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Policy Brief 5

Source Sustainability: A Critical Issue in Maharashtra's Rural Drinking Water Supply

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Introduction

Sources of water are finite. Among the finite availability of water sources, ensuring their sustainability while fulfilling competing demands becomes the backbone of Rural Drinking Water Supply (RDWS) schemes in Jal Jeevan Mission (JJM). The full functionality of the water supply infrastructure is contingent upon the availability of water to ensure a consistent supply. The country remains heavily dependent on groundwater for its piped water supply under the ongoing Jal Jeevan Mission (JJM). The sustainability of these groundwater sources is crucial to meeting the water demands of the large rural population. Against this backdrop, this policy brief discusses the source sustainability aspect of the RDWS schemes in Maharashtra using secondary data and literature. It highlights the issue of maintenance of groundwater recharge structures and groundwater monitoring as pivotal areas to ensure source sustainability.

Research Objective, Questions and Methodology

This policy brief aims at two objectives:

- i. To identify gaps and scope to improve the sustainability of groundwater-based sources,
- ii. to assess the progress in groundwater recharge in Maharashtra.

The research questions guiding this study are:

- i. What has been the status of groundwater recharge activities in Maharashtra?
- ii. What are the ways to improve the performance of groundwater recharge in Maharashtra?

The policy brief uses limited literature on the maintenance and monitoring of groundwater recharge structures and their performance in India. It relies on secondary data from government programmes like JJM and Atal Bhujal Yojana (ABY) for evidence. It also uses limited information collected in Maharashtra, where Groundwater Surveys & Development Agency (GSDA) functionaries were interviewed but does not draw heavily from them.

Structure:

The policy brief discusses the status of source sustainability of groundwater sources used for rural water supply schemes under JJM in Maharashtra. The data for discussion is of Maharashtra state as an example — section one of the policy brief highlights the high groundwater dependency of the water supply schemes in rural Maharashtra. It then goes on to explore the progress of artificial groundwater recharge structures. Sections two and three discuss the maintenance of the artificial groundwater recharge structures and groundwater recharge monitoring systems, respectively. The policy brief concludes with recommendations to improve the source sustainability efforts for water supply schemes.

Section 1: Water Source and Groundwater Recharge Structures

According to National Compilation on Dynamic Ground Water Resources of India, 2023, domestic use accounts for 11% of annual groundwater extraction in India. The JJM data shows Maharashtra¹ highly depends on groundwater (~80% (GW) + 2% (SW-GW) of schemes), making groundwater the primary source of rural drinking water in Maharashtra, as shown in Figure 1. Problems like climate change,

¹ Hereafter in the brief 'state' means Maharashtra and the data is for Maharashtra state mentioned otherwise.

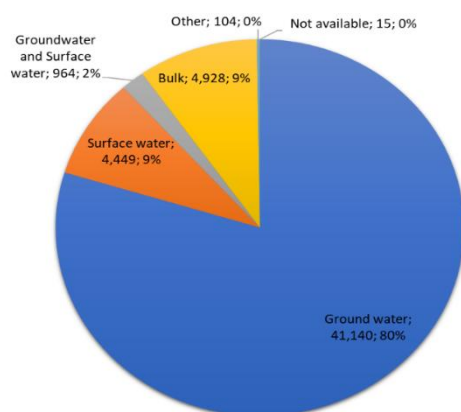


Figure 1 JJM water supply scheme source dependency (data: JJM portal 12/06/24)

over-extraction, poor recharge, poor operation and maintenance, and increased source contamination make rural water supply complex. Many of these very reasons have been attributed to the ‘slip-back’ of drinking water schemes across the country (CAG, 2018; Reddy et al., 2010). The JJM programme accommodated the learnings from previous water supply programmes to ensure the provision of possible mitigation measures for each problem. This policy brief has considered it an umbrella issue of ‘source sustainability’. An aspect of source sustainability is the dependency of the RDWS on various water sources. 2.5% blocks in Maharashtra were identified as over-exploited category assessment units (OEAs) and 2.5% as critical category assessment units (CAUs) in 2023. The high dependency (~80%) on groundwater for fulfilling rural water supply demand without sufficient restoration measures may lead to severe sustainability issues. While mitigating over-extraction by agricultural and industrial users is a complex issue, effective operational measures can be taken more readily to optimise water extraction for piped water supply and ensure its replenishment. Considering these facts, JJM has provisions for groundwater recharge structures (GWS) to ensure source sustainability. JJM facilitates convergence with other schemes to implement rainwater harvesting and artificial groundwater recharge. An artificial water recharge structure like recharge shafts/wells generally costs significantly less than a complete water supply scheme (Atal Bhujal Yojana Haryana, 2024; CGWB, 2000). Therefore, the construction of GWS accompanying the groundwater-based rural water supply (RWS) scheme is feasible without drastically increasing the financial burden. It would make a more considerable impact by improving the water security and sustainability of the source by ensuring attention to each source identified. Considering the given background, the progress in constructing groundwater recharge structures is analysed further.

Table 1 District-wise water sources and groundwater recharge structures (data: JJM portal 16/06/24)

Sr. No.	District Name	No. of PWS Sources	No. of Ground Water Recharge Structures
1	Ahmednagar	3940	26
2	Akola	698	7
3	Amravati	819	1
4	Beed	29	0
5	Bhandara	1215	2
6	Buldhana	1724	3
7	Chandrapur	881	7
8	Chhatrapati Sambhajinagar	518	35
9	Dharashiv	784	4
10	Dhule	1365	3
11	Gadchiroli	4408	58
12	Gondia	2922	5
13	Hingoli	575	6
14	Jalgaon	1266	16
15	Jalna	644	1

16	Kolhapur	4409	22
17	Latur	976	3
18	Nagpur	1809	2
19	Nanded	4003	34
20	Nandurbar	1964	2
21	Nashik	2338	4
22	Palghar	960	1
23	Parbhani	918	9
24	Pune	4070	4
25	Raigad	2896	8
26	Ratnagiri	955	10
27	Sangli	1600	19
28	Satara	2493	16
29	Sindhudurg	721	0
30	Solapur	3604	3
31	Thane	660	1
32	Wardha	792	5
33	Washim	659	0
34	Yavatmal	445	9
Total		58,060	326

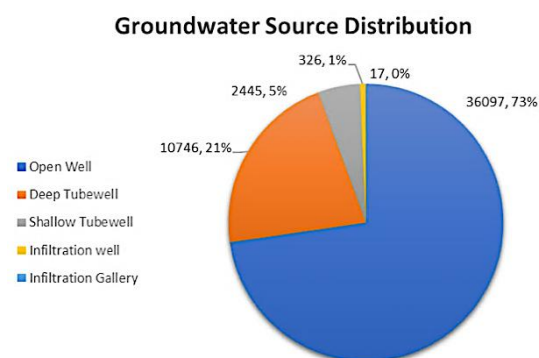


Figure 2 Distribution of groundwater sources for rural water supply (data: JJM portal 16/06/24)

The distribution of groundwater sources: 22% of groundwater sources are deep tube wells per the FUA5 report of the JJM; open wells, with 73%, are the leading source in 49,631 geotagged groundwater sources as per JJM data. On the other hand, the groundwater recharge structures constructed are less than 1% of all sources. It reflects a gap in the number of water sources and groundwater recharge structures. This is a concerning situation considering JJM operational guideline trusts the District Water and Sanitation Mission (DWSM) to give the required clearance to a project after ensuring sanitation and sustainability works are part of the DPR. Also,

DWSM is entrusted with ensuring the availability of funds through convergence for these activities. It can be inferred that the DWSM does not prioritise effective recharge structures while assessing project proposals. The Master Plan for Artificial Recharge to Groundwater in India (2020) CGWB (CGWB, 2020) lists four artificial recharge structures suitable for terrains in Maharashtra: Percolation tank, Recharge Shaft, Check Dam, and Roof-top rainwater harvesting. Moreover, the central government guidelines (CGWB, 2000) for groundwater recharge mention that a recharge shaft is one of the most efficient and cost-effective methods of GWR. However, the Atal Bhujal Yojana (ABY) data² showed that 37 groundwater recharge shafts were constructed in the project area of Maharashtra. This is in line with the observation that the rate of growth of GWRS is not at par with the increase in groundwater extraction despite the potential for several million GWRS (Dillon et al., 2019).

The above discussion indicates that the ABY and JJM programmes need course correction to ensure the better utilisation of recharge structures for groundwater management and governance efforts in the state. Such neglect might lead to failure of sources, especially in water-scarce areas. If sources fail, these high-cost investments will be unavailing, making efforts to ensure long-term sustainability more critical in JJM. The sources might function for the complete design period if the required attention is given towards groundwater recharge than the present data reflects. Despite the course correction, there is a barrier of poor or no maintenance and limited monitoring in sustaining the good results of these efforts.

Section 2: Maintenance of GWRS

The groundwater recharge structures (GWRSs) are constructed through various government programmes. They need regular maintenance as the unlined pits get filled in by silt and other unwanted debris, and the filter media of shafts get choked, among other maintenance requirements. The clogging of the recharge structure reduces its recharge capacity (Wintgens et al., 2016). GWRSs in India often lack regular maintenance (Wintgens et al., 2016). One of the most prominent programmes lacks a dedicated provision for the regular maintenance of such structures. The manual on artificial recharge of groundwater in 'chapter 10' briefly discusses the requirement for the maintenance of GWRS (CGWB, 2007; p172). Various government schemes/programme-related documents also mention that government agencies will work with the community to maintain GWRS, but no explicit mechanism³ is suggested. Also, available public domain data has no schedule for GWRS maintenance. Despite these provisions, there is a lack of maintenance of these structures on the ground. In prolonged neglect towards maintenance, a progressive reduction in the recharge capacity of these structures can be recorded, and even before the end of their structural life, they become defunct (CGWB, 2007). Nevertheless, the construction or maintenance of GWRS and capacity building related to the

² The ABY works in 1133 villages of 13 districts² of Maharashtra. Its data shows that there are 21,669 artificial groundwater recharge structures reported, out of which close to 11000, more than 50% of data, is in the 'others' category. Such data is of little help in understanding the reflection of efforts.

³<https://cdnbbsr.s3waas.gov.in/s3a70dc40477bc2adceef4d2c90f47eb82/uploads/2023/02/2023021742.pdf>

maintenance of GWRS is not part of JJM, as they are recommended to be done through convergence with other programmes.

The maintenance of the structure increases its efficiency and structural life. The draft groundwater bill of 2016 foresaw the gram panchayat (GP) level groundwater sub-committee to manage and protect groundwater resources. This committee is responsible for developing an integrated groundwater security plan. Also, it has to register groundwater sources in a village and keep a record of persons or agencies engaged in activities related to groundwater management. However, these bodies lack the technical expertise to devise a groundwater security plan. Moreover, there is no mention of funds and resources provided to GP or collected by GP to implement that plan through convergence or otherwise. Also, there is a need for capacity building of the community involved to ensure the decisions are well-informed and appropriate. Still, it is a step toward better groundwater management, which would contribute to the sustainability of water sources in a village.

Despite the fact that domestic water demand constitutes a small proportion of the total water demand in rural areas (the greater demand being for agriculture), many aspects of the programme fail to integrate provisions to control the over-extraction of groundwater as part of any water security plan. The groundwater governing bodies lack a well-structured regulatory mechanism to enforce provisions of various groundwater acts, rules, and guidelines. It is crucial to arrange required resources through various arrangements, viz., international funding, institutional convergence, and public-private partnership, to ascertain the implementation of all required activities. The programmes related to groundwater recharge do not have explicit provisions for the maintenance of GWRS. It highlights the need for well-structured provisions for the maintenance of GWRSs in government policies and tools to facilitate its enforcement, as there is a requirement for a mechanism to implement and regulate GWRSs' maintenance. These initiatives will also help to save government resources as GWRS maintenance activities are much cheaper than constructing new GWRSs. Some reasons for the neglect in the maintenance of GWRSs are (i) lesser attention to maintenance in regular monitoring (CAG, 2021), (ii) lack of local community capacity to maintain GWRSs (Shah, 2008), and (ii) explicit fund allocation for maintenance activities (Reddy et al., 2010). It hints that there is a construct-and-forget approach towards the GWRS, and it prevents effectively utilising these structures.

Section 3: Monitoring the Groundwater Recharge

Present groundwater monitoring data has limited use for decision-making as it is indicative, not representational, and lacks data availability at temporal and spatial scales (Kulkarni et al., 2015). Every rural drinking water project is either a single-village scheme or a cluster-based multi-village scheme. Either way, decision support, especially on recharge and changes therein, must not only be dynamic in nature but has to be based on granular, high-resolution information. There is limited data available for decision-making about every aquifer and indicators reflecting the performance of each structure. The present groundwater monitoring mechanism needs to be more comprehensive to support effective decision-making. For example, data about water inflow through the artificial GWRS and groundwater extraction from the same aquifer is unavailable, especially when drinking water sources may be tapping a single aquifer or multiple aquifers. Similarly, the data about the activity-wise breakdown of funds allocation for groundwater recharge at various spatial and temporal levels is outside the public domain, if available. Such unavailability of data creates a barrier to determining the financial, technical, and environmental viability of each GWRS. Such continuous assessments would have helped design targeted interventions for improving groundwater recharge. It is possible to bridge this gap in data with a comprehensive and integrated data management system.

Table 2 List of indicators which can be potentially used for groundwater recharge monitoring

Sr. No.	Indicators	Document referred
1	Flow rate, duration of source water	Manual on artificial recharge of groundwater CGWB
2	Quality of source water	Manual on artificial recharge of groundwater CGWB, Guide on Artificial Recharge to Groundwater CGWB, Master Plan for Artificial Recharge to Groundwater in India (2020) CGWB Saha et al., 2024 Dillon et al., 2019
3	Inflow and outflow rates, duration and quality of inflow and outflow into and out of each unit of the recharge system	Manual on artificial recharge of groundwater CGWB Saha et al., 2024
4	Recharge Efficiency	Saha et al., 2024
5	Recharge rates versus time for each unit and the whole system	Manual on artificial recharge of groundwater CGWB Saha et al., 2024
6	Depth to water and groundwater quality in the recharged area and adjacent areas	Manual on artificial recharge of groundwater CGWB, Guide on Artificial Recharge to Groundwater CGWB, Master Plan for Artificial Recharge to Groundwater in India (2020) CGWB
7	Power usage by individual units and for the system as a whole	Manual on artificial recharge of groundwater CGWB
8	Depth to water in the recharge structures versus time (in the case of surface structures)	Manual on artificial recharge of groundwater CGWB
9	Thickness and composition of surface clogging layer when the structure is dry (in the case of surface structures)	Manual on artificial recharge of groundwater CGWB
10	Pressure versus time (in case of pressure injection)	Manual on artificial recharge of groundwater CGWB
11	Depth to water in recharge well versus time in case of gravity head recharge wells	Manual on artificial recharge of groundwater CGWB
12	Precipitation and evaporation from surface ponds	Manual on artificial recharge of groundwater CGWB
13	Temperature of water at inflow and outflow locations	Manual on artificial recharge of groundwater CGWB
14	Time, rate and volume of pumping for each structure and the whole system	Manual on artificial recharge of groundwater CGWB
15	Period of water shortage	Guide on Artificial Recharge to Groundwater CGWB, Master Plan for Artificial Recharge to Groundwater in India (2020) CGWB
16	Compliance with regulations	Saha et al., 2024
17	Water Potential, Vapour pressure, Temperature	Fernandez et al., 2022

The present monitoring mechanism follows the recommendations of existing literature. It uses indicators like potentiometric head, zone of influence, volumetric change, and volume availability for future use in assessing groundwater recharge in the limited number of observation wells in the benefit zone. Therefore, other parameters like the quality of the water entering the aquifer do not receive sufficient attention (Dillon et al., 2019; Saha et al., 2022) even though the Manual on Artificial Recharge of Ground Water (2007) mentions water quality as an essential indicator in groundwater recharge monitoring. The manual also recommends using indicators, such as the water inflow, recharge duration, water quality, and pumped-out volume of water from nearby water sources related to each recharge shaft or well, for an integrated data management system. A detailed list of indicators which can be potentially used for groundwater recharge monitoring is shown in Table 2. The integrated data system will collect cross-sectional and temporal data generated by the monitoring mechanism.

This regularly collected data can support groundwater regulation and better understand the recharge facility. This understanding can help fine-tune GWRS, create accurate water budgets, and design future

activities for source sustainability. These activities require a well-devised decision support system for implementation.

Section 4: Recommendations

The JJM programme has taken strides in providing water to households compared to previous government programmes. However, there is scope to improve the programme outcomes with incremental changes in policies and governance mechanism. One major area that needs attention is the sustainability of groundwater-based sources. Making artificial groundwater recharge structures and their maintenance part of the scheme design would ensure better implementation of GWRS. The maintenance of GWRS can be institutionalised through community participation. With maintenance, the GWRS could yield fruitful results for groundwater sustainability. Additional efforts are required to establish a comprehensive monitoring system for better decision-making for groundwater governance. A more detailed study should be conducted to develop an optimised data management system for monitoring groundwater recharge activities. The framework given in Policy Brief 3 can be used to assess the needs of the decision support system. Some of the possible ideas to strengthen the groundwater source sustainability are:

- A private-public partnership model along with a special purpose vehicle (SPV) to oversee the groundwater management can be piloted. A private and public source should be registered, along with the installation of water extraction metering, to prevent the over-exploitation of groundwater resources. When the exploitation in the water scarce area passes the standard limit decided by the study, the extraction rules can be made more stringent as guided by the National Water Policy 2012. Also, a private well with a groundwater recharge facility can be registered and monitored. The private water supply personnel can be given this additional responsibility, and institutionalisation can be sustained from the tariff collection for groundwater use. Similar public-private partnerships for groundwater maintenance and monitoring can change the governance situation.
- CGWB or GSDA could use a crowdsourcing-based monitoring tool, which involves public participation for data collection at a large scale. The field-level and satellite data using a better groundwater assessment model supported by data assimilation techniques can provide a more accurate micro-level picture of groundwater extraction and recharge at various scales. Furthermore, it will create a well-informed citizenry through continuous active engagement. The application should ensure triangulation and adherence to procedures defined for data collection. One of the ways could be using school/college clubs, National Social Service wings, and other youth groups to build local technical and digital capacity by providing necessary support at the ground level in coordination with relevant government institutions.

The maintenance of the GWRSs can be included under the regular MGNREGA activities in villages where these structures are constructed, aligning it with JJM's recommendation of convergence. India's groundwater-related organisations can take cognisance of the situation and assess the need for GWRSs to ensure that the extraction remains below the recharged volume of water. A well-devised monitoring system and mechanism for regular maintenance are necessary elements for long-term source sustainability.

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