



**INNOVATIVE INTERVENTIONS
STARTUPS IN INDIA'S ENVIRONMENTAL BATTLE**

Preface

In addressing the challenges faced by modern society, two primary categories of solutions can be identified: those requiring individual behavioral changes and those necessitating administrative and diplomatic interventions. This report primarily focuses on the former, with the aim of influencing and informing the latter.

My interest in developing innovative ideas and technologies is often driven by the need to address pressing hazards and foreseeable issues. Climate change is a key area where both categories of solutions are relevant. In my search for novel approaches to combat climate change, I discovered that no comprehensive report exists that outlines the major problems, the existing measures, and potential additional actions. This realization motivated the creation of this document.

While the report addresses the concept of individual change, it does not delve into specific recommendations such as turning off lights or faucets. Instead, the focus is on raising awareness about existing policies, their successes, and the areas where improvements are still needed. This approach aims to enhance accountability for the relevant authorities.

The final section of each problem explores current or theoretical solutions that could improve our ability to address the issue. This includes startup ideas for technologies that directly tackle the problem and leverage government schemes to achieve these objectives.

It is important to note that this report represents the first part of my research. Future work will involve a more detailed analysis of the data presented herein to derive deeper insights and recommendations.

Dedicated to the hope of a Cleaner Future

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Abbreviations

Some abbreviations are mentioned below. All others are mentioned in parenthesis when their full-form is used for the first time.

- **AQI** - Air Quality Index
- **BOD** - Biological Oxygen Demand
- **CPCB** - Central Pollution Control Board
- **CO₂** - Carbon Dioxide
- **GHG** - Greenhouse Gas
- **GOI** - Government of India
- **MoEFCC** - Ministry of Environment, Forest and Climate Change
- **NGT** - National Green Tribunal
- **NGO** - Non-Governmental Organization
- **NO_x** - Nitrogen Oxides
- **PM_{2.5}** - Particulate Matter (with a diameter of less than 2.5 micrometers)
- **PM₁₀** - Particulate Matter (with a diameter of less than 10 micrometers)
- **PPP** - Public-Private Partnership
- **SDG** - Sustainable Development Goals
- **UN** - United Nations
- **WHO** - World Health Organization
- **WWF** - World Wildlife Fund
- **PCB** - Pollution Control Board
- **UNEP** - United Nations Environment Programme
- **EPA** - Environmental Protection Agency
- **WRI** - World Resources Institute
- **IPCC** - Intergovernmental Panel on Climate Change
- **CSR** - Corporate Social Responsibility
- **SBR** - Sequencing Batch Reactor
- **STP** - Sewage Treatment Plant
- **WWTP** - Wastewater Treatment Plant
- **COD** - Chemical Oxygen Demand
- **EIA** - Environmental Impact Assessment
- **NABARD** - National Bank for Agriculture and Rural Development

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Introduction

This report addresses four critical environmental and health issues: air pollution, carbon footprint, water pollution, and the water crisis. Initially, water pollution and the water crisis were considered for consolidation under a single category; however, the distinct nature of their solutions and implementations necessitated separate sections to provide a comprehensive understanding and targeted solutions for each.

Air pollution poses significant risks to public health and the environment, contributing to respiratory diseases and ecological degradation. The carbon footprint, closely related to air pollution, reflects the total greenhouse gas emissions caused directly and indirectly by human activities. Reducing the carbon footprint is crucial for mitigating climate change and promoting sustainable development. Water pollution, on the other hand, involves the contamination of water bodies, adversely affecting aquatic ecosystems and human health. The water crisis, characterized by the scarcity of clean and accessible water, poses a threat to the well-being of millions and hampers economic growth.

For each of these topics, the report provides an initial overview, setting the stage for a more in-depth analysis. The overview is followed by a detailed examination of the available data, which is crucial for understanding the extent and impact of these issues. This data analysis serves as a foundation for future research, which will delve deeper into specific sub-topics to uncover more nuanced insights and develop more effective solutions.

The report also identifies the major organizations in India that are actively working towards solutions for these environmental and health challenges. These organizations play a pivotal role in research, policy advocacy, and the implementation of various initiatives aimed at mitigating these issues. Understanding their efforts and contributions is essential for a comprehensive assessment of the current landscape and for identifying gaps that need to be addressed.

Additionally, the report outlines the schemes and policies announced by the Government of India to tackle these problems. These government initiatives are crucial for providing the necessary support and resources to combat air pollution, reduce the carbon footprint, address water pollution, and alleviate the water crisis. The report includes an analysis of these schemes based on the available data; however, given the vastness and complexity of the information sources, a more comprehensive automated analysis could yield more precise and actionable insights.

Lastly, the report includes a brief examination of policies designed to support startups, recognizing their potential to develop innovative solutions for these pressing issues. The role of startups is particularly significant as they bring fresh perspectives and agile approaches to problem-solving. The report identifies domains where mutual benefits can be realized through collaboration between startups and established entities, thereby fostering an ecosystem of innovation and sustainable development.

Air Pollution

Overview

Air pollution is a complex and pervasive environmental issue that substantially threatens the global climate, ecosystems, and human health. Human activities, including transportation, agriculture, industrial processes, and residential energy consumption, are the primary causes of releasing harmful substances into the atmosphere. This list of pollutants encompasses nitrogen oxides (NO_x), sulfur dioxide (SO₂), carbon monoxide (CO), volatile organic compounds (VOCs), and greenhouse gases such as carbon dioxide (CO₂).

Air pollution has far-reaching and profound repercussions. The increased mortality rates, particularly in vulnerable populations such as children, the elderly, and those with pre-existing health conditions, are a result of the contribution of PM and NO_x to respiratory and cardiovascular diseases. Prolonged exposure to these pollutants may also exacerbate asthma and bronchitis. In addition to health impacts, air pollution damages ecosystems by contributing to acid rain, which harms forests, lakes, and soil quality. Additionally, certain pollutants, including VOCs and CO₂, are substantial contributors to climate change responsible for global warming and its associated consequences, including sea-level rise and extreme weather events.

Addressing air pollution requires comprehensive local, national, and global strategies. Governments play a crucial role in implementing and enforcing regulations to limit emissions from industries, vehicles, and power plants. Transitioning to cleaner energy sources, such as renewables, and promoting energy efficiency can significantly reduce emissions. Urban planning that prioritises public transportation, cycling, and walking over private car use can also mitigate pollution in densely populated areas.

There is vast potential for innovation in the fight against air pollution, which presents opportunities for established companies and startups. Startups may concentrate on developing sophisticated technologies, including real-time air quality monitoring devices, low-emission transportation solutions, and air purification technology. Data analytics and artificial intelligence can be pivotal in identifying pollution hotspots and optimising interventions.

Furthermore, growing consumer and corporate awareness of environmental issues creates a demand for eco-friendly products and services. This shift allows startups to develop and market sustainable alternatives in various sectors, including energy, transportation, and agriculture. Collaborations between startups, research institutions, and governments can foster innovation and accelerate the adoption of cleaner technologies.

Looking at the Data

→ Current State of Air Pollution in India

The Central Pollution Control Board (CPCB) has published several reports highlighting the severity of air pollution across different regions of India. According to the CPCB, major Indian cities frequently exceed the National Ambient Air Quality Standards (NAAQS) for pollutants such as particulate matter (PM₁₀ and PM_{2.5}), nitrogen dioxide (NO₂), and sulfur dioxide (SO₂) (CPCB, 2023a; CPCB, 2023b). The CPCB's Comprehensive Environmental Pollution Index (CEPI) also indicates critical pollution levels in several industrial clusters (CPCB, 2023c).

→ Major Sources of Air Pollution

Air pollution in India primarily originates from industrial emissions, vehicular exhaust, construction activities, biomass burning, and dust. Industrial processes release significant amounts of pollutants, including PM, NO₂, and volatile organic compounds (VOCs). The transportation sector, dominated by diesel and petrol vehicles, is a major contributor to urban air pollution, particularly in cities like Delhi and Mumbai (Ministry of Environment, Forest and Climate Change, 2024).

→ Health Impacts of Air Pollution

Air pollution has severe health consequences, particularly for vulnerable populations such as children, the elderly, and those with pre-existing health conditions. The World Health Organization (WHO) estimates that household air pollution alone is responsible for a significant number of deaths due to ischemic heart disease, stroke, chronic obstructive pulmonary disease, and lung cancer (WHO, 2024). Outdoor air pollution exacerbates respiratory diseases, cardiovascular diseases, and can lead to premature mortality (World Bank, 2023).

→ Economic and Environmental Impacts

The economic burden of air pollution in India is substantial. According to a report by the World Bank, the cost of health damages due to air pollution is estimated to be several billion dollars annually (World Bank, 2023). These costs include healthcare expenses, lost labor productivity, and reduced agricultural yields. Environmentally, air pollution leads to acid rain, loss of biodiversity, and degradation of ecosystems.

→ Government Initiatives and Policies

The Government of India has implemented various policies and programs to combat air pollution. The National Clean Air Programme (NCAP) aims to reduce PM_{2.5} and PM₁₀ levels by 20-30% by 2024, compared to 2017 levels (Ministry of Environment, Forest and Climate Change, 2024). The NCAP involves multi-sectoral and collaborative approaches, including enhancing air quality monitoring, promoting clean technologies, and raising public awareness.

→ **Role of Technology and Research**

Technological advancements and research play a crucial role in addressing air pollution. Institutions like the Indian Institute of Technology (IIT) Kanpur and the Indian Institute of Science (IISc) Bangalore are at the forefront of air quality research, developing innovative solutions such as low-cost sensors for real-time monitoring and advanced pollution control technologies (IIT Kanpur, 2024; IISc, 2024).

→ **Non-Governmental Organizations and Public Participation**

Non-governmental organizations (NGOs) and public participation are vital in the fight against air pollution. Organizations like the Centre for Science and Environment (CSE) and Clean Air Asia advocate for stricter regulations, conduct independent air quality assessments, and engage in public awareness campaigns (CSE, 2024; Clean Air Asia, 2024). Public participation, through citizen science initiatives and community-driven actions, also contributes significantly to air quality management.

→ **International Cooperation and Global Perspectives**

International cooperation is essential for addressing transboundary air pollution and sharing best practices. The State of Global Air report highlights the global nature of air pollution and the need for collaborative efforts to mitigate its impacts (State of Global Air, 2024). Partnerships with global organizations such as the WHO and the World Bank help India align its policies with international standards and benefit from global expertise and funding.

Organisations

Indian Organisations

1. Central Pollution Control Board ([CPCB](#))

Role: The primary regulatory body for monitoring and controlling air pollution in India, implementing the National Air Quality Monitoring Programme (NAMP).

2. Ministry of Environment, Forest and Climate Change ([MoEFCC](#))

Role: Formulates policies and programs for environmental protection, including air quality management.

3. Centre for Science and Environment ([CSE](#))

Role: Conducts research, advocacy, and public awareness campaigns on air quality and pollution control measures.

4. The Energy and Resources Institute ([TERI](#))

Role: Engages in research and policy advocacy to promote sustainable development, including air quality improvement.

5. Indian Institute of Tropical Meteorology ([IITM](#)):

Role: Runs the SAFAR project, which provides real-time air quality forecasting and research on atmospheric sciences.

International Organisations

1. World Health Organization (WHO)

Role: Provides guidelines, data, and research on global air quality, including specific studies and recommendations for India.

2. United Nations Environment Programme (UNEP)

Role: Works on global environmental issues, including air pollution, by supporting projects and initiatives in India.

3. World Bank

Role: Funds and supports projects aimed at improving air quality and sustainable development in India.

4. Clean Air Asia

Role: Focuses on improving air quality in Asian cities through policy advocacy, capacity building, and research, including efforts in India.

5. International Council on Clean Transportation (ICCT)

Role: Provides research and policy recommendations on transportation emissions, supporting efforts to reduce vehicular pollution in India.

Schemes and Policies in India

1. National Clean Air Programme (NCAP)

Objective: Launched in January 2019, NCAP aims to reduce PM_{2.5} and PM₁₀ levels by 20-30% by 2024, taking 2017 as the base year. It involves implementing mitigation strategies in 122 non-attainment cities across India.

- The programme aimed to increase the number of air quality monitoring stations. By 2023, 931 manual monitoring stations were operational, although this was still short of the target of 1,500 stations (CRECA, 2023).
- Reports indicate that 90 out of 131 cities showed improvement in PM₁₀ levels in FY 2022-23 compared to the FY 2017-18 baseline (Press Information Bureau, 2023).
- By mid-2023, only 44 out of 131 non-attainment cities had conducted source apportionment studies, which are crucial for identifying and targeting major sources of pollution (CPCB, 2023a).
- While there has been progress in expanding monitoring networks, the transparency and accessibility of data to the public remain limited. Comprehensive, real-time data availability is crucial for effective public awareness and participation (CPCB, 2023b).

2. Graded Response Action Plan (GRAP)

Objective: Implemented in Delhi-NCR in 2017, GRAP is a set of emergency measures to be implemented based on the severity of air pollution levels. It includes halting construction activities, closing schools, and restricting vehicle use.

- GRAP specifies actions to be taken as pollution levels increase. For instance, stopping the entry of trucks into Delhi, halting construction activities, and closing schools during severe pollution levels.
- GRAP measures are categorized based on the AQI levels: Moderate to Poor, Very Poor, Severe, Severe or Emergency.
- GRAP has been somewhat effective in providing immediate relief during peak pollution periods. Measures like restricting truck entry and stopping construction work have shown temporary improvements in air quality during severe episodes (Hindustan Times, 2023).
- As an emergency measure, GRAP does not address the root causes of air pollution, such as industrial emissions, vehicular pollution, and biomass burning. It lacks year-round interventions which are crucial for sustained air quality improvement (NEXT IAS, 2023).

3. Bharat Stage Emission Standards (BSES)

Objective: These are emission standards instituted by the Government of India to regulate the output of air pollutants from internal combustion engine equipment, including motor vehicles. The most recent implementation, Bharat Stage VI, was enforced in 2020.

- BS-VI fuels contain 10 ppm of sulfur, significantly lower than the 50 ppm in BS-IV fuels. This reduction helps lower emissions of particulate matter (PM) and nitrogen oxides (NOx) (ICCT, 2023).
- BS-VI standards include stringent limits on PM and introduce particulate number (PN) limits, necessitating the use of diesel particulate filters (DPFs) for diesel vehicles.
- Enhanced On-Board Diagnostics (OBD) requirements ensure continuous monitoring of vehicle emission performance, including the first-ever OBD specifications for two- and three-wheeled vehicles (Drishti IAS, 2023).
- Initial studies and reports suggest that the implementation of BS-VI standards has led to a noticeable reduction in vehicular emissions. BS-VI compliant vehicles emit significantly lower levels of PM2.5 and NOx compared to their BS-IV counterparts (Wikipedia, 2023).

4. National Air Quality Monitoring Programme (NAMP)

Objective: NAMP aims to monitor air quality across India through a network of monitoring stations. It provides data on key pollutants such as SO₂, NO₂, PM₁₀, and PM_{2.5}.

- As of 2023, the number of manual monitoring stations under NAMP increased from 703 to 931. However, this is still short of the target of 1,500 stations by 2024 (CRECA, 2023).
- Installing Continuous Ambient Air Quality Monitoring Stations (CAAQMS) saw significant progress, with 531 stations operational, surpassing the initial targets (Greenpeace, 2023).
- Despite the increase in monitoring stations, coverage remains inadequate, especially in rural areas, with only 26 manual stations currently operational. The goal of setting up 100 rural monitoring stations by 2024 appears challenging to achieve (CRECA, 2023).
- The utilization of allocated funds has been suboptimal, with only 40% of the allocated budget for non-attainment cities being utilized by late 2023. This underutilization hampers the effective implementation of pollution control measures (CRECA, 2023).

5. Pradhan Mantri Ujjwala Yojana (PMUY)

Objective: Launched in May 2016 to provide Liquefied Petroleum Gas (LPG) connections to women from below poverty line (BPL) households—the scheme aimed to address health hazards associated with traditional cooking fuels and promote clean cooking practices.

- The LPG coverage in India increased significantly from 62% in May 2016 to 94% by March 2019. The scheme has issued over 7.2 crore connections against a target of 8 crore by March 2020 (PRS India, 2023).
- One of the major criticisms of PMUY is the low refill rate among beneficiaries. The average annual refill consumption for PMUY beneficiaries has been around 3-4 cylinders, compared to 6-7 cylinders for non-PMUY consumers. This indicates that while access to LPG has improved, sustained usage remains low (IMPRI, 2023).
- The CAG report highlighted several implementation issues, including delays in installation of connections, discrepancies in beneficiary identification, and instances of LPG cylinders being diverted for commercial use. Only 19% of new connections were installed within the stipulated seven days, and nearly half took more than 30 days (CAG, 2023).
- There is a need for more extensive safety campaigns and incentives to ensure proper use and handling of LPG. Behavior change towards regular LPG use requires continuous awareness and education efforts.

6. Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles (FAME) India Scheme

Objective: Launched in 2015, FAME aims to promote the adoption of electric and hybrid vehicles through financial incentives and infrastructure development. FAME II, introduced in 2019, focuses on public and shared transportation.

- Under FAME-I, which ran from 2015 to 2019, significant growth in the sales of electric vehicles was observed. Electric two-wheeler sales increased substantially, contributing to reducing vehicular emissions and promoting clean mobility (Ministry of Heavy Industries & Public Enterprises, 2023).
- FAME schemes provided subsidies on the purchase of electric vehicles and supported the deployment of charging infrastructure to incentivize consumers and manufacturers.
- Despite efforts, the availability of charging stations remains a significant challenge, particularly in non-urban and rural areas, limiting the widespread adoption of EVs (Livemint, 2023).
- The evolution of FAME schemes and periodic changes in subsidy structures have sometimes led to uncertainty among manufacturers and consumers, affecting long-term planning and investment decisions (Hindustan Times, 2023).

Scope for Startups

Government Policies

- **National Clean Air Programme (NCAP):** Launched in 2019, NCAP aims to reduce particulate matter (PM) pollution by 20-30% by 2024. It includes funding support for projects focusing on monitoring air quality, emission control, and development of clean technologies. Startups working on air pollution control technologies, real-time monitoring systems, and data analytics can benefit from this program.
- **Startup India Initiative:** This initiative provides a platform for startups across various sectors, including environmental technology. Startups can access funding, mentorship, and networking opportunities. Specific support for air pollution-related startups includes tax exemptions and simplified regulatory processes.
- **Clean Air Cities Initiative:** Focuses on city-specific air pollution issues, encouraging startups to develop localized solutions. It includes pilot projects and collaborations with municipal corporations to test and implement innovative technologies.

Areas benefitting from Start-Up Involvement

- **Real-Time Monitoring and Analytics:** There is a need for advanced air quality monitoring systems that provide real-time data and predictive analytics. Startups can innovate in developing affordable sensors and analytics platforms.
- **Emission Control Technologies:** Innovative solutions for controlling industrial and vehicular emissions are crucial. Startups can explore technologies such as low-emission fuels, catalytic converters, and air purifiers.
- **Indoor Air Quality Solutions:** As urban areas become more congested, indoor air pollution is increasingly affecting public health. Startups can innovate in developing advanced air purification systems and sensors for indoor environments, particularly for homes and workplaces.
- **Alternative Fuels and Sustainable Transportation:** There is a growing need for cleaner transportation options. Startups can explore alternative fuels such as hydrogen and biofuels, as well as innovations in electric and hybrid vehicles to reduce emissions from the transport sector.

Carbon Footprint

Overview

The carbon footprint problem refers to the total amount of greenhouse gases, primarily carbon dioxide (CO₂), released into the atmosphere due to human activities such as burning fossil fuels, deforestation, and industrial processes. This footprint is a major contributor to climate change and has significant environmental, social, and economic impacts.

India's carbon footprint is a pressing issue due to its rapid economic growth, high energy consumption, and heavy reliance on coal. As the third-largest emitter of CO₂ globally, India's emissions are driven by industrial activity, extensive fossil fuel use, and deforestation. These factors contribute to severe climate impacts, including more intense heat waves, unpredictable monsoons, and rising sea levels that threaten coastal areas. Additionally, the country faces increased frequency of extreme weather events like floods and cyclones, which exacerbate vulnerabilities in its infrastructure and agriculture sectors.

Addressing this challenge requires transitioning to renewable energy, improving energy efficiency, and adopting sustainable practices across all sectors. Balancing economic growth with environmental responsibility is crucial for mitigating the carbon footprint and ensuring long-term climate stability. Initiatives like enhancing public transportation, promoting energy-efficient technologies, and implementing stricter regulations on industrial emissions are essential. Moreover, raising public awareness about sustainable practices and encouraging community participation can significantly reduce India's carbon footprint.

Looking at the Data

Global Ranking: India is the third-largest emitter of carbon dioxide (CO₂) globally, following China and the United States.

CO₂ Emissions: In 2022, India's CO₂ emissions were approximately 2.9 billion metric tons, accounting for about 7% of global emissions.

Per Capita Emissions: India's per capita CO₂ emissions are around 2.4 metric tons, significantly lower than the global average of about 4.8 metric tons. However, the absolute volume is substantial due to the large population.

Energy Sector: The energy sector is the largest contributor to India's CO₂ emissions, with coal-fired power plants being the primary source. Over 70% of India's electricity is generated from coal.

Transportation: The transportation sector contributes about 13% of the total CO₂ emissions, with a rapidly growing number of vehicles on the roads.

Industrial Emissions: The industrial sector, including cement, steel, and chemical production, is responsible for about 25% of the country's total emissions.

Renewable Energy: India has made significant strides in renewable energy, with an installed capacity of over 100 GW from solar and wind sources as of 2023. However, the transition from coal is slow, and renewables still constitute a smaller fraction of the overall energy mix.

Deforestation: Deforestation and land-use changes contribute to CO₂ emissions, though India's forest cover has improved, reaching about 24.56% of the total geographical area in 2021.

Climate Impact: India is highly vulnerable to climate change, with increasing instances of extreme weather events such as heatwaves, floods, and cyclones. For example, the severe heatwave in 2015 led to over 2,500 deaths.

Policy Initiatives: The Indian government has committed to reducing the emissions intensity of its GDP by 33-35% by 2030 compared to 2005 levels under the Paris Agreement. Additionally, India aims to achieve 175 GW of renewable energy capacity by 2022 and 450 GW by 2030.

Organisations

Indian Organisations

1. The Energy and Resources Institute (TERI)

Role: TERI conducts research and provides policy recommendations to promote sustainable development. Its initiatives include renewable energy projects, energy efficiency programs, and climate change mitigation strategies.

2. Centre for Science and Environment (CSE)

Role: CSE focuses on environmental research and advocacy. It works on issues like air and water pollution, waste management, and climate change, promoting sustainable development through policy interventions and public awareness campaigns.

3. Indian Network on Climate Change Assessment (INCCA)

Role: INCCA is a network of scientists and researchers that conducts climate change assessments and projections. It provides crucial data and analysis to inform national climate policies and actions.

International Organisations

1. International Energy Agency (IEA)

Role: IEA works globally to promote clean energy technologies and improve energy efficiency. In India, it collaborates with the government on energy policy development, renewable energy integration, and emissions reduction strategies.

2. World Resources Institute (WRI)

Role: WRI focuses on sustainable development through research, policy analysis, and partnerships. In India, it works on climate resilience, renewable energy, sustainable cities, and low-carbon development.

3. Greenpeace

Role: Greenpeace campaigns for environmental protection and advocates for clean energy solutions. In India, it addresses issues like air pollution, deforestation, and climate change, aiming to transition to a sustainable and renewable energy future.

Schemes and Policies in India

1. National Action Plan on Climate Change (NAPCC):

Objective: Launched in 2008, the NAPCC outlines India's strategy to tackle climate change through eight national missions, including solar energy, energy efficiency, sustainable agriculture, and water conservation. The plan aims to enhance India's climate resilience by implementing various initiatives that address key sectors contributing to greenhouse gas emissions.

- The NAPCC's National Solar Mission has significantly boosted India's solar capacity. By 2021, India had installed over 40 GW of solar power, contributing to a total renewable energy capacity of over 100 GW. This success positions India as one of the world's leading producers of solar energy. [Ministry of New and Renewable Energy](#)
- The NAPCC aims to reduce the emission intensity of GDP by 33-35% by 2030 compared to 2005 levels. While there has been some progress, the pace is not sufficient to meet the targets. The overall reduction in emission intensity has been gradual, indicating the need for more aggressive policies and measures. [Climate Action Tracker](#)
- Despite its comprehensive approach, the NAPCC has faced significant implementation challenges. Many of the initiatives under its various missions have been hampered by bureaucratic hurdles, insufficient inter-agency coordination, and limited funding. For instance, the National Water Mission and the National Mission for Sustainable Agriculture have seen slow progress. [Centre for Science and Environment](#)

2. Perform, Achieve and Trade (PAT) Scheme:

Objective: Introduced in 2012 under the National Mission for Enhanced Energy Efficiency (NMEEE), PAT aims to improve energy efficiency in large industrial sectors through market-based mechanisms. The scheme encourages industries to achieve energy savings beyond their targets and allows them to trade the excess savings through Energy Saving Certificates (ESCs).

- The PAT scheme has been successful in improving energy efficiency in large industrial sectors. During the first cycle (2012-2015), it achieved energy savings of about 8.67 million tonnes of oil equivalent (MTOE), resulting in a reduction of approximately 31 million tonnes of CO2 emissions. [Bureau of Energy Efficiency](#)
- The PAT scheme utilizes a market-based mechanism, allowing companies to trade energy saving certificates (ESCs). This provides a financial incentive for industries to exceed their energy saving targets and sell excess savings to those who fall short. As of 2020, over 38 lakh ESCs have been issued, and around 11 lakh have been traded. [Bureau of Energy Efficiency](#)
- One of the significant challenges faced by the PAT scheme is the accuracy of baseline data and effective monitoring. Variability in data collection methods and reporting standards across different industries has made it difficult to assess performance accurately. This inconsistency undermines the credibility and effectiveness of the scheme. [International Energy Agency](#)
- Despite its innovative approach, the PAT scheme faces implementation and compliance challenges. Many designated consumers have struggled to meet their targets due to a lack of technical expertise and financial constraints. Furthermore, the enforcement of penalties for non-compliance has been weak, reducing the scheme's effectiveness. [Centre for Science and Environment](#)

3. Pradhan Mantri Ujjwala Yojana (PMUY):

Objective: Launched in 2016, PMUY aims to provide LPG connections to women from households below the poverty line to reduce dependency on traditional biomass fuels. The scheme targets improving indoor air quality, enhancing health outcomes, and reducing environmental pollution by replacing traditional stoves with cleaner cooking fuel.

- As of early 2024, PMUY has successfully provided over 9 crore LPG connections to women from below-the-poverty-line households. This initiative has significantly improved household air quality and health outcomes. Ministry of Petroleum and Natural Gas
- By reducing the use of traditional biomass fuels, PMUY has contributed to decreased indoor air pollution and related health issues. Studies indicate a reduction in respiratory and cardiovascular diseases among beneficiaries. [World Health Organization](#)
- Despite the successes, challenges include ensuring the timely delivery of connections, maintaining a reliable supply of LPG, and addressing issues related to the affordability of refills for low-income households. [Centre for Science and Environment](#)

4. National Solar Mission (NSM):

Objective: Part of the NAPCC, the NSM launched in 2010 aims to promote solar energy in India with a target of 100 GW of solar capacity by 2022. The mission focuses on accelerating the adoption of solar power through subsidies, research and development, and infrastructure development.

- The NSM has significantly increased India's solar power capacity. By 2023, India had achieved over 40 GW of installed solar capacity, making it one of the world's largest solar power producers. [Ministry of New and Renewable Energy](#)
- The mission has contributed to reducing the cost of solar energy, making it more competitive with traditional fossil fuels. Additionally, it has helped reduce CO2 emissions by offsetting a substantial amount of fossil fuel-based electricity generation. [International Renewable Energy Agency](#)
- One of the major challenges faced by the NSM is land acquisition. Securing large tracts of land for solar projects has led to delays and conflicts. Furthermore, the development of necessary infrastructure, such as transmission lines, has not kept pace with the rapid growth in solar capacity. [Centre for Science and Environment](#)
- Integrating the growing solar capacity into the national grid has been challenging. The variability of solar power generation requires robust grid management and storage solutions, which are still underdeveloped in India. This has led to instances of grid instability and solar power curtailment. [The Energy and Resources Institute](#)

5. FAME India Scheme (Faster Adoption and Manufacturing of Hybrid and Electric Vehicles):

Objective: Launched in 2015, FAME aims to promote electric mobility through subsidies for electric vehicles (EVs) and charging infrastructure development. The scheme supports adopting electric vehicles to reduce emissions from the transportation sector and foster the development of a clean transport ecosystem.

- The FAME India Scheme has significantly contributed to the growth of electric vehicles in India. It has supported the installation of charging infrastructure and offered incentives for EV purchases, promoting a cleaner transportation alternative. [Ministry of Heavy Industries & Public Enterprises](#)
- The scheme has led to increased adoption of electric vehicles, with a notable rise in the number of EVs registered and charging stations established across major cities. [Society of Indian Automobile Manufacturers](#)
- Despite the progress, challenges include the high upfront cost of EVs, limited availability of charging infrastructure in rural areas, and the need for enhanced battery technology. [Centre for Science and Environment](#)

6. National Afforestation Programme (NAP):

Objective: The NAP aims to increase forest and tree cover in the country through afforestation and reforestation activities. The program seeks to restore degraded lands, improve ecological balance, and enhance carbon sequestration by promoting tree planting and forest management.

- The NAP has contributed to an increase in India's forest cover. According to the Forest Survey of India, there was an increase of about 5,188 square kilometres in forest and tree cover from 2017 to 2019, indicating the program's positive impact. [Forest Survey of India](#)
- Despite the increase in plantation activities, the survival rate of planted trees remains a significant challenge. Reports indicate that a substantial portion of saplings fail to survive due to inadequate post-plantation care, lack of water, and poor soil conditions. [Centre for Science and Environment](#)
- Effective monitoring and evaluation mechanisms are crucial for the success of the NAP. There have been criticisms regarding the lack of robust monitoring frameworks, which makes it difficult to assess the actual impact of the afforestation efforts accurately. Improved monitoring and reporting systems are needed to ensure transparency and accountability. [Forest Survey of India](#)

Scope for Startups

Government Policies

- **Perform, Achieve, and Trade (PAT) Scheme:** Under the National Mission for Enhanced Energy Efficiency (NMEEE), the PAT Scheme incentivises industries to reduce energy consumption and greenhouse gas emissions. Startups developing energy-efficient technologies and carbon management solutions can benefit from financial incentives and market opportunities.
- **Clean Energy Fund:** Created from a cess on coal production, this fund supports research and innovative projects in clean energy and carbon reduction technologies. Startups focused on renewable energy, carbon capture, and sustainable practices can apply for grants and funding.
- **National Electric Mobility Mission Plan (NEMMP):** This plan promotes developing and adopting electric vehicles (EVs) and battery technologies. Startups in the EV sector, including those working on battery technology, charging infrastructure, and vehicle design, can access support through this initiative.

Areas benefitting from Start-Ups

- **Carbon Capture and Storage (CCS):** Innovative CCS technologies can help mitigate CO₂ emissions from industrial processes. Startups can explore new materials, processes, and methods for effective carbon capture and storage.
- **Renewable Energy Solutions:** There is ongoing demand for advancements in renewable energy sources, including solar, wind, and hydropower. Startups can focus on improving efficiency, storage, and integration of renewable energy technologies.
- **Carbon Footprint Tracking and Reporting Tools:** Accurate measurement and reporting of carbon footprints are crucial for businesses and individuals to manage their emissions. Startups can innovate in creating advanced software tools and platforms that provide real-time carbon footprint tracking and actionable insights.
- **Sustainable Materials and Circular Economy:** Startups can develop new materials with lower carbon footprints and explore circular economy models where waste is minimized and materials are reused or recycled. This includes innovations in biodegradable materials and sustainable packaging solutions.

Water Pollution

Overview

Water pollution is a critical environmental issue caused by introduction of harmful substances into water bodies, including rivers, lakes, oceans, and groundwater. These pollutants originate from various sources, such as industrial activities, agricultural practices, urban runoff, and inadequate wastewater treatment. The consequences of water pollution are profound and multifaceted, affecting aquatic ecosystems, human health, and economic activities reliant on clean water.

One of the primary concerns of water pollution is its impact on aquatic life. Pollutants such as heavy metals, pesticides, fertilizers, and plastics can accumulate in water bodies, disrupting ecosystems and endangering species. Contaminants may bioaccumulate in organisms, leading to long-term ecological damage and threatening biodiversity. Additionally, pollutants can alter water chemistry, contributing to eutrophication, where excessive nutrients cause harmful algal blooms that deplete oxygen levels and create dead zones.

Water pollution also poses significant risks to human health. Pathogens from untreated sewage and industrial effluents can contaminate drinking water sources, leading to waterborne diseases such as cholera, typhoid, and hepatitis. Chemical pollutants, including carcinogens and endocrine disruptors, can enter the food chain through contaminated water sources, posing health risks to communities that rely on fisheries and agriculture.

The economic impacts of water pollution are substantial. Industries reliant on clean water for manufacturing processes face increased costs for water treatment and compliance with regulations. Tourism and recreational activities suffer when water bodies become polluted, affecting local economies and livelihoods dependent on these industries.

In response to these challenges, startups increasingly leverage innovation and technology to address water pollution. The scope for startups in this field is broad and includes the development of advanced water treatment technologies, such as filtration systems, membrane technologies, and chemical-free disinfection methods. Startups also focus on bioremediation techniques that use natural organisms to degrade pollutants and restore water quality.

Moreover, startups are exploring the potential of IoT and sensor technologies to monitor water quality in real time. These technologies enable early detection of pollution events and facilitate timely responses to mitigate environmental impacts. Innovative water management solutions, including efficient irrigation systems and leak detection technologies, help conserve water resources and reduce the overall burden on freshwater ecosystems.

Looking at the Data

Water pollution in India during the 20th century was a significant issue due to rapid industrialisation, urbanisation, and population growth. The major pollutants typically included industrial waste, agricultural runoff, untreated sewage, and chemical effluents. Here's a summary of critical data and trends regarding water pollution in India during that period:

Major Pollutants

1. **Industrial Waste:** Heavy metals (e.g., lead, mercury, and chromium), toxic chemicals, and other industrial effluents were significant contributors.
2. **Agricultural runoff:** pesticides, fertilisers (nitrates and phosphates), and animal waste.
3. **Untreated Sewage:** Organic waste, pathogens (bacteria, viruses), and nutrients.
4. **Chemical Effluents:** Detergents, pharmaceuticals, and other hazardous chemicals.

Key Rivers and Pollution Trends

1. Ganga River:

- Early 20th century: The river was relatively clean, with minimal industrial activity.
- Mid- to Late-20th Century: Significant pollution from industrial effluents, untreated sewage, and religious activities. Key pollutants included heavy metals, organic waste, and pathogens.

2. Yamuna River:

- Early 20th century: moderate pollution levels with some urban waste.
- Mid- to late-20th century: high levels of pollutants from Delhi and other industrial cities, including ammonia, phosphates, and heavy metals.

3. Godavari River:

- Early 20th century: lower pollution levels, mostly agricultural runoff.
- Mid- to Late 20th Century: Increased pollution from industrial activities, urban waste, and agricultural runoff.

4. Krishna River:

- Early 20th century: minimal pollution with primarily agricultural runoff.
- Mid-to-late 20th century: Increased pollution due to urbanization and industrialization, leading to higher levels of organic waste and industrial chemicals.

Government Actions and Policies

1. **1960s–1970s:** Initial recognition of water pollution issues, with some early regulatory measures.
2. **1980s:** Establishment of the Central Pollution Control Board (CPCB) in 1974 and the Water (Prevention and Control of Pollution) Act in 1974, aiming to regulate and control water pollution.
3. **1990s:** Implementation of various river action plans, such as the Ganga Action Plan (GAP), aimed at reducing pollution levels in major rivers.

Statistical Data

- Biochemical Oxygen Demand (BOD): increased in many rivers, indicating higher levels of organic pollution.
- Chemical Oxygen Demand (COD): Elevated levels reflect industrial pollution.
- Heavy metals: detected in higher concentrations, particularly in industrial regions.

Challenges

- Implementation: inefficient implementation of pollution control measures and regulations.
- Infrastructure: Lack of adequate sewage treatment infrastructure.
- Public Awareness: low public awareness and involvement in pollution control efforts.

Organisations

Indian Organisations

1. Central Pollution Control Board (CPCB):

Role: The apex regulatory body in India, which controls and prevents water pollution, CPCB formulates policies and guidelines for pollution control.

2. State Pollution Control Boards (SPCBs):

Role: Each state has its own SPCB responsible for implementing pollution control measures within their respective states.

3. National Mission for Clean Ganga (NMCG):

Role: Formerly known as the National Ganga River Basin Authority (NGRBA), it focuses on cleaning and rejuvenating the river Ganga, which is severely polluted.

4. TERI (The Energy and Resources Institute):

Role: Works on sustainable development and environmental conservation, including water pollution management.

5. Centre for Science and Environment (CSE):

Role: A research and advocacy organization focusing on environmental issues, including water pollution.

6. Indian Council of Agricultural Research (ICAR):

Role: Researches agricultural practices that affect water quality and provides guidelines for sustainable farming.

International Organisations

1. United Nations Environment Programme (UNEP):

Role: UNEP works globally to address environmental issues, including water pollution, through policy advocacy and international cooperation.

2. World Health Organization (WHO):

Role: WHO sets guidelines and standards for water quality to protect human health from pollutants and contaminants in water.

3. International Water Association (IWA):

Role: IWA, a global network of water professionals, promotes the best water management and pollution control practices.

4. Greenpeace

Role: An international environmental organization that campaigns against pollution, including water pollution, and advocates for sustainable water management.

5. Waterkeeper Alliance:

Role: A global movement of grassroots organizations protecting waterways and communities from pollution.

Schemes and Policies in India

1. National Mission for Clean Ganga (NMCG):

Objective: Formerly known as the National Ganga River Basin Authority (NGRBA), this mission focuses on cleaning and rejuvenating the river Ganga, which is severely polluted due to various industrial and domestic sources.

- As of now, about 20% of the sewage generated in the Ganga river basin is being treated. The NMCG targets increasing this capacity to 33% by 2024 and 60% by 2026. To achieve this, numerous sewage treatment plants (STPs) and sewerage networks are being established ([Civildaily](#)) ([Drishti IAS](#)). By July 2023, operational STPs had a total capacity of 2,665 million liters per day (MLD), with 1,455 MLD added in the 2022-23 fiscal year alone.
- From the program's inception until December 2023, the Indian government allocated ₹16,461.65 crore to the NMCG, out of which ₹15,665.97 crore has been disbursed to various implementing agencies ([PIB](#)). In addition, the World Bank approved a ₹3,000 crore loan for the second phase of the Namami Gange Project to support pollution control efforts further.
- Though NMCG is a ₹20,000 crore mission, the government has so far given in-principle approval for projects worth ₹37,396 crore, of which only ₹14,745 crore has been released to States for infrastructure work as of June 2023.
- The NMCG is now working to develop a water quality index on the lines of the air quality index to communicate river-water quality better.

2. National River Conservation Plan (NRCP):

Objective: The NRCP aims to improve the water quality of rivers through various pollution abatement initiatives. It covers polluted stretches of various rivers across the country.

- The NRCP has covered 34 rivers across 77 towns in 16 states. This broad reach highlights the plan's extensive impact across different regions in India.. The program has sanctioned a total of ₹5965.90 crore, significantly contributing to the development of sewage treatment infrastructure. This funding has helped set up a sewage treatment capacity of 2522.03 million liters per day (MLD) ([mint](#)).
- Under the broader Namami Gange Programme, which also falls under the river conservation efforts, 335 projects have been sanctioned with a total cost of ₹29,578 crore. Out of these, 142 projects have been completed, creating a total sewage treatment capacity of 4867 MLD and a sewerage network of 5066 km.

The following rivers are covered under NRCP:

Sl. No.	River	Sl. No.	River	Sl. No.	River	Sl. No.	River
1	Adyar	10	Godavari	19	Pamba	28	Tunga
2	Beas	11	Krishna	20	Panchganga	29	Tungabhadra
3	Bhadra	12	Mahanadi	21	Rani Chu	30	Tamrabarani
4	Brahmani	13	Mandovi	22	Sabarmati	31	Vaigai
5	Cauvery	14	Mindhola	23	Satluj	32	Vennar
6	Cooum	15	MulaMutha	24	Subarnarekha	33	Wainganga
7	Devika	16	Musi	25	Tapti		
8	Diphu & Dhansiri	17	Narmada	26	Tapi		
9	Ghaggar	18	Pennar	27	Tawi		

3. Atal Bhujal Yojana (ABHY):

Objective: This scheme focuses on sustainable management of groundwater resources with community participation to ensure water security and quality.

- ABHY is a ₹6000 crore scheme, with equal contributions from the World Bank and the Government of India. It targets 8774 water-stressed Gram Panchayats in Gujarat, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan, and Uttar Pradesh. The funding is based on the Program for Results ([PforR](#)) model, where funds are disbursed based on the achievement of specific results ([Jal Shakti](#)).
- The scheme has made some progress in promoting awareness and capacity building. However, translating these efforts into measurable outcomes, such as improved groundwater levels and sustainable water use practices, **remains a work in progress**.
- [Department of Water Resources](#) || [India Water Portal](#) || [Press Information Bureau](#)

Madhya Pradesh No. of selected Districts 6 No. of selected blocks 9 Total GPs in Atal Bhujal 672	Gujarat No. of selected Districts 7 No. of selected blocks 34 Total GPs in Atal Bhujal 2201	Uttar Pradesh No. of selected Districts 10 No. of selected blocks 26 Total GPs in Atal Bhujal 550	Maharashtra No. of selected Districts 13 No. of selected blocks 38 Total GPs in Atal Bhujal 1339
Karnataka No. of selected Districts 14 No. of selected blocks 41 Total GPs in Atal Bhujal 1199	Haryana No. of selected Districts 14 No. of selected blocks 36 Total GPs in Atal Bhujal 1669	Rajasthan No. of selected Districts 17 No. of selected blocks 38 Total GPs in Atal Bhujal 1144	TOTAL No. of selected Districts 81 No. of selected blocks 222 Total GPs in Atal Bhujal 8774

4. National Water Quality Sub-Mission (NWQSM):

Objective: Part of the National Rural Drinking Water Programme (NRDWP), NWQSM aims to provide safe drinking water in rural areas by addressing water quality issues, including pollution.

- NWQSM was launched to tackle the problem of Arsenic and Fluoride contamination in drinking water across 27,544 identified rural habitations. The program has received substantial funding, with Rs. 3,940.34 crore allocated as of recent reports ([PIB](#)). So far, 10,650 Arsenic and fluoride-affected habitations have been covered, and efforts are ongoing to reach the remaining ones.
- Field Testing Kits (FTKs) have been distributed, and over 4.7 lakh women from 1.25 lakh villages have been trained to use these kits, facilitating early detection of water quality issues. Additionally, the Water Quality Management Information System (WAMIS) has been launched, integrating over 2,000 water quality testing labs nationwide to provide accessible testing services for the public. ([PM India](#))
- It comes under the Jal Jeevan Mission but is significant to study separately.

5. Namami Gange Programme:

Objective: Launched as a comprehensive approach to rejuvenating the river Ganga, Namami Gange integrates various efforts such as sewage treatment, river surface cleaning, afforestation, and public awareness campaigns.

- The program has initiated 457 projects with a significant focus on constructing sewage treatment plants (STPs) and related infrastructure. The introduction of the Hybrid Annuity Model (HAM) for these projects has improved their financial sustainability and operational efficiency ([IndiaTimes](#)) ([The Jaipur Dialogues](#)). However, only 280 out of the 457 projects were completed as of 2023, with many not functioning to their designed capacities. Issues with governance and the actual operation of these plants have been highlighted as significant hurdles ([The Wire](#)).
- Efforts under Namami Gange have led to improved water quality in certain stretches of the river. The program claims a notable decrease in the biological oxygen demand (BOD) levels and an increase in dissolved oxygen levels in parts of the river. The revival of the aquatic ecosystem, including reintroducing species like the Gangetic Dolphin and Hilsa fish, indicates positive environmental impacts.
- There have been criticisms regarding the lack of data on the functionality of STPs and the continued diversion of river water through various barrages, affecting the river's flow and overall health.

Gomti River (tributary of Ganga) : The stretch near Shaheed Smarak and Shani Mandir Ghat is most polluted (DO level 0.5 mg/liter and 0.4 mg/liter respectively). Dr. Dutta professor at Babasaheb Bhim Rao Ambedkar University said that only 438 million liters per day (MLD) of the 761 MLD of sewage waste produced is treated, while the remaining flows directly into the river.

6. Pradhan Mantri Krishi Sinchayee Yojana (PMKSY):

Objective: Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) was launched during the year 2015-16 to enhance physical access of water on farm and expand cultivable area under assured irrigation, improve on-farm water use efficiency, introduce sustainable water conservation practices, etc.

PMKSY is an umbrella scheme, consisting of two major components being implemented by Ministry of Jal Shakti, namely, Accelerated Irrigation Benefit Programme (**AIBP**), and Har Khet Ko Pani (**HKKP**). HKKP, in turn, consists of four sub-components: (i) Command Area Development & Water Management (**CADWM**); (ii) Surface Minor Irrigation (SMI); (iii) Repair, Renovation and Restoration (RRR) of Water Bodies; and (iv) Ground Water (GW) Development (approval only till 2021-2022, and thereafter only for ongoing works). Further, in 2016, CAD&WM sub-component of HKKP was taken up for pari passu implementation with AIBP.

In addition, PMKSY also consists of Watershed Development Component (**WDC**) which is being implemented by Department of Land Resources, Ministry of Rural Development. Further, Per Drop More Crop (**PDMC**) component being implemented by Department of Agriculture and Farmers Welfare (DoA&FW) was also a component of PMKSY during 2015-22, and is now being implemented separately by DoA&FW.

- PMKSY has significantly contributed to creating new irrigation potential. For example, under the Har Khet Ko Pani (HKKP) component, approximately 115.28 thousand hectares of irrigation potential have been created through Surface Minor Irrigation (SMI) and an additional 60.35 thousand hectares through the Repair, Renovation, and Restoration (RRR) of water bodies ([Press Information Bureau](#)).
- There have been significant advancements in groundwater development projects, covering areas in states like Uttar Pradesh and Assam, with tens of thousands of hectares brought under irrigation
- Despite the successes, there have been significant implementation challenges. Several states have not submitted eligible proposals for various components of the scheme, leading to gaps in coverage and utilization of funds
- The financial and physical progress of the projects varies significantly across states, with some states like West Bengal having minimal engagement in certain components of the scheme

Central assistance released under various components of PMKSY (Rs. in crore)

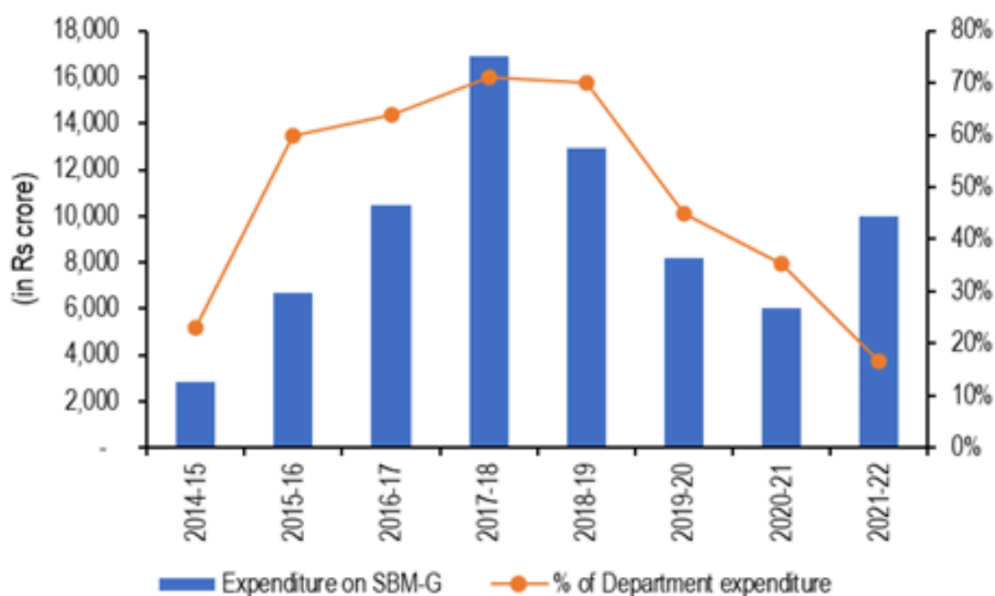
S.No.	States	AIBP with pari passu implementation of CADWM	HKKP	WDC	PDMC (2015-16 to 2021-22 under PMKSY)
1	Andhra Pradesh	91.81	2.7	746.32	2,284.16
2	Bihar	146.06	71.61	300.55	112.21
3	Chhattisgarh	67.76	32.77	255.81	240.64
4	Goa	3.94	-	2.1	2.8
5	Gujarat	6,220.55	83.41	609.43	1,685.34
6	Haryana	-	-	67.52	275.79
7	Himachal Pradesh	2.25	358.92	194.51	116.85
8	Jharkhand	834.98	-	195.66	175.64
9	J&K and Ladakh	46.26	354.68	263.68	60.47
10	Karnataka	1,268.29	30	792.19	2,509.15
11	Kerala	2.69	-	129.53	42.53
12	Madhya Pradesh	1072.24	-	1,215.52	792.4
13	Maharashtra	2,514.73	-	1,141.12	1,960.46
14	Odisha	1,340.83	103.38	609.57	231.4
15	Punjab	79.5	-	24.24	53.18
16	Rajasthan	633.42	71.48	1793.83	922.82
17	Tamil Nadu	34.74	84.66	364.29	2,036.83
18	Telangana	1,017.82	104.56	335.87	679.32
19	Uttarakhand	0	246.1	89.34	206.8
20	Uttar Pradesh	1577.82	43.1	219.09	671.79
21	West Bengal	-	-	224.69	176.7
22	Arunachal Pradesh	-	454.76	224.48	108.4
23	Assam	49.53	2,015.16	465.43	122.03
24	Manipur	267.07	332.58	58.97	181.36
25	Meghalaya	-	346.36	107.19	31.73
26	Mizoram	-	47.76	121.13	137.47
27	Nagaland	-	223.14	326.02	191.64
28	Sikkim	-	54.37	18.49	178.25
29	Tripura	-	52.63	123.35	51.5
30	Andaman & Nicobar	-	-	-	2.73
31	Puducherry				-
32	Ladakh				2.4

7. Swachh Bharat Mission (SBM) - Urban and Rural:

Objective: Although primarily focused on sanitation, SBM also includes components related to solid waste management and sewage treatment, which indirectly contribute to reducing water pollution.

- Under SBM-G, rural toilet coverage increased from 43.8% in 2014 to 100% in 2019. This massive increase is a significant achievement, contributing to public health improvements by reducing open defecation ([PRS Legislative Research](#)).
- SBM-U aimed to construct over 66 lakh individual household toilets and 5 lakh community and public toilets by 2019. The targets were revised and mostly achieved by 2020, with 62.6 lakh individual household toilets and 6.15 lakh community toilets constructed ([PRS Legislative Research](#)) ([Drishti IAS](#)).
- Despite the increase in toilet coverage, reports indicate that many constructed toilets are non-functional or poorly maintained. Quality issues and the lack of water supply and maintenance have led to continued open defecation in some areas ([UPSC Current Affairs](#)).
- Independent studies have pointed out discrepancies in official data. For instance, unused toilets from previous government schemes were counted under SBM, inflating the success numbers. Additionally, surveys with biased questionnaires have been used to present a more favorable picture of latrine usage than is accurate.

Figure 1: Expenditure on Swachh Bharat Mission-Gramin during 2014-22



Note: Values for 2020-21 are revised estimates and 2021-22 are budget estimates. Expenditure before 2019-20 were from the erstwhile Ministry of Drinking Water and Sanitation.

Sources: Union Budgets 2014-15 to 2021-22; PRS.

Source: Seven years of Swachh Bharat Mission (2021)

8. Jal Jeevan Mission (Urban and Rural):

Objective: Aimed at providing safe and adequate drinking water through functional household tap connections to all households in rural India (JJM-Rural) and ensuring piped water supply to all households in urban areas (JJM-Urban), thereby addressing water quality issues.

- The mission has significantly increased access to clean drinking water in rural areas. As of 2023, it is reported that several households have received tap water connections, contributing to improved public health outcomes, including the potential to avert close to 400,000 deaths from water-borne diseases like diarrhea ([Drishti IAS](#)).
- The provision of safe drinking water helps in avoiding approximately 14 million Disability-Adjusted Life Years (DALYs) associated with diarrhea and saves substantial economic resources that would otherwise be spent on health issues and water collection activities
- Continuous monitoring of water quality is crucial. There have been concerns about the adequacy of systems in place for regular testing and maintenance of water quality standards.

Water Crisis

Overview

The global water crisis is a multifaceted challenge marked by the scarcity of potable water, inefficient water management, and the adverse effects of climate change. A key issue is the depletion of freshwater resources, exacerbated by over-extraction and poor management. Agricultural demands drive this overuse, often inefficiently consuming approximately 70% of the world's freshwater for irrigation. Industrial activities also contribute significantly, polluting water bodies with chemicals and waste, rendering them unsafe for consumption.

Climate change disrupts the natural water cycle, altering precipitation patterns and leading to prolonged droughts in some regions and intense flooding in others, straining existing water infrastructure. Rapid urbanisation and population growth further amplify the crisis by increasing water demand and generating more wastewater than can be adequately treated.

In many developing regions, inadequate infrastructure and governance compound the issue. Poorly maintained pipelines and ineffective water management policies result in significant water loss and contamination. Socio-economic factors such as poverty and inequality limit access to clean water for millions, exacerbating health issues and hindering development. Collectively, these causes create a complex and urgent challenge that necessitates coordinated global efforts to ensure sustainable water management and access.

Emerging technologies have given rise to various water-related startups offering innovative solutions. Startups increasingly focus on digital technologies for water management, which show significant potential in improving public health and water conservation despite their relatively low current revenues. Integrating advanced systems in water-related infrastructure, such as smart startup devices for water pumps, can prevent damage and ensure smoother operations. These advancements address immediate water supply issues and contribute to the long-term sustainability of water resources. The entrepreneurial landscape for water startups is evolving, with an increased emphasis on digital solutions, demonstrating substantial potential for impact and growth in this sector.

A promising area is rainwater harvesting solutions. Startups can design efficient systems for collecting, storing, and purifying rainwater, tailored for residential and commercial use, offering modular and easy-to-install kits. Wastewater treatment and recycling also present significant opportunities. Innovating methods for treating and recycling wastewater for agricultural or industrial purposes would address water scarcity and promote sustainable water management practices.

To ensure widespread impact, startups could develop affordable water infrastructure solutions. These would be scalable and suitable for delivering clean water to underserved regions, focusing on modular and mobile infrastructure for rapid emergency deployment. Education and awareness are also crucial. Startups could create platforms or apps that educate the public on water conservation and sustainable management practices.

By addressing these challenges with innovative solutions, startups play a crucial role in tackling the global water crisis, paving the way for a sustainable and water-secure future.

Looking at the Data

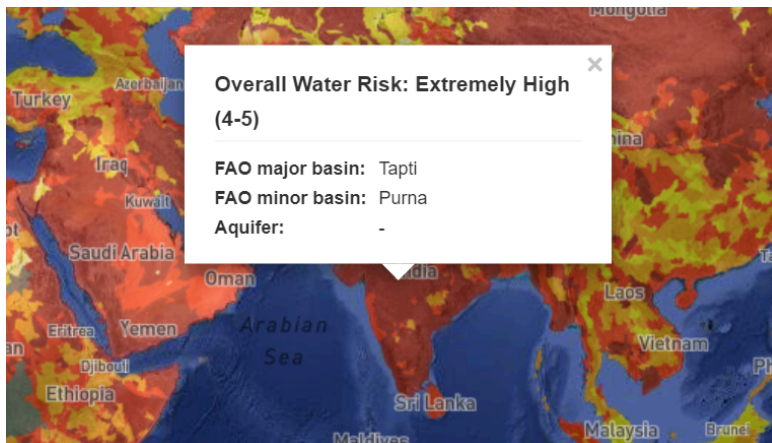
→ [NITI Aayog CWMI Report](#)

- ◆ The CWMI report offers a detailed evaluation of water management across Indian states, highlighting severe water stress in many regions. It provides state-wise performance on water resources management and recommendations for improvement.
- ◆ According to NITI Aayog, 21 cities, including Delhi, Bengaluru, Chennai, and Hyderabad, are expected to run out of groundwater by 2020, affecting around 100 million people.
- ◆ Agriculture accounts for about 80% of India's water use, with inefficient irrigation practices leading to significant wastage.

→ [UNICEF India Water, Sanitation and Hygiene](#)

- ◆ “Less than 50 per cent of the population has access to safely managed drinking water (located on-premises, available when needed and free of contamination).”, says the report.
- ◆ The risk of spreading diarrheal and waterborne diseases gets compounded by the lack of regular handwashing and microbial contamination of water in their homes and communities. This practice amounted to tonnes of feces introduced daily into the environment, regularly exposing India's children to excrement through direct contact. The situation contributed to nearly 100,000 diarrhoeal deaths of children under five years in India.
- ◆ The report points out other severe diseases that newborns are unable to fight against, mostly caused by unclean water.

([WRI Aqueduct Water Risk Atlas](#))



See also: [CWC Reports](#)

Organisations

Indian Organisations

1. [Ministry of Jal Shakti](#)

Role: Formed by merging the Ministry of Water Resources, River Development, and Ganga Rejuvenation, and the Ministry of Drinking Water and Sanitation, it oversees the comprehensive management of water resources, implementation of water conservation programs, and ensures safe drinking water and sanitation across India.

2. **Central Water Commission** ([CWC](#))

Role: An attached office of the Ministry of Jal Shakti, CWC is responsible for initiating, coordinating, and furthering in consultation with state governments, schemes for control, conservation, and utilization of water resources throughout the country.

3. [NITI Aayog](#)

Role: A policy think tank of the Government of India, NITI Aayog publishes various reports and indices, including the Composite Water Management Index, to drive better management of water resources and provide strategic direction and policy advice.

4. **National Water Mission** ([NWM](#))

Role: Part of the National Action Plan on Climate Change, NWM focuses on the conservation of water, minimising wastage, and ensuring its more equitable distribution both across and within states through integrated water resources development and management.

International Organisations

1. **UNICEF India**

Role: Works on water, sanitation, and hygiene (WASH) programs, aiming to improve access to safe water and sanitation facilities, and promoting hygiene practices in schools and communities.

2. [World Bank](#)

Role: Provides funding and technical assistance for various water management projects in India, focusing on sustainable water resource management, irrigation efficiency, and urban water supply and sanitation.

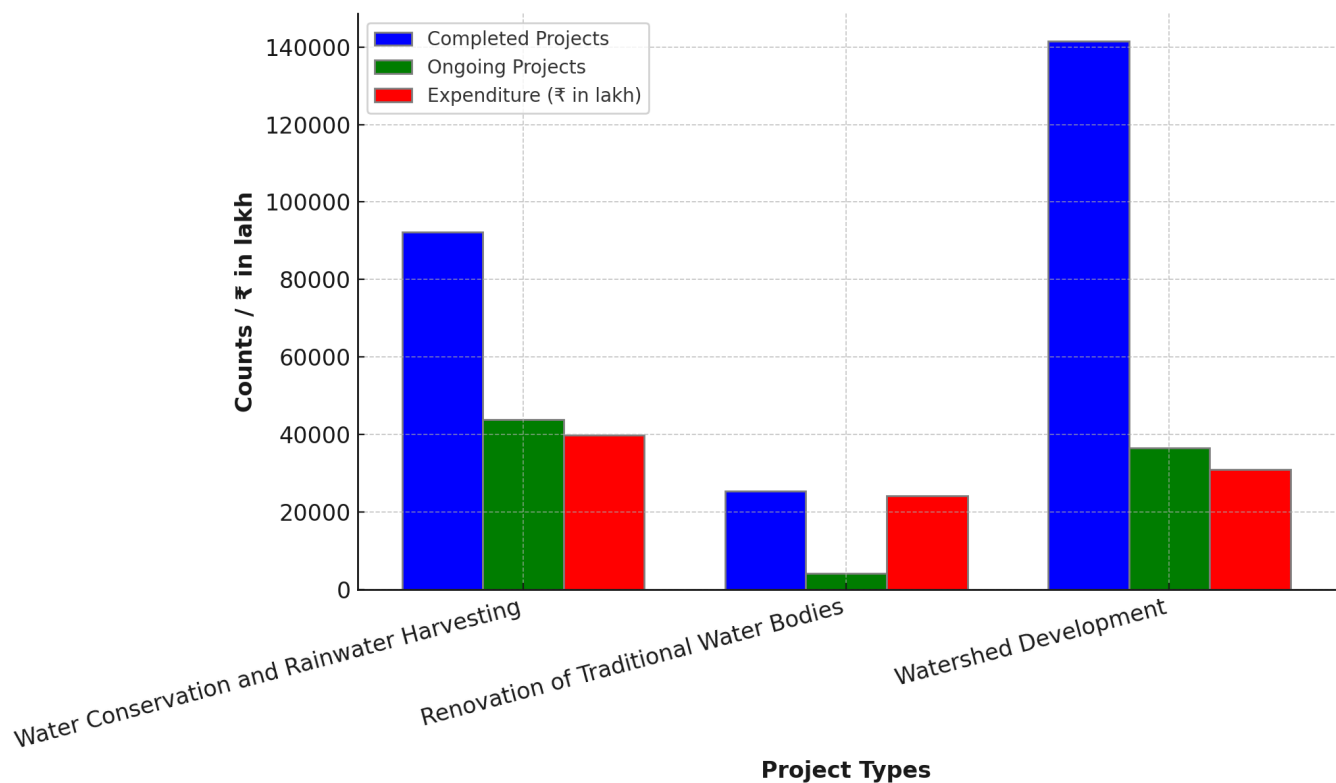
Schemes and Policies in India

Apart from schemes already covered for combating water pollution, the following schemes and policies focus on combating the problem.

1. Jal Shakti Abhiyan (JSA)

Objective: Promote water conservation and rainwater harvesting through targeted activities in water-stressed districts. The campaign involves water conservation projects, afforestation, renovation of traditional water bodies, and awareness generation to ensure long-term water sustainability.

- Focuses on water-stressed districts, involving various activities like water conservation, afforestation, and awareness generation.
- One of the major critiques of JSA is the disparity between planning and actual on-ground implementation. The competitive nature of the campaign sometimes diverts attention from substantive conservation efforts to merely reporting achievements.
- The long-term sustainability of the structures and conservation methods implemented under JSA remains uncertain. Regular maintenance and follow-up actions are crucial for these interventions' lasting effects ([ClearIAS](#)).



(Generated after collecting data from the above sources)

2. Har Ghar Nal Yojana

Objective: The initiative focuses on developing piped water infrastructure to provide households with reliable and safe drinking water.

- Part of the broader Jal Jeevan Mission, focusing specifically on piped water infrastructure development.
- As of early 2024, over 10 crore households across India have been provided with piped water connections.
- Beneficiaries have reported significant reductions in time spent collecting water, positively impacting household productivity and quality of life.
- Reports of infrastructure issues, including incomplete pipelines, leaks, and frequent maintenance problems (WaterAid India, World Bank Reports on Water Projects, NITI Aayog Publications).
- Issues related to the sustainability of water sources, particularly in regions with depleted groundwater tables or unreliable surface water sources.

3. Mission Bhagiratha

Objective: Provide safe and sustainable drinking water to every household in Telangana through a comprehensive water grid. The program leverages reservoirs and water bodies to supply piped water to rural and urban areas.

- Focuses on creating a comprehensive water grid to supply piped water to rural and urban areas, leveraging reservoirs and water bodies.
- As of 2024, Mission Bhagiratha has successfully provided piped water to over 23,000 villages and 67 urban local bodies in Telangana, covering approximately 90% of the state's population (Government of Telangana Reports, Mission Bhagiratha, WaterAid India, The Hindu, World Bank Reports on Water Projects).
- Implementation has faced budget overruns, impacting the timely completion of some project phases (The Hindu, World Bank Reports on Water Projects).
- Some remote or underserved areas have experienced slower implementation, with certain regions lagging behind (The Hindu, World Bank Reports on Water Projects).

4. National Rural Drinking Water Programme (NRDWP)

Objective: Provide safe and adequate drinking water supply to rural areas, ensuring sustainability and equity. The program focuses on decentralised approaches, empowering local communities, and incorporating water quality monitoring and treatment.

- Focuses on decentralised approaches, empowering local communities, and incorporating water quality monitoring and treatment.
- As of 2023, around 60% of rural households have been provided piped water connections (NRDWP Official Website, The Hindu, JJM, NITI Aayog Publications).
- Over 100,000 rural water quality testing units have been set up across various states (NRDWP Official Website, The Hindu, JJM, NITI Aayog Publications).
- Over 200,000 Village Water and Sanitation Committees (VWSCs) have been established to manage and maintain water resources (NRDWP Official Website, The Hindu, JJM, NITI Aayog Publications).

- Coverage remains low in some remote or economically disadvantaged areas, with around 40% of rural households still lacking piped water connections (The Hindu, NITI Aayog Publications).
- Reports indicate that up to 30% of rural water supply systems face operational issues, such as breakdowns and inadequate repair services (NRDWP Official Website, The Hindu, JJM, NITI Aayog Publications).

Scope for Startups (Water Crisis and Pollution)

Government Policies

- **National Mission for Clean Ganga (NMCG):** This mission aims to rejuvenate the Ganges River by reducing pollution and improving water quality. Startups can apply for grants and collaborate on projects related to wastewater treatment, riverfront development, and pollution control technologies.
- **Atal Mission for Rejuvenation and Urban Transformation (AMRUT):** AMRUT focuses on improving urban infrastructure, including water supply and sewerage systems. Startups offering innovative solutions for urban water management, wastewater recycling, and smart water distribution systems can find opportunities under this scheme.
- **Pradhan Mantri Krishi Sinchai Yojana (PMKSY):** This scheme emphasizes efficient irrigation practices and water conservation in agriculture. Startups working on precision irrigation, soil moisture sensors, and water-saving technologies are encouraged to engage with this program.

Areas benefitting from Start-Up Involvement

- **Wastewater Treatment:** Cost-effective and efficient wastewater treatment technologies are in high demand. Startups can focus on developing advanced filtration systems, bioreactors, and decentralised treatment units.
- **Water Conservation Technologies:** Solutions for water conservation in agriculture and urban areas are needed. Startups can innovate in areas such as precision irrigation, rainwater harvesting systems, and water-efficient fixtures.
- **Advanced Water Filtration Technologies:** Despite existing technologies, there is a need for more efficient and cost-effective filtration systems that can remove a broader range of contaminants. Startups can focus on developing nanotechnology-based filters or bioengineering solutions to address emerging pollutants.
- **Smart Water Management Systems:** There is an opportunity to create integrated systems that use IoT and AI to monitor and manage water resources more effectively. Startups can work on developing smart sensors, automated leak detection systems, and data analytics platforms to optimise water usage and conservation.

Discussion and Conclusion

In conclusion, addressing the pressing environmental and health challenges of air pollution, carbon footprint, water pollution, and the water crisis is crucial for India's sustainable development and public health. This report has provided a comprehensive overview of these issues, analyzed pertinent data, and highlighted the significant efforts of key organizations and government initiatives aimed at mitigating these problems.

The analysis reveals that while substantial progress has been made, there are still significant gaps and areas that require further attention. Effective solutions necessitate a multi-faceted approach that integrates individual behavioral changes, robust administrative policies, and innovative technological advancements. Startups play a pivotal role in this ecosystem, offering novel solutions and leveraging government schemes to address these challenges.

Government initiatives and policies are essential in providing the necessary support and resources, but their effectiveness can be significantly enhanced through better implementation and monitoring. The role of major organizations in driving research, policy advocacy, and implementation cannot be overstated, as their efforts form the backbone of India's response to these issues.

Future research should continue to delve deeper into the specific sub-topics highlighted in this report, utilizing comprehensive automated analysis to uncover more precise and actionable insights. By fostering collaboration between startups, government entities, and established organizations, India can develop a resilient and adaptive framework to tackle these environmental and health challenges effectively.

In summary, this report underscores the urgency of addressing air pollution, carbon footprint, water pollution, and the water crisis, and the potential for innovation and collaboration in driving sustainable solutions. Through continued efforts and strategic interventions, India can make significant strides towards a healthier environment and a more sustainable future.

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Thank you!

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