Source: https://mcmscache.epapr.in/post_images/website_350/post_15756996/thumb.jpg

# Groundwater Management in India

**A multi-state field study of availability, utilisation and locally appropriate solutions for sustainable, equitable and efficient use of groundwater**

## Madhya Pradesh State Report

April 2023

RAJIV GANDHI
INSTITUTE FOR CONTEMPORARY STUDIES

**Concept and Overall Guidance:**
Mr. Vijay Mahajan, Director
Rajiv Gandhi Institute for Contemporary Studies, New Delhi

**Review and Editing:**
Mr. Jeet Singh, Fellow, RGICS

**Research Team:**
Mr. Deepak Kumar Yogi,
Development Support Centre, Ahmedabad



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# Contents

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# Madhya Pradesh State Report

## 1 Executive summary

### 1.1 Groundwater scenario in India

Over the last few decades our dependence on ground water has increased tremendously. It has become a major source of water for domestic and agricultural use in India. According to an estimate the ground water resource meets 80% of our water demand. Agriculture is a major consumer of the ground water; it supplies nearly 60% of water demand of the agriculture sector. Worryingly, since the 1990s the area under canal and tank irrigation has observed absolute decrease in India, whereas, ground water fed agricultural area has increased in these years. The convenience and efficient last mile connectivity of ground water resources encouraged many farmers in this country to switch from canal/tank irrigation to the tube well/bore well.

A committee constituted by the government of India to review water governance in the country led by Dr. Mihir Shah in his report in 2016 observed that the public finance on water resources after independence largely focused on surface water.[1] Huge amount was invested on creating surface water infrastructure. The ground water resource remains neglected despite it is replacing surface water from agriculture to domestic use in the last some decades. Individuals invested hugely in ground water infrastructure especially after the green revolution as it was easier and efficient in terms of available for the end use. The technological advancement and availability & affordability of power also helped individual investors (largely farmers) to create groundwater structures. Currently there are around 30 million groundwater structures in this country.

For the purpose of ground water extraction, enough knowledge and data is available. The problem is with lack of data on aquifer management. Being a large country, the geological and hydrological characteristics of the landmass varies from region to region. It further creates complexity to understand sub-surface characteristics pertinent to water seepage, storage and water movement. The CGWB has categorized 14 different aquifer settings in India. Major aquifers include Alluvial, Laterite, Sand stone, shale aquifer, Lime stone aquifer, Basalt aquifers and Crystalline aquifers. According to a classification of geohydrologist Dr. Kulkarni, Crystalline and Alluvial aquifers comprise 59% of the total aquifer area in the country. The mountain and volcanic system of aquifers accounts for 16% of the total area each. These complex aquifer systems require detailed mapping and study for better management of ground water.

1 https://www.indiawaterportal.org/sites/default/files/iwp2/report_on_restructuring_cwc_cgwb.pdf

## 1.2 Groundwater policy gaps

The increasing unsustainable extraction of groundwater is a serious issue that has now turned into a water crisis in many parts of the country. In the states like Punjab, Rajasthan, Haryana, Delhi, Madhya Pradesh, parts of Uttar Pradesh and Tamil Nadu have started withdrawing more water from sub surface than available for usage. This gap in demand and supply is continuously increasing as there is no aquifer management system in the place. The numbers of critical and over exploited units are on rise. This invited crisis due to mismanagement of natural wealth has serious social, economic and ecological consequences. There are many reasons behind this problem and these problems have been discussed a number of times.

Ground water extraction is largely unregulated. The only law that loosely governs this precious resource in India is the Indian Easement Act, 1882. This law gives all rights to land owners to extract the ground water. In other words it excludes land less people from access and use of groundwater. This law does not control or regulate water extraction and its usage by the land owner. To strengthen the regulatory mechanisms, the central government has so far issued four versions of model law to be adopted by state governments. The first model bill was released in 1992 and the latest bill was released in 2017.

Yet not all states have converted the model Bill into state legislation. Andhra Pradesh, Assam, Goa, Bihar, Delhi, Himachal Pradesh, Jammu and Kashmir, Karnataka, Kerala, Lakshadweep, Puducherry and West Bengal have adopted the older version of model bill, but in most cases the attempt is half hearted.[2] Moreover experts believe that the model Bill must also move from command and control mode to participatory mode to ensure full participation of people.

The unavailability of data and knowledge on aquifer systems is another big problem in developing better management plans for the ground water. The CGWB collects data from selected wells four times a year to monitor ground water development. The sample size for this yearly exercise is so low that nothing can be argued conclusively based on collected information. There is a long pending demand of mapping aquifers in this country for better management plan. The CGWB has been attempting to map aquifers for all districts in the country. This data and mapping of aquifers would definitely improve our ability to manage groundwater better.

The absence of an integrated approach of ground water recharge and extraction is completely missing in India. There have been some attempts through government and non-government agencies to integrate both of these aspects, but this idea is still not part of national or state level management plans. The absence of regulations and public finance for the management of ground water further discourages any national or state level plans for ground water resource management.

In the past the CGWB attempted to design a national level master plan for artificial recharge of aquifers in 2002 and 2013. The board has now revised this master plan in 2021. According to this master plan, nearly 1.41 crore artificial recharge structures are needed across the country. The type of structures recommended for states and districts varies depending on their geological and hydrological features. The plan is expected to be financed by ongoing projects such as MGNREGA and Watershed Management. The implementation of the master plans requires investment of Rs. 1.33 lakh crore.[3]

Involvement of people in planning and execution of activities related to artificial recharge and ground water extraction has not been seriously promoted at the policy level. However, we have numerous small examples across the country to show that if people are involved aquifers can be managed sustainably and benefits can be shared equitably.

## 1.3 The multi-state study

There have been some attempts in various states commissioned by nongovernmental organizations to empower farmers with knowledge and capacity to help them to make the right agricultural decisions and choices. Many of these serious attempts helped in yielding good results as well. On the other hand there are numerous examples where projects related to artificial recharge were carried out successfully both by the government and non-government agencies. Some states also tried to regulate groundwater resources. All these actions by different organizations generated huge knowledge and experiences to vet success and failure of each type of programs. These small scale and localized solutions for ground water management are effective in terms of striking a balance between water supply and demand.

Learning from these models can help improving ground water regulations in different states. Therefore this study was commissioned by Rajiv Gandhi Institute for Contemporary Studies (RGICS) in 2021 in ten different states namely Punjab, Rajasthan, Gujarat, Uttar Pradesh, West Bengal, Assam, Madhya Pradesh, Maharashtra, Telangana and Tamil Nadu. Main objectives of the study were as follows:

- To develop an overview of the hydro-geological characterises of different states/regions and the extent of ground water extraction.
- To document and assess the regulatory framework in different states for the management of ground water resources.
- To assess the ability of localized solutions for management of ground water resources to strike a balance between demand and supply of groundwater.
- To draw policy lessons from successful localized solutions for ground water resource management

Groundwater experts and NGOs specialized in groundwater management in different states helped us to implement this project. This is a qualitative research project which involved methods like field work, stakeholder consultation and secondary data analysis. This state report gives an overview of the context and main natural features- geographical, geological, hydrological and hydrogeological- which impacts that status of groundwater in the state. Then it deals with the human interventions – in terms of demand and utilisation, the major policies, laws and regulations, programs, schemes and institutions pertinent to groundwater in the study state.

The main incremental contribution is in the section on lessons from locally appropriate solutions for sustainable groundwater management.We have given summaries of case studies from different location in the study state documenting such locally appropriate solutions.

Finally we summarise the main lessons from the study in a section titled the eightfold path.

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[2] https://scroll.in/article/929433/as-the-water-crisis-deepens-can-india-afford-to-leave-groundwater-unregulated

[3] http://cgwb.gov.in/Whatisnew/2021-06-30-Final-Approved%20Master%20Plan%202020-00002.pdf

# 2 Madhya Pradesh State Report

## 2.1 Context and key features

Madhya Pradesh is located in the central part of India and is a land-locked state, bordered on the west by Gujarat, on the northwest by Rajasthan, on the northeast by Uttar Pradesh, on the east by Chhattisgarh and on the south by Maharashtra State. It has a geographical area of 3,08,252 $km^2$. There are 52 districts and 313 community development blocks in Madhya Pradesh. The population of state as per census 2011 is 7, 25, 97, 565 with a population density of 236 persons per km2 area. Out of total population, 75% lives in the villages and their main occupation is agriculture. The important urban areas in the state are Bhopal, Indore, Jabalpur, Ujjain and Gwalior. Dhupgarh in Pachmarhi is the highest point in the state. Madhya Pradesh comprises several linguistically and culturally distinct regions.

Madhya Pradesh can be divided into seven different linguistically and culturally different regions. The cultural and geographical distinction further affect the pattern of groundwater availability and use in the state. These seven regions are- Malwa Plateau, Nimar region, Bundelkahnd, Chambal region, Baghelkhand, Mahakoshal and Central Vindhya and Satpura region.

The Malwa plateau is located in the northwest of the state and situated on the north of the Vindhya range. Cities like Indore, Ujjain and partially Bhopal lie in the Malwa region. Bhopal is also situated on the edge of the Bundelkhand region. The southwest portion of the state is called Nimar region. In the east of Nimar the Narmada river valley is located. Districts like Khandwa, Khargone, Burhanpur and Barwani are part of the Nimar region.

Madhya Pradesh shares half of Bundelkhand region which is located in the northern part of the state. It slopes down towards the pains of Ganga and Yamuna towards the north. Districts like Gwalior, Sagar, Damoh, Panna, Chhattarpur and Tikamgarh are part of the Bundelkhand region. Chambal region is a highly difficult region located in the north-western part of the state. Districts like Sheopur, Morena and Bhind are part of the Chambal region.

*Source: https://groundreport.in/groundwater-depletion-in-madhya-pradesh-2022/*

The hilly region in the northwest parts of Madhya Pradesh is known as Baghelkhand which covers districts like Satna, Rewa and Sidhi. Mahakoshal region of the state lies in the southeastern portion of the state. Eastern Satpuras and part of Narmada river lies in this region. Districts like Katni and Jabalpur are part of the Mahakoshal region. The central part of the Narmada river valley is known as the central Vindhyan and Satpura region. Districts like Hoshangabad, Harda and Narsimhapur are part of this region.

### 2.1.1 Hydrogeology

The geographical diversity of Madhya Pradesh along with high variations in its geological formations further makes its composition and formation complex. The area is underlain by various geological formations ranging in age from the Archaean to the Recent. While the 80% of the state landmass is covered by hard rocks, the variation in types of hard rock makes its geologoy and hydrogeology more complicated to understand. These variations in the hard rocks are related to composition of rocks, geological structures, geomorpholigical and hydrometeorological conditions. The hydrogeology of the state is defined by the CGWB is as follows:

*"The crystalline rocks of Archaean age like granite, gneiss, granulites, schist, quartzite and granitoids occupy about 14.7% of geographical area of the State. The basaltic rocks of Deccan lava flows are the predominant formations and occupy nearly 44.5% of total geographical area. The consolidated sedimentary rocks of Vindhyan Super Group and Mahakoshal (Cuddapah) Super Group of Proterozoic age occupy about 19.1% of total geographical area and the semi consolidated (Gondwana Formation) occupies about 6.7%. Recent unconsolidated alluvial sediments occupy about 14.4% of total geographical area."* [4]

#### Archeans

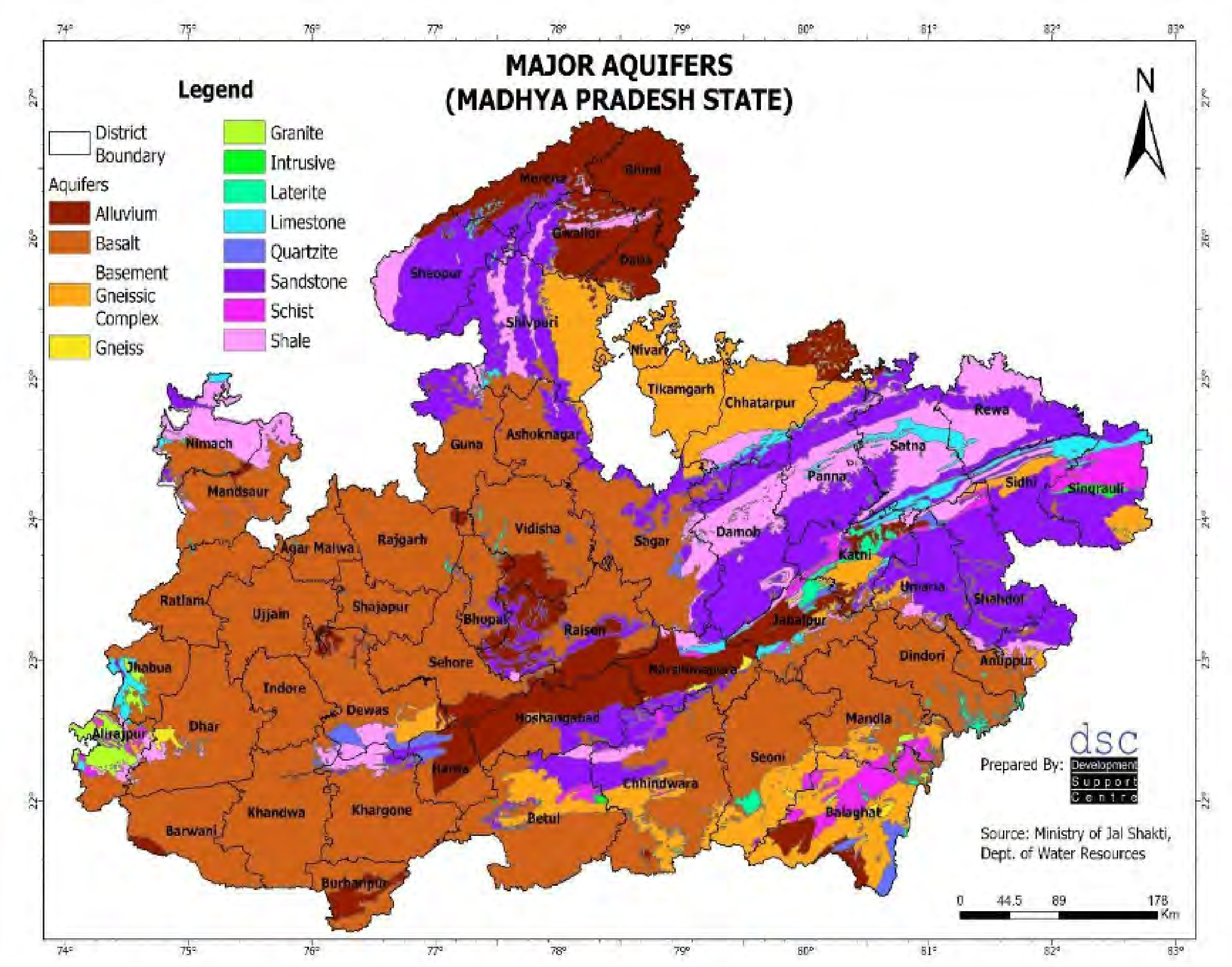
Archaeans comprise of old metamorphics, granites, gneisses and schiests. They are hard and compact formations with low primary permeability, forming poor aquifers. Ground water occurs in these only in the weathered mantle and underlying fractured zone. Dug wells in this formation have depths of 5-30 m with water levels between 3-17 mbgl. Where thickness of aquifer is considerable, specific capacity ranges from 20-200 lpm/m of draw down. Hydraulic conductivity is generally less than 1 m/d and specific yield less than 5%. The yield of open wells ranges between 40-135 m3/d.

Source: https://www.mindat.org/imagecache/08/dc/02529760016755635882333.jpg

## Vindhyans

Vindhyan Group of rocks comprise of sandstone, shale and limestone. The sandstone and shale are hard and compact and form poor aquifers. Ground water occurs in these in the weathered mantle and fractured zone or bedding plane fissures. The limestone is different in its hydrogeological properties having large solution cavities, which give rise to immense secondary permeability. The wells in limestone formations yield 100-500 m3/day for less than 5m draw down. Specific capacity ranges from 100-300 lpm/m of draw down, hydraulic conductivity varies between 5-15 m/d and specific yield ranges from 5-15% in good karstic zones.

### Major Aquifers of Madhya Pradesh




4 http://cgwb.gov.in/Regions/NCR/Reports/Ground%20Water%20Year%20Book%20(Year%202020-21)_Madhya%20Pradesh.pdf

**Gondwanas**

The geological formations of the Gondwanas are sedimentary in nature and therefore, form good aquifers. They support both dugwells and tubewells, capable of yielding 100-500 m3/d for the drawdown of 6-10 m. The specific capacity ranges between 75-250 lpm/m of drawdown, hydraulic conductivity varies between 10-25 m/d and specific yield is from 10-15%. However, the clayey and silty formations (shales/claystone/siltstone) of Dewas District are poor aquifers.

**Infra Trappeans**

According to the CGWB report, :the Bagh and Lameta beds and Nimar Sandstone are also sedimentary formations but have a limited extent and poor to moderate permeability. The limestone and calcareous clays when karstified form productive aquifers.[5]" The corralling limestone, the marls and nodular limestone are hard and compact having poor permeability. The Nimar sandstone has intergranular porosity, joints, fracture, bedding planes, which give moderate scope for ground water movement. The depth of wells varies from 3 to 13 m and depth to water level between 2 to 12 mbgl.

**Deccan Traps**

These form the most important aquifers in the region. The weathered, fractured, jointed and vesicular units of basalts form moderate to good aquifers. These formations have highly variable yields ranging from 10 to 750 m3/d. "Dug wells range in depth from 4 to 20 m with water levels varying between 2 and 14 mbgl. The specific capacity ranges from 50 to 150 lpm/m of drawdown, hydraulic conductivity varies between 5 and 15 m/d and the specific yield is 5-10%.

The Deccan Traps formations can be tapped by dug-cum-bore and drilled wells. It is observed that the yield increases by 5-10 times when 10-15 m bores extending to the lower vesicular zone are drilled at the base of dug wells. Yields of 400-600 m3/d can be obtained in this way."[6] In some areas the control of doleritic dykes on occurrence of ground water was observed. Wells located on the upstream side of these dykes gave better yields. Also wells located on tectonic lineaments gave better yields.

**Alluvium**

It comprises of unconsolidated gravel, sand, silt, clay in various proportions and has primary intergranular porosity and permeability. Hence it is the most promising formation for ground water development. The thickness of alluvium varies from 10 to 318 m with aquifer thickness from 10 to 160 m being more in the Ganga basin than in the Narmada basin. The depth to water ranges from 5 to 30 mbgl. The transmissivity is high in the Ganga basin reached upto 300 m2/d. In the Narmada basin transmissivity ranges between 83-283 m2/d. the yields vary from 30 to 50 m3/hr in the shallow wells and 30-200 m3/hr for deep wells in the Ganga basin.

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[5] http://cgwb.gov.in/Regions/NCR/Reports/Ground%20Water%20Year%20Book%20(Year%202020-21)_Madhya%20Pradesh.pdf

[6] http://cgwb.gov.in/Regions/NCR/Reports/Ground%20Water%20Year%20Book%20(Year%202020-21)_Madhya%20Pradesh.pdf

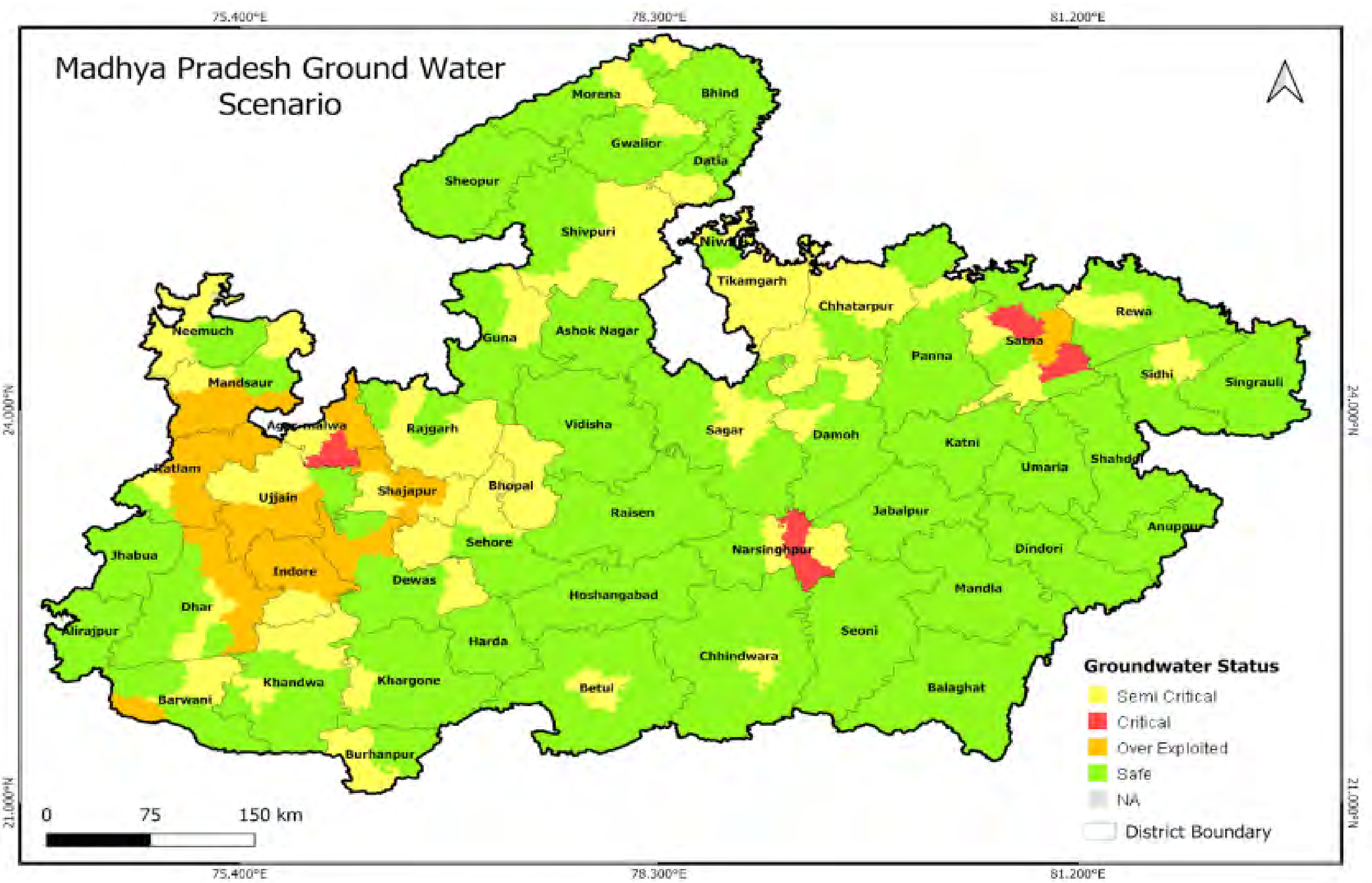
In the Narmada basin the yields are of the order of 15-30 m3/hr in the phreatic zone and 70-200 m3/hr in the deeper zone. In the Wainganga sub basin, the wells yield 60-600 m3/d. In the Tapi basin, the yields are 25-95 m3/d.

## 2.2 Groundwater availability and utilization

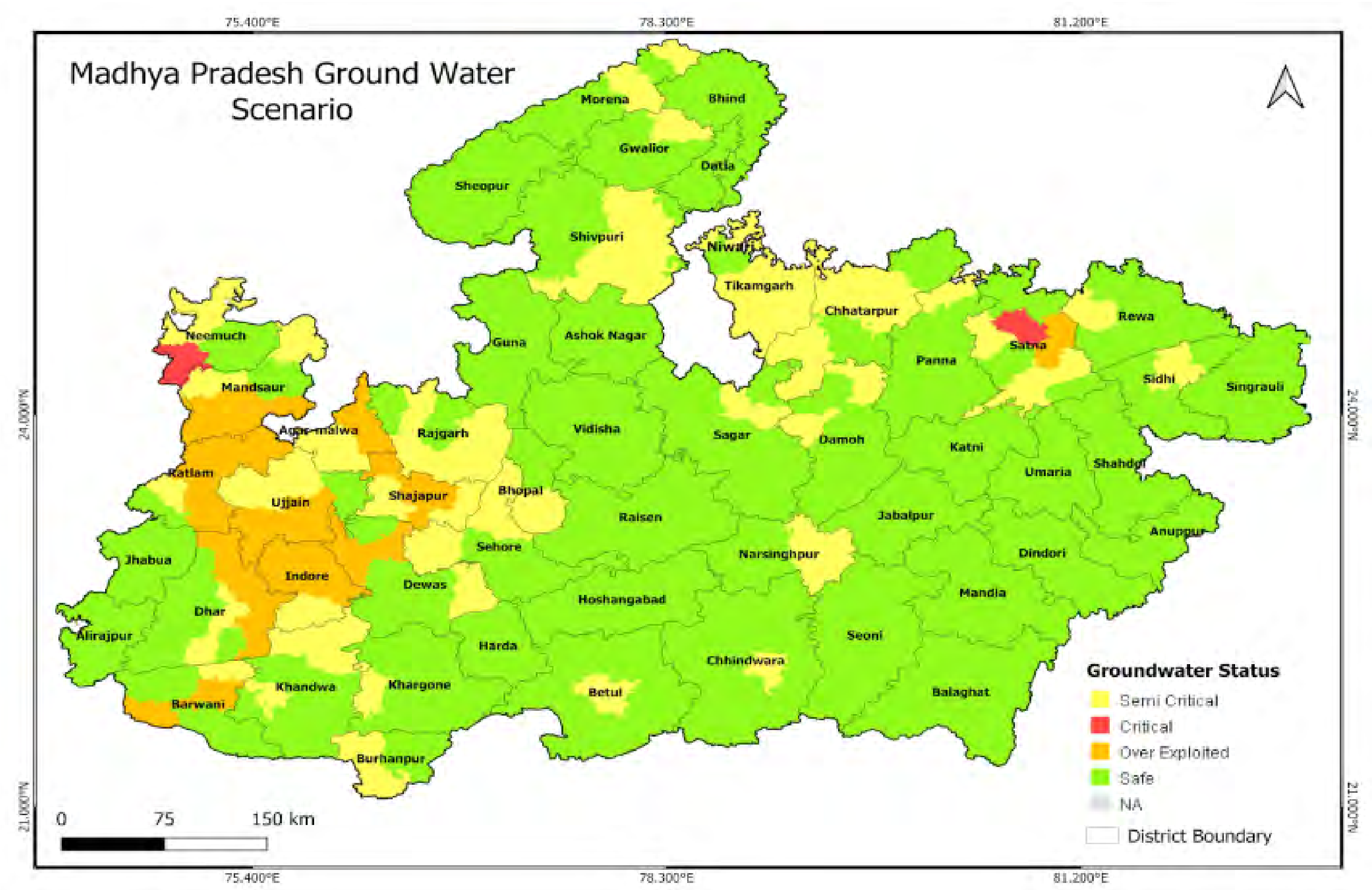
The dependence on ground water for irrigation has increased significantly also water requirements in urban areas in Madhya Pradesh has shot up exponentially in last few decades. It has therefore, urgent call for judicious and planned uses of ground water resources in order to reach sustainability. For proper planning and management of ground water development in a judicious and socio-economically equitable manner, assessment of ground water scenario is one of the most important prerequisites.

Central Ground Water Board (CGWB) monitors ground water levels all over the country four times in a year in order to bring out the spatial and temporal changes in the ground water regime. This continuous monitoring provides a valuable tool to decipher the annual, seasonal and long-term changes in ground water regime, and in turn helps in managing the ground water resources in a scientific manner.

**Madhya Pradesh Groundwater Scenario (2011)**



## Madhya Pradesh Groundwater Scenario (2016)




The North Central Region office of CGWB, based at Bhopal, monitor the ground water wells spread all over the state. As on start of the year i.e. 31-03-2021, the number of ground water monitoring wells are 1511 which includes 1202 dug wells and 309 piezometers. Few of the exiting dug wells and piezometers were declared as abandoned. District-wise distribution of Ground Water Monitoring Wells in Madhya Pradesh during 2020-21 is given in Table.

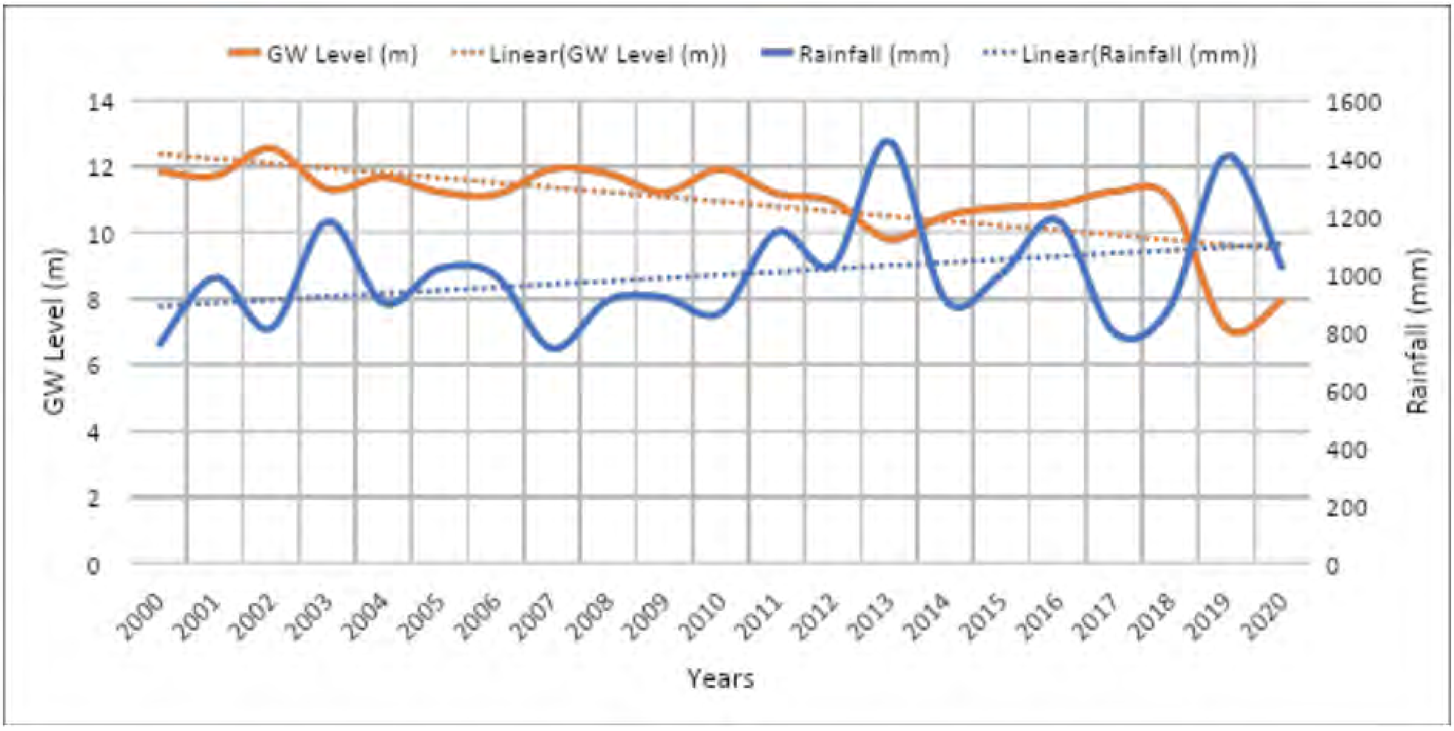
The locations of these monitoring wells are shown in Figure. All monitoring wells are monitored four times in a given hydrological year in the months of August (20st to 30th day), November (post monsoon) (1st to 10th day), January (1st to 10th day) and May (pre monsoon) (20th to 30th day). The long-term data generated during these monitoring seasons are important for computation, comparison and analysis of ground water utilization and its availability. Reports on the status of ground water levels are produced within one month from each monitoring period and contain analysis of ground water levels in that particular season, and compare these water levels with those of the same season of previous year, pre monsoon period and previous seasons of the same hydrological year and decadal mean (10 years of average) of the same season.

**Water level fluctuations Decadal Mean (May 2010-2019) to May 2020.**

The ground water levels of May 2020 were compared with the 10 years May (2010-2019) average ground water levels to decipher the long-term changes in the ground water regime. It is observed that 74.20% of the wells show rise and about 25.80% of wells show decline in water levels in the state.

The rise in water level is in the order of 0-2 m in 41.29% of the wells, 2-4 m in 19.71% of the wells and more than 4 m in about 13.20% of the wells. The rise in water level is more prominent in the Eastern part of the state compared to that of Western part. Water level rise more than 4m is mainly observed in Morena, Gwalior, Sheopur, Sagar, Sehore, Shajapur, Ratlam, Ujjain, Khargone, Narsinghpur, Rewa and Satna District.

**Rainfall vs. GW Level Trend -Madhya Pradesh**




The decline in water levels in the order of 0-2 m is about 16.58% of the wells, between 2-4 m in 4.82% of the wells and more than 4 m in 4.40% of the wells. Decline in water level less than 2 m is covering most of the district in Northern and Central part of the state. Decline in water level more than 4m is mainly observed in Gwalior, Bhind Dewas, Dhar, Mandsaur, Jabalpur, Shivpuri, Satna, Datia and Sheopur District of the state. In general, by comparing mean of water level of previous 10 year and current year water level, it is inferred that there is no significant decline in water level but in general there is a rise in water level in most of the part of the state due to excess to large excess rainfall in most of the districts in monsoon season of 2019.

Source: https://news.cgtn.com/news/2019-06-17/Water-crisis-rocks-villagers-in-India-s-Madhya-Pradesh-state-HAQtBSdcuQ/index.html

## 2.3 Groundwater policies and governance in the state

| Major Policies and Legislations Governing Ground Water Resources in Madhya Pradesh | |
|---|---|
| Madhya Pradesh Irrigation Act, 1931 | • Appointment of canal officers for construction and management of canals<br>• All rights in the water of any river, natural stream or natural drainage channel, natural lake or other natural collection of water shall vest in the Government<br>• Regulating water supply for irrigation on the direction of canal officers. |
| Madhya Pradesh SinchaiPrabandhan Me Krishkon KiBhagidariAdhiniyam, 1999 | • An Act to provide for Farmers' participation in the Management of Irrigation System and for matters connected therewith or Incidental thereto.<br>• Constitution of water users' association for minor, medium and major irrigation system.<br>• to prepare and implement a warabandi schedule for each irrigation season, consistent with the operational plan based upon the entitlement, area, soil and cropping pattern<br>• to prepare a plan for the maintenance of irrigation system in the area of its operation at the end of each crop season and carry out the maintenance works |
| State Water Policy (Year 2003) | • Prioritizing water allocation for various uses<br>• While planning projects, attention should be given for development and conjunctive use of surface and ground water, and it should be made part of the project<br>• The policies of land use and its levelling shall be co-related with the policy of water use<br>• Water rates should be such which conveys the beneficiary the scares value of water<br>• participation of beneficiary groups in water planning, project operation and maintenance |

## 2.4 Locally appropriate solutions for groundwater management

### 2.4.1 Community-based Drinking Water Scheme and Fluorosis Mitigation

Madhya Pradesh is one of the states affected by fluorosis. The state receives low rainfall of less than an average 1000 mm per year, which has a serious and significant impact on the availability of safe drinking water. There are seven major rivers in the state, but groundwater intake almost completely (about 99%) meets drinking water requirements. The presence of fluorosis was first discovered in 1997 in Madhya Pradesh.

According to a report (Water Aid India, 2005) there were 4,018 villages with 7,746 water sources in 22 districts of Madhya Pradesh, affected by exposure to fluoride in groundwater. Since then, the number of fluoride-affected districts has continued to grow. In 2012, 27 of the 50 districts of Madhya Pradesh were affected by fluoride. Dhar district lies in the southern tribal belt of Madhya Pradesh. It is a drought prone area and has a high geogenic concentration of fluoride in its ground water.

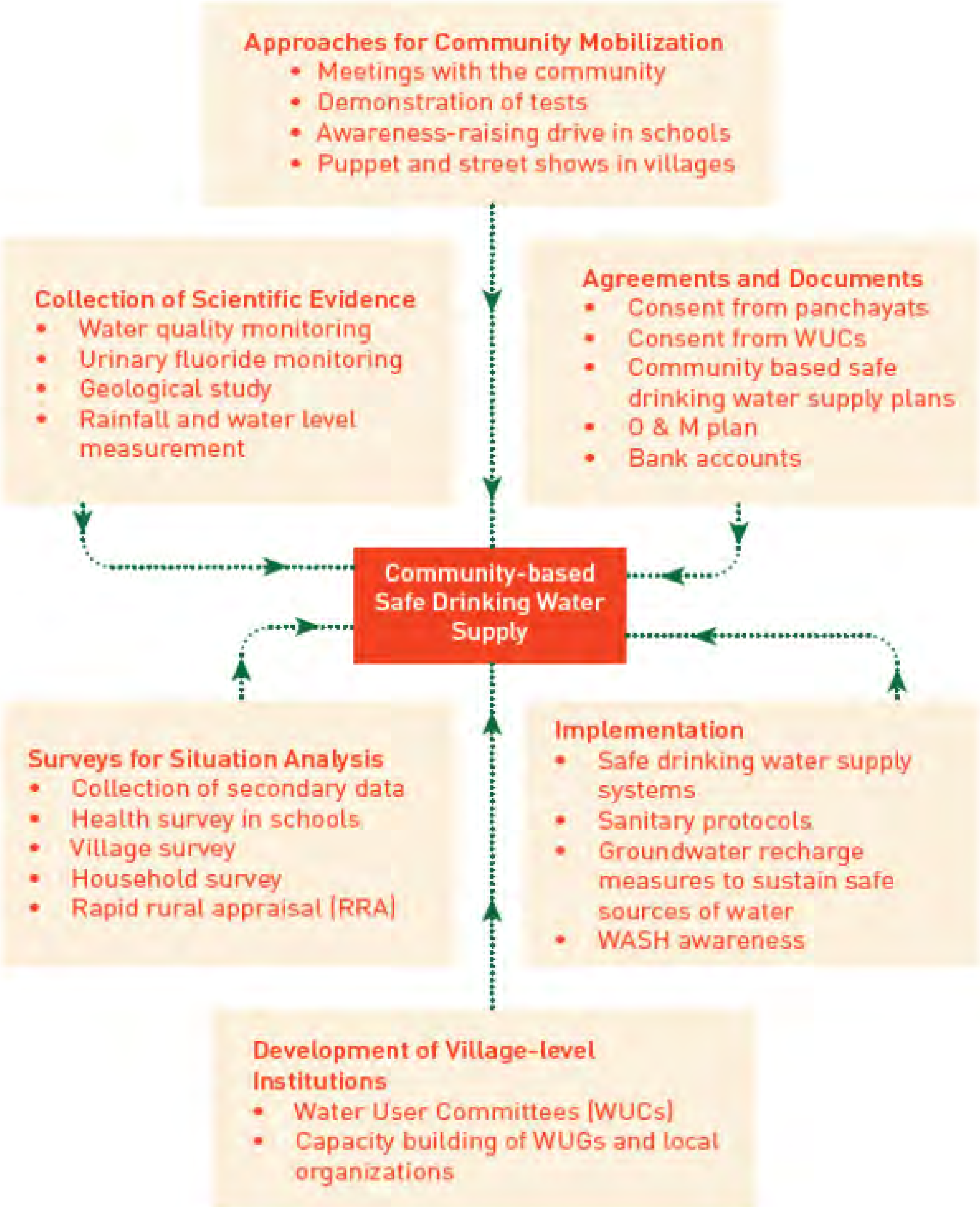
Peoples' Science Institute (PSI), Dehradun a renowned Voluntary Organization has successfully implemented a community based safe drinking water supply systems in Jamnia village of Dhar district with the financial support of Frank Water, UK. The interventions are based on local hydro geological studies, groundwater quality monitoring and strong community mobilization which resulted in preparation of operation and maintenance plans, monthly contributions and sharing of groundwater by the communities. The initiative has set a successful example of decentralized management of groundwater resource and promises a sustainable and cost-effective solution to fluorosis without the use of de-fluoridation or filtration techniques.

The program started with hydrogeological and quality study of the available water resources in a scientific manner. As per the results of the study it was found that most of the tube wells and hand pumps have higher concentration of fluoride (>1.5 mg/L more than permissible limit) as compared to wells. This is because deeper sources allow for more contact of water with the rocks containing fluoride-bearing mineral. Based on these findings, PSI insisted on the use of well water for drinking and cooking purposes, which was very challenging.

The community was not ready to believe that locally available drinking water was responsible for their health problems and was reluctant to accept the change. PSI conducted a mass awareness campaign in the program villages to generate awareness about not only fluoride but also on health and hygiene to sensitize local community. In the awareness campaign scientific evidences were shared with the local community through street plays and puppet shows to orient them about locally available drinking water situation.

Source: https://i.ndtvimg.com/i/2016-05/drought-situation_650x400_51462907591.jpg?ver-20230324.111

Community based safe drinking water supply model



After awareness component of the project and convincing the local community, Water User Committees (WUCs), or Gram Jal Upbhokta Samitis, were formed at the village level to regulate and manage the local water supply system.

After awareness component official implementation of the program started, the first step was to get a letter of consent from the local Gram Panchayat office which allowed PSI to start physical work related to water supply officially.

After getting the letter of consent from the local authority, village level Operation and Maintenance (O&M) plan was prepared by the villagers and members of Water Users Committee (WUC). The role and responsibilities of the WUC were clearly defined and other issues were also discussed.

**Well from water is suppled**

**Check dam constructed near by the well**

To develop drinking water supply, a well was identified by PSI with support of local community in the village. The owner of the well gave his consent for using it for public use.

PSI developed small check dams nearby the well with financial help of the funding agency and labor counterpart by the local community. These check dams recharge the well which ensured availability of safe drinking water round the year.

From the well water is supplied through pipeline to the 45 households of the village. Since, PSI has already withdrawn itself after the completion of the project hence, responsibility of water supply system is entirely managed local community without any external support.

The supplied water was only for drinking and domestic consumption no other use such as for gardening and any other commercial use is totally prohibited. For family functions, wedding special permission should be taken from the WUC.

Cleaning of the water tanks installed in the community is done twice in a month, while Chlorination of wells is done once in a month. Open defecation is prohibited nearby the water sources.


Water tanks installed in the community

The WUC collects user charges monthly from the beneficiaries at the rate of Rs.100 per month/ per household and uses collected money in operation and maintenance of the water supply. The WUC has appointed a waterman from the local community on honorarium basis to look after regular supply of the drinking water.

**Impact of the intervention:**

**1. Improvement in Health conditions in the village:**

Within eight months of the project's launch, a reduction in human urinary fluoride was observed indicating a reduced intake of fluoride by the body. It was observed in an evaluation study that there is drastic decrease in water borne diseases in the program villages, which has a positive impact on the socio-economic conditions of the local community.

**2. Improved access to safe drinking water:**

This intervention has ensured availability of clean drinking water for the local community at the doorstep. This has an implication in form of drudgery reduction of the women.

**3. Behavioral changes:**

The intervention was successful enough in changing behavioral aspects of the community. It was observed among the people in a study that, 95 per cent of the respondents reported that they started using soap for handwash after defecation, which is due to awareness campaign conducted by the PSI.

**4. Initiatives taken by the district administration:**

Intervention made by PSI was noticed and appreciated by the local government authorities. The District Collector sanctioned Rs. 25 lakh to the self-help group (SHG) of one of the program villages for construction of 203 toilets. Some local doctors came forward to help the victims of fluorosis. They organized a health camp and announced free surgery for 23 severely affected people. Under the National Fluorosis Mitigation and Control Programme, a one-day district-level workshop was organized for local doctors to brief them about the causes, symptoms, and treatment of fluorosis. The workshop was conducted in Dhar on 17 August 2015 by the Department of Community Services and Health.

## 2.4.2 Engaging Individual Rural Households in Groundwater Recharge in Khandwa

Khandwa District is situated South West of the state of Madhya Pradesh. The district is in Indore Division of Madhya Pradesh. The district is bounded on the east by the Betul and Hoshangabad district of Hoshangabad division, and Burhanpur district of Indore division on south, on the west-by-West Nimar district of Indore division, and on the north by Dewas district of the Indore division. The district has an area of 7352 $km^2$, and it ranks 14th among all districts of state by area.

Aga Khan Rural Society Program India popularly known as AKRSPI is a voluntary organization working on Natural Resource Management in Khalawa block of Khandwa district, Madhya Pradesh. Ground water is one of the important natural resources which was depleting day by day and posed as one of the serious challenges in front of local community. Government, NGOs started focusing on this issue and AKRSPI also initiated in this direction.

Roof top rain water harvesting structure

Kumharkheda is one of the villages of AKRSP(I)'s working area. The total population of the village is 2278 as per Census, 2011. The main source of livelihood is agriculture which is dependent on groundwater. AKRSP (I) has launched a Groundwater recharge initiative through developing household rooftop rain water harvesting structures. These structures have been developed by AKRSP(I) with funding support from the Children's Investment Fund Foundation.

The rooftop water harvesting structures recharge groundwater by collecting rain water and percolating it into aquifers through soak pit.

As Khandwa falls under area with high annual rainfall but a smaller number of rainy days, these structures help to harvest running rain water and maintain groundwater level. Since these structures recharge aquifers, water percolates in central well from nearby aquifers. This reduces time required for well recharge and dependence on main aquifer. Indirectly it helps in surface water irrigation. The main well then can be used for irrigating agriculture land and meeting domestic needs. Although there are several factors which are important and play a vital role in the amount of water harvested, such as the capacity of storage tanks, types of the roof, its slops and its materials and the frequency and quality of the rainfall.

**Cost structure for Rooftop harvesting**

| Particulars | Cost of structure | | | | |
|---|---|---|---|---|---|
| CAPACITY (litres) | 5000 | 6000 | 7000 | 9000 | 10,000 |
| Total cost in rupees | 12,430 | 12,975 | 13,970 | 14,380 | 15,800 |

The community adopted concept of Roof top rain water harvesting structure knowing the importance and urgency of the situation. This intervention helped in recharging aquifer of the local village and meeting water demand by reducing rainwater drainage.

**Advantages and disadvantages of rooftop water harvesting structures**

| Advantages | Disadvantages |
|---|---|
| • Decreases the demand for water.<br>• Less cost.<br>• Does not require a filtration system for landscape irrigation. Infact It is an excellent source of water for landscape irrigation with no chemicals and dissolved salts and free from all minerals.<br>• It reduces soil erosion, stormwater runoff, flooding, and pollution of surface water with fertilizers, pesticides, metals and other sediments.<br>• Improves the quality and quantity of groundwater. | • Regular Maintenance is required.<br>• If not installed correctly, it may attract mosquitoes and other waterborne diseases.<br>• One of the significant drawbacks of the rainwater harvesting system is storage limits. |

**Estimating Impact or Benefit of intervention in meeting Rural water demand**

As per data of (climatedata.org) 1 mm of rainfall gives 1 lt. of water for every square meter of field. Khandwa receives 1012 mm therefore household having 200 Sq.m rooftop can harvest 20,240 liters of water if rainfall rate is 1012 mm and if the rainfall rate is 900 mm than 18,000 liters of rainwater could be harvested. On the basis of this calculation, it could be estimated that through 11 structures 1,98,000 liters of rainwater was harvested and put into the local aquifer which has a positive impact on the ground water level as reported by the villagers. Through this initiative village could recharge its ground water to meet out its water demand without depending on the ground water reserves.

Government of Madhya Pradesh made rooftop Rain Water Harvesting Structure (RWHS) mandatory for all types of buildings on plot size of more than 140 Sq. m. and as an incentive 6% rebate in property tax was also given. The inclusion of such interventions shows it feasibility and paves way for quick action. This could be linked with MGNERGA so that in rural areas every household can develop RWHS which will have a drastic impact on the groundwater level.

## 3. Lessons from the fieldwork in Madhya Pradesh – The eightfold path

This is a multi-state study of locally appropriate solutions of groundwater management to draw policy lessons from them. In each state, we found exceptional work at micro level ensuring sustainable, efficient and equitable management of groundwater resources. Based on our findings from ten different states, we have developed eight principles which can guide our policy formulation and actions on ground. This section attempts to describe this eightfold path in the context of Madhya Pradesh.

### 3.1 Need for a new approach to achieve sustainable, equitable, efficient use

The state of Madhya Pradesh has varied hydrogeological characteristics due to which ground water potential differs from place to place. The area is underlain by various geological formations ranging in age from the Archaean to the Recent. Hard rock areas cover more than 80% of total land area of the state. These hard-rock areas show wide variations and complexities in nature and composition of rocks, geological structures, geomorphological set up and hydrometeorological conditions. The crystalline rocks of Archaean age like granite, gneiss, granulites, schist, quartzite and granitoids occupy about 14.7% of geographical area of the State. The basaltic rocks of Deccan lava flows are the predominant formations and occupy nearly 44.5% of total geographical area.

Madhya Pradesh is one of the states affected by fluorosis. The state receives low rainfall of less than an average 1000 mm per year, which has a serious and significant impact on the availability of safe drinking water. Given this highly diverse physiography, hydrology and hydrogeology besides varying rainfall patterns, the regional potential of groundwater recharge and withdrawal is also highly uneven. In such conditions, locally appropriate approaches for groundwater recharge and withdrawal is important.

Source: https://science.thewire.in/environment/smart-city-indore-water-access/

## 3.2 The efficacy of participatory data collection

The ground water levels of May 2020 were compared with the 10 years May (2010-2019) average ground water levels to decipher the long-term changes in the ground water regime. It is observed that 74.20% of the wells show rise and about 25.80% of wells show decline in water levels in the state. The rise in water level is in the order of 0-2 m in 41.29% of the wells, 2-4 m in 19.71% of the wells and more than 4 m in about 13.20% of the wells. The rise in water level is more prominent in the Eastern part of the state compared to that of Western part. Water level rise more than 4m is mainly observed in Morena, Gwalior, Sheopur, Sagar, Sehore, Shajapur, Ratlam, Ujjain, Khargone, Narsinghpur, Rewa and Satna District.

The Meta data presented in the above paragraph has been collected by expert agencies, which gives us detailed information about groundwater development. However, such Meta data is not enough to instigate people to act or change their behaviors. To effectively manage ground water resources, participatory data collection plays a vital role in sensitizing people and changing their behavior. It further helps them to take collective decisions related to water conservation and usage.

The intervention of People's Science Institute in Dhar district to address issue of fluoride contamination water is largely dependent on people's awareness and participation. The result of the intervention as discussed in the case study reveals that it is only because of community participation and awareness, the access to safe drinking water initiative has sustained even after withdrawal of the project.

## 3.3 Understanding the prevailing policy framework and using it beneficially

Water policies in India aimed at optimising water availability for different purposes, especially for supply of water for drinking, food production, livestock, as well as for power generation, navigation, and various commercial and domestic uses. It simultaneously attempted the objectives of achieving efficiency, equity and sustainability in water use – the sustainability issues being particularly important in the light of the declining per capita availability and the pollution through human intervention.

Unlike many other states, the Madhya Pradesh has not enacted any law that comprehensively regulates the groundwater resources. However, there are three legislations that have impact on water usage and groundwater development. Major such legislations and policies includes, the State Water Policy, 2003, The Madhya Pradesh Irrigation Act, 1931 and The Madhya Pradesh Sinchai Prabandhan me Krishkon ki Bhagidari Act, 1999. A better understanding of existing policy framework and policy gap is highly important to leverage benefits of policies and program for the management of groundwater in sustainable manner.

## 3.4 Whistleblowing in the face of non-Implementation of Laws and Regulations

Once the community is involved with collecting the data and understands the prevailing policy, laws and regulations, it can become a watchdog against any violations. Moreover, demands can be raised for more appropriate laws and policies. Like in many other parts of the country, concerned individuals and institutions have been raising voices against non-implementation of existing laws in the state.

## 3.5 Planning for balancing demand with supply

The total annual replenishable groundwater resource in Madhya Pradesh is accounted about 37.19 BCM. Out of this net 35.33 BCM ground water is available for use in a year. The net annual groundwater draft is about 17.12 BCM in the state. It comes around 48% ground water development in Madhya Pradesh. However, the stage of groundwater development is highly uneven across the state. According to the data of Central Groundwater Board (CGWB) there are 24 blocks in the state are over exploited, 5 blocks critical and 19 blocks are semi critical.

Moreover, the available water in various parts of the state are highly contaminated and unfit for use. The fluoride contamination is a serious issue in the state. Districts like Bhind, Chhatarpur, Chhindwara, Datia, Dewas, Dhar, Guna, Gwalior, Harda, Jabalpur, Jhabua, Khargaon, Mandsaur, Rajgarh, Satna, Seoni, Shajapur, Sheopur and Sidhi are facing fluoride contamination. Moreover contamination of iron and nitrate is also a big issue.

The gap in demand and supply of the groundwater is increasing exponentially. The urgent need is to balance this gap both by enhancing recharge capacities and rationalizing demand.

## 3.6 Enhancing supply by groundwater conservation and recharge

Two case studies part of this report are classic example of enhancing supply of by groundwater conservation and recharge. For example the AKRSP effort of installing rooftop water harvesting structures in the rural areas of Madhya Pradesh has enhanced the groundwater level in the area. The organization has installed 11 structures in a village and these structures are harvesting 1.98 lakh liters of rainwater and put into the local aquifer. Similarly, the initiative of People's Science Institute in Dhar district has invested in harvesting rainwater that led to availability of fluoride free drinking water. With rapidly declining groundwater level such more efforts are needed to be promoted. The CGWB has estimated that 2320 MCM surface water can be used to recharge aquifer by constructing artificial recharge structures. Major artificial recharge structure suggested by the CGWB in the state are percolation tanks, nala bunds, check dam, dug wells, recharge shafts, gully plugs and gabion structures.

Source: https://i0.wp.com/gsmtyavatmal.org/wp-content/uploads/2020/04/1.jpg?fit=532%2C304&ssl=1

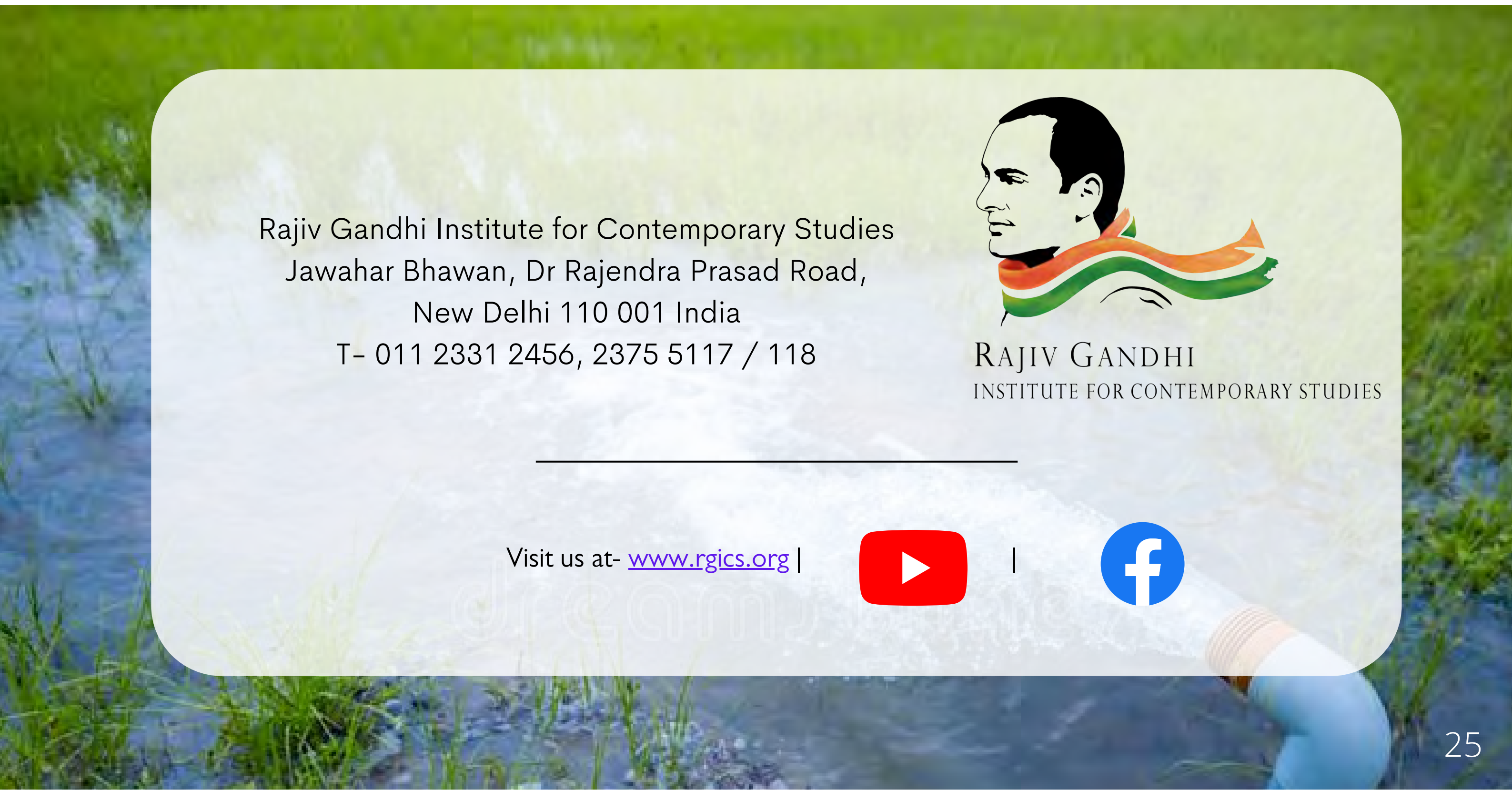
## 3.7 Rationalising demand for water by rationalising prices for crops and energy

India has 18% of world population, having 4% of world's fresh water, out of which 80% is used in agriculture. India receives an average of 4,000 billion cubic meters of precipitation every year. However, only 48% of it is used in India's surface and groundwater bodies. A dearth of storage procedure, lack of adequate infrastructure, inappropriate water management has created a situation where only 18-20% of the water is actually used. India's annual rainfall is around 1183 mm, out of which 75% is received in a short span of four months during monsoon (July to September). This result in run offs during monsoon and calls for irrigation investments for the rest of the year.

Examples documented in this report shows that wherever the supply of the water has increased due to locally appropriate solutions, the agricultural productivity has also increased. In many cases farmers have started harvesting two crops in a year. Such developments are really good, but it is necessary to rationalize demand to ensure sustainability of demand and supply of water. Moreover, pricing of energy and water is an important factor to ensure sustainability.

## 3.8 Building capacity of the community for the above functions is a must

It is very clear that the 'one size fits all' approach is not going to solve the problem of groundwater. Every step from groundwater recharge to the utilization of water has deep social, economic, geological, hydro geological and geo morphological underpinning. Therefore, it is necessary to understand physical and social sciences in each region to experiment locally appropriate solutions for groundwater management. Moreover, this exercise cannot be done without building capacities of the community. It is worth mentioning here that all successful interventions documented in this study have attempted to develop the capacity of people.



Rajiv Gandhi Institute for Contemporary Studies
Jawahar Bhawan, Dr Rajendra Prasad Road,
New Delhi 110 001 India
T- 011 2331 2456, 2375 5117 / 118

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