularity. These hybrid systems can be arranged with HF followed by VF, or vice versa, depending on the treatment objectives.



Hybrid Wetland

Aerated Constructed Wetlands: Oxygen availability is a key limiting factor in constructed wetlands (CWs), particularly during nitrogen removal processes. To improve oxygen supply, CWs can be equipped with aeration systems designed to deliver enough oxygen for aerobic processes. Aerated CWs have the potential to reduce the land area needed compared to traditional non-aerated CWs in certain wastewater treatment applications. This reduction in area is mainly due to the improved treatment efficiency resulting from the addition of aeration.



Aerated Wetland

How a Constructed Wetland Functions: A constructed wetland is a system that combines wastewater, substrate, vegetation, and microorganisms to remove pollutants. Vegetation provides surfaces for microbial growth and filtration. Pollutants are removed through physical, chemical, and biological processes. Settleable and suspended solids are filtered, while microbes degrade organic compounds through aerobic and anaerobic processes. Oxygen for aerobic degradation comes from atmospheric diffusion or plant root leakage. Phosphorus is removed by adsorption, precipitation, plant uptake, and microbial processes. Nitrogen is mainly removed by nitrification/denitrification, plant uptake, and adsorption. Metals are removed through sedimentation, filtration, adsorption, and plant uptake. Pathogens are reduced by sedimentation, filtration, adsorption, and natural die-off.

Design Considerations: When designing a constructed wetland, it's important to consider that the substrate can become quickly clogged with debris, grit, and solids from raw wastewater if these materials are not removed beforehand. Therefore, some form of preliminary/primary treatment is recommended to eliminate settleable solids. Preliminary treatment is aimed at removing coarse solids from the wastewater to prepare it for further treatment in the wetland. It typically includes screening and grit chambers. Primary treatment involves separating suspended solids through physical means, mainly sedimentation.

A two-compartment septic tank is commonly used for primary treatment in small -

Sizing of the wetland: The wetland might be sized based on the equation proposed by

Kickuth: $\mathbf{A_h = Q_d (\ln C_i - \ln C_e) / K_{BOD}}$

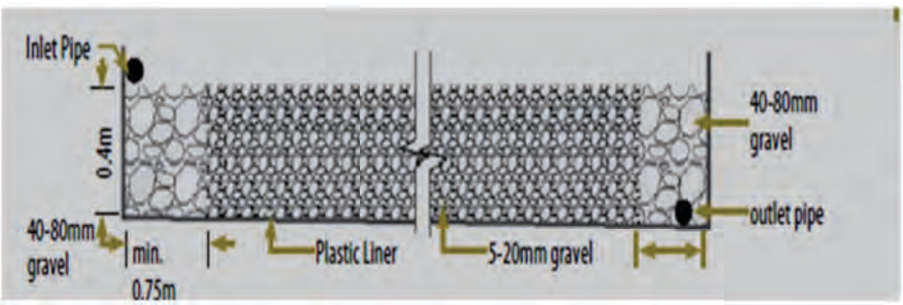
Where A_h = Surface area of bed (m^2); Q_d = average daily flow rate of sewage (m^3/d)

C_i = influent BOD_5 concentration (mg/l); C_e = effluent BOD_5 concentration (mg/l)

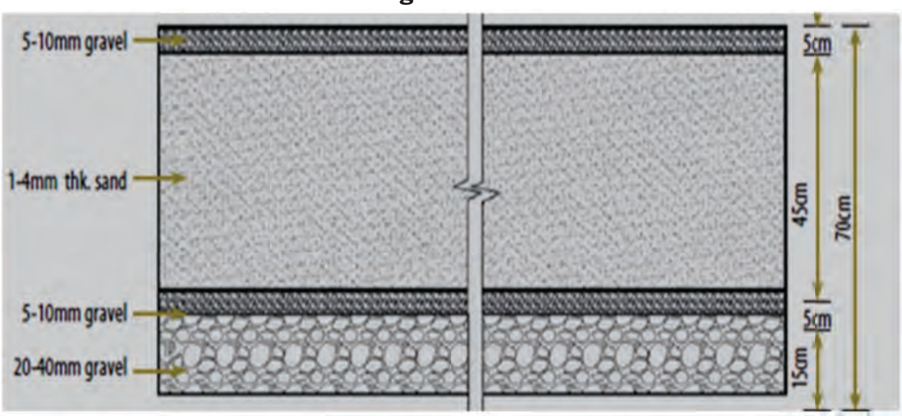
K_{BOD} = rate constant (m/d), The K_{BOD} for HF and VF wetlands are taken as 0.15 and 0.20 respectively. A specific area requirement of 1 – 2 m^2/pe would be required of HF constructed wetlands where as a specific area of 0.8 – 1.5 m^2/pe for the VF wetland.

Depth: HF wetland- 40 cm: VF wetland-70 cm.

Media selection:



Substrate arrangement in a HF wetland



Substrate arrangement in a VF wetland

Plant selection: Constructed wetlands (CWs) in South India require plant species that can thrive in the region's tropical climate, high temperatures, and seasonal rainfall. The plants used should be effective in treating wastewater while also being resilient to the local environmental conditions.

For constructed wetlands in Kerala, incorporate emergent plants like Phragmites, Typha, and Canna indica, alongside floating and submerged species, to efficiently treat wastewater and foster biodiversity.

Emergent Herbaceous Plants:

- **Phragmites (Common Reed):** A fast-growing reed that filters pollutants and provides habitat.
- **Typha (Cattail):** Tolerates various conditions, aiding in water purification.
- **Canna indica (Indian Canna):** A hardy, visually appealing plant that aids nutrient uptake.
- **Vetiver Grass:** Its strong root system stabilizes wetlands and prevents erosion.

Water Grass (Echinochloa spp.): Helps with nutrient uptake and water purification.

Floating and Submerged Plants:

- **Duckweed (Lemna spp.):** A fast-growing, floating plant that absorbs nutrients.
- **Water Hyacinth (Eichhornia crassipes):** Effective at pollutant removal, but can be invasive.
- **Water Lettuce (Pistia stratiotes):** A floating plant that assists in water purification.
- **Submerged Plants (e.g., Hydrilla verticillata, Vallisneria spiralis):** Aid in oxygenation and provide habitat for aquatic life.

Water Lilly

Canna indica

Vetiver Grass

Water Hyacinth

Merits:

- Cost-effective: CWs have low capital, energy, and maintenance costs (1–2% of capital cost).
- Versatility: Effective in treating various types of wastewater, including agricultural, industrial, and municipal waste.
- Aesthetic value: Enhances the landscape and appearance of treatment plants, resembling a garden.
- Treatment efficiency: Comparable to modern systems like activated sludge, with high removal rates for BOD (85-90%), COD (65-80%), TSS (90-95%), nitrogen (65-80%), and phosphorus (35-50%).
- Sustainability: Can use industrial waste as media, aiding in waste management while supporting microbial growth.

Demerits:

- Clogging issues: Biomass buildup can clog the system, raising operational costs.
- Maintenance: Requires timely harvesting of plants to prevent decay, which can deteriorate effluent quality.
- Limited pollutant removal: Not all plant species are suitable, and CWs may not remove all pollutants.
- Seasonal variation: Performance decreases in winter and improves in summer.
- Limited for toxic waste: Ineffective for high-strength or toxic wastewater due to negative impacts on plants and microbes.
- Space requirements: CWs need more space than conventional methods due to longer hydraulic retention time (HRT).

Conclusion:

Several physical, chemical, and biological processes occurring within wetlands help remove suspended solids (TSS, total suspended solids), organic compounds (BOD, biological oxygen demand), and chemicals (COD, chemical oxygen demand), as well as phosphorus, nitrogen, metals, and pathogens present in wastewater. Water quality tests on wastewater effluents from various constructed wetlands in India have shown that TSS, BOD, and COD are removed by more than 95%. Similarly, coliform bacteria are also removed by up to 99%.

Constructed wetlands (CWs) are an ideal wastewater treatment technology for Kerala, particularly for its rural and peri-urban areas. Due to Kerala's unique topography—ranging from lowlands to midlands and highlands—constructing extensive sewer lines for centralized wastewater treatment is economically unfeasible. In contrast, decentralized wastewater treatment systems like constructed wetlands offer a more cost-effective and efficient solution. While land in Kerala is often expensive, CWs still provide an affordable alternative compared to conventional wastewater treatment plants and sewer systems. The technology is relatively simple and requires minimal attention and technical expertise for proper operation.

Despite the enormous potential of CWs for wastewater treatment in Kerala, the rate of adoption remains low. This could be attributed to limited knowledge and experience regarding the design, implementation, and management of this technology.

By leveraging the natural processes of plants, soil, and microbes, CWs not only improve water quality but also promote biodiversity and enhance the aesthetic value of Kerala's landscapes. With careful planning, the right plant selection, and proper integration into the region's natural beauty, constructed wetlands can meet wastewater treatment standards while contributing to Kerala's environmental and ecological goals. These systems could serve as an exemplary model of eco-friendly infrastructure, benefiting both the people of Kerala and the surrounding environment.

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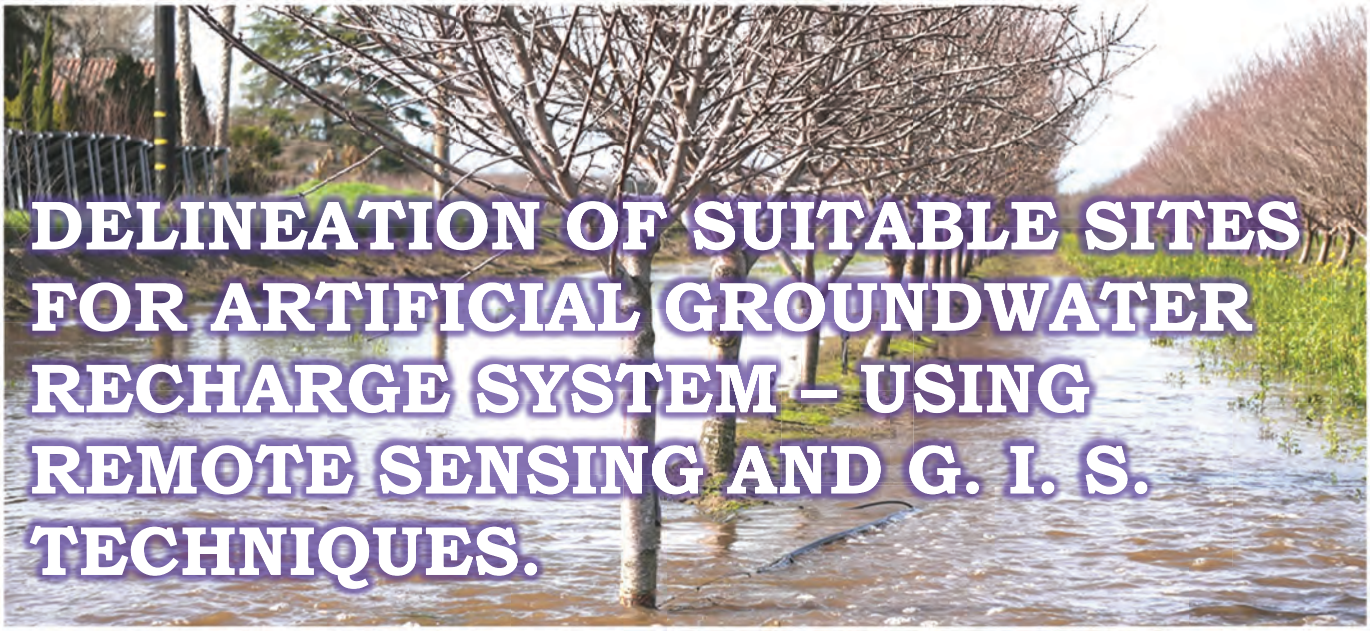


DELINEATION OF SUITABLE SITES FOR ARTIFICIAL GROUNDWATER RECHARGE SYSTEM – USING REMOTE SENSING AND G. I. S. TECHNIQUES.

MURALI KOCHUKRISHNAN
Environmental Expert cum Hydrogeologist,
State Mission Management Unit, AMRUT

About Author:
Murali Kochukrishnan, is a post Graduate (MSc in Geology (with Specialization in Hydrogeology) from Presidency College, University of Madras. He has also attained a Certificate course in Remote Sensing & GIS applications from NRSA, Hyderabad and have more than 30 years of field experiences as an Environmental Expert/ Hydrogeologist across India, Nepal, Bhutan, and Malaysia. He is currently working with AMRUT, SMMU, Kerala.

Introduction:

Water is life. The Socio-Economic Development of any country is based on the availability of the water resources. Due to increase in population, the water resources are over stretched often leading to resource depletion. There is a need to prudently manage this delicate resource. For every living organism, water is precious for continuing its life. Everybody is aware of the importance of water. In India, the groundwater was earlier utilized mainly for drinking purposes in the initial stages and on later part it is being over exploited for irrigation and industrial purposes. About 85% of Drinking water in India is available through dug well, bore well, filter point and tube wells etc. The Indian farmers have the age-old tradition of utilizing Ground water for Irrigation purposes. In India during 1950-51, about 65 Lakhs hectares of land were used for irrigation that which has crossed-over to 400 Lakhs plus hectare by now. Also, to feed the planet's 8 billion inhabitants in 2025, the world will need as much extra water simply for food production alone but not yet satisfying our needs on Drinking, Sanitation, Industrial and Irrigation requirements. **From where does all the water will come? is a big question mark**. **Groundwater distribution in the country is uneven due to spatio-temporal variations in Rainfall, Geology, Hydrogeology, Hydrology and Geomorphology.** Unplanned groundwater exploitation has led to declining water levels, causing shallow wells to dry up and affecting drinking water availability in 20–25% of habitations. In coastal areas, seawater intrusion has disrupted the freshwater balance, leading to environmental degradation. Optimal groundwater utilization requires systematic estimation, allocation for competing demands, and conjunctive use of surface and groundwater resources. **Understanding groundwater conditions clearly involves studying lithology, structural disposition, geomorphology, surface water, and climate**. Traditionally, extensive fieldwork was used, but advancements in remote sensing have improved our approaches towards groundwater studies. **While remote sensing cannot directly detect groundwater, it provides reliable inferences about potential groundwater zones amenable for recharge and also for tapping productive zones**. Professional organizations now begin groundwater investigations with remote sensing data analysis. Interpretation of these data, followed by selective field checks and geophysical methods, enhances accuracy in identifying potential areas amenable for ground water recharge as well for tapping productive groundwater zones. **This paper will deal with the ideas of using remote sensing and G.I.S techniques to effective measure to generate data and information for sustainable development of water resources in finding out areas amenable for ground water recharge on a regional scale.**

Over Exploitation of Ground Water Resource and its Effects:

- Drastic fall of groundwater levels.
- Drying up of wells/bore wells.
- Enhanced use of energy.
- Ingress of seawater in coastal areas.
- Drought situation.

Matter of Prime Concern:

If the over exploitation is not curtailed and the ground water reservoir are not replenished properly, we are forcing our future generation to be water starved. Therefore, there is strong need of an appropriate and low cost rain water harvesting technologies in order to artificially recharge the ground water reservoirs and Managed Aquifer recharge (MAR) methodologies.

What is Recharge System?

Recharge is a process, by which the ground water reservoir (aquifer) is augmented/replenished by process of infiltration and percolation of precipitation. Any man-made feature facilitating the process of adding up of water to an aquifer is considered as **"Artificial recharge system or Managed aquifer recharge system".**

Purpose of Artificial Recharge System/ Managed aquifer recharge system:

- To create a water balance between **demand** and **supply**.
- To replenish aquifer, which are over-exploited.
- To combat adverse conditions such as **Drought, Salinity and Sea water intrusion** and mitigate the processes.
- To judiciously maintain the water table in the area of influence.
- To reduce surface run-off and arrest soil erosionand enhance soil- moisture content.
- To reduce or stop significant land subsidence.
- To artificially store water for future generation.
- To provide irrigation potential to farmers.
- To improve the physical and chemical quality of water.

Why Remote Sensing Data are Important?

* Quick interpretation of perspective zones amenable for in- situ recharge on a regional scale.
* Cost effectiveness. Larger areas are quickly mapped/ traversed for speedy surveys and better cognizing of areas for the execution of activities.
* Single satellite imagery gives information on Geology, Geomorphology, Hydrology, Structural features etc. that which provides valuable data and resource set.

Factors Controlling Groundwater Regime and Ground Water Recharge: Ground water system is a dynamic system, whereby water is absorbed at the surface and eventually recycled back to the surface. **The parameters involved in this dynamic process are geological boundaries, hydro-geological boundaries, soil characteristics, inflow and out flow of water, storage capacity, porosity, permeability, hydraulic conductivity, transmissivity, natural discharge of springs, water available for recharge, natural recharge, type and depth of aquifer, lithology, tectonic boundaries** etc...

As groundwater regime is a dynamic system which is further influenced by various other factors such as relief, slope, depth of weathering, deposited material, surface water bodies, river networks, precipitation, and irrigated areas. Additionally, geological frameworks, including rock types, structural deformation, and geomorphic history, significantly impact groundwater distribution. Given the infinite combinations of these variables, groundwater conditions at any site are unique and not fully predictable. Some conditions remain obscured despite field observations. A factor-wise analysis, systematic mapping, and data integration based on conceptual understanding can help overcome these challenges. However, given the large number of variables affecting groundwater conditions, it is impractical to study each one separately. Conventional hydrogeological mapping carries inherent uncertainties, making systematic and simplified approaches necessary for better inferences.

Streamline groundwater Studies:

There are four primary controlling factors that have been identified:

1. **Geology/Lithology**: Determines rock type and water -holding capacity.
2. **Geological Structures**: Includes faults, folds, and fractures that influence groundwater movement.
3. **Geomorphology/Landforms**: Governs groundwater storage and recharge potential.
4. **Recharge Conditions:** Affects groundwater replenishment through rainfall, rivers, and human activities.

Precise knowledge of these factors enhances understanding of aquifer characteristics. Satellite imagery, combined with geological, hydrogeological, and geomorphological data, supported by field observations, improves groundwater mapping. Integrating lithological, structural, landform, and hydrological data leads to better groundwater prospect maps compared to traditional hydrogeological mapping.

Lithology:

Satellite imagery, with its synoptic view and multispectral capabilities, aids in differentiating and mapping lithologic units. Geological mapping primarily relies on visual interpretation using a deductive approach, considering image characteristics, terrain information, and prior geological knowledge. Key indicators include tone (color), landform features, erodibility, drainage patterns, soil type, and land use/ land cover.

Tone provides a direct clue to rock types—acidic and arenaceous rocks appear lighter than basic or argillaceous rocks. Coarse-grained, porous rocks are brighter, while fine-grained, moisture-retaining rocks appear darker. Resistant formations form hills, whereas easily erodible rocks create plains and valleys. Drainage patterns also indicate lithology; dendritic drainage suggests homogeneous rocks, while trellis, rectangular, and parallel patterns indicate structural controls. Coarse drainage texture points to porous formations, whereas fine drainage suggests less permeability. Light -coloured, coarse-textured soils indicate quartz- and feldspar-rich rocks, whereas dark, fine-textured soils suggest argillaceous formations.

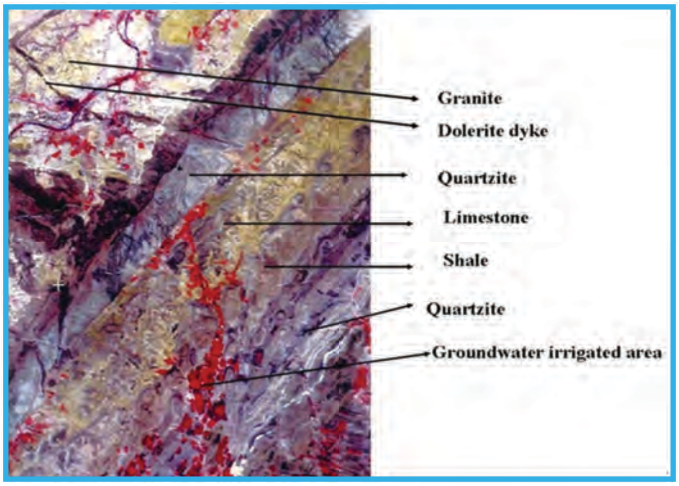


Figure : 1:- Interpretation of Lithology from Satellite Imagery: Source NRSA

Lithologic interpretation requires convergence of multiple evidences rather than reliance on a single factor. Field validation is essential for accuracy, allowing refinement of interpreted maps. Once rock types are identified, their contacts can be extended over large areas with minimal ground verification, enabling correlation and extrapolation based on spectral and morphological similarities. For lithological mapping data sources includes the existing geological/ hydrogeological maps and literature, Satellite image interpretation, field surveys for validation and refinement.

Geological Structures:

Satellite imagery is invaluable for mapping geological structures, offering a synoptic view that aids regional-scale interpretation, overcoming limitations of ground surveys such as scanty rock exposures and soil cover. Primary and secondary structures, including bed attitudes, schistosity/foliation, folds, and lineaments, can be identified by analysing landforms, slope asymmetry, outcrop and drainage patterns, and stream courses.

Figure : 2:- Satellite imagery of the study area

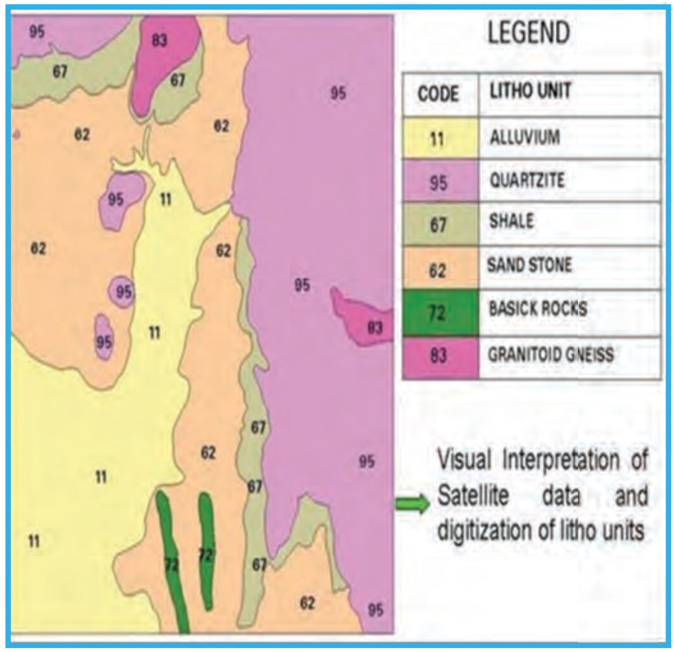


Figure:3:- Preparation of lithological map

Lineaments, representing faults, fractures, and shear zones, are the most prominent structural features observable on satellite. They influence groundwater occurrence and movement in hard rock terrains and appear as linear to curvilinear features, often marked by vegetation alignment, moisture presence, and straight stream courses. Based on image characteristics and geological evidence, they can be further classified into faults, fractures, and shear zones. Lineaments are important in rocks where secondary permeability and porosity dominate the inter -granular characteristics combine in Secondary openings influencing weathering, soil water and ground water movements. The fracture zones form an interlaced network of high transmissivity and acts as ground water conduits in massive rocks in inter fractured areas. **The lineament intersection areas are considered to be good ground water potential zones**. **The areas with higher lineament density and topographically low elevated grounds are considered to be the best aquifer zones.** All the linear features in the study area should be marked on the lineament map.

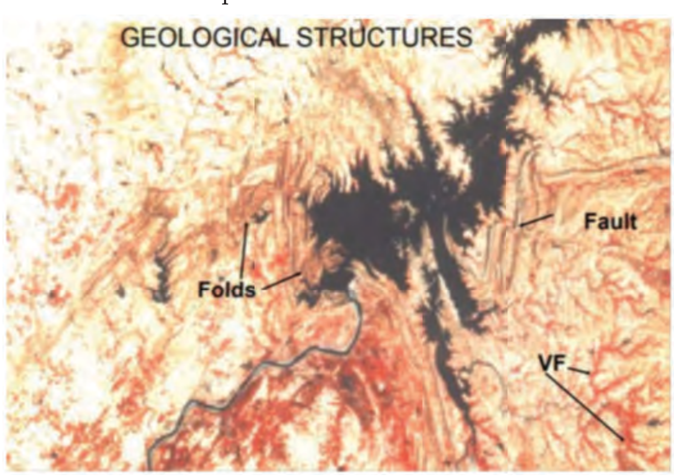


Figure 4:- Geological Structures and Lineaments

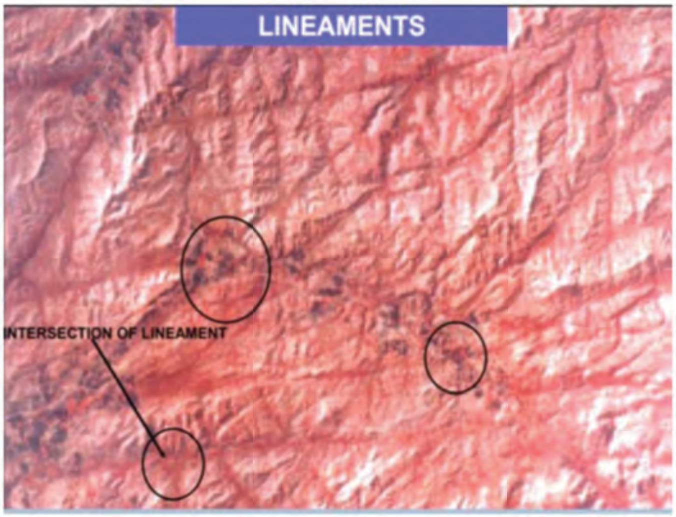


Figure 4 A:- Geological Structures and Lineaments

Bed attitudes (strike and dip) are inferred from slope asymmetry and drainage features. Horizontal beds exhibit mesa/butte landforms and dendritic drainage, while inclined beds show triangular dip facets, cuestas, and hogbacks. Schistosity/foliation appears as thin, wavy, discontinuous lines, and folds are mapped by identifying marker horizons, further classified into anticlines or synclines based on dip direction. Structural mapping requires data from Existing geological/ hydrogeological maps, Satellite image interpretation and Field surveys for validation and refinement.

Geomorphology:

Satellite imagery provides a synoptic view that enhances geomorphological mapping by identifying various landforms and their assemblages. Interpretation relies on criteria such as tone, texture, shape, size, location, physiography, genesis, rock/sediment nature, and associated geological structures. Initially, the landscape is categorized into three major zones: Hills & Plateaus, Piedmont Zones, and Plains, based on physiography and relief. Within each zone, geomorphic units are mapped considering landform characteristics, aerial extent, weathering depth, and deposition thickness. Specific landforms in alluvial, deltaic, coastal, eolian, and floodplain environments are identified and coded on maps using standard symbols. Field verification is essential for accuracy, involving examination of nala/ stream cuttings, wells, and litho logs to assess weathering depth, material composition, and deposition thickness. These details refine the pre-field interpretation, leading to a final geomorphic map overlay. The sources for geomorphic mapping include lithological map overlays, Satellite image interpretation, Field surveys for ground validation.

Geomorphological Mapping

Identification of drainage and drainage pattern, its density, slope analysis, feasible zones like paleo channels, fluvial deposits, alluvial fans, braided streams, piedmont zones, Pedi plain zones etc are areas of good recharge and exploitation. Previous maps and literature facilitate geomorphological mapping, but even in their absence, an accurate map can be prepared using satellite imagery, lithological overlays, and field data.

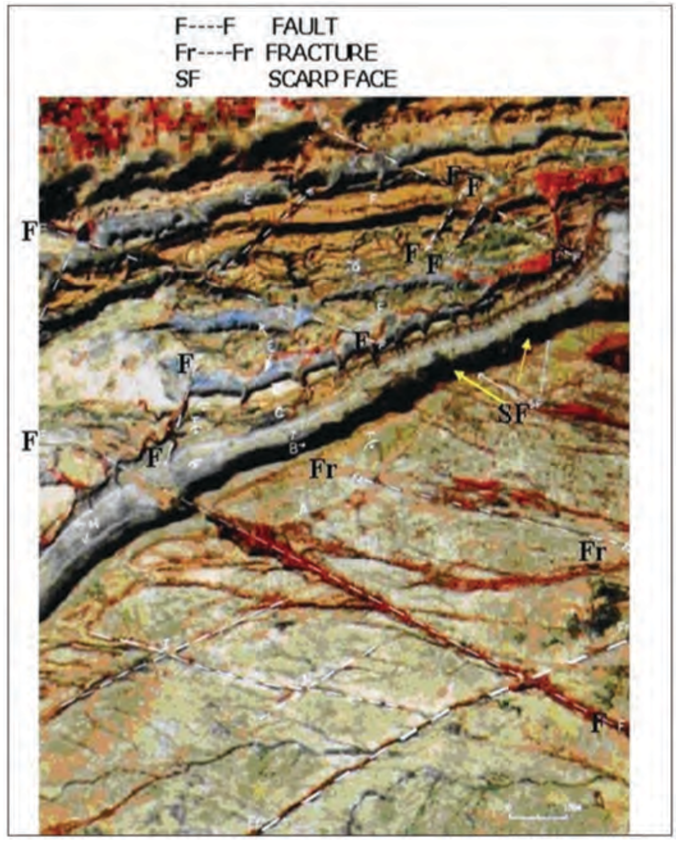


Figure 5:- Interpretation of structural features from satellite imagery

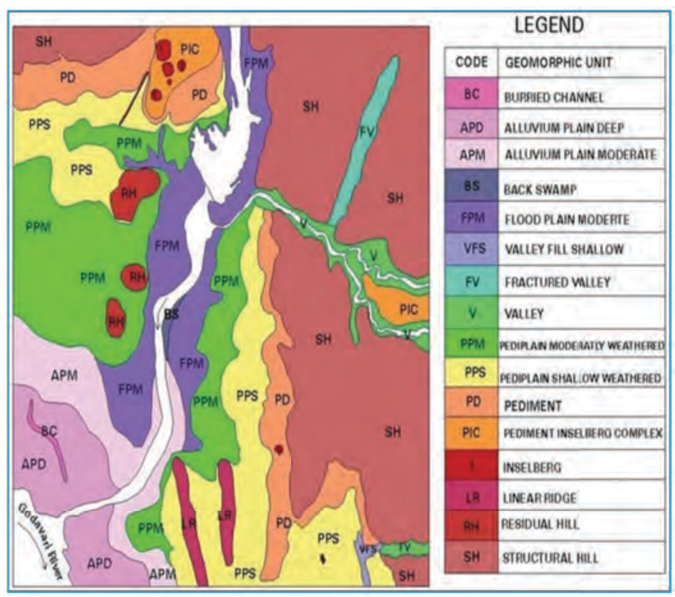


Figure 6 :- Preparation of Geomorphological Mapping from satellite imagery. Source NRSA

To create a geomorphic map, the satellite image and interpreted lithological overlay are placed on a light table. A transparent overlay is used to classify rock types into geomorphic units based on a standardized system. Some lithologic units may correspond to multiple geomorphic units, while others may share a single classification. Boundaries between lithologic and geomorphic units should be co-terminus where applicable.

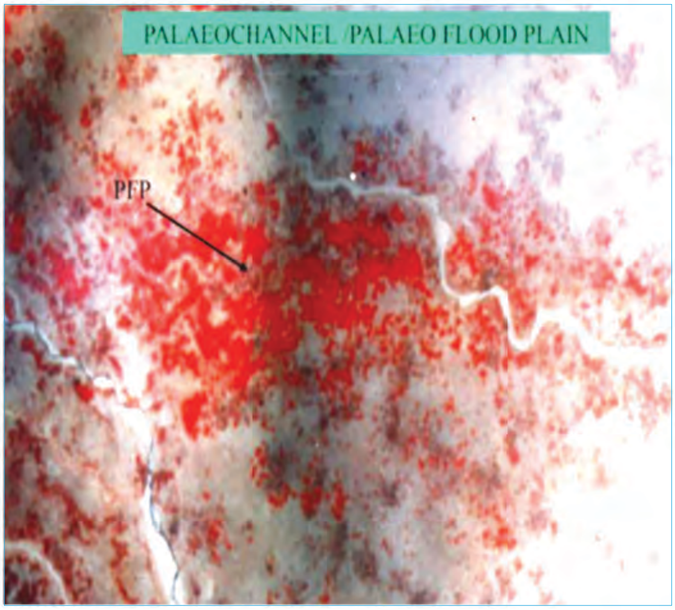


Fig.7 : Paleo channel delineation in imagery

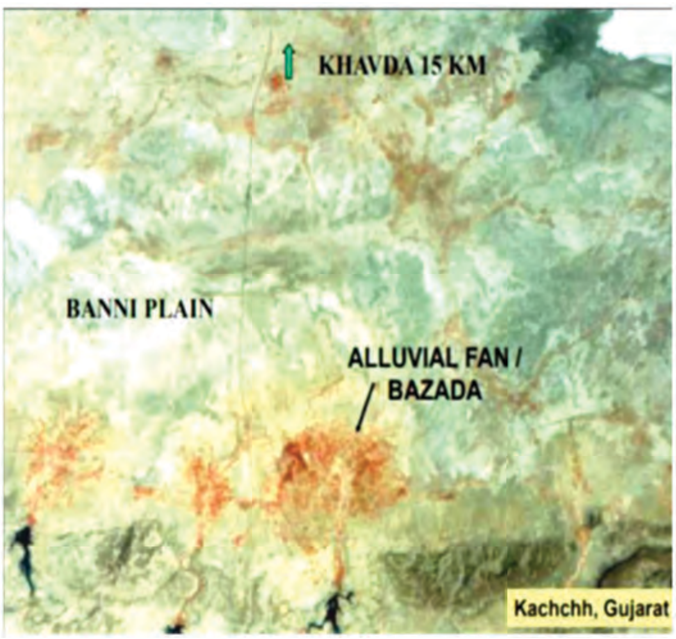


Figure 8 : Alluvial fan/ Bazada delineation in satellite imagery.

Each geomorphic unit or landform is labelled with standard alphabetic annotations, such as RH, PPS, and VFD, ensuring clarity and consistency in classification.

Hydrological Mapping:

Satellite imagery provides valuable insights into hydrologic features such as rivers, canals, reservoirs, lakes, tanks, springs, and groundwater-irrigated areas. Visual interpretation of satellite data, combined with collateral information, allows for the creation of a classified hydrological map overlay with appropriate symbols. Observation wells from State and Central Groundwater Departments, along with wells inventoried during field visits, are marked on this overlay. Additional hydrological data sources include satellite imagery interpretation, field surveys, observation well data, and meteorological records.

The hydrological map overlay includes:

Canal/tank commands, Groundwater-irrigated areas, Well observation data from field and government records. Rain gauge stations with average annual rainfall. If a rain gauge station is absent in a Toposheet, the average annual rainfall (mm) is provided in the legend, sourced from IMD or District Gazetteers. Delineation of drainage features, pattern and densities, influent and effluent streams, springs, seepage zones etc could be assessed by the analyses of remote sense imageries.

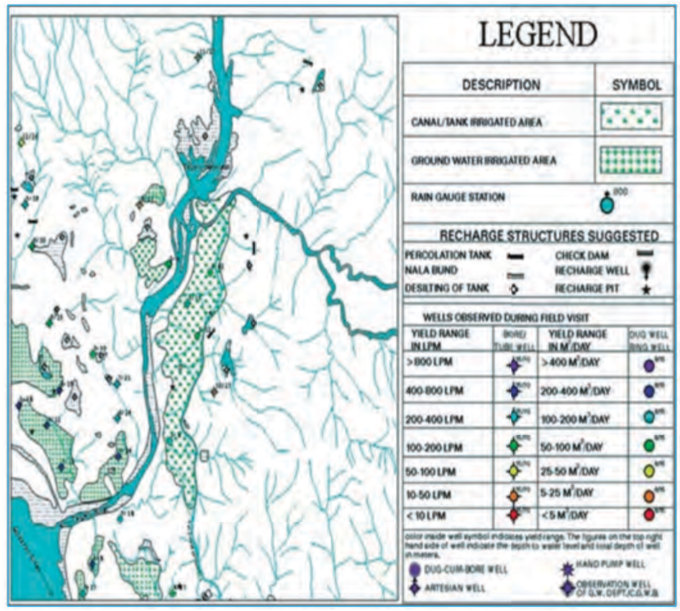


Fig:9 Preparation of Hydrological map from satellite imagery. Source NRSA, Hyderabad,

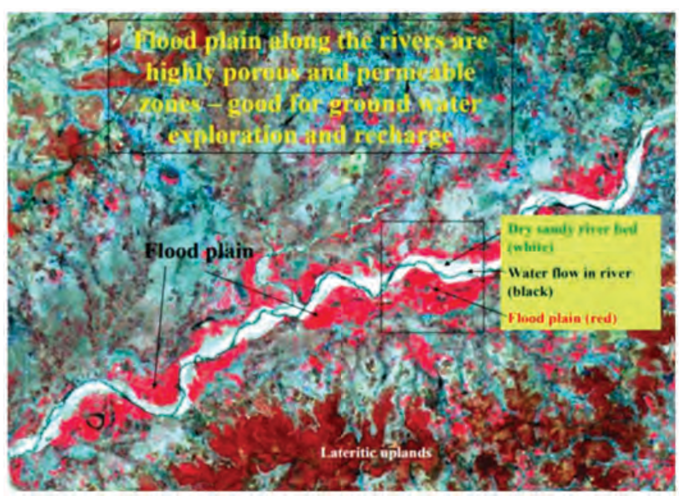
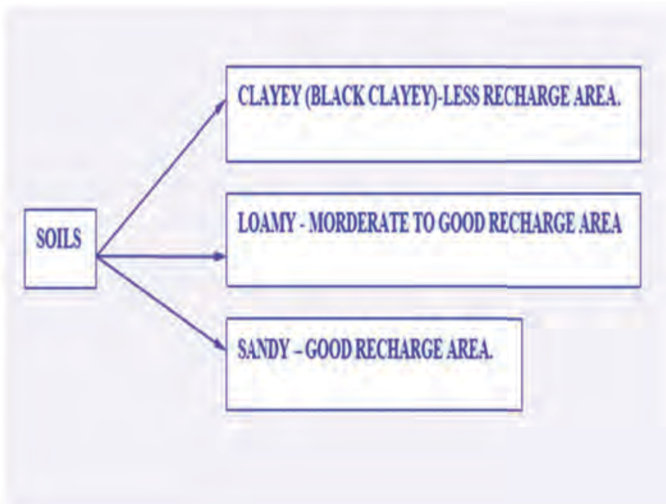


Figure 10: Porus and Permeable zones along flood plains are good recharge zones.

Soil Classification Studies: Soil boundaries can be demarcated according to the physiography. The textural classes can be visually interpreted. The fine-grained would appear darker than the coarse grained due to spectral reflectance of different types of soil. Summer time images are good for soil textural classification studies. Differentiation of various textural classes of soil through image interpretation will help to locate areas of recharge.



Computer aided interpretation: Computer aided image enhancement techniques also ensure faster, easier analysis so as to meet the objectives. Few of the techniques like, image enhancement techniques, spatial filtering, density slicing, principal component transformation, band ratio, multi spectral classification etc...are the useful techniques to fulfill the objective.

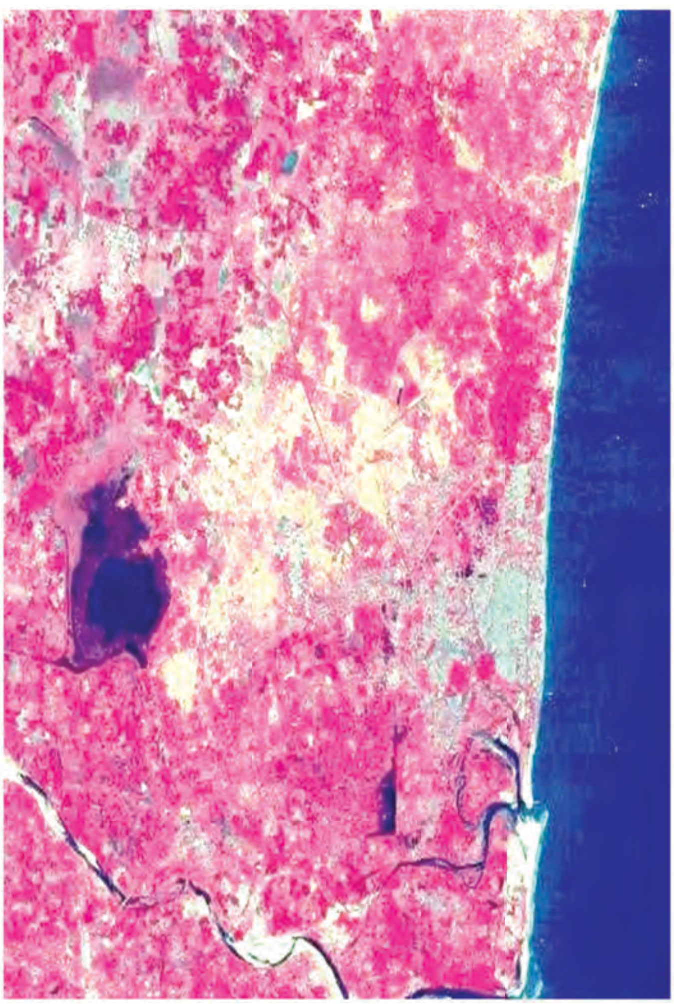


Fig :11 Imagery showing paleo-channel zones & coastal dunes as preferred zone for artificial recharge.
(Sensor : LANDSAT TM)

Practical Utilities of Remote sensing imageries data interpretation:

- Remote sensing data provides clues for deciding the most appropriate site for development of rainwater harvesting or recharge structures.
- High drainage density and low lineament density seen through imageries clearly indicates the areas of low porosity and permeability. (Hard rock area).
- Low drainage density and high lineament intensity indicates the areas having high infiltration capacity and such areas are highly suitable spots for artificial recharge.
- Areas of high porosity can be delineated whereby maximum seepage/ percolation can be facilitated.
- Straight segments of streams and intersection of lineaments zones will be an ideal location for storing ground water. I.e. wherever the linear features cut across with the drainage are the most favourable sites for development of recharge structures.
- Valley filled zones; confluence of channel zones could be a preferred site for artificial recharge.
- Coastal dunes and delta areas can be delineated and are the favourable zones for recharge.
- Large sedimentary hydro geological basin where the water table is subsequently lowered as a result of overdraft could be an ideal location for recharge
- Intersection of dykes (Discordant type) is a suitable location for recharge.
- Alluvial terrain with identified possible locations of paleo channel characterized by coarser sediments is good area of recharge.
- The general understanding is that in the remote sensing imagery wherever the linear features cut with the drainage are most favourable sites for artificial recharge measures by constructing Rain water harvesting structures and artificial recharge systems.
- The area with 2 to 5% slope is suitable for artificial recharge structure like percolation ponds, check dams and area with slope less than 2% is suitable for recharge pits. The second and third order streams are normally suitable for locating artificial recharge structures.
- The soil horizons of A and B zones have to be given top priority for choosing artificial recharge structures.
- Moderate to highly weathered thickness (5to 15m) is suitable for percolation ponds, check dams and recharge pits. Areas of moderate to high ground water level (5 to 15m) are feasible for locating recharge structures. More than 15m ground water level zones are feasible for recharge bore wells.
- Buried pediments, shallow buried pediments have to be given top priority for locating recharge measures. The areas with good moderate irrigation quality of ground water have to be given top priority for locating recharge structures due to its exploitation.

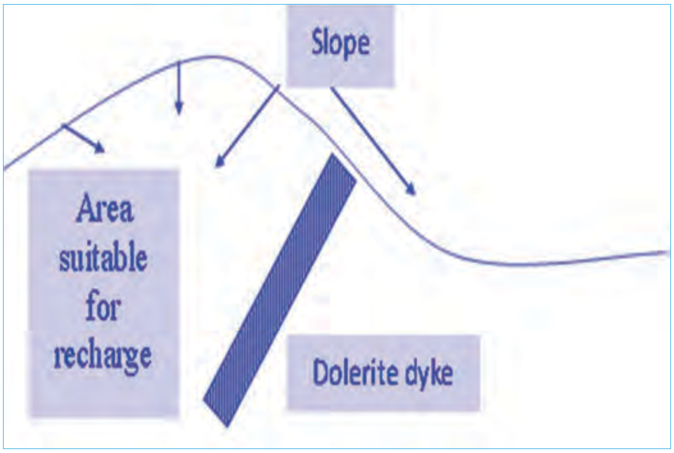


Figure 12 Area amenable for good groundwater Recharge: Murali.K (IGC -2007 Technical Paper)

Calculation of Water resource potential through comparative study of Remote sensing and conventional field data:

Step-1 : Length and width of the lineament can be demarcated or traced out and computed in........sq. k.m of the specified location on the imageries suitable for recharge.

Step-2 : Extraction of available pumping test data of the bore well yield and its depth along the lineament zones gives the **"Specific Capacity" of the rock in the lineament zone .....%.**

If these two features are known, the ground water potential can be calculated as Cumulative area of lineament...... sq. k.m.* specific capacity of the rock along the lineament ..... % * average depth of the bore wells in meters.

This gives the volume of water available in the area as**....... Mcm. (Million cubic Metre)**

The doubtful areas need to be marked in the base map derived from imageries in consideration with top sheet. Necessary field verification and crosscheck on random basis at ground level will help us in ascertaining the correctness of information.

Key Steps involved:

Data Acquisition:

Remote sensing imagery: Obtain high-resolution satellite imagery to generate land cover maps, identify lineaments, and analyse topographic features.

Topographic data: Access digital elevation models (DEMs) to derive slope, aspect, and curvature maps.

Geological data: Compile existing geological maps to identify lithological units with high permeability.

Hydrological data: Collect data on rainfall patterns, stream networks, and groundwater levels.

Soil data: Obtain soil texture and permeability information.

Pre-processing and Analysis:

Image classification: Classify land cover types from satellite imagery using supervised or unsupervised methods.

Drainage analysis: Extract drainage networks from DEMs to calculate drainage density.

Slope analysis: Generate slope maps based on DEMs to identify areas with gentle slopes suitable for infiltration.

Lineament extraction: Identify lineaments (fractures) from satellite imagery that can enhance groundwater recharge.

Thematic Layer Creation:

Geology layer: Map the distribution of different rock formations based on their permeability potential.

Geomorphology layer: Identify landforms like floodplains or alluvial fans with high recharge potential.

Soil layer: Create a map representing soil types with varying infiltration rates.

Land use/land cover layer: Classify land use types like urban, agricultural, and forested areas which influence recharge.

Overlay Analysis and Weighting:

GIS overlay analysis: Combine all thematic layers using weighted overlay analysis where each layer is assigned a weight based on its relative importance in determining groundwater recharge potential.

Analytical Hierarchy Process (AHP): Employ AHP to assign weights to different thematic layers based on expert knowledge and stakeholder input.

Result Interpretation and Site Selection:

Recharge zone delineation: Identify zones with high weighted overlay values as the most suitable areas for artificial recharge.

Site selection: Based on the recharge zone map, select specific locations considering factors like accessibility, land availability, and potential for recharge structure development.

Benefits of using remote sensing and GIS:

Large area coverage: Efficiently analyse large geographical areas within a short timeframe.

High accuracy: Detailed spatial information can be extracted from high-resolution imagery.

Cost-effective: Reduced field survey requirements by utilizing satellite data.

Integration with other data: Easily incorporate diverse data sources like well logs and groundwater level measurements.

Important considerations:

Field validation: Ground truth data is crucial to verify the accuracy of the analysis and identify potential limitations.

Local context: Consider local geological and hydrological conditions when interpreting results.

Community engagement: Involve stakeholders in the decision-making process regarding site selection for artificial recharge projects.

Work flow chart:

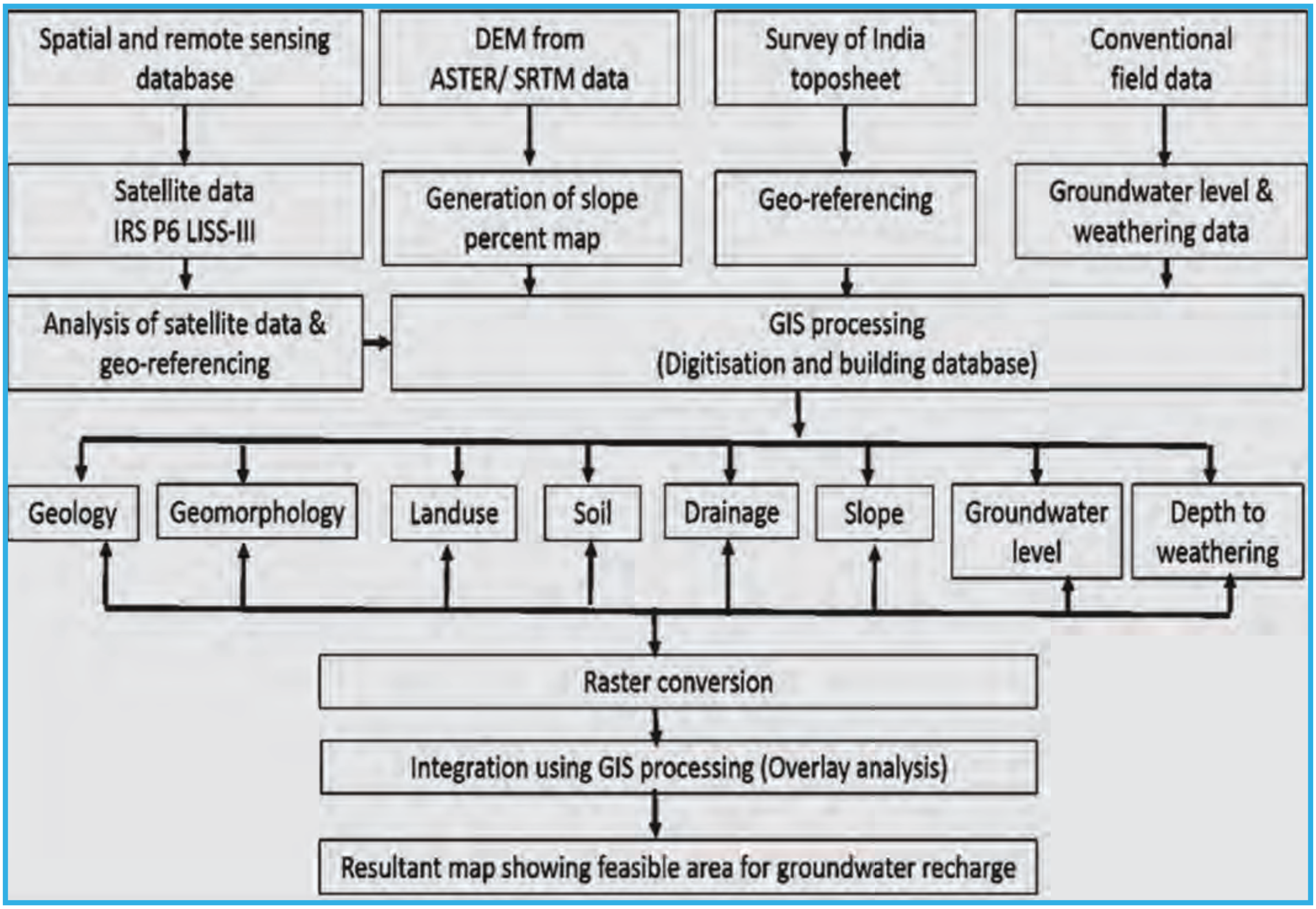


Figure 13 : Flow Chart for Data validation in finding suitable Sites amenable for Groundwater re-charge.

Data validation for Artificial Sites Amenable for Recharge:

The overall attributes which sets in for finding the regions amenable for ground water recharge and Utilization by considering various geological/ structural, geomorphological and hydrological features are Lineaments, Dykes, Valley Fills, Paleo-channels, Abandoned/ Buried Channels, Flood Plains, Alluvial Plains, Alluvial Fans, Inter-dunal Depressions, Anomalous Vegetation, Surface Water Bodies/ Springs with understanding to AHP (Analytic Hierarchy Process) which is a multi-criteria decision-making method where decision-makers compare options pairwise to determine priorities, while Fuzzy AHP is an extension of AHP that allows decision-makers to express their preferences using fuzzy numbers, accommodating uncertainty and vagueness in their judgments, making it more suitable for situations where precise comparisons are difficult.

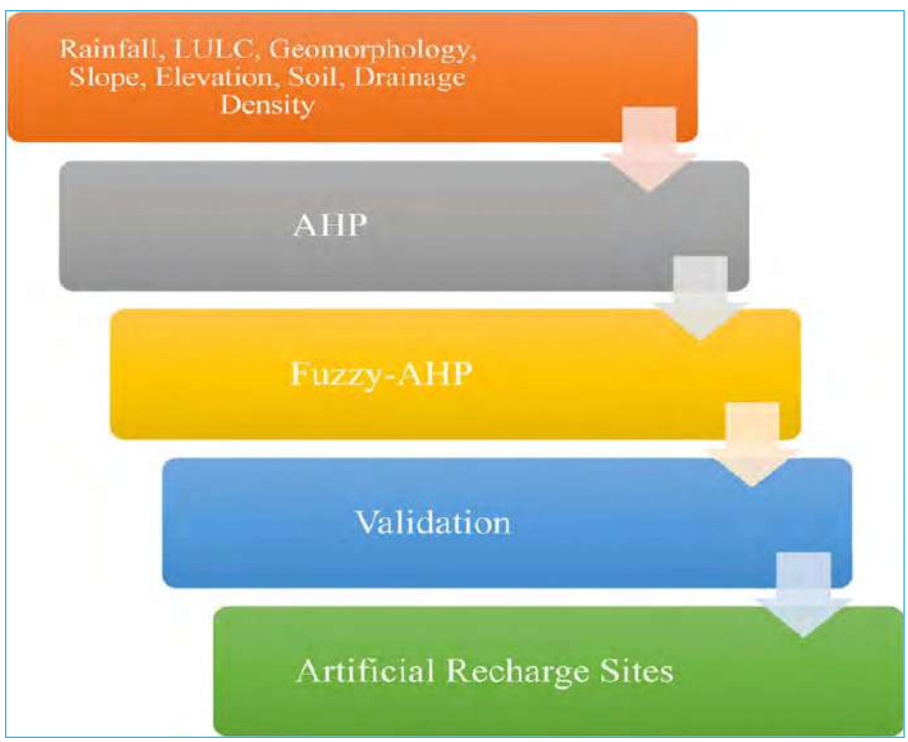


Figure 14 : Data validation process and delineation of sites amenable for artificial recharge

METHODOLOGY FLOW CHART FOR SELECTION OF SUITABLE LOCATIONS FOR GROUNDWATER RECHARGE

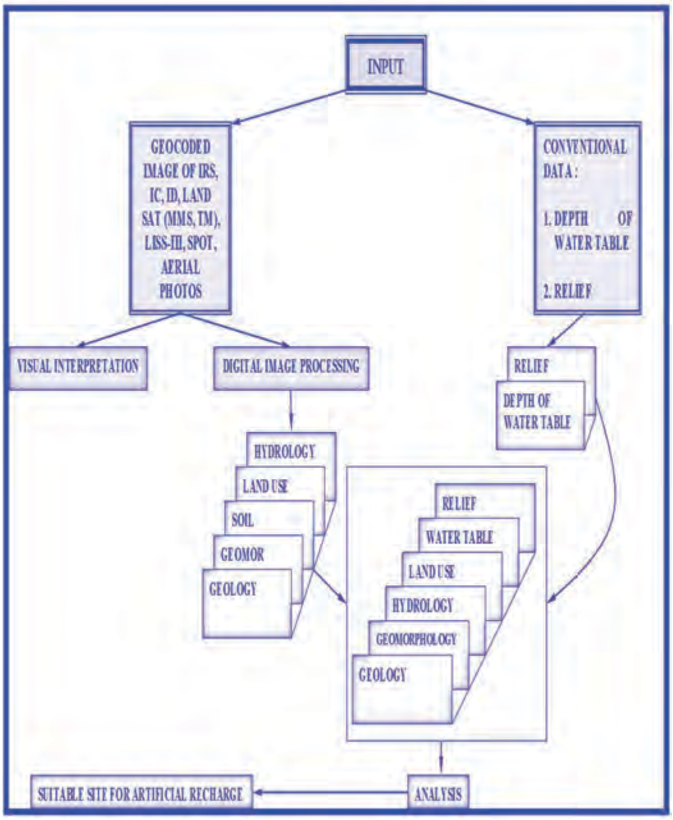


Figure: 15 : - METHODOLOGY FLOW CHART FOR SELECTION OF SUITABLE LOCATIONS FOR GROUNDWATER RECHARGE

What Concept should be adopted for the Artificial Groundwater Recharge Methodology?

Basin wide Management study through **"Watershed Concepts"** and applying the norms of Ground water Budgeting as per the recommendation of "**National Groundwater Estimation Committee"** in collaboration with the findings of usage of Remote-sensing data Through G.I.S methodology would be an ideal tool for the appropriate recharge measures.

Prioritization of the Area for Construction of Recharge Structures:

- **Based on the status of the groundwater Development.**
- **Areas where ground water level are declining fast,**
- **Areas where water quality problem are prevailing,**
- **Areas where natural recharge is poor or limited due to unfavourable hydro geological conditions.**
- **The terrain for Ground water recharge can be classified in to two types. The soft rocks of semi-consolidated/unconsolidated material comprise of Shale, clay, sand and gravels.**
- **The hard rock includes consolidated, compact, cemented and crystalline rocks such as granite, gneiss, charnokite, sand stone and lime stone.**
- **The Occurrence, movement and distribution of Groundwater depends largely up on the aquifer material in the case of soft rock and in hard rocks it depends up on the weathered horizon, Secondary porosity, permeability, foliations, joints, fractures and faults. Hence, the selection of suitable location for recharge structures has to be determined based on the proper selection and overlaying of the following themes viz. Geology, Geomorphology, hydrogeology and Hydro Geo-chemistry.**
- **An ideal aquifer best suited for recharge is that the one which absorb large quantities of water and do not release them to fast. Aquifer must be unconfined, permeable and sufficiently thick to hold large amount of water.**
- **The artificial recharge measures through rainwater harvesting will curtail the surface run -off and help in enhancing the moisture content of the soil, Ground water table enhancement, and irrigation potential, intercept run-off and reduces the silt/sedimentation flow to major reservoirs.**

Artificial/ Induced Recharge Methods/MAR

The artificial recharge methods can be classified in to Direct and indirect methods. Various recharge methods are represented below:

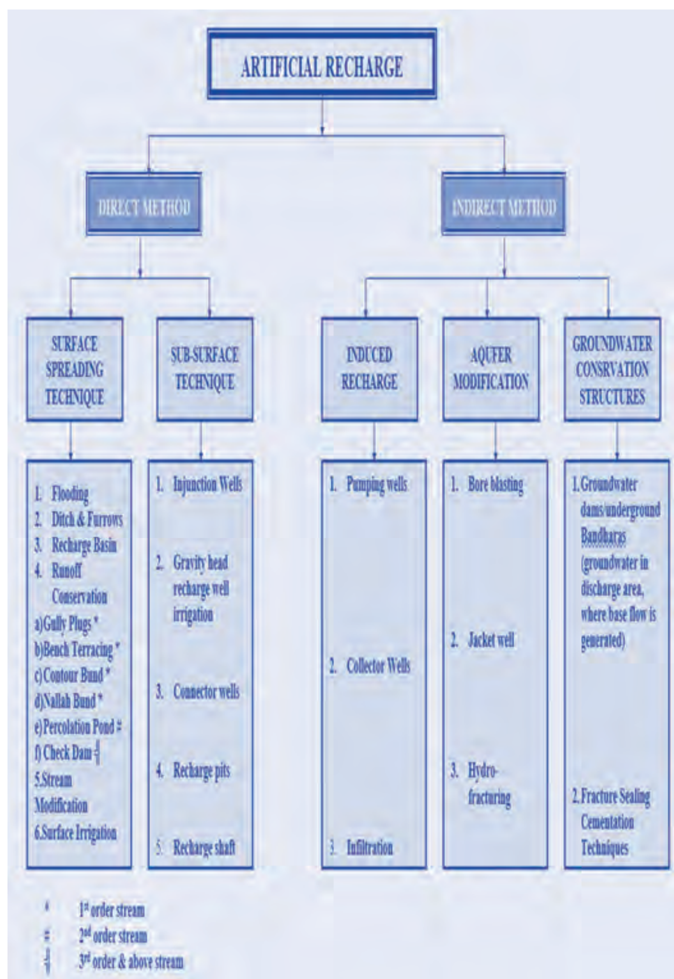


Table:1 Artificial Recharge systems

General Suitability of Recharge Methods:

Lithology	Topography	Type of Structures Feasible.
Alluvial or hard rock up to 40m depth.	Plain area or gently Undulating area.	Spreading pond, groundwater dams, irrigation tanks, check dams, percolation tanks, unlined canal systems.
Hard rock down to 40m depth.	Valley slopes.	Contour Bunds and Trenches.
Hard Rocks	Plateau Region	Recharge Ponds.
Alluvial or Hard rock with confined Aquifer. (40m Depth).	Plain area or Gently Undulating Area.	Injection wells and connector wells.
Alluvial deposits with confined aquifer up to 40m depth.	Flood plain deposits.	Injection wells, connector wells.
Hard rocks.	Foot hill zones.	Farm ponds, recharge trenches.
Hard rock with alluvium.	Forested area	Ground Water dams.
Residual Capping. (Laterite).	Remnants of planar structure-Plateau, Mesa, Buttes.	Low transmissivity. Recharge is feasible only along fractures through shafts, injection wells etc.
Deccan traps. Good zone of recharge will be of inter -trapean aquifer material with sands.	Plateau	Injection bore wells and shafts up to the sandy aquifer.
Coastal alluvium. (Saline water intrusion).	Plain area	Injection wells/ shafts.

Table:2 Geological suitability of Recharge methodologies.

Conclusion:

Water is essential for life on the planet. Water resources have been a decisive factor in the growth and Development of any country. Water conservation improves the quantity and quality of ground water regime. Supply of groundwater even in the dry month is very much essential for Sustainable development. Evolution and implementation of well thought, long term national policies and creation of a promotive atmosphere enabling entire humankind to share the benefits of satellite remote sensing and GIS technique. It is true that satellite imagery alone cannot provide information regarding underground aquifers and ground water dynamics, thus geophysical, drilling data, yield testing data and logging methodology have to be consulted for acquiring subsurface information and decisions file need to be created through overlay by GIS technique. Geo-informatics has made attempts to incorporate spatial data and non-spatial attributes to find areas amenable for artificial recharge. India's groundwater demand exceeds availability, requiring augmentation through percolation tanks, check dams, and other water harvesting and artificial recharge systems and also the managed aquifer recharge systems at large. Prioritization is crucial, with satellite data aiding in site selection. Problem villages lacking drinking water take precedence, followed by overexploited agricultural and industrial zones should be given priority towards recharge measures. Satellite data help identify groundwater-deficient areas, optimize land use, and guide conservation efforts. They also support the conjunctive use of surface and groundwater by mapping reservoirs, irrigation zones, and groundwater sources. High-resolution imagery assists in monitoring and regulating groundwater use, detecting unauthorized extraction, and establishing groundwater sanctuaries/ regime of the region. Continuous monitoring through multi-temporal satellite images prevents overexploitation. GIS integration enhances groundwater recharge estimation and resource planning. Emerging remote sensing technologies like Polarimetric SAR, radar interferometry, and Ground Penetrating Radar (GPR) will further improve groundwater mapping. The NRSC, should in collaboration with various other state agencies, should develop many a thematic layer on groundwater quality to ensure sustainable surface and groundwater management in India.

"Incorporating artificial Recharge and Managed Aquifer Recharge (MAR) Techniques into community knowledge and practice is vital for fostering widespread awareness of Rainwater harvesting and artificial recharge system. By empowering communities with this understanding, we can ensure the sustainable replenishment of groundwater resources, securing their availability for diverse uses now and for future generations.

"IF WE FAIL TO PLAN TODAY, WE HAVE PLANNED TO FAIL TOMMORROW".

SAVE WATER-SAVE LIFE!!

AMRUT 1 PROGRESS

- **TOTAL**: 1110 Nos., | ₹ 2357 Cr.
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- **AWARDED**: 1110 Nos., | ₹ 2357 Cr.
- **ONGOING**: 92 Nos., | ₹ 772 Cr.
- **COMPLETED**: 1018 Nos. | EXPENDITURE: ₹ 2212.22 Cr.

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പ്രോത്സാഹിപ്പിക്കുക

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