2024 ഡിസംബർ

अमृत
Atal Mission for Rejuvenation and Urban Transformation

ലക്കം 10

അമൃത്
വാർത്താ പത്രിക

Azadi Ka Amrit Mahotsav

അമൃത് പദ്ധതിയിൽ ഉൾപ്പെടുത്തി തൃശ്ശൂർ കോർപ്പറേഷനിൽ നിർമ്മിച്ച ആകാശപ്പാത
തദ്ദേശ സ്വയംഭരണ വകുപ്പ് പ്രിൻസിപ്പൽ സെക്രട്ടറി സന്ദർശിക്കുന്നു

അമൃത് പദ്ധതിയിൽ ഉൾപ്പെടുത്തി തൃശ്ശൂർ കോർപ്പറേഷനിൽ നിർമ്മിച്ച ദ്രവ മാലിന്യ സംസ്കരണ പ്ലാന്റ്
തദ്ദേശ സ്വയംഭരണ വകുപ്പ് പ്രിൻസിപ്പൽ സെക്രട്ടറി സന്ദർശിക്കുന്നു

അമൃത് വാർത്താ പത്രിക

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എഡിറ്റോറിയൽ

അമൃത് ഒന്നാം ഘട്ട പദ്ധതികളുടെ പൂർത്തീകരണ കാലാവധി 2024 ഡിസംബർ 31 ന് അവസാനിക്കുകയാണ്. കേരളത്തിലെ 9 അമൃത് നഗരങ്ങൾക്കായി 2357.69 കോടി രൂപയുടെ 1111 പദ്ധതികൾക്കാണ് കേന്ദ്ര ഭവന നഗരകാര്യ മന്ത്രാലയം അംഗീകാരം നൽകിയിട്ടുള്ളത്. പദ്ധതി കാലയളവ് അഞ്ച് വർഷമാണെങ്കിലും കോവിഡ് ഉൾപ്പടെ വിവിധ കാരണങ്ങളാൽ പദ്ധതി കാലയളവ് പല ഘട്ടങ്ങളിലായി ദീർഘിപ്പിച്ച് നൽകിയിരുന്നു. അഞ്ച് സെക്ടറുകളിലായി സംസ്ഥാനം ഏറ്റെടുത്ത 1111 പദ്ധതികളിൽ നാളിതുവരെ 981 പദ്ധതികൾ പൂർത്തീകരിക്കാൻ നമുക്ക് സാധിച്ചു. ശേഷിക്കുന്ന പദ്ധതികൾ പൂർത്തീകരണത്തിന്റെ വിവിധ ഘട്ടങ്ങളിലാണ്. സെപ്റ്റേജ് സിവേജ് സെക്ടറിലെ പദ്ധതികളാണ് പൂർത്തീകരിക്കാൻ സാധിക്കാത്ത പദ്ധതികളിൽ ഭൂരിഭാഗവും. വിവിധ പദ്ധതികൾക്കായി 2026 കോടി രൂപ നാം ചെലവഴിച്ചിട്ടുണ്ട്. എല്ലാ പദ്ധതികളും സമയ പരിധിയായ 2024 ഡിസംബർ 31 നകം ഭൗതീകമായും സാമ്പത്തികമായും പൂർത്തീകരിച്ച് പൂർത്തീകരണ പത്രം നൽകേണ്ടതുണ്ട്.

കേന്ദ്ര ഭവന നഗരകാര്യ മന്ത്രാലയം 'ജൽ ഹി അമൃത്' എന്ന പേരിൽ സംസ്ഥാനത്തെ ദ്രവ മാലിന്യ സംസ്കരണ പ്ലാന്റുകളിൽ നടത്തി വന്ന വിലയിരുത്തൽ സന്ദർശനങ്ങൾ പൂർത്തിയാക്കി. അമൃത് 2.0 യുടെ ഭാഗമായി നടത്തുന്ന 'ജലം ജീവിതം' പ്രചരണ പരിപാടിയുടെ രണ്ടാം ഘട്ടം ഉടൻ ആരംഭിക്കുകയാണ്. ആദ്യ ഘട്ടത്തിലേതെന്നതു പോലെ പങ്കാളിത്തം രണ്ടാം ഘട്ടത്തിനും ഉറപ്പ് വരുത്തണം. സംസ്ഥാനത്തെ നഗരസഭകളിൽ അമൃത് 2.0 യിൽ ഉൾപ്പെടുത്തി ജി.ഐ.എസ്. അധിഷ്ഠിത മാസ്റ്റർ പ്ലാൻ തയ്യാറാക്കുന്നതിനുള്ള നടപടികൾ ആരംഭിച്ചു കഴിഞ്ഞു.

അമൃത് 2.0 പദ്ധതികൾ സംസ്ഥാനത്തെ എല്ലാ നഗരസഭകളിലും നടന്നുവരികയാണ്. പദ്ധതികൾ നടപ്പിലാക്കുന്നതോടൊപ്പം പദ്ധതി നിർവ്വഹണ പുരോഗതി സംബന്ധിച്ച വിവരങ്ങൾ പോർട്ടലിൽ രേഖപ്പെടുത്തേണ്ടതുണ്ട്. പോർട്ടലിൽ രേഖപ്പെടുത്തുന്ന പദ്ധതി പുരോഗതി വിവരങ്ങളുടെ സൂചികകൾക്കനുസൃതമായാണ് അടുത്ത ഗഡു ഫണ്ട് കേന്ദ്ര സർക്കാർ അനുവദിക്കുന്നത്. ആയതിനാൽ പദ്ധതികളുടെ പൂർണ്ണമായ വിവരങ്ങൾ പോർട്ടലിൽ യഥാസമയം രേഖപ്പെടുത്തുവാൻ ശ്രദ്ധിക്കേണ്ടതാണ്.

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.

Atal Mission for Rejuvenation and Urban Transformation

സ്റ്റേറ്റ് മിഷൻ മാനേജ്മെന്റ് യൂണിറ്റ് (അമൃത്)
നാലാം നില, മീനാക്ഷിപ്ലാസാ,
ആർടെക് ബിൽഡിംഗ്,
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വെബ്സൈറ്റ് : www.amrutkerala.org
ഇമെയിൽ : smmukerala@gmail.com

അമൃത് പദ്ധതിയിൽ ഉൾപ്പെടുത്തി നവീകരിച്ച തൃപ്പൂണിത്തുറ നഗരസഭയിലെ താമണ്ടി കുളം

അമൃത് 2.0 പദ്ധതിയിൽ ഉൾപ്പെടുത്തി നവീകരിക്കുന്ന മഞ്ചേരി മുനിസിപ്പാലിറ്റിയിലെ തടപ്പറമ്പ് കുളം

അമൃത് വാർത്താ പത്രിക
ഡിസംബർ 2024

ഉള്ളടക്കം

അമൃത് 2.0 പദ്ധതിയിൽ ഉൾപ്പെടുത്തി നവീകരിക്കുന്ന മണ്ണാർക്കാട് മുനിസിപ്പാലിറ്റിയിലെ ചോമേരി കുളം

അമൃത് പദ്ധതിയിൽ ഉൾപ്പെടുത്തി കുന്ദംകുളം മുനിസിപ്പാലിറ്റിയിൽ നിർമ്മിക്കുന്ന 10 എൽ.എൽ. ഓവർ ഹെഡ് റിസർവോയറിന്റെ നിർമാണം പുരോഗമിക്കുന്നു.

അമൃത് പദ്ധതിയിലെ ഗ്രീൻ സ്പെയ്സ് & പാർക്ക് സെക്ടറിൽ ഉൾപ്പെടുത്തി നവീകരിച്ച ചാവക്കാട് ഹൈസ്കൂൾ ഗ്രൗണ്ട്

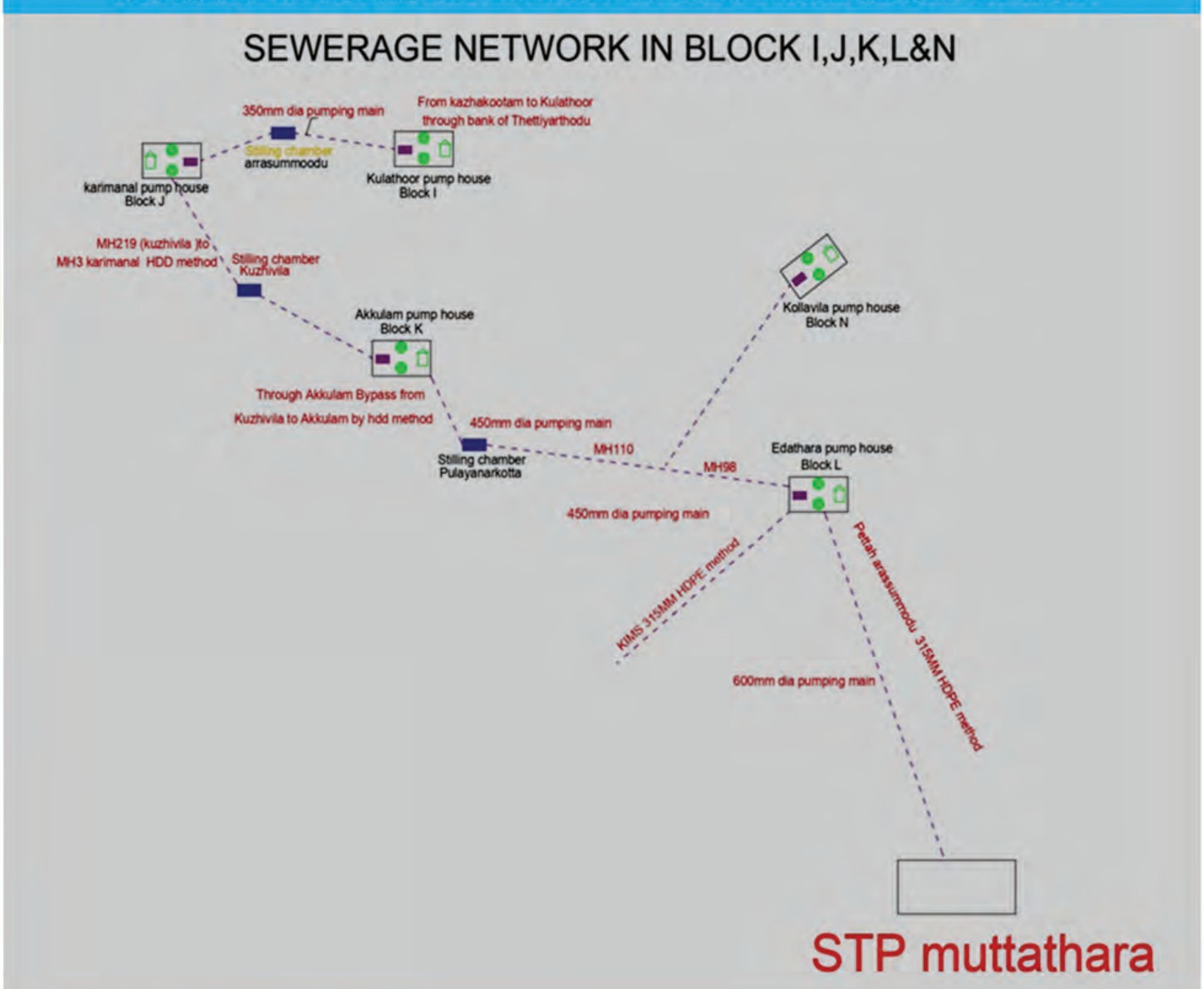
തിരുവനന്തപുരം കോർപ്പറേഷനിലെ സ്വിവേജ് സംവിധാനം

സംസ്ഥാന തലസ്ഥാനമായ തിരുവനന്തപുരത്തിന്റെ നഗരപ്രദേശമാണ് തിരുവനന്തപുരം കോർപ്പറേഷൻ. 214.86 ചതുരശ്ര കി.മീ. വിസ്തൃതിയിൽ 100 വാർഡുകളടങ്ങിയതാണ് കോർപ്പറേഷൻ പരിധി. 9,87,730 ആണ് ഇവിടുത്തെ ജനസംഖ്യ. സമഗ്രമായ സ്വിവേജ് സംവിധാനത്തിനായുള്ള തിരുവനന്തപുരം നഗരത്തിന്റെ ശ്രമങ്ങൾ 1931 മുതൽ ആരംഭിച്ചതാണ്. തിരുവനന്തപുരം നഗരത്തിന്റെ ഭാവിയിലെ ആവശ്യം ഉൾപ്പടെ കണക്കിലെടുത്ത് ആധുനിക രീതിയിൽ പല ബ്ലോക്കുകളായി തിരിച്ചാണ് ഇതിനായുള്ള പ്രവർത്തികൾ ആരംഭിച്ചത്. ഇതിനായി പദ്ധതി മേഖലയെ എ,ബി.സി.ഡി,ഇ,എഫ്,ജി. എന്നിങ്ങനെ 7 ബ്ലോക്കുകളായി തിരിച്ചു. ആദ്യ ബ്ലോക്കായ 'എ' 1945 ൽ കമ്മീഷൻ ചെയ്തു. എന്നാൽ നഗര വികസനത്തിനനുപാതമായി സ്വിവേജ് ശൃംഖല വികസിപ്പിക്കാൻ സാധിച്ചിരുന്നില്ല. 2013 ൽ നഗരത്തിനായി 107 എം.എൽ.ഡി. ശേഷിയുള്ള ഒരു ദ്രവമാലിന്യ സംസ്കരണ ശാല മുട്ടത്തറയിൽ ആരംഭിച്ചു. എന്നാൽ ആകെ നഗര പരിധിയുടെ 40% പ്രദേശങ്ങൾക്ക് മാത്രമാണ് ഇതിന്റെ പ്രയോജനം ലഭിച്ചിരുന്നത്. പ്ലാന്റിന്റെ ശേഷിയുടെ 50% മാത്രമാണ് നിലവിൽ ഉപയോഗിക്കുന്നത്.

നഗരത്തെ എ മുതൽ ജി വരെ 7 സ്വിവേജ് ബ്ലോക്കുകളായി തിരിച്ചിരിക്കുന്നു. ഇതിൽ എ മുതൽ ഇ. വരെയുള്ള ബ്ലോക്കിൽ പൂർണ്ണമായോ ഭാഗീകമായോ സ്വിവേജ് ശൃംഖല നിലവിലുണ്ട്. ഇതിൽ എഫ് ഉം ജി യും തീരപ്രദേശങ്ങളടങ്ങിയ മേഖലകളാണ്. ഇവിടെ സ്വിവേജ് ശൃംഖല നിലവിലില്ല. നിലവിലെ സ്വിവേജ് സംവിധാനം നഗരത്തിന് പര്യാപ്തമല്ല. പ്ലാന്റിൽ മാലിന്യം എത്തിക്കുന്നതിന് മതിയായ നെറ്റ്വർക്ക് ഇല്ലാത്തതിനാൽ ദ്രവമാലിന്യം നഗര ഹൃദയത്തിലൂടെ ഒഴുകി പാർവ്വതി പുത്തനാറിലാണ് എത്തിച്ചേരുന്നത്.

പാർവ്വതി പുത്തനാർ

SEWERAGE NETWORK AND PUMPING STATION UNDER AMRUT 1.0 & 2.0



തിരുവനന്തപുരം നഗരത്തിൽ സിവേജ് ശൃംഖല നിലവിലില്ലാത്ത സ്ഥലങ്ങളിൽ അവ സ്ഥാപിക്കുന്നതിന് കോർപ്പറേഷൻ തീരുമാനമെടുത്തു. അമൃത് 1.0 യിൽ ഉൾപ്പെടുത്തി തിരുവനന്തപുരം മെഡിക്കൽ കോളേജിൽ 5 എം.എൽ.ഡി. ശേഷിയുള്ള പ്ലാന്റ് സ്ഥാപിക്കുകയും അതോടൊപ്പം സിവേജ് ശൃംഖലകളും സ്ഥാപിച്ചു വരുന്നു. അമൃത് 1.0 യിൽ പൂർത്തീകരിക്കാൻ സാധിക്കാത്ത പദ്ധതികൾ അമൃത് 2.0 യിൽ പൂർത്തീകരിക്കും.

ബ്ലോക്ക് ഐ.ജെ,കെ,എൽ എന്നിവിടങ്ങളിലെ സിവേജ് ശൃംഖലയും കുളത്തൂർ, കരിമണൽ, ആക്കുളം, ഇടത്തറ എന്നിവിടങ്ങളിലെ പമ്പിംഗ് സ്റ്റേഷനുകളും അമൃത് 1.0 യിൽ പൂർത്തിയാക്കി. ബ്ലോക്ക് എൻ ലെ സിവേജ് ശൃംഖലയും നിലവിൽ ശൃംഖലകളില്ലാത്ത പ്രദേശങ്ങളിലെ ശേഷിക്കുന്ന വർക്കുകളും അമൃത് 2.0 യിൽ ഉൾപ്പെടുത്തി നടപ്പിലാക്കി വരുന്നു.

തിരുവനന്തപുരം നഗരത്തിൽ ധാരാളം പേർ ദിനംപ്രതി വന്നുപോകുന്ന മെഡിക്കൽ കോളേജ് കാമ്പസിൽ അമൃത് പദ്ധതിയിലുൾപ്പെടുത്തി 19.16 കോടി രൂപ ചെലവിൽ ദിനംപ്രതി 5 എം.എൽ.ഡി. സംസ്കരണ ശേഷിയുള്ള മലിനജല സംസ്കരണ പ്ലാന്റിന്റെ നിർമാണം പൂർത്തിയായി. ഇതിലൂടെ മെഡിക്കൽ കോളേജ് കാമ്പസിലെയും പരിസരപ്രദേശങ്ങളിലെയും ദ്രവമാലിന്യ പ്രശ്നത്തിന ശാശ്വത പരിഹാരമാകും.

മെഡിക്കൽ കോളേജ് ആശുപത്രിയിൽ എത്തിച്ചേരുന്ന രോഗികൾ, സഹായികൾ, മറ്റ് സ്ഥാപനങ്ങൾ എന്നിവയിൽ നിന്ന് പുറംതള്ളുന്ന മാലിന്യത്തിന്റെ അളവ് നിലവിലെ മാനദണ്ഡങ്ങൾ അനുസരിച്ച് വിലയിരുത്തി അടുത്ത 50 വർഷത്തെ ആവശ്യം കൂടി കണക്കിലെടുത്താണ് പ്ലാന്റ് വിഭാവന ചെയ്തിട്ടുള്ളത്. ഇതനുസരിച്ച് ദിനംപ്രതി 5 ദശലക്ഷം ലിറ്റർ സംസ്കരണശേഷിയുള്ള പ്ലാന്റാണ് നിർമ്മിച്ചിരിക്കുന്നത്.

ഇന്ത്യയിലും വിദേശത്തും പ്രവർത്തന ക്ഷമത തെളിയിച്ച MBBR സാങ്കേതികവിദ്യ അനുസരിച്ചാണ് പ്ലാന്റ് രൂപകൽപന ചെയ്തിരിക്കുന്നത്. ആശുപത്രിയിലെ ലാബിൽ നിന്നും പുറന്തള്ളുന്ന മാലിന്യം പ്ലാന്റിൽ ലഭ്യമാക്കുന്നതിന് മുമ്പ് രാസമാലിന്യങ്ങൾ നീക്കം ചെയ്യുന്നതിനും പുതിയ പ്ലാന്റിൽ സംവിധാനമുണ്ട്. മലിനജല സംസ്കരണിന് കേന്ദ്രസംസ്ഥാന മലിനീകരണ നിയന്ത്രണ ബോർഡുകളുടെ എല്ലാ മാനദണ്ഡങ്ങളും പാലിച്ചു കൊണ്ടാണ് പദ്ധതി വിഭാവനം ചെയ്തിട്ടുള്ളത്. മലിനജലം ശുദ്ധീകരിച്ചശേഷം തോട്ടം നനയ്ക്കുന്നതിനും, എ.സി. ചില്ലർ യൂണിറ്റിനും, ശ്രീചിത്രയിലെ ഫ്ളെഷിംഗ് യൂണിറ്റിനും ഉപയോഗിക്കാവുന്നതാണ്. അതോടൊപ്പം സംസ്കരിക്കുമ്പോൾ ലഭിക്കുന്ന സ്ലറി നല്ല വളമാണ്. നിലവിൽ പ്ലാന്റ് കമ്മീഷൻ ചെയ്ത് പ്രവർത്തിച്ചു വരുന്നു.

അമൃത് പദ്ധതിയിൽ ഉൾപ്പെടുത്തി തൃശ്ശൂർ ജനറൽ ഹോസ്പിറ്റലിൽ സ്ഥാപിച്ചിരിക്കുന്ന 360 കെ.എൽ.ഡി. ശേഷിയുള്ള ദ്രവ മാലിന്യ സംസ്കരണ പ്ലാന്റ്

അമൃത് പദ്ധതിയിൽ ഉൾപ്പെടുത്തി തൃശ്ശൂർ കോർപ്പറേഷനിൽ നടപ്പിലാക്കുന്ന സമഗ്ര കുടിവെള്ള വിതരണ പദ്ധതിയുടെ ഭാഗമായി പീച്ചി ഡാമിൽ സ്ഥാപിച്ചിരിക്കുന്ന ഫ്ളോട്ടിംഗ് ഇൻ ടേക്ക് സംവിധാനം

The Smart City Expo World Congress (SCEWC) Fira Barcelona

The Smart City Expo World Congress (SCEWC)Fira Barcelona is one of the leading global events for smart cities, bringing together innovators, leaders, and organizations to showcase technological advancements and discuss strategies for improving urban living. The expo is a platform where ideas, technologies, and solutions for more sustainable, efficient, and livable cities are shared.

Key Learnings

1. **Technological Innovations Shaping Smart Cities**:

- **Internet of Things (IoT) Integration**: A major focus of the event was the role of IoT in smart cities. IoT technologies are being increasingly utilized to enhance urban living through smart infrastructure like traffic lights, waste management systems, and building monitoring systems.
- **5G Networks**: The implementation of 5G technology in urban environments is revolutionizing real-time communication, enhancing mobile services, and enabling innovations in autonomous vehicles, smart healthcare, and smart grids.
- **Artificial Intelligence and Machine Learning**: AI applications in smart cities help analyze vast amounts of data for traffic management, predictive maintenance of infrastructure, and city planning. AI-driven solutions also assist in making cities safer, more efficient, and responsive to citizen needs.

2. **Sustainability & Green Technologies**:

- **Smart Energy Management**: Various solutions were showcased to optimize energy consumption, reduce emissions, and promote renewable energy sources. Smart grids and energy storage systems were a key highlight, enabling cities to manage power distribution more efficiently.
- **Circular Economy Initiatives**: The expo emphasized the concept of a circular economy, where waste is minimized, products are reused, and resources are managed sustainably. Technologies for waste management, recycling, and sustainable urban mobility were discussed as part of reducing the ecological footprint of cities.
- **Green Buildings and Smart Homes**: Innovations in construction and design were focused on making buildings more energy-efficient through sensors, automation, and sustainable materials. Smart homes, powered by AI and IoT, enable better energy management and improved living conditions.

Mission Director, AMRUT participated in SMART CITY conference in Barcelona, Spain in explore Innovative Urban Solution and Technologies

3. **Urban Mobility & Transport Solutions**:

- **Autonomous Vehicles & Electric Mobility**: The event highlighted the rise of autonomous vehicles, electric cars, e-bikes, and shared mobility solutions aimed at reducing traffic congestion and pollution. Smart traffic management systems were also showcased, helping cities optimize road usage and improve public transportation systems.
- **Mobility as a Service (MaaS)**:The concept of MaaS, where users can plan and pay for different modes of transport in a seamless manner, was presented as a solution to enhance urban mobility and reduce dependency on private cars.

4. **Data-Driven City Planning**:

- **Big Data Analytics**: Data is a cornerstone of smart cities. Cities are using big data to make decisions related to urban planning, resource allocation, and citizen engagement. Real-time data collection through sensors allows for improved decision-making in city management, like predicting traffic patterns or detecting infrastructure failures before they become critical.
- **Digital Twins**-Several exhibitors demonstrated the use of Digital Twin technology, which involves creating virtual models of cities or buildings. This allows city planners and administrators to simulate various scenarios and optimize urban planning, disaster response, and resource management.

5. **Smart Governance & Citizen Engagement**:

- **E-Governance Solutions**: The event underscored the growing importance of digital platforms for governance. E-governance tools help citizens access public services more easily and engage with decision-makers, fostering transparency and participation.
- **Citizen-Centric Solutions**: Technologies were also highlighted that improve citizen quality of life through mobile apps, platforms for public participation, and personalized city services. Smart cities use technology to listen to their citizens' needs and respond more quickly to demands for improved services.

6. **Cybersecurity and Privacy in Smart Cities**

- As cities become more connected, the importance of cybersecurity is critical. Many discussions focused on protecting urban infrastructure from cyber threats, with emphasis on ensuring data privacy and security for citizens.

7. **Global Collaboration and Challenges**

- The event featured representatives from various global cities and organizations, discussing the challenges of making cities smarter and more sustainable. Issues like funding, data privacy, and infrastructure integration were debated, along with potential solutions for these challenges through international cooperation and partnerships.
- **Smart Cities for All**: There was a strong emphasis on inclusivity, ensuring that smart city technologies are accessible to all citizens, including marginalized and underserved.
- Smart City World Congress Expoat Fira Barcelona provided a comprehensive view of the current and future landscape of urban development. The convergence of cutting-edge technologies - such as IoT, AI, 5G, and renewable energy - demonstrates the potential for cities to become more sustainable, efficient, and responsive to the needs of their citizens. Key takeaways include the integration of digital technologies for smarter governance, sustainable urban mobility, and energy management. The expo also highlighted the importance of collaboration between public and private sectors, as well as international cooperation, to solve the complex challenges cities face as they evolve into smart ecosystems.

This event offered a glimpse into how technology is transforming cities worldwide, paving the way for a more sustainable and citizen-friendly urban future.

Waste management in Barcelona

Waste management in Barcelona is a well-organized system designed to ensure sustainability, efficiency, and cleanliness. The city's waste management strategy focuses on reducing waste, promoting recycling, and maintaining a clean environment through a combination of public participation, technological innovation, and strict regulations. Here are the key aspects of waste management in Barcelona:

1. Waste Segregation and Collection

Separate Collection: Barcelona encourages residents and businesses to separate waste into four main categories: organic (green bin), paper and cardboard (blue bin), glass (green bin), and plastic/metal (yellow bin). The goal is to reduce contamination and improve recycling rates.

Door-to-Door Collection: In some areas, especially in central neighborhoods, Barcelona uses a door-to-door waste collection system. This system is designed to reduce the amount of waste left in public spaces and encourage better waste segregation.

Underground Containers: In certain parts of the city, underground waste collection bins have been installed. These bins, which are more aesthetically pleasing and efficient, help to minimize street clutter and odors.

2. Waste Minimization and Recycling

Recycling Rate: Barcelona has made significant strides in improving its recycling rate, with the goal to meet European Union recycling targets. As of recent years, the city has achieved a recycling rate of over 40%.

Public Education: The city runs educational campaigns to inform citizens about proper waste disposal and recycling. Information is made available in various languages to ensure inclusivity.

Waste-to-Energy: The city has implemented waste-to-energy systems where non-recyclable waste is converted into energy, reducing the burden on landfills.

3. Green and Organic Waste

Barcelona encourages the separate collection of organic waste (food scraps, garden waste, etc.), which is then composted or used for biogas production. Organic waste has a separate collection system that operates several times a week in most districts.

4. Special Waste Streams

Electronic Waste: The city provides designated points for the collection of electronic waste, which can be dropped off at recycling centers or specialized bins around the city.

Bulky Waste: Residents can arrange for the collection of large items like furniture and appliances. Barcelona offers a free service for this, with specific dates and times for collection. Hazardous Waste: Hazardous materials such as batteries, chemicals, and paints are collected at specialized facilities or mobile collection points.

5. Waste Disposal Infrastructure

Recycling Centers: Barcelona has a network of "puntos limpios" (clean points) where citizens can drop off larger quantities of recyclable or special waste.

Waste Sorting Facilities: The city works with various sorting plants and recycling facilities to process the waste collected and ensure it is properly recycled or treated.

6. Environmental Impact and Goals

Circular Economy: Barcelona aims to move towards a circular economy, where resources are reused and waste is minimized. The city is implementing strategies to reduce landfill waste, encourage the reuse of materials, and reduce CO2 emissions.

EU Targets: Barcelona's waste management policies are aligned with EU directives, aiming to meet recycling and composting targets set by the European Union. The city is continuously improving its waste collection, sorting, and recycling systems.

7. Public Involvement and Innovation

Smart Waste Management: The city is adopting "smart" waste management solutions, including sensors in bins that alert when containers are full, helping optimize collection routes and times.

Citizen Participation: Barcelona has actively involved its citizens in waste reduction initiatives, offering educational programs and incentives for proper waste sorting. The city also encourages residents to participate in local clean-up programs

അമൃത് എക്സപർട്ടുകൾക്കായി പരിശീലനം സംഘടിപ്പിച്ചു

അമൃത് മിഷനിൽ പ്രവർത്തിക്കുന്ന എക്സപർട്ടുകളുടെ കപ്പാസിറ്റി ബിൽഡിംഗിന്റെ ഭാഗമായി സെന്റർ ഫോർ മാനേജ്മെന്റ് ഡെവലപ്മെന്റ്, തിരുവനന്തപുരത്തിന്റെ സഹകരണത്തോടെ പരിശീലന പരിപാടി സംഘടിപ്പിച്ചു. വ്യക്തിഗത മികവിലൂടെ പ്രൊഫഷണൽ മികവ് കൈവരിക്കുക എന്ന ലക്ഷ്യത്തോടെയാണ് പരിപാടി സംഘടിപ്പിച്ചത്. 2024 നവംബർ 13 മുതൽ 16 വരെ മൂന്നാറിലെ ടീ കൗണ്ടിയിൽ വച്ചാണ് പരിശീലനം സംഘടിപ്പിച്ചത്. ആദ്യ ദിവസം ടീം മാനേജ്മെന്റ്, പേഴ്സണൽ ബൗണ്ടിംഗ്, ട്രസ്റ്റ് ബിൽഡിംഗ്, ടൈം മാനേജ്മെന്റ് എന്നീ വിഷയങ്ങളിൽ ഇന്റർ നാഷണൽ ട്രെയിനിംഗ് ഫോറം അംഗമായ അനൂപ് ആർ.പി. പരിശീലനം നൽകി.

രണ്ടാം ദിവസം ലീഡർഷിപ്പ്, ഇമോഷണൽ മെച്ച്വുരിറ്റി, കമ്മ്യൂണിക്കേഷൻ, ഇന്റർ പേഴ്സണൽ റിലേഷൻഷിപ്പ്, മൾട്ടി ടാസ്കിംഗ് സ്കിൽ, പ്രൊഫഷണലിസം എന്നീ വിഷയങ്ങളെ സംബന്ധിച്ച് തോമസ് സക്കറിയ ക്ലാസ്സെടുത്തു. മൂന്നാ ദിവസം പബ്ലിക് ഫിനാൻസ് മാനേജ്മെന്റ്, ഐ.ടി. & ഇ ഗവേണൻസ്, അമൃത് 2.0 എന്നിവ സംബന്ധിച്ച് അമൃതിലെ ഉയർന്ന ഉദ്യോഗസ്ഥർ ക്ലാസ്സെടുത്തു. അനുഭവ പാഠങ്ങളിലൂടെയും, ഗെയിമിലൂടെയും, ഇന്ററാക്ഷനിലൂടെയും നടത്തിയ പരിശീലന പരിപാടി വേറിട്ടൊരു അനുഭവമായി. അമൃത് മിഷൻ കപ്പാസിറ്റി ബിൽഡിംഗ് ആന്റ് ഇൻസ്റ്റിറ്റ്യൂഷനിംഗ് സ്ട്രെംഗ്ത് എക്സപർട്ട് സതി കുമാരി പരിശീന പരിപാടികളുടെ ഏകോപനം നടത്തി.

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Septic Tank Crisis in Kerala: A Threat to Water Quality and Public Health.

Kerala, a state renowned for its pristine backwaters and lush greenery, is grappling with a hidden crisis: the widespread misuse and mismanagement of septic tanks. Despite being a common method of wastewater treatment, these systems, when not properly designed, maintained, and desludged, pose a significant threat to the state's water bodies. The high levels of coliform bacteria detected in rivers, lakes, and groundwater sources can be directly linked to the failure of septic tank systems. This alarming situation not only endangers public health but also jeopardizes the delicate ecological balance of Kerala's aquatic ecosystems. As per the study conducted by Suchitwa Mission reveals that over 60% of the water bodies in the state are contaminated with coliform bacteria.

Current Issues with Septic Tanks:

I. Improper Design and Construction: Many septic tanks in Kerala are poorly designed with inadequate size, improper inlet/outlet arrangements, and lack of proper sludge chambers, leading to inefficiency, overflow, and untreated sewage seepage.

II. Poor Effluent Quality: The effluent is malodorous and contains high levels of dissolved organic matter and pathogens. The BOD removal rate is barely 30%, requiring further treatment before disposal.

III. Soak Pits: Soak pits, commonly used for disposal, are not advisable due to risks of soil and groundwater contamination. They do not effectively remove pathogens or organic matter and may lead to overflows and environmental harm.

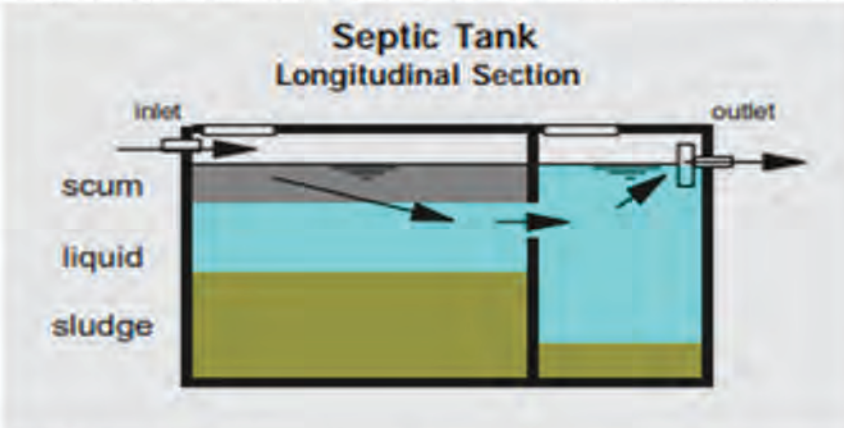
IV. Maintenance Challenges: Neglecting regular desludging causes solid buildup, reducing system efficiency and allowing untreated effluent to leak into the environment.

V. High Coliform Levels: High coliform bacteria, particularly E. coli, in water bodies are linked to septic tank malfunctions, leading to the spread of faecal contamination in rivers, lakes, and groundwater.

VI. Lack of Awareness: Many people are unaware of proper septic tank construction, maintenance, and operation, leading to neglect and untreated sewage entering the environment

Treatment Processes in a Septic Tank.

A septic tank is a sedimentation tank where sludge is stabilized by anaerobic digestion, leaving dissolved and suspended matter mostly untreated. It uses two treatment principles: sedimentation, which works best with smooth flow, and biological treatment, enhanced by turbulent flow that increases interaction between wastewater and active sludge. Smooth flow results in relatively fresh and odourless effluent, while turbulent flow accelerates degradation but disrupts sedimentation, leading to more suspended solids and foul-smelling effluent with partially decomposed solids. In domestic wastewater, a scum layer forms near the inlet, consisting of lighter materials like fat, grease, and debris, along with sludge particles lifted by treatment gases. Over time, scum accumulates as it dries and becomes lighter. While it doesn't interfere with treatment, it occupies tank volume and should be removed every three years.



Flow principle of the septic tank.
Most sludge and scum it retained in the first chamber; the second chamber contains only little sludge which allows the water to flow undisturbed by rising gas bubbles.

Design Standards for Septic Tanks (IS 2470-1:1985)

1. General Guidelines: In areas without sewerage systems, every household must have a septic tank, with effluent undergoing secondary treatment through methods like biological filters, land application, or subsurface up flow systems.
2. Prevention of Water Ingress: Prevent surface runoff and subsoil water from entering the tank, as it can dilute contents and reduce treatment efficiency.
3. Separation of Foul Sewage and Sullage: Only treat foul sewage in the septic tank. Sullage (kitchen, bathroom, laundry wastewater) should be disposed of in gardens or seepage pits.
4. Effluent Disposal Restrictions: Effluent should not be discharged into open drains or water bodies without secondary treatment to reduce pathogens and pollutants.
5. Avoid Inhibitory Wastes: Avoid discharging excessive detergents, grease, or disinfectants, which disrupt the anaerobic treatment process.
6. Gradient Management for Incoming Drains: Ensure the final section of the incoming drain has a gradient of no steeper than 1:50 to minimize turbulence inside the tank.
7. Pumping Arrangements: Sewage should first flow into a holding tank before entering the septic tank gravitationally, with a pumping rate not exceeding three times the Dry Weather Flow.
8. Pipe Diameter: Use pipes with a minimum diameter of 100 mm for adequate flow and to prevent blockages

Layout:

Pipe layouts should be simple, with straight lines preferred. Bends must have long radii and cleaning eyes, and flow disruptions minimized. At manholes, branch connections should merge at angles ≤45° to the main flow. The septic tank should be installed in an open area, away from building walls, swampy areas, or flood-prone zones. It should be accessible for regular cleaning and maintenance.

Septic Tank Design:

Sedimentation: The surface area of the septic tank required is 0.92 m^2 for every 10 liters per minute of peak flow rate at a temperature of 25°C. The minimum sedimentation depth should be between 250 mm and 300 mm to allow effective settling of solids.

Sludge Digestion: The **per capita suspended solids** entering the tank can be estimated at **70g/day**. The required capacity for sludge digestion is **0.033 m^3 per capita** at 25°C.The volume of digested sludge generated is approximately **0.00021 m^3 per capita per day**.
These parameters are essential for ensuring efficient sedimentation and sludge digestion within the tank.

Detention Time:

A septic tank should be designed to provide a detention period of 24 to 48 hours, based on the average daily flow of sewage. This allows adequate time for sedimentation and preliminary treatment.

Dimensions of Septic Tank: The septic tank must have the following minimum dimensions:

- Width: At least 750 mm.; Depth: A minimum of 1 meter below the water level;
- Liquid Capacity: The tank must have a minimum liquid capacity of 1,000 liters.

For rectangular septic tanks:

- The length of the tank should be 2 to 4 times its width.
- Suitable sizes for different tank capacities are provided in Appendix A.

For circular tanks:

- The minimum diameter shall not be less than 1.35 meters, and the operating depth must be at least 1 meter.

Inlet: The septic tank inlet should minimize disturbance to sludge and scum. For tanks ≤1200 mm wide, use a securely fixed T-shaped dip-pipe matching the incoming drain size. The top limb extends above the scum level, and the bottom limb reaches 300 mm below the top water level, ensuring efficient flow and minimal disruption.

Outlet: For tanks less than 1200 mm wide, use a 100 mm dip-pipe outlet, with the top limb above the scum level and the bottom extending to 1/3 of the liquid depth. The outlet invert should be 50 mm below the inlet invert. For wider tanks, use a full-width weir outlet with a scum board fixed 15 mm away, extending 150 mm above and 1/3 below the liquid level. A deflector 150 mm below the scum board base should protrude 150 mm to block rising particle

Partition: For tanks over 2000 liters, use a durable partition to divide the tank into two chambers, with the first chamber twice the size of the second. Provide openings (100-150 mm diameter) in the partition, 300 mm below the top water level.

Free-Board - A minimum free board of 300 mm should be provided.

Access openings: Each septic tank compartment must have an access opening of at least 455x610 mm (rectangular) or 500 mm diameter (circular).

Ventilating Pipe : A septic tank must have a ventilating pipe (≥50 mm diameter) with a mosquito-proof mesh. The pipe should extend 2 m high if the tank is ≥20 m from a building, or 2 m above the building's roof if closer.

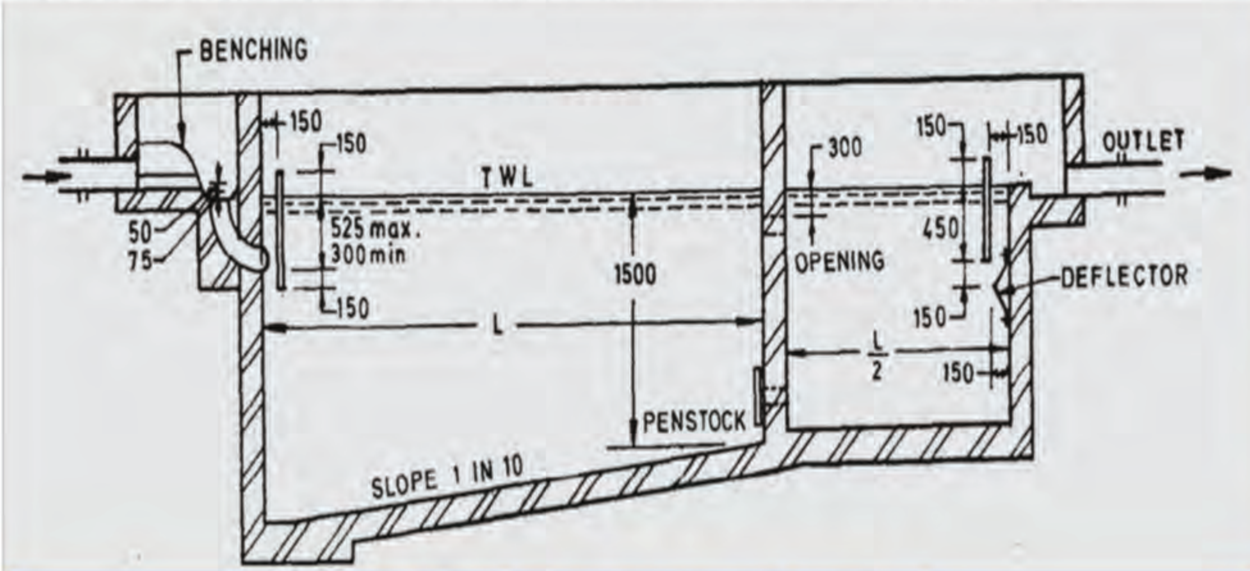
Floor: The tank floor must be watertight, strong enough to resist earth movement, and support the tank's structure and contents. Use minimum M15 grade cement concrete with a 1:10 slope towards the sludge outlet for easy desludging.

Walls : Walls must ensure strength and watertightness. Brick walls should be at least 200 mm thick, plastered 12 mm thick inside and outside with 1:3 cement mortar. Stone masonry walls should be at least 370 mm thick.

Sludge withdrawal: Septic tanks should be desludged every 1–2 years, ensuring they are not overloaded. Desludging is needed when scum and sludge exceed half the tank's depth. Leave at least 25 mm of sludge as seeding material. Use a dip pipe (≥150 mm diameter) under hydrostatic pressure or portable pumps for sludge removal, avoiding manual handling. Minimize scum disturbance during desludging. Dispose of sludge in covered pits or vehicles; spreading it on nearby ground is prohibited.

Commissioning of Septic Tank: The sewerage system must be operational before connecting to the building. Fill the tank with water to the outlet level before use and seed it with digested sludge or decaying organic matter like cow dung if sludge is unavailable.

By adhering to these detailed design considerations, septic tanks can function efficiently, ensuring effective wastewater treatment while minimizing environmental and public health risks. Proper implementation of these guidelines is crucial for sustainable sanitation in unsewered areas.



Typical sketch of two compartment Septic Tank

Recommended sizes for Septic Tanks

Recommended size of septic tank up to 20 users

No. of Users	Length (m)	Breadth (m)	Liquid depth (m) (cleaning interval of)	
			2 years	3 years
5	1.5	0.75	1.0	1.05
10	2.0	0.90	1.0	1.40
15	2.0	0.90	1.3	2.00
20	2.3	1.10	1.3	1.80

Note 1: The capacities are recommended on the assumption that discharge from only WC will be treated in the septic tank

Note 2: A provision of 300 mm should be made for free broad.

Note 3: The sizes of septic tank are based on certain assumption on peak discharges, as estimated in IS: 2470 (part 1) and while choosing the size of septic tank exact calculations shall be made.

Source: CPHEEO, 1993

Way Forward:

* Standardization and Regulation: Strict guidelines for septic tank construction should be enforced by the Kerala State Pollution Control Board (KSPCB) and local bodies, ensuring proper design, capacity, and maintenance.

* Secondary Treatment: Despite clarification, septic tank effluent still contains harmful solids and pathogens. Integrating anaerobic filters or biofilters before discharge is recommended for effective disposal.

* Awareness and Training: A statewide campaign should educate the public on septic tank construction, maintenance, and desludging, with local authorities conducting workshops for residents and professionals.

* Monitoring and Inspection: Local authorities should mandate regular inspections and desludging schedules to prevent overflow and leakage, ensuring proper waste disposal.
* Alternative Treatment Methods: In densely populated areas, DEWATS could be explored as an alternative to traditional septic tanks.
* Pollution Control: Monitoring of water quality in rivers and lakes should be strict, with corrective actions taken when high coliform levels are found, including sewage treatment and restoration efforts.

* Research and Technological Support: The government should partner with research institutions to study septic tank failures and develop affordable, effective wastewater treatment technologies for rural and semi-urban areas

Conclusion:

The present scenario of septic tank management in Kerala demands immediate attention and concerted action. By addressing the issues of improper design, inadequate maintenance, and lack of awareness, we can significantly reduce the pollution load on our water bodies. A comprehensive approach involving government regulations, public education, and technological advancements is essential to safeguard Kerala's water resources and ensure a sustainable future.

References : 1. CPHEEO - On Site Sanitation.
2. Design Standards for Septic Tanks (IS 2470-1 , 1985)

അമൃത് പദ്ധതിയിൽ ഉൾപ്പെടുത്തി നവീകരിക്കുന്ന പാലക്കാട് മുനിസിപ്പാലിറ്റിയിലെ ഗണേഷ് നഗർ പാർക്ക്

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"WATER - ENERGY - FOOD NEXUS": INDIA'S PERSPECTIVE IN TERMS OF CHALLENGES AND OPPORTUNITIES."

Introduction:

India faces a serious and persistent water crisis owing to a growing gap between demand and supply. According to the World Bank, India is the world's most important user of groundwater and it estimates that 114 million Indians are facing domestic, agricultural and industrial water shortages, which threatens their long-term food security, livelihoods, and economic growth. This increase in water demand is also increasing pressure on groundwater resources and further depleting aquifers. The lack of quality drinking water for people is a pressing issue that contributes to India's water security challenge. The agriculture sector is the main consumer of water and freshwater withdrawal for irrigation comprises nearly 90%. India's water resource for agriculture is also under stress, which will invariably affect national food security. India faces many challenges caused by the inefficient management of existing water resources. The consumption of water is crucial – it is equally important to provide water for irrigation to increase food production and livestock management, and to ensure food security and domestic water for the rising population. The population growth rate is a serious concern as it will create a burden on the per capita water availability in the future. The consumption of water in India will increase by over 50% while the supply will increase only by 5–10% during the next 12–15 years. This gap in supply and demand will affect food production, biodiversity and other environmental components. To improve the availability of water resources, more emphasis should be given to the following activities: Increasing Water Storage Capacity, Efficient Irrigation Practices, Watershed Development and Management & Research and Development.

India's energy consumption stands at 3.5% of the world's global energy consumption and is likely to be 10% by 2031, but the country is not endowed with abundant energy resources. India's agriculture is responsible for over 18% of overall national power consumption, however, its contribution to GDP is just 5 %. As fossil fuel energy is becoming scarcer and costlier, India will face significant energy shortages due to an increase in energy prices and energy insecurity within the next few decades. Increased use of fossil fuels also causes environmental problems both locally and globally such as frequent flooding and droughts, deforestation and desertification as well as possible glacial melting in the Himalayas. India has the 5th largest electricity generating capacity and is the 6th largest consumer accounting for about 3.4% of global energy consumption. India's energy needs have grown at 3.6% per annum over the past 30 years. Over 80% of the energy needs are met by three fuels - coal, oil and solid biomass. The Government of India has set a target to increase the share of renewable energy: to set 175 GW of the renewable project by end of 2022 and 450 GW by 2030. India ranked fourth in wind power and fifth in solar power and fourth in renewable power installed capacity as of 2022 in the world. India has set a target of 500 GW by 2030 as far as a renewable source of energy is concerned. It is envisaged that by 2050 India will have an annual energy demand of about 14500 Terawatt-hours (TWh)/ Year

In 2022, India's rank of 107 out of 121 countries in the Global Hunger Index with a GHI score of 27.5 is a matter of serious concern. In 2016, India ranked 97 with a score of 28.5. Comparing the last five years India's performance in the Global Hunger Index is a matter of prime concern. The challenges to food security include - crop diversification, biofuel and medicinal plant cultivation, climate change, the mismatch between water demand and availability, agricultural prices, production of High yielding crop varieties with fewer inputs, new trends of globalization, capital investment, infrastructure requirements etc.

The water, energy and food security nexus according to the "Food and Agriculture Organization" of the United Nations (FAO), means that water security, energy security and food security are very much linked to one another, meaning that the actions in any one particular area often can have effects in one or both of the other areas.

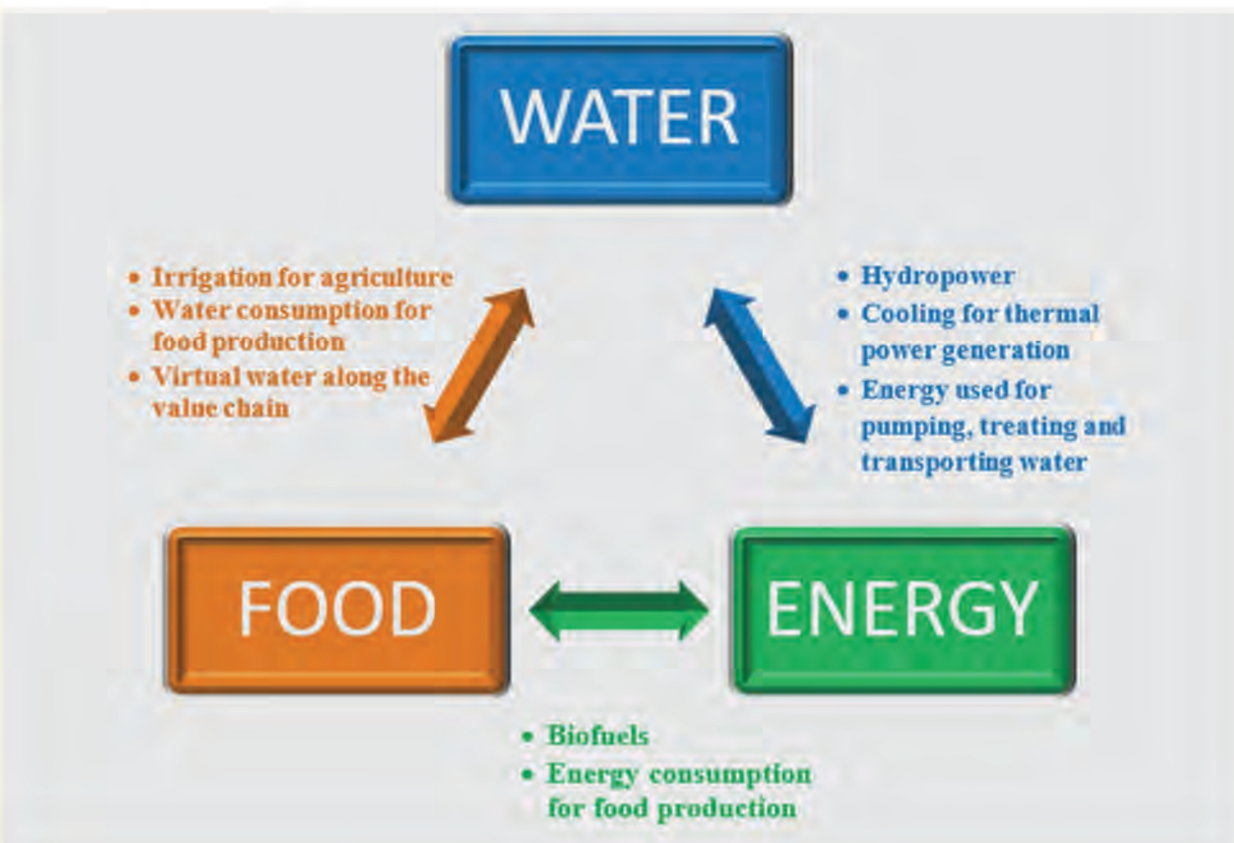


Figure 1: Water, Energy, Food Nexus

Framework Toward India's WEF Nexus and Challenges

The framework for WEF NEXUS was presented by the World Economic Forum in 2011. The main goal was to help decision-makers better understand risks associated with managing resources ahead of time and respond proactively in times of crisis. This approach recognizes that the water–energy–food nexus is subject to (and also drives) external factors like global governance failure, economic disparity and geopolitical conflict. Taken together, this is the global risk area for the water-energy-food nexus (WEF, 2011). The framework also shows the connection between energy and economic securities in the context of energy shortages and the potential impact of social stability. It highlights the energy embedded in food production and water use in both water and energy. Similar to the Bonn 2011 Nexus framework, WEF identifies the importance of population growth and environmental pressures as drivers of the nexus (WEF, 2011).

Water Energy Food Nexus Framework

The WEF nexus focuses on complex interactions, trade-offs, and synergies between the water, energy, and food systems. Traditionally, the various dimensions of the nexus have been viewed independently. It is being increasingly realized that developments or challenges in one of these dimensions could have significant implications for the other dimensions of the nexus. For example, a lack of energy would hinder the withdrawal of adequate groundwater for irrigating crops. Similarly, the lack of water availability has already led to the shutting down of the power plants during peak summer months in arid regions of India as well as in many other parts of the world. While planning food, water, and energy security, it is not enough to look at these systems independently. The interdependence of the systems, the trade-offs between them, and the synergistic opportunities could only be explored and better understood by viewing all these systems simultaneously within a common WEF nexus framework.

The framework considers water supply security, energy security and food security as core nexus themes, which depend on renewable (such as soil, water and biomass) or non-renewable natural resources (such as fossil fuel, minerals etc). Focusing on interactions, synergies and possible trade-offs among nexus themes will support sustainable development efforts. Depending on the local context, other themes or sectors may complement the nexus perspective. In any case, all nexus interventions must take due to account cross-cutting issues, principles and good practices in development.

Interlinking of Water, Energy, Food and Climate Change

Water, food and energy are interdependent and demand for all three is increasing as a result of rising population, rapid urbanization, economic growth and changes in food habits. These interlinked domains need a suitable integrated management approach to ensure food and water security, sustainable agriculture and energy production. The post-2015 agenda of the UN has set new sustainable development goals (SDGs) to achieve sustainable water use, energy use and agricultural practices, as well as promote more inclusive economic development. The water-energy-food nexus has thus become relevant in the context of the development and subsequent monitoring of the SDGs.

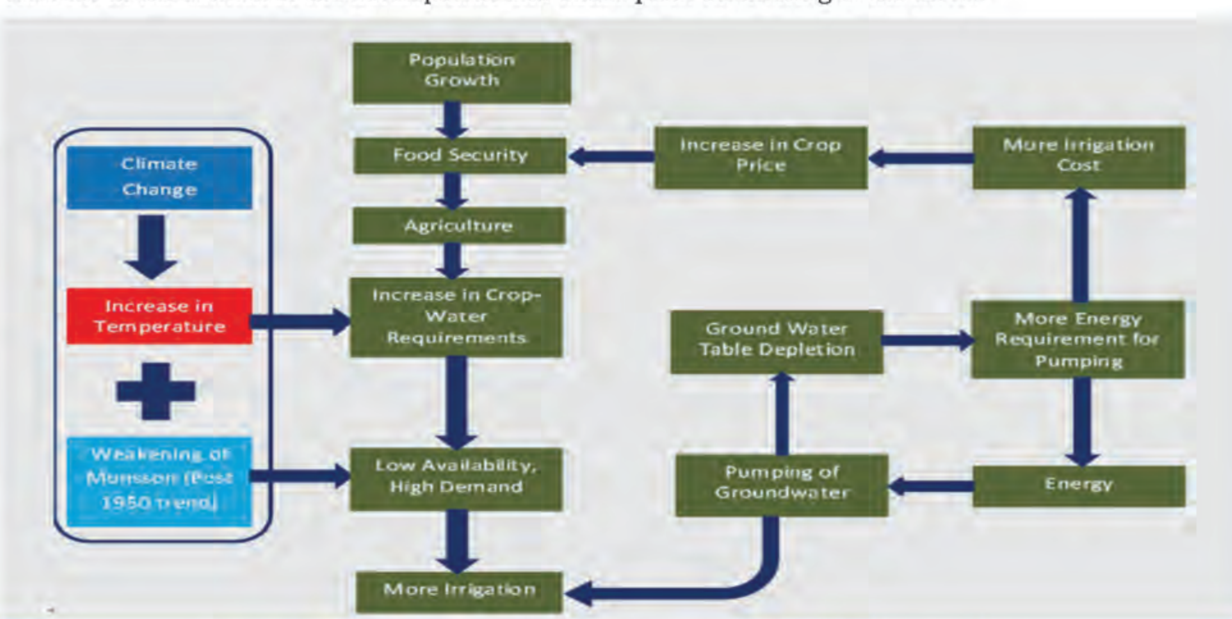


Figure 2: Interlinkages of Water, Energy, Food and Climate Change

The population of India is expected to increase to 1.4 billion by 2025. Of the projected increase in population, nearly 50% is likely to occur in the states of Bihar, Chhattisgarh, Jharkhand, Madhya Pradesh, Rajasthan, Uttar Pradesh and Uttaranchal. To support the increasing population food production is also increasing, though the net cultivable area in India has not changed much since 1990. A Major proportion of India's agricultural land (45.7%) uses irrigation for water supply to agriculture-lands (Department of Agriculture, Cooperation & Farmers Welfare 2015). With the green revolution in the 1970s, the irrigated area has increased, as has the number of wells and tube wells. Rice, wheat and other staple food require a huge amount of water, which has led to overexploitation of groundwater. Growth in electricity consumption in the agricultural sector has also outpaced other sectors. The popularity of an uncontrolled and subsidized supply of energy for irrigation is responsible for this sudden growth. Moreover, farmers in Eastern India depend pre-dominantly on diesel pumps, while the rest of India has electric pumps, which makes the food-energy-water nexus location-specific.

In a nutshell, to meet the growing food demand of the increasing population, India's irrigation sector is being over-dependent on groundwater. More and more groundwater is extracted using electricity which is highly subsidized for the agri-sector. This creates a nexus where agriculture is dependent on the unsustainable groundwater and electricity sector. To combat the challenges, technological options should be explored, irrigation efficiency has to be improved and there is also a need for strong policy interventions and incentive-based facilities from the government.

Interlinkages between Water-Energy-Food-Ecosystems

The Nexus approach stems from the realization that water, energy, agriculture and natural ecosystems exhibit strong inter-linkages, and that under a traditional sectoral approach, attempting to achieve resource security independently often endangers sustainability and security in one or more of the other sectors. Under the Nexus approach, inter-linkages, synergies and trade-offs are analyzed, to identify solutions, foster water-food-energy security and efficiency, and reduce impacts and risks on water-dependent ecosystems.

Multi-dimensional Interlinkages between Water, Energy, Food and Ecosystems

- **Water <-> Energy**: Water plays a key role in energy production, e.g., in hydroelectric plants, for cooling thermal (fossil-fuel or nuclear) plants and in growing plants for biofuels. Conversely, energy is required to process and distribute water, treat wastewater, pump groundwater and desalinate seawater.
- **Water <-> Food**: Water is the keystone for the entire agri-food supply chain. Conversely, agricultural intensification impacts water quality and availability.
- **Food <-> Energy:** Energy is an essential input throughout the entire agro-food supply chain, from pumping water to processing, transporting and refrigerating food. Conflicts around land use for food production may arise in the case of biofuels or extended solar installations.

Healthy ecosystems are an essential requirement for the sustainability of all the above and are negatively affected if water, energy or food are used in an unsustainable way.

This seeks to establish a new nexus-oriented approach to promote sustainable use of resources and ensure the security of access to basic services. Water availability is at the center of the framework to reflect its importance as a key driver of other resources. The goal of the framework can be achieved by incorporating megatrends like urbanization, population growth and climate change into nexus policy decision-making. The aim is to raise economic growth without increasing the use of nexus resources and investments to sustain ecosystems' services

Food and water are deeply linked, and together with energy, have ensured the continued existence of humans and ecosystems on Earth for millennia. There are several embedded intimate links within socio-ecological systems such as agricultural production systems that characterize the nexus between water, energy and food.

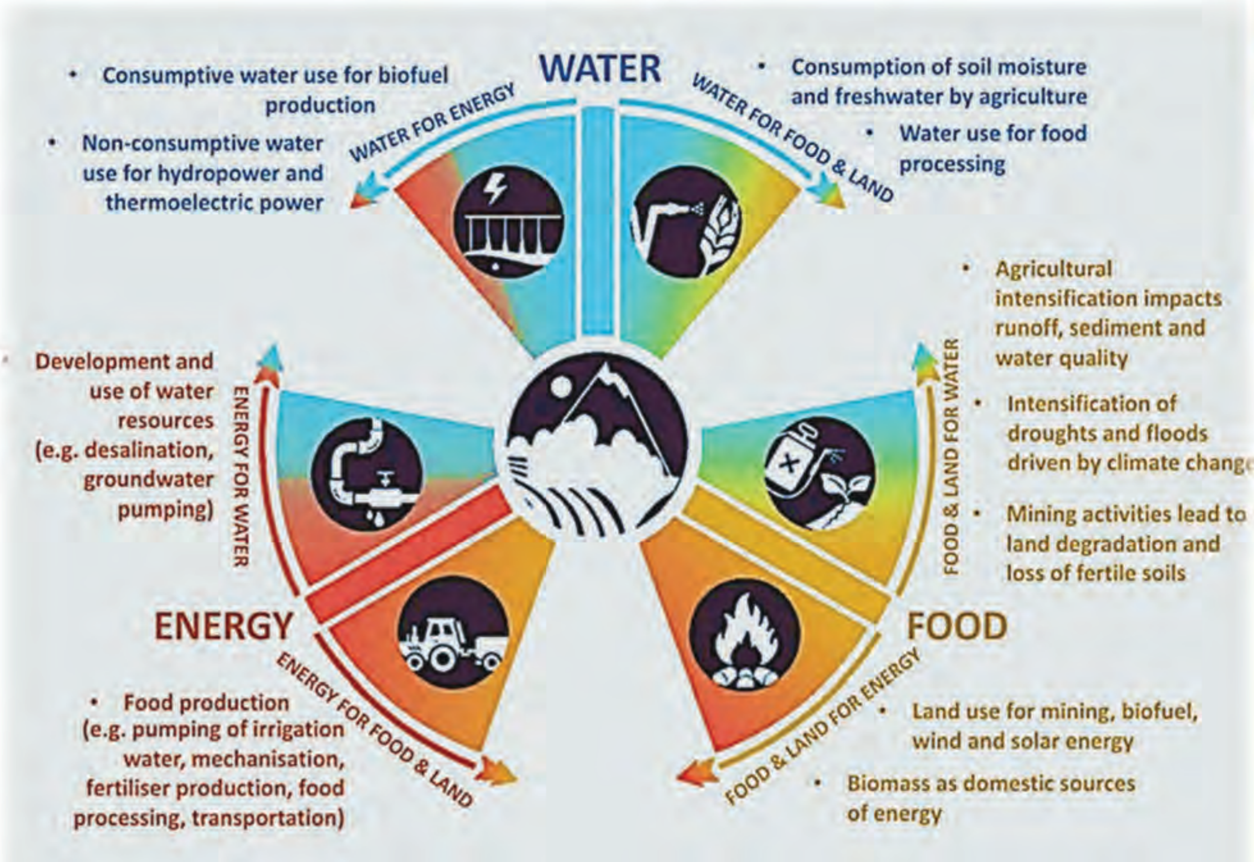


Figure 3: Food- Water-Energy Nexus

Interdependence and Inter-linkages of Water, Food and Energy Aspect:

The lack of funds for high-quality food products that contain enough calories and nutrients for the normal functioning of the human body forces people to switch to poor nutrition. More than 2 billion people suffer from a lack of microelements necessary for the growth, development and prevention of diseases.

It is necessary to meet the needs of the agriculture sector for reliable food supplies, which is one of the most water-intensive sectors of the economy and requires significant energy consumption. According to various estimates, depending on the region, from 500 to 4000 litres of water is required to produce 1 kg of wheat, and the production of 1 kg of meat requires from 5,000 to 20,000 litres of water. Energy is required at all stages of production: for the work of agricultural machinery, irrigation, growing and harvesting, processing, storing and transporting products. In addition, the stability of agriculture entails the indirect energy consumption required to produce pesticides, herbicides and, in particular, mineral fertilizers. For some crops, such as oats, corn, wheat, and barley, energy costs account for more than half of the production costs. The food sector, including processing, transportation, marketing and consumption, consumes 10^{18}J of energy per year, or about 30% of global energy consumption.

The correlation between water, energy and the food sector has formed the basis of the water-food-energy nexus, in response to climate change, population growth, urbanization and socio-economic inequality that put increasing pressure on natural resources. The interdependence between components implies that changes in one sector will inevitably affect others, with significant environmental, economic, social and political consequences. In this case, water plays a key role, occupying a central position in the formula.

Water consumption is increasing in all sectors without exception due to the population growth, its movement from rural to urban areas, the industrialization of developing countries and the improvement of water supply infrastructure. Population growth entails the need to increase food production, coupled with intensive irrigation. Industrialization leads to an increase in energy production and, consequently, in water intake in the industrial sector. The movement of people from rural to urban areas increases the demand for domestic water consumption. The shift in dietary habits due to the increasing incomes of the population leads to the consumption of products, which demand a lot of water for production. All these factors lead to competition for water resources, ensuring the stability of some industries to the detriment of others.

For example, the cultivation of corn can be carried out both for food purposes, and as a raw material for the production of biofuels based on ethanol. A whole hectare of a cornfield is required for the production of only 3,000 litres of ethanol. At the same time, 1 litre of ethanol requires at least 1500 litres of water: this is one of the most water-intensive ways of producing Energy. Moreover, the cultivation of corn is an extremely energy-intensive process, since corn requires more fertilization than other crops. Biofuel production contributes to energy security, but it poses a threat to food and water security, reducing the production of corn as a food product, causing a rise in food prices and putting a significant strain on water resources.

The competition between water for irrigation and water for hydropower is another example. Intensive irrigation, which accounts for almost 70% of the global water consumption, ensures food security, but disrupts the water balance and, ultimately, leads to a reduction in water supplies in a geographic region. The construction of hydropower plants provides energy independence but is accompanied by the expropriation of lands, and redistribution of river flow, which also violates the water balance, leading to the restructuring of ecosystems.

Factors Driving Unsustainable Practices:

What drives the unsustainable use of resources? To understand the opportunities better, it is important to understand the driving forces and context of resource scarcity. The following paragraphs present a short overview of the root causes of the problem.

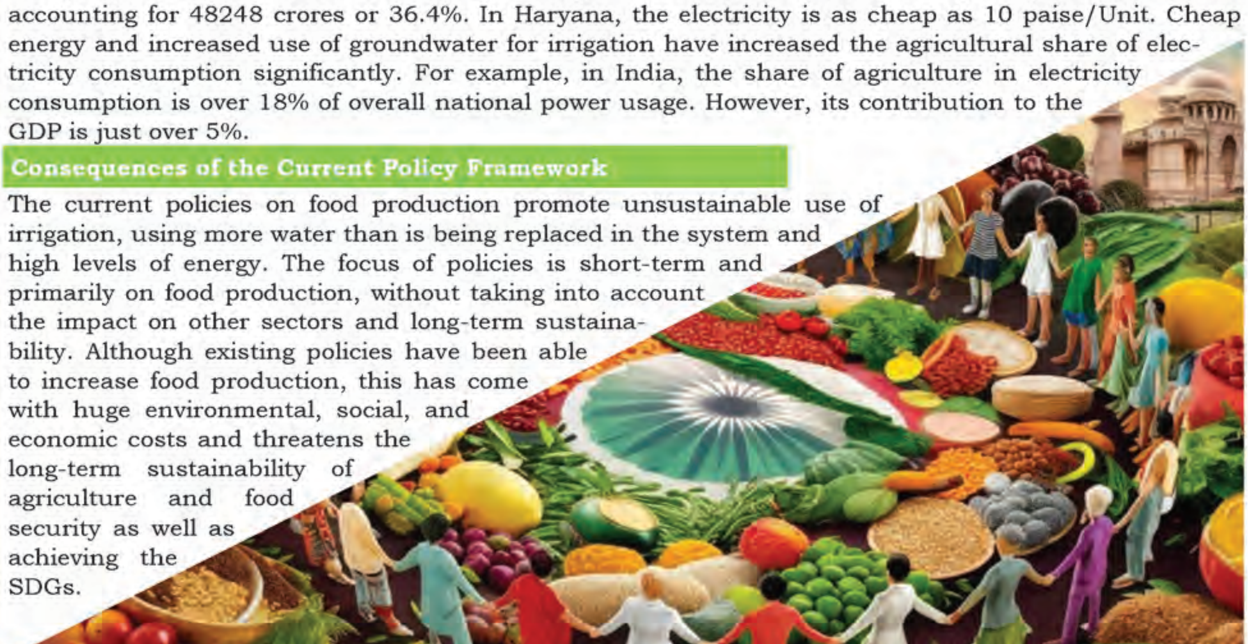
Current Policy Approaches to Ensuring Food Security in India:

To ensure food self-sufficiency, India has adopted policy measures to induce farmers to increase food production, including providing subsidies for agrochemicals, energy use, and irrigation. Specifically, they have focused on increasing the production of the principal food crops of rice and wheat by subsidizing the supply of modern agricultural inputs – the seed of High yielding varieties (HYVs), fertilizers, pesticides, irrigation, and machinery. Measures were taken to utilize surface and groundwater by expanding irrigation facilities and installing tube wells for Groundwater extraction. The favorable policy support in the form of input subsidies, market support, and infrastructure development has changed cropping patterns and farming practices. The area under irrigated rice and wheat has increased tremendously in India. Irrigation has been almost entirely mechanized with either diesel or electricity, which has also increased greenhouse gas emissions (GHGs) by more than 30% of GHG and 20% of methane comes from agriculture. While this has led to substantial increases in crop production, the demise of traditional food crops has hurt nutrition.

The water resource department strategies have been centered on the expansion of irrigation to promote food grain production. Water for irrigation is provided free of cost, and the cost of water delivery is highly subsidized. Different systems of water charges are practiced in different states within India. To promote the use of irrigation facilities, energy for irrigation has been highly subsidized. Electricity is provided free of cost or highly subsidized in many a state of India such as Punjab, Haryana, Tamil Nādu, Karnataka, Telangana and Andhra Pradesh, Rajasthan, Madhya Pradesh etc totaling to 27 states. At least 1.5 trillion spent nationwide in 2022-2023 financial year as per power ministry data. Madhya Pradesh, Rajasthan, Karnataka, Tamil Nādu, Telangana antra Pradesh footed the highest power subsidy bill accounting for 48248 crores or 36.4%. In Haryana, the electricity is as cheap as 10 paise/Unit. Cheap energy and increased use of groundwater for irrigation have increased the agricultural share of electricity consumption significantly. For example, in India, the share of agriculture in electricity consumption is over 18% of overall national power usage. However, its contribution to the GDP is just over 5%.

Consequences of the Current Policy Framework

The current policies on food production promote unsustainable use of irrigation, using more water than is being replaced in the system and high levels of energy. The focus of policies is short-term and primarily on food production, without taking into account the impact on other sectors and long-term sustainability. Although existing policies have been able to increase food production, this has come with huge environmental, social, and economic costs and threatens the long-term sustainability of agriculture and food security as well as achieving the SDGs.



Cross-Sectoral Externalities and Socio-Economic and Environmental Impacts of Sectoral Policies.

Table 1: Cross-Sectoral Externalities and Socio-Economic and Environmental Impacts	
Cross-Sectoral Impacts	Implications for Sustainability and the SDGs
1. Policy: Subsidies for agrochemicals	
ECONOMIC	
Food: Both positive and negative	Inefficient allocation of resources. The fiscal burden on the government.
Higher yields, lower food prices	Constraints for investment in agriculture infrastructure, research, and development.
Excessive use of agro-chemicals	Increasing dependence on agrochemicals Discourages the use of organic fertilizers and environmentally friendly pest, insect, and disease management.
Intensifies pressure on irrigated crops increases mono-cropping and reduces the diversity of agriculture	Stagnation/decline in productivity of the rice-wheat system
	Long-term loss of productivity of land and water and threat to agricultural sustainability Affects agricultural productivity in the long-run
WATER	
Social	
Eutrophication of surface water and contamination of groundwater. **Overuse of surface and groundwater**	Deteriorating quality of drinking water Cost of water purification for public use
Water pollution and degradation affect aquatic life.	Concern about food safety - pesticide residues in the food chain.
Pollution of drinking water	Increased waterborne and water-related disease.
Loss of aquatic diversity	Adverse impact on public health and healthy lives [SDG 3, 6].
ENERGY	
Environmental	
Excessive use of agrochemicals	NPK (Nitrogen, Phosphorus, Potassium) imbalance. Soil salinity, waterlogging, land degradation Eutrophication of freshwater
increased use of energy for production and transportation of agrochemicals	N_2O emissions, air pollution.
Subsidized agrochemicals lead to water and energy-intensive crops.	Arsenic contamination in soil and water. Loss of biodiversity, degradation of ecosystems that support food production [SDG 15]
2. Policy: Subsidies for Energy for irrigation	
ECONOMIC	
Food: Positive and Negative	
Increased food production, lower food prices	Inefficient and excessive use of energy. Inefficiency in power generation.
Reduced food imports, enhanced food and nutrition security	Less incentive to adopt energy-efficient irrigation technologies.
Change in cropping patterns switch to energy-intensive crops	Sub-optimal use of surface water irrigation. Farmers often switch from surface to groundwater irrigation.
Reduced crop and dietary diversity.	Inadequate investment in energy.
Excessive reliance on expensive, imported energy for food production.	Poor and unreliable energy system - threats to food and water security and access to energy [SDG 7, 2, 6, 8].

WATER – NEGATIVE	
Social	
Free energy encourages excessive water use.	Undermines access to modern energy, health, and rural livelihoods. Widespread electricity outages
Overexploitation of groundwater & wasteful use of water for irrigation.	Individualization of irrigation system, break-down of community-managed irrigation systems – loss of social capital.
Less water for other uses	Unsustainable irrigation and energy systems [SDG 2, 7].
Energy negative – Environment	
Increased demand for energy.	Increased emission of GHGs
Shortage of energy for alternative uses.	Depletion of groundwater aquifers and reduced streamflow.
Inefficient energy systems	Degradation of environment that affects healthy lives [SDG 3].
3. Policy: Free or subsidized water for irrigation	
FOOD: POSITIVE	
Economic	
Increased production	Encourages cultivation of water-intensive crops.
Switch to water-intensive crops	Overuse and wastage of water.
Reduce crop diversity.	Disincentive for adopting water-saving technologies and practices.
The increased cost of lifting groundwater	Inadequate public investments in irrigation. Inefficient and unsustainable irrigation systems. The irrigation system is financially unsustainable.
WATER NEGATIVE	
Social	
Overexploitation of water.	Depletion of water bodies and drying up of streams, wells
The high opportunity cost of water for other uses and Less water and energy for domestic and industrial use	Affects drinking water supplies, water and sanitation
Inefficient management of irrigation systems.	Affects water-dependent livelihoods, Affects fisheries and other aquatic life.
ENERGY: NEGATIVE	
Environment	
Shortage of water for other uses such as electricity generation, and drinking.	Overuse of water and energy. Groundwater depletion. Waterlogging and salinization of soils at some places
Less energy for domestic and industrial use	Less water is available for domestic and industrial purposes.

Environmental Costs:

Intensive agriculture has accelerated the use of water and energy in food production. Incentives provided to increase food production have distorted agricultural input markets and led to inefficient use of energy, overexploitation of water, and indiscriminate use of pesticides and chemical fertilizers. This has raised serious concerns related to land degradation, water pollution, groundwater depletion, salinity, waterlogging, arsenic contamination, biodiversity loss, the environment, and negative impacts on human health.

In much of Punjab and the neighboring state of Haryana, the cheap energy has led to overexploitation and wastage of groundwater resources resulting in lowering of groundwater tables, degradation and contamination of groundwater, waterlogging, and salinization. Many recent studies have reported an alarming rate of decline in groundwater levels in many parts of South India and also in the Indo Gangetic Plain, the breadbasket of South Asia. The groundwater table is going down by 1 m every three years in high potential green revolution areas in India and about 30% of the tube wells in Punjab have become redundant (no longer used). If remedial measures are not taken to ensure sustainable groundwater usage in the next 10 years, all the centrifugal pumps will become non-functional and will need to be converted into submersible pumps, which will require a huge financial investment as well as increased energy to extract water. Similar is the situation in the hard rock terrain of south India.

Waterlogging and salinization have affected nearly 20 million ha in India and are the second most important cause of land degradation. The irrigated areas in semi-arid regions that support large rural populations are of particular concern, such as western Punjab and Indus valley where large areas of waterlogged saline land are spreading through the intensively irrigated plains. Surface irrigation in India is prone to inefficiency and needs urgent attention. For example, the canal irrigation network of most dam-based irrigation has deteriorated severely over the years. Estimates indicate that water conservation simply by improving the efficiency of the current irrigation systems can improve the water supply by over 25%. Significant investment is needed for improving and expanding the existing irrigation networks in almost all states of India.

Social Costs:

The indiscriminate and excessive use of pesticides and nitrogenous fertilizers associated with more intensive agriculture seriously affects shallow groundwater; also, the entry of effluents (chemical waste) into rivers and canals is affecting the quality of freshwater. Almost all shallow freshwater is polluted with agricultural pollutants and sewage. Arsenic contamination of groundwater has been observed in Bihar and West Bengal where groundwater is being used intensively for irrigation. Recent evidence suggests that arsenic is entering the human food chain through crops. Waterborne diseases have also continued to increase over the years despite government efforts to combat them. In India, 44 million people (Department of water and sanitation, Government of India) were affected by water-related diseases. In India, 55–60% of the population depends on groundwater. The free water and subsidized energy have changed copping patterns, replaced traditional crops with rice as well as changing dietary patterns with diet becoming cereal dominant.

Economic Costs:

The subsidy approach to promoting agriculture is becoming financially unsustainable, with increasing loss of revenues through subsidies and resultant inadequate investment in irrigation and power infrastructure and maintenance. In India, the amount of power for agriculture is being reduced and the quality of power is deteriorating as the government struggles to cope with increasing demand. For example, farmers in Madhya Pradesh, India, receive only 2–4 hours of electricity a day for irrigation, and in Rajasthan 6–8 hours a day. The poor quality of the power (limited, low voltage off-peak, and unreliable) and frequent interruptions, mean that farmers do not have control over irrigation, which also affects food production. As a result, farmers have shifted towards diesel pumping, which brings problems of air pollution and diesel supply. The subsidies have discouraged farmers from considering alternative cropping systems or growing high-value crops using less water and energy which are capable of generating higher returns both for farmers and the national economy. With high subsidies and guaranteed minimum prices for wheat and rice, Punjab farmers are tied into the rice-wheat farming system, which is a major constraint to diversifying the agricultural system in line with changing demand.

Impact of Policies:

The cross-sectorial impact of the various policy measures and consequences for sustainability are summarized in the above table. While the existing agricultural policy framework has helped increase food grain production in the short term, it has weakened the long-term sustainability of agriculture and food security in India as a result of the unsustainable exploitation of water and energy. The existing policies and regulatory frameworks were developed without considering the cross-sectorial consequences and are implemented by agencies working in isolation. The disconnect between the food, water and energy sectors has resulted in the cross-sectorial externalities being ignored and a failure to take into account social, economic and environmental costs.

WEF Nexus Challenges:

- The challenge – known as the Water- Energy-Agriculture/Food nexus – has led to a crisis in all three sectors involved. While groundwater levels have fallen dramatically, agriculture continues to follow unsustainable practices and farmer incomes remain low and stagnating. In peninsular India, the sustainability of groundwater-based agriculture itself is a big question mark. At the same time, the power subsidy is burgeoning, draining scarce resources and depriving essential sectors such as education, health, and other social programs. To add to the challenge, climate change is disrupting agrarian ecosystems and livelihoods in adverse and unpredictable ways.

- India is one of the most water-stressed countries in the world. With the rapidly increasing population and growing energy demand, the country is already facing challenges in the interaction between water, energy, and food systems. Water scarcity plays a significant obstacle in meeting the required energy needs and agricultural production. Water and energy are often entwined in the sense that the use of one depends on the availability of the other and food production depends on the availability of both Water and Energy. Hence, decision-making in one sector significantly affects the other and overall action for food production.

- Groundwater levels in India are depleting at an alarming rate. While groundwater has played a key role in boosting agricultural production, the provision of subsidized power to farmers has led to the ubiquitous use of irrigation pumps and the over-extraction of this vital resource.

- Rapid rural electrification combined with the availability of modern pump technologies has led to an increase in the number of bore wells to meet that demand. Over the last 50 years, the number of bore wells has grown from 1 million to 25 million, making India the world's largest exploiter of groundwater.

- The Central Groundwater Board of India estimates that about almost 20 % of groundwater blocks are overexploited (meaning the rate at which water is extracted exceeds the rate at which the aquifer can recharge) while 6% and 14%, respectively, are at critical and semi-critical stages. The situation is particularly alarming in three major regions – the North-western, western, and southern peninsular. The Current groundwater overexploitation rates pose threats to livelihoods, food security, climate-driven migration, sustainable poverty reduction and urban development.

- Increased access to groundwater resources and extraction allows households to boost agricultural production in the short term. Many farm households owning wells indicated that their vulnerability is lower partly because of income growth and diversification and buffers provided by social safety nets. However, without sufficient regulation or replenishment of aquifers, the increased access to and use of groundwater for irrigation could lead to declining water tables and increasing water scarcity, which risks escalating toward long-term vulnerability.

- As per the projection of population growth, India's population will reach 1.5 billion people in 2030 and over 1.7 billion by 2050. The International Energy Agency (IEA) projects that India could add about 600 million new electricity consumers by 2040. India is one of the world's largest producers of rice, vegetables, fruits, and cotton. India will need to expand food production or imports to feed the increasing population.

- India is also one of the most water-stressed countries and its water resources (both surface and Groundwater) are getting diminished, showing falling water tables and water quality issues. This creates threats to the country's security because it puts stress on agriculture, the power sector, and industry. India's chronic water scarcity problems will become an even bigger challenge in the future.

- About 600 million people in India face high to extreme water stress in India. NITI Aayog estimated that twenty-one major Indian cities will run out of groundwater by this decade's end. The Indian government is trying to formulate and implement suitable strategies for better management of water resources, but the risks remain to be very high.
- According to a report by the Intergovernmental Panel on Climate Change (IPCC), India will be most significantly affected by climate change, given its huge population and levels of inequality. Heatwaves can seriously affect water availability for agriculture and the power sector drastically.

- Improving our understanding of the complex interdependencies of the Food -water-energy nexus is essential for continued sustainable development in the face of the uncertainties posed by climate change.

To overcome the above: -

1. **Integrated Demand and Supply-Side Solutions Offer the Best Option for Sustainable Water Use**

   The supply-side measures, such as watershed management programs, aquifer recharging and tank rehabilitation activities, along with demand-side action/ measures such as surface water harvesting through farm ponds and check-dams, the installation of water-efficient irrigation systems (e.g., more efficient drips and sprinklers) and growing less water-intensive crops, need to be integrated on the demand side for improved groundwater management and reduction depletion.

2. **Weak Regulatory Action to Limit Demand for Groundwater can Hinder the Success of Programs in Reversing Groundwater Depletion.**

   Weak regulations result in the expansion of groundwater irrigated areas and drilling of additional wells leading to further depletion. The government of India regulates groundwater exploitation in water-stressed states through "notification" of highly overexploited blocks that restrict the development of new groundwater structures (except those for drinking water). However, only about say 15% of the overexploited blocks in the country are currently notified. Local-level regulatory action in all threatened blocks before they reach the "overexploited" stage is vital to avert further depletion.

3. **Strengthening Community Participation and Rights in Groundwater Governance can Improve Groundwater Management.**

   The Participatory Groundwater Management approach (PGM) will empower communities in a defined aquifer area by providing governance rights, community awareness, capacity development, and knowledge and motivation for social regulation and the implementation of coordinated actions. However, the success of the PGM approach will work only when the local institutions are strong. The groups like Water User Associations (WUA) and Ground Water Management Committees (GWMC) can be formal institutions with a wider mandate to manage irrigation systems (surface and groundwater) and have budget allocations for maintaining the systems and collecting user charges for the sustainability of the systems. The key institutional challenge for groundwater governance is strengthening local institutions and helping the informal groups to remain viable during the post-project phase in a sustainable manner.

Why Food, Water and Energy Nexus is of prime importance in India?

Water, energy and food are vital resources for human well-being, poverty reduction and sustainable development. Demand for these resources is projected to increase significantly shortly due to population growth and migration, economic development, international trade, urbanization, diversifying diets, cultural and technological changes, as well as climate variability and change. These current societal megatrends, coupled with environmental, technological, economic and demographic changes, continue exerting pressure on already scarce and depleting natural resources, threatening their sustainability, and, thereby, undermining the resilience (ability to recover/ adapt to adversities) of communities. The resultant challenge requires transdisciplinary and transformative approaches in resource management, development and utilization, using integrative approaches such as the water-energy-food (WEF) nexus, which allows for inclusive and equitable development, as well as coordinated resource planning and management.

The WEF nexus refers to the complex and inextricable (inseparable) inter-linkages (synergies and trade-
The WEF nexus refers to the complex and inextricable (inseparable) inter-linkages (synergies and trade-offs) that exist between the water, energy, and food sectors, in pursuit of balanced and sustainable development. The WEF nexus approach takes into consideration cross-sectoral synergies and trade-offs among WEF sectors, while simultaneously mitigating duplication of activities. Development, management and use of resources through the WEF nexus are evidence-based, integrative, and ensure improvements in livelihoods and sustainability of resources for human well-being. The current silo drove disproportionate use and allocation of WEF resources has created an imbalance in the physical and natural systems, to the extent that sustainability for future generations cannot be guaranteed.

For example, agriculture accounts for 70% of total global freshwater withdrawals, making it the largest consumer of water. Water is used for agricultural production, forestry and fisheries, yet the same water is also required to produce or transport energy in different forms. Concurrently, the food production and supply chain consume about 30% of total energy consumed globally Continuing with the current siloed (isolated/ separate) sectoral approach in resource management directly impacts the livelihoods of the rural poor and severely exacerbates (worsens) their vulnerabilities as they generally lack resources to adapt to change

Livelihood refers to the ability to obtain the basic needs in life, which include food, water, energy and clothing. The sustainable rural livelihoods framework is the widely used approach in livelihoods studies and emphasizes how people use their assets (natural, physical, social, human, and financial) to come up with livelihood strategies and positive outcomes. In a livelihood approach, a detailed analysis of the factors that shape water, energy, and food security is done at the local or community levels. As livelihood approaches capture the processes and contextual factors that shape adaptive capacity, the WEF nexus analytical livelihoods framework can, thus, be integrated into livelihood analyses, as this framework is capable of assessing, monitoring and evaluating resource use and social development. In most rural areas of developing countries, these three basic needs, and their delivery by the government, are limited, which results in rural populations turning to natural systems for basic survival, or emigrating from rural to urban areas. The WEF nexus is mainly concerned with integrating these three connected resources of water, energy, and food, as well as simplifying the human understanding of the complex linkages among them, at the same time, ensuring resource security for sustainability. The approach is envisaged to provide pathways that transform rural livelihoods and ensure their resilience.

In the case of India, more than 70% of the population still lives in rural areas with limited access to these basic needs. As land is a readily available resource, people in rural areas have always been largely dependent on farming as their main livelihood activity. About 60% per cent of the income of rural households in India is derived from small-scale farming under rain-fed agriculture, coupled with a poor resource base, exposing rural populations to climate variability and change. Other sources of income for people living in rural areas include non-farming natural resource-based activities such as minor forest produce collection, artisanal work and also migration to other regions to secure livelihood. Moreover, livelihood activities are also climate-sensitive. All these factors contribute to the vulnerabilities of rural populations to the vagaries of extreme weather events and diseases. Presently, a significant proportion of people in India do not have access to nutritious food that guarantees a healthy and active life. Rising food prices, and the recurrence of extreme weather events like floods and droughts, are pushing more people into poverty and hunger, compromising human health and well-being.

Small farmers who rely on rain-fed agriculture contribute meagerly to total agricultural produce and the level of food insecurity among them is very high, affecting mostly rural populations. As climate change is cross-sectoral and multidimensional, the WEF nexus can play an important role in climate change adaptation as it offers cross-sectoral mitigation and adaptation opportunities to harmonious interventions and build resilience. A nexus perspective increases the understanding of the inter-dependencies across the water, energy and food sectors and influences policies in other areas of concern such as climate and biodiversity. The nexus perspective helps to move with interdisciplinary solutions, thus increasing opportunities for mutually beneficial responses and enhancing the potential for cooperation between and among all sectors. Everyone in all disciplines needs to think and act from the perspective of being interlinked to realize the full impact of both direct and indirect synergies.

A deep understanding of the nexus will provide an informed and transparent framework that is required to meet increasing demands without compromising sustainability The nexus approach will also allow decision-makers to develop appropriate policies, strategies and investments, to explore and exploit synergies, and to identify and mitigate trade-offs among the development goals related to water, energy and food security.

Active participation by and among government agencies, the private sector and civil society is critical to avoid unintended adverse consequences. A true nexus approach can only be achieved through close collaboration of all actors from all sectors. While the opportunities provided by the nexus perspective and the consequent social, environmental and economic benefits are real, implementation requires the right policies, incentives and encouragement, and institutions and leaders that are up to the task, as well as frameworks that encourage empowerment, research, information and education. Accelerating the involvement of the private sector through establishing and promoting the business case for both sustainability and the nexus is essential to driving change and getting to scale. Nexus perspective can be an option for adaptation to climate change.

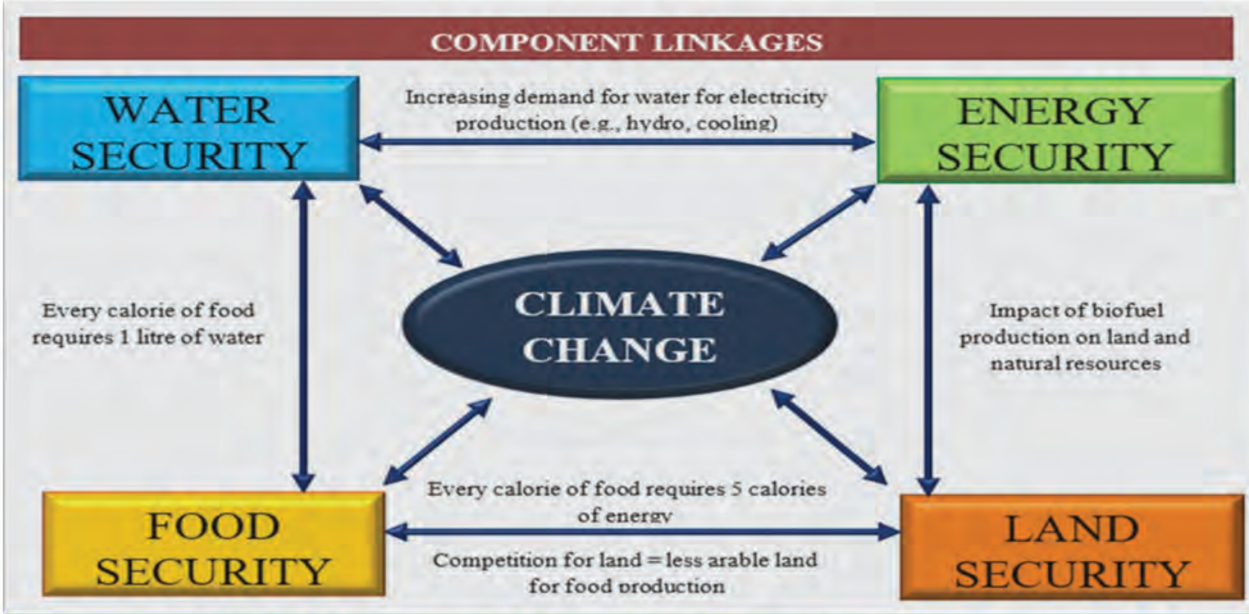


FIGURE : 4 Component linkages towards Climate change scenerio

Four key barriers restrict participatory WR management. Among India's many challenges, these need to be overcome to create favorable conditions for participatory area-based water & energy security.

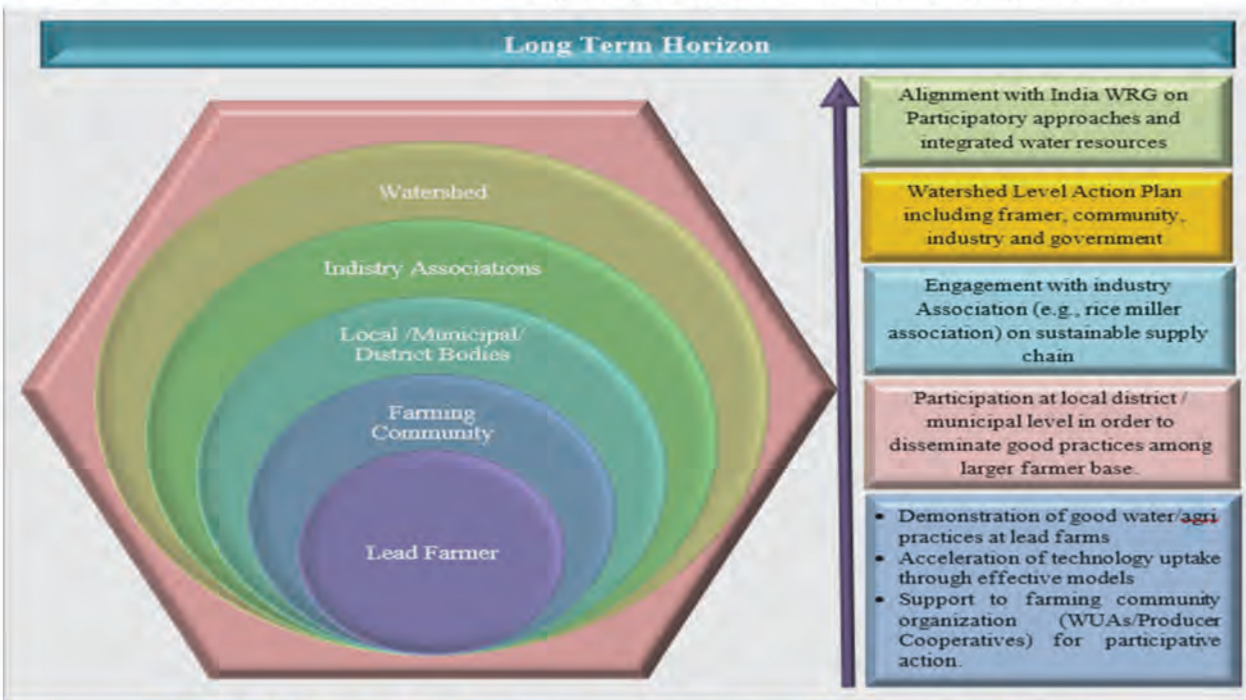


Figure 5: Multi-Stakeholder involvement and proactive approaches towards the water-food-energy nexus

The Private Sector as part of their CSR effort can also assume leadership. Emerging water and energy challenges require scalable solutions with multi-stakeholder involvement and proactive approaches. The Central to the solution is farmers' participation and drafting of a 10-year vision aimed at facilitating watershed-level action in partnership with other stakeholders inclusive of the community, local bodies, private partners, NGOs and Government line departments.

A water-energy-food (WEF) nexus assessment supports natural resource management by providing an integrated framework for evaluation and decision-making. The participation of a wide range of stakeholders is essential for achieving environmental, economic, and social sustainability in this framework. This analysis supports the decision-making process of the nexus assessment by facilitating dialogue between stakeholders to achieve long-term efficiencies, especially in rural landscapes where most of the services connected to WEF securities are provided. The lack of communication between the parties is the main threat to the development of the WEF nexus projects.

Key Trends and Patterns in Food, Water and Energy Security of India

India is one of the most dynamic regions of the world. High population growth, rapid urbanization, fast economic progress, and industrialization have increased the demand for resources, including food, water, and energy, and intensified their use, with serious implications for the environment and long-term security of these sectors. Indian agriculture is dominated by small and marginal farmers constituting 82%. The percentage of agricultural land in India is 60.43% (2018) as per World Bank data. The total food grain production is estimated to be 275 MT (million tons), followed by the second-largest cattle population of around 195 million. India is the largest producer of milk, jute, and pulses and the second-largest producer of wheat, rice, sugarcane, groundnut, as well as fruits and vegetables. However, there are many growing problems.

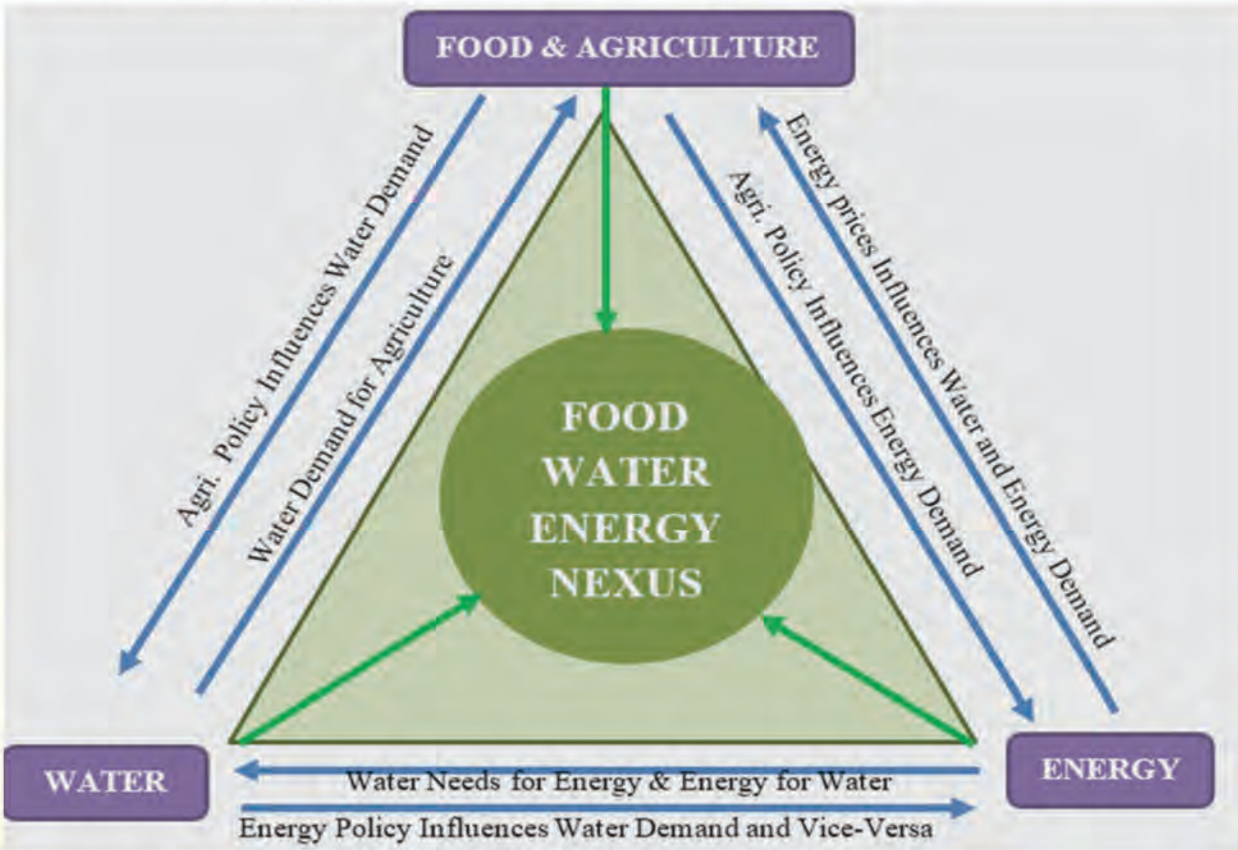


Figure: 6. Key Trends and Patterns in Food, Water and Energy Security of India

Over 80 % of total water withdrawals in India are used for agriculture. About 48.8 % of the total 140 million hectares of agricultural land are irrigated. Rice and wheat are the major staple food crops cultivated. Agriculture consumes about 80% of water use and 30% of energy. Groundwater has become the major source of irrigation in the region providing close to three-fifths of irrigation water. About 60% of the population in India depends on groundwater for irrigation. Irrigation efficiency is low and climate change is expected to exacerbate the food, water, and energy challenges. The key trends and issues in food, water, and energy in India are summarized in table 2.

Meeting the Challenges: Options for Managing Trade-offs and Enhancing Synergies:

Technological Options:

Technological innovations that enable more food to be produced with fewer resources will be critical to addressing the growing challenge of resource constraints. It will be important to minimize trade-offs and maximize the synergies among the food, water, and energy sectors in a sustainable manner. The policy environment will need to encourage the implementation of such options, and discourage the practices that are likely to have negative impacts in the long term. There are many different innovative options and technologies already available; some are already being practiced in different parts of India on a small scale. This section briefly explores some of the technological, policy, and institutional options available that encourage more efficient use of water and reduction of energy in food production.

Table 2: Key trends and issues in food, water, and energy security and achieving the SDGs

Drivers of Change	Key Trends	Future challenges
Burgeoning human population	The increasing intensification of water and energy use in food production. Food production will have to increase by 70% in the next 25 years; energy availability will need to increase by 40%, and water by 57% if management is not improved.	Increasing food production without increasing the intensity of water and energy use and environmental degradation.
The growing middle class and rapid urbanization increased per capita income and intensified food, water and energy use.	Changing food preferences from coarse grain to fine types of grain and from grain to animal and horticultural products, require more energy and water.	Meeting the increased requirement for water and energy for the production of increased amounts of meat and fine grain.
Growing requirement for land, water, and energy for different uses.	Growing competition for resources for different uses.	Balancing different needs for land, water, and energy, whilst maintaining environmental integrity.
The increasing intensification of resource use for food production	Dwindling resource base. Slowing of agricultural growth rate.	Providing food, water, and energy to a large malnourished population.
Growing demand for water - for agriculture, livestock, energy, urban centres, and industry.	Increasing pressure on water resources for multiple uses; per capita water availability in India is declining from 1816 cubic metres in 2001 to 1544 in 2011 and 1367 in 2021	Meeting the competing demands for water for agriculture, domestic use, industry, energy, and the environment and ecosystems.
Declining performance of canal irrigation; subsidies on energy for groundwater irrigation. Increased dependence on groundwater for food production; about 70–80% of agricultural production depends on groundwater.	Increasing individualization of irrigation systems and decreasing community participation in irrigation management.	Improving the efficiency of irrigation water and energy use. Increasing community participation in irrigation management.
Increasing costs for securing water availability such as high costs of groundwater pumping due to high fossil fuel prices and a declining groundwater table.	The increasing financial burden on farmers.	Making agriculture economically viable.
Growing demand for energy – demand increasing at a rate of 5% per annum	Growing demand for water and land for energy production.	Providing adequate and reliable energy to a large population without increasing pollution.
Rapid economic growth, industrialization, urbanization	With increasing imports of fossil fuels, over 80% of the energy is provided by oil imports.	Ensuring a stable energy supply for food and water security. Reducing fossil fuel imports.
Intensification of energy use in food production – greatly increased electricity consumption in irrigation due to groundwater pumping (e.g. in India, a six-fold increase in electricity consumption per 1000 ha cultivated between 1980/81 and 2020).	Growing demand for water and land for energy production, and increasing fossil fuel imports.	Ensuring sufficient reliable and quality energy for agriculture, water, industry and other economic activities.
Factors encouraging the use of irrigation – advances in groundwater technologies; declining cost of water extraction pumps; absence of government regulation in groundwater irrigation; government subsidies on fuel and electricity for irrigation.	Declining groundwater tables; declining water availability and quality for domestic, agricultural and other uses; increase in waterborne diseases.	Managing groundwater for food production and controlling overexploitation of groundwater.
Extensive irrigation leads to land degradation and declining soil fertility	Degradation and loss of productivity of agricultural land; increased use of chemical fertilizers to maintain productivity.	Long-term sustainability of food production, sustaining the natural resource base and a healthy environment

Improving Irrigation Efficiency:

At present, irrigation efficiency in India is low, estimated at roughly between 38% - 40%. Often flood irrigation water is pumped to fields and allowed to flow on the ground among the crops, which is inefficient as it results in high evaporation and runoff. More efficient irrigation and approaches have been developed that can increase production and reduce water demand. For example, The System of Rice Intensification (SRI), with alternate cycles of drying and wetting, is a promising method for increasing rice productivity while reducing water and energy use and GHG emissions, if properly practiced, this method can also be applied to other crops such as wheat, finger millet, and sugarcane. SRI could be particularly suitable in India, where groundwater supplies have been depleted by excessive use of water for irrigation. It is estimated that the adoption of SRI in over 25% of the rice-growing area in India would save 20 billion m^3 (bcm) of water and 632.61 million kWh of energy. Water saved through improved irrigation could be made available for other uses and sustain environmental flow.

Various micro irrigation systems such as drip and sprinkler methods can also enhance irrigation efficiency in suitable areas. Evidence from field research in different parts of India suggests that drip and sprinkler methods can result in water savings of 40–80% and increase crop productivity by 100% if properly applied. Agricultural scientists suggest that these technologies can raise the efficiency of water use in irrigation to between 60% (sprinkler) and 90% (drip). Furrow Irrigation and raised bed planting can also reduce water use (by 35%) and improve yields (by 10%). Zero Tillage systems also use less water. The introduction of these technologies, together with careful timing of irrigation (e.g., in the evening rather than the morning) can reduce water use and increase yields of fruit, sunflower, pulses, vegetables, and other high-value products, and also help diversify farmers' income. Drip irrigation for Indian agriculture has the technical potential to cover 37 million hectares by 2030. But these technologies are capital intensive. On average, it costs about Rs. 65000/ha investment to introduce such technologies. Micro-irrigation on a large scale has the potential to maximize both water productivity and energy efficiency in groundwater irrigation, but not all crops are suited to such techniques. Where micro-irrigation technologies are not appropriate, better irrigation and water management such as scheduling of irrigation, maintenance of irrigation canals, and sowing seeds directly in the field can enhance water use efficiency. Improving irrigation efficiency and promoting micro-irrigation will require massive private sector involvement which will need to take place in a well-regulated, efficient, and supportive environment with facilitative financing institutions.

The costs of irrigation equipment such as motorized pumps have declined substantially in recent decades and several advanced technologies such as drip irrigation are now also available in low-cost versions and subsidies. In the absence of credit, several irrigation technologies remain out of the financial reach of most small farmers. Energy used in irrigation can also be reduced through increased use of technologies like gravity-fed piped water systems, treadle pumps or other human-powered water-lifting devices. Renewable energy technologies including solar pumped irrigation and production of bioenergy in wastelands can diversify energy sources, provide energy for agriculture, enhance energy security, and reduce the dependency on imported fossil fuel.

Promotion of Conservation Agriculture in the Context of WEF Nexus

Conservation Agriculture is a management system that maintains a soil cover through surface retention of crop residues with no till/zero till and reduced tillage. It enhances biodiversity and natural biological processes above and below the ground surface, which contribute to increased water and nutrient use efficiency and to improved and sustained crop production (FAO, 2020) **(http:// www.fao.org/conservation-agriculture/en/)**. Conservation agriculture is based on the interrelated principles of minimal mechanical soil disturbance, permanent soil cover with living or dead plant material, and crop diversification through rotation or intercropping.

Conservation agricultural systems are gaining attention to reduce the water footprint of growing crops by improving soil water infiltration, increasing soil moisture retention, and reducing runoff and contamination of surface and ground water. This also reduces energy use in agriculture due to reduced/no-tillage and reduced water footprint also leads to reduced energy consumption in pumping groundwater for irrigation. The CA technologies thus provide opportunities to save water and nutrients, reduce energy use, increase yields, reduce cost of production, increase crop diversification, improve efficient use of inputs, and benefit the environment

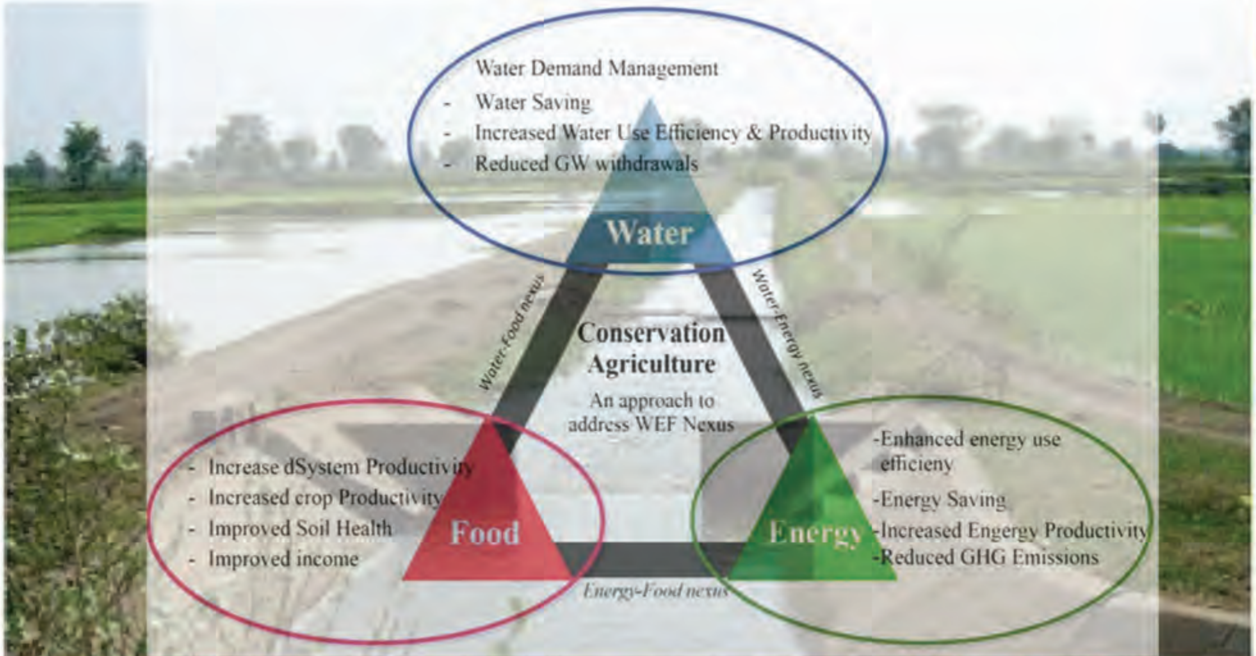


Figure:7 Conservation Agricultural Practices in addressing the WEF nexus

Policy and Institutional Responses:

Various policy, institutional, and regulatory measures have been introduced to address the nexus challenges. In India, some states are trying to regulate and ration electricity in agriculture through random power cuts; others are gradually reducing the electricity subsidy for irrigation. One important measure is the Jyoti gram Yojana (rural lighting scheme) in Gujarat, in which the electricity feeders are segregated between agriculture and other uses and electricity for irrigation is rationed to limit water use. This approach has helped to increase the quality of the power supply for normal users but has not motivated farmers to adopt water and energy-saving technologies. Segregation of electricity lines also requires a huge investment in infrastructure, which is beyond the capacity of many states.

Other efforts are underway to involve farmers in irrigation water management to increase the cost recovery of water fees and achieve better distribution and management of irrigation water. Notable efforts have been made in Andhra Pradesh which enacted the Farmers Management Irrigation Act in 1997 to promote participatory irrigation management. Success, however, has remained limited due to inadequate support from government irrigation agencies, limited authority, unequal distribution of power, and weak institutional capacity. Except in Andhra Pradesh and West Bengal, participatory irrigation management has remained marginal.

The nexus approach requires a major shift in the decision-making process towards taking a holistic view and developing institutional mechanisms to coordinate the actions of diverse actors and strengthen complementarities and synergies among the three sectors. It suggests a generic framework for integrating policies and strategies and supporting the move from a sectoral to a holistic approach. This should be seen as a broadly explorative proposal showing suggested key elements; the development of a detailed framework is beyond the scope of this paper. The key elements of the framework are strengthening cross -sectoral coordination, harmonizing public policies, aligning cross-sectoral strategies and incentive structures, strengthening regulation, and facilitation of nexus smart investment and technologies. Some of the specific approaches are discussed in more detail below: -

Strengthen Cross-Sectoral Coordination:

Appropriate mechanisms need to be put in place to strengthen horizontal and vertical integration among the three sectors. Strengthening the role of the national planning commissions or establishing a high-level commission with representatives from the three ministries, think tanks, and civil society with a mandate to oversee the coordination of the three sectors could be useful. Strengthening institutional capacity for understanding the dynamics and inter-linkages among the three sectors at different scales, and introducing the nexus perspective into planning and implementation, are essential for promoting mutually reinforcing policies and achieving multiple goals. Increasing dialogue among the key actors of the three sectors is also critical.

Harmonize Cross-Sectoral Policies:

Policies should be harmonized among the three sectors taking into account the interdependencies of resources to minimize cross-sectoral conflicts, maximize synergies, and achieve policy objectives using a systems approach. Policy strategies and instruments employed in achieving sectoral goals need to be harmonized to ensure the systematic promotion of mutually reinforcing strategies and instruments and resolve policy conflicts to meet the competing demands for resources.

Align Cross-Sectoral Strategies:

Coordination of strategies across the sectors is essential for exploiting complementarities and synergies (where all sectors receive the benefits of other sectors) and minimizing trade-offs (where one loses at the cost of the other), and achieving optimal alignment of the strategic objectives. It will be necessary to examine strategies in the three sectors from a nexus perspective and identify areas of trade-offs and options for synergies to develop and promote mutually reinforcing strategies.

Converge Cross-Sectoral Incentive Structures:

The incentive (encouragement through concessions/ payments) structures need to be converged and reoriented towards promoting water and energy-saving technologies and encouraging investment in enhancing the efficiency of water and energy, and away from the policy distortion towards the water and energy-intensive food production. Subsidies for groundwater irrigation need to be progressively reduced, and operating and maintenance costs of canal irrigation fully recovered, to make the irrigation system financially viable and environmentally sustainable. Barriers to the adoption of water harvesting, water-efficient technologies, and renewable energy options should be removed.

Regulate Unsustainable Practices and Promote Technological and Institutional Innovations:

As food production depends heavily on groundwater, and the link between groundwater and energy is strong, it is important to establish a groundwater management framework to regulate and facilitate the optimal use of groundwater rationally and sustainably based on availability and recharge conditions. While in certain areas groundwater is depleting, in others, such as the Orissa, North Bihar, North Bengal, and Eastern Uttar Pradesh, there is still scope for further development of groundwater resources. Critical areas where groundwater levels are falling fast should be demarcated and regulated to avoid an ecological crisis. It is important to raise public awareness and advocate for the responsible use of groundwater resources. Involving farmers in water and energy management is vital for the sustainable use of resources.

Encourage Investment in Infrastructure Development:

Investment in energy and water-saving technologies and renewable energy options should be encouraged through innovative policies and institutional support to decouple the intensity of resource use from food production. Effective strategies should be designed to attract investment to exploit win-win opportunities such as production and use of renewable energy, for example through hydropower, solar-powered water pumps for irrigation, generation of electricity from crop residues, production of biogas from manure, and introduction of trees or perennials on farms to produce wood for on-farm energy purposes.

Create an Interdisciplinary Knowledge Base:

It is important to create an interdisciplinary knowledge base and disseminate knowledge that can offer integrated solutions and a balanced approach for well-informed decision making guided by the nexus approach.

Criticism:

Critics of the application of the nexus concept argue that the integration of water, energy, and food systems is agreeable in theory, but it often remains unclear what the application of the concept means in reality. First of all, there are often disagreements between actors that emphasize economics and those that stress environmental concerns. More importantly, however, some references consider a discussion of resource access and distribution missing from the nexus debates, contributing to social inequity. If these concerns were not to be addressed, the nexus concept risks turning into an empty shell that merely serves powerful actors to legitimize exclusionary policies.

Figure: 8: Fundamental Criteria: Synergies/Trade -off/ Neutral /No influences towards Food – water – Energy Nexus.

Conclusion and Going Forward:

Given the nature of competing for developmental and environmental goals along with trends of rapid urbanization and population expansion in India, important questions arise:

1. What is the rational amount and mix of food production to meet the demands of the growing population?
2. Would aspirations for a food-secure future jeopardize water security?
3. How can political attention be drawn to the need to better understand the nexus question?
4. How can the present power distribution system better respond to falling groundwater tables, existing cropping patterns and climate change?
5. What is the carbon footprint of groundwater overdraft for agriculture in the decades to come?

Despite its many implications, the nexus concept has been given inadequate attention in India's current policy frameworks. The design and implementation sides of national policy on farm incomes, food security, groundwater, energy and electricity have refrained from taking into account each other's experiences at the implementation level. Addressing these challenges would likely require a re-imagination of the agricultural sector regarding water and energy policies in India.

Free water and subsidized electricity have not only encouraged overexploitation of resources, but they have also led to under-investment in water and energy-saving technologies and approaches and hindered crop diversification and broad-based agricultural growth in line with the comparative advantages. Despite the inherent interconnections between food, water, and energy production, agencies often work in a fragmented and isolated way. Poor sectoral coordination and institutional fragmentation have triggered an unsustainable use of resources and threatened the long-term sustainability of food, water, and energy security in our country, and also posed challenges to achieving the Sustainable Development Goals (SDGs).

Hence, Greater policy coherence among the three sectors is critical for decoupling increased food production from water and energy intensity and moving to sustainable and efficient use of resources. The nexus approach can enhance understanding of the interconnectedness of the sectors and strengthen coordination among them. But it requires a major shift in the decision-making process towards taking a holistic view and developing institutional mechanisms to coordinate the actions of diverse actors and strengthen complementarities and synergies among the three sectors.

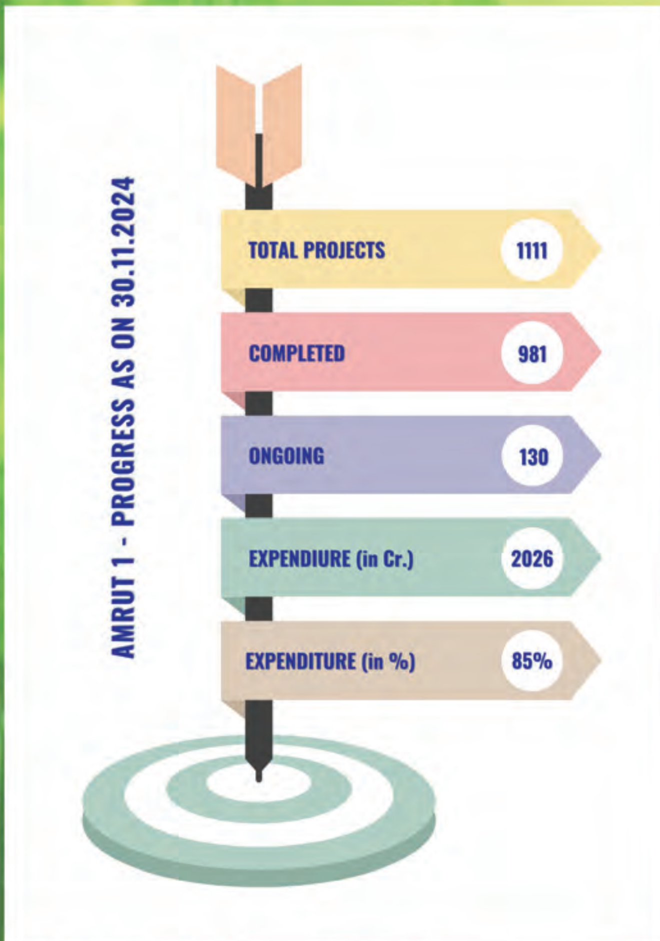
India faces mounting challenges in meeting the growing demand for food, water, and energy resources and increasing environmental pressure. To increase cereal production, India has introduced many policy initiatives including providing incentives through subsiding water and energy and guaranteeing prices. While such incentives have helped increase cereal production, they have also increased the demand for water and energy, led to degradation of the resource base, and contributed to an increase in water-related diseases. Although the food, water, and energy sectors are inherently interconnected, the connection in terms of policy and implementation is weak.

Development of policies and approaches without regard for cross -sectoral consequences, poor sectoral coordination and institutional fragmentation, have triggered an unsustainable use of resources and threatened the long-term sustainability of food, water, and energy security in the region. Efforts should be made to integrate environmental considerations in the pricing of water, energy and other natural resources so that prices reflect social costs and the opportunity cost of alternative uses of resources.

Special care should be taken, however, to mitigate the immediate effects of changing pricing and fiscal mechanisms on poor and smallholding farmers. Resources saved through changing pricing mechanisms could be spent on the development of irrigation, water, energy, and other rural infrastructure, agricultural research, renewable energy, and water-saving technologies, as well as farmers' education on sustainable agriculture and resource management. Such policies will not only support the balanced development of food, water, and energy security but also contribute to achieving the SDGs.

Our study analysis of different relevant reports reveals that opportunities lie in choosing more water and energy-efficient and environmentally-friendly technologies for increased food production. It is important to get the price right and phase out environmentally harmful subsidies gradually. Special attention needs to be paid to the impacts of subsidy withdrawal on the poor, and a food safety net needs to be provided. However, technology alone may not be sufficient. More importantly, greater policy coherence among the three sectors will be critical for moving towards a more efficient, equitable, and sustainable use of resources.

The decision-making framework urgently needs a paradigm shift that recognizes cross-sectoral externalities, explores feasible trade-offs, and helps policymakers achieve greater policy coherence, integrating environmental considerations in the pricing of water, energy and other natural resources so that prices reflect social costs. The nexus approach is a system-wide approach that recognizes the inherent interdependencies of the food, water, and energy sectors for resource use and seeks to optimize the trade-offs and synergies, and can thus help provide such a framework. It can be used in the design of integrated policies and strategies and provides a means for systematically assessing cross-sectoral interactions, and identifying areas of interconnections and newer options. By enhancing understanding of the interconnectedness among the food, water, and energy sectors, the nexus approach will also help to strengthen cross-sectoral coordination.



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Atal Mission for Rejuvenation and Urban Transformation

AMRUT 1

Achievements

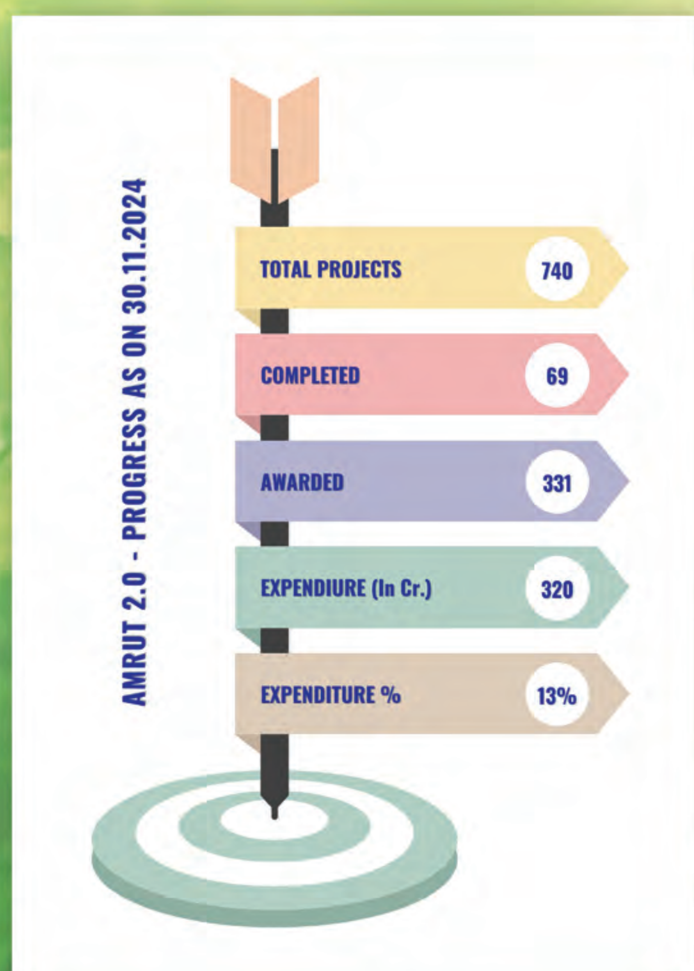
100% Central Assistance received

85% of financial completion

88% of projects completion

अमृत 2.0

Atal Mission for Rejuvenation and Urban Transformation



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