BEHAVIOURAL PERSPECTIVES ON WATER MANAGEMENT AND USE IN INDIA

An Evidence Review

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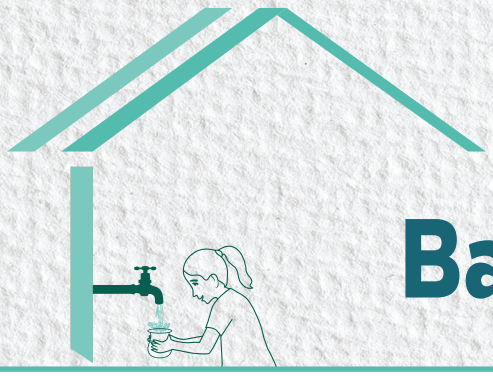
for every child

Contents



Background

Access to clean water, basic toiles and good hygiene practices are critical pre-requisites to individual and community health and well-being.

Consequences of unsafe water, sanitation, and hygiene (WASH) can be catastrophic leading to high mortality and morbidity outcomes especially for children. The COVID-19 pandemic has also once again highlighted the criticality of hygiene practices, especially handwashing with soap and water. When people do not have access to clean water it not only negatively impacts their health but also their nutrition, participation in school, income-generating activities and all other aspects of life. Girls, women, people with disabilities and marginalized populations are especially impacted.

Evidence suggests that strengthening management around drinking and domestic water supply, increasing service delivery and coverage, and ensuring access to water can have dramatic impacts across development outcomes among populations.

In August 2019, the Government of India launched the Jal Jeevan Mission (JJM) with the aim to provide functional household tap connections (FHTCs) to every rural Indian household by 2024. The focus of the programme is on service delivery at the household level, i.e., water supply on a regular basis in adequate quantity and of prescribed quality, to every rural household. The process of ensuring improved and equitable service delivery necessitates methodical planning and implementation of water supply, development of water sources, empowerment and capacity building of communities and administration, and recognition of behavioural factors that can impact the efficiency of all these processes.

The **JJM has six objectives** in total, regarding the nature of management that it envisions for the future of domestic and drinking water management in India. These are:[1]

- **Functional household tap connections (FHTC):** Provide FHTC to every rural household. Prioritize provision in quality-affected, drought-prone and Sansad Adarsh Gram Yojana (SAGY) villages.
- **Functional tap connections (FTC) in institutions:** Provide FTC to schools, anganwadi centres, gram panchayat buildings and other community facilities.
- **Voluntary ownership:** Ensure ownership and management of water resources by local community through labour, monetary or in-kind contribution.

[1] Jal Jeevan Mission: Operational Guidelines, 2019

- **Water supply infrastructure:** Contribute to sustainability of water supply system and infrastructure. Ensure all households (HH) and all public places practice effective liquid waste management (LWM) (e.g., greywater, storm water and faecal sludge management).
- **Strengthened human resources:** Empower and ensure human resources in water and adjacent sectors in the short and long term.
- **Awareness generation:** Improve stakeholders' understanding of the importance of safe drinking water and water supply.

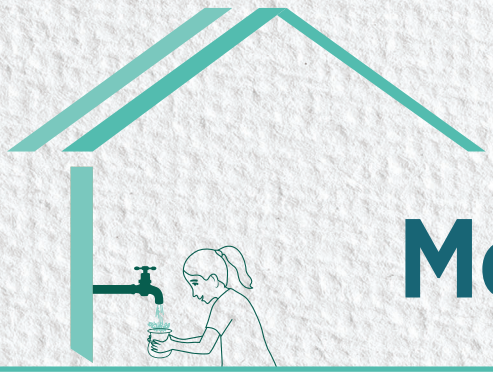
Key to achieving the Jal Jeevan Mission's objectives is bringing about effective behaviour change among communities and institutions, such that community priorities drive demand for improved domestic and drinking water management. The Jal Jeevan Mission highlights the following **objectives for the information, education and communication (IEC) activities** that come under the flagship programme:[2]

- **Drive positive behavioural changes** among stakeholders on judicious use of water, safe handling and storage, ownership of water supply system, etc.
- **Create awareness** around protection of drinking water sources, conserving water resources
- **Encourage community contribution** towards capital cost to instil a sense of ownership
- **Promote measurement** and data of water usage, and water tariffs and user charges
- **Recognize performance** of various stakeholders

The JJM Operational Guidelines indicates a range of social and behaviour change communication (SBCC) approaches that can be employed in the implementation of the Jal Jeevan Mission. These include, but are not limited to, interpersonal communications, social and community mobilization, capacity building, participatory rural appraisal, all with the objective of bringing about a Jan *Andolan* that drives demand for improved drinking and domestic water management. Social and behaviour change efforts are essential to driving community awareness and intention around optimal drinking and domestic water management. In conjunction with this, capacities of service delivery and governance personnel are to be enhanced on both hardware and software skills in order to create an enabling environment within which populations can be engaged and uptake positive behaviours with regard to drinking water and its management.

This literature review aims to draw out evidence around SBCC approaches and community engagement interventions that have taken place around drinking and domestic water management in India. The objective is to understand the role that behavioural factors can play in realizing the objectives of the JJM and in driving effective domestic and drinking water management practices. The review will support in developing the communication guidelines for JJM at national and state levels by providing insights on the approaches that have worked or not worked in the past across the country.

[1] Jal Jeevan Mission: Operational Guidelines, 2019



Methodology

Based on the programmatic and SBCC objectives of the Jal Jeevan Mission, the concept of domestic and drinking water management has been divided into five pathways for the purpose of this evidence review.

These are access to water; availability of safe water; demand generation for water; conservation and judicious use of fresh water; and citizen contribution and tariffs towards water as a resource. This review is conducted to better understand and prepare for India's comprehensive domestic and drinking water management efforts under the JJM and identify key behavioural insights and approaches that can be employed in the development of JJM's SBCC/BCC strategy. Each pathway of domestic and drinking water management identified in this evidence review, describes different approaches to ensuring the effective and efficient management of water as a critical resource. Though five exposure pathways are posited in this paper, the aim is to highlight the relevance of multiple pathways to the incidence of water insecurity and poverty, and potential approaches that can be undertaken to address these vulnerabilities. While these five pathways aim to address a majority of the efforts that fall under domestic and drinking water management, the authors of this review recognize that there may be other strategies for domestic and drinking water management that are not covered under this review.

Pathways of domestic and drinking water management

Pathways

Pathway I: Access to water is determined by a multitude of factors, including policy and institutional capacities for resource management and service delivery, physical availability of and proximity to natural resources, community awareness and demand generation for improved service delivery etc.

Pathway II: Safe water access is increasingly important, as widespread chemical and biological contamination of ground and surface water threatens availability of potable water to rural households, and impacts public health with frequent and long-term exposure. Access to safe water in particular is evidenced to reduce morbidity and mortality among children and adults alike, and also impact long-term poverty reduction and socioeconomic development.

Pathway III: Demand generation and management among communities is critical to ensuring that all populations have access to sufficient quantity and quality of water for consumption and use. In light of India's impending water crisis, demand for sustainable and optimized water use and domestic and drinking water management must also be established among all key stakeholders, to ensure water availability in the long term.

Pathway IV: Conservation and judicious use of water is essential as India's water consumption and demands often exceed its capacity to supply sufficient quantity and quality of water. Though demand generation among certain sections of India's society is essential to achieving equitable water access, understanding how to best promote judicious use and conservation of remaining freshwater sources is key to domestic and drinking water management and sustainable water use.

Pathway V: Citizen contribution and tariffs will play a significant role in enabling an equitable and sustainable domestic and drinking water management system. Currently, India is seen to lack a comprehensive pricing approach to water resources (groundwater, surface water etc.) and uses (domestic, irrigation, industry, environment etc.) As the importance of water pricing reforms becomes more apparent in the context of India, it is also essential to consider its social acceptability and impact on domestic and drinking water management behaviours.

The evidence presented in this document was put together through a desk review process, with literature on domestic and drinking water management gathered from a range of knowledge platforms. Key search terms and criteria for pertinent literature were determined, yielding 36 papers in total being considered for this evidence review.

Data sources

This evidence review sources its contents from a range of databases and knowledge platforms, including Google Scholar, PubMed and Science Direct. Peer reviewed journal articles and grey literature were utilized to serve as evidence in this review on domestic and drinking water management.

Methods

Databases were searched for a range of terms relating to domestic and drinking water management, including *'access to water', 'safe water', 'domestic and drinking water management', 'water conservation', 'demand generation for water' and 'citizen participation/contribution', 'Social and Behaviour Change Communication'*.

Documentation of domestic and drinking water management conducted in the Indian context have been primarily considered, with three papers relevant to the LMIC (Low- and Middle-Income Country) context also included. The search was restricted for the country of 'India' and for the years '2015 to 2021'. In order to set the context, some literature from before 2015 has been referenced and included in the introductory segments of each pathway review. The search terms were used for all fields (including title, abstract, keywords and full text). Following the databases search, additional focused searches were conducted using references of interest, and by screening relevant literature reviews. A pooled list of articles and reports from the search were created, and duplicates were removed. Titles, abstracts and full texts of the articles were screened for relevance. Data were extracted from the included articles for year, context, nature of problem and adaptations described, and the level at which the adaptation was designed or conducted. After this additional step, 36 papers were finalized for this review.

Thirty three of the 36 publications considered under this review are limited to the context of India; however, many are specific to local contexts and circumstances in particular regions and states of India. Recommendations from these bodies of evidence have been drawn out, with the intention that they will be of relevance when conducting context-specific research, and designing national SBCC efforts under the JJM.

The gathered articles were categorized into the five pathways described above. In cases where certain articles are relevant under multiple pathways, they have been categorized under the most pertinent pathway. Below is a table of the categorization of the final selected papers:

Authors	Year	Article Title	Geography
Pathway 1 : Access to water			
Sarkhel & Paul	2019	Does Social Connectivity Influence Tap Water Access? Evidence from India	India
Cronin et al	2016	Drinking water supply in India: Context and prospects	India
Bisung & Elliott	2016	Psychosocial impacts of the lack of access to water and sanitation in low- and middle-income countries: a scoping review	India
O'Leary	2016	Between Stagnancy and Affluence: Reinterpreting Water Poverty and Domestic Flows in Delhi, India	Delhi
Inukonda	2017	Deliberating Reforms: Public–Private Partnerships in Indian Water and Sewerage Sector	India
Hutchings et al	2016	Revisiting the history, concepts and typologies of community management for rural drinking water supply in India	India
Johnson et al	2020	Performance Behavior of Participatory Water Institutions in Eastern India: A Study through Structural Equation Modelling	Assam, Bihar
Pathway 2 : Safe water			
Sindhura et a	2018	An Assessment of Water, Sanitation and Hygiene Practices in an Urban Slum of Visakhapatnam, Andhra Pradesh	Andhra Pradesh
Del Bello	2020	High levels of fluoride from food and contaminated groundwater are putting many people in India at risk of fluorosis, an underappreciated and sometimes debilitating disease	India
Delaire	2016	Improving Access to Safe Water in West Bengal, India: From Arsenic and Bacteria Removal to Household Behavior Change	West Bengal
Sharma et al	2017	Water Quality and Sustainability in India: Challenges and Opportunities	India
Trent et al	2018	Access to household water quality information leads to safer water: a cluster randomized controlled trial in India	Uttar Pradesh
Falkenberg et al	2018	Impact of wastewater irrigation on in-household water contamination. A cohort study among urban farmers in Ahmedabad	Gujarat
Francis et al	2015	Perception of drinking water safety and factors influencing acceptance and sustainability of a water quality intervention in rural southern India	Tamil Nadu
Panda et al	2019	Improving access to safe drinking water requires leadership at different levels	Odisha

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Authors	Year	Article Title	Geography
Pathway 3: Demand generation and management			
Ramsey	2017	The Impact of Demographic Factors, Beliefs, and Social Influences on Residential Water Consumption and Implications for Non-Price Policies in Urban India	
Singh et al	2017	Analysis of domestic water demand variables of a residential colony in Ajmer; Rajasthan	
Shannon	2019	The price of purity: Willingness to pay for air and water purification technologies in Rajasthan, India	
Reynaud & Romano	2018	Advances in the economic analysis of residential water use: An introduction	
Ghosh et al	2016	Implications of end-user behaviour in response to deficiencies in water supply for electricity consumption – a case study of Delhi	
Pathway 4: Conservation and judicious use of water			
Reddy et al	2020	Scale for Attitude towards Water Conservation	India
Singh et al	2018	The implications of rural perceptions of water scarcity on differential adaptation behaviours in Rajasthan, India	Rajasthan
Meinzen-Dick et al	2018	Playing games to save water: Collective action games for groundwater management in Andhra Pradesh	Andhra Pradesh
Nayar & Kanaka	2017	A Comparative Study on Water Conservation through Behavioral Economics based Nudging: Evidence from Indian City	Tamil Nadu
O'Keeffe et al	2018	Including farmer irrigation behaviour in a Sociohydrological Modelling Framework with application in North India	Uttar Pradesh
Kakwani & Kalbar	2020	Review of Circular Economy in urban water sector: Challenges and opportunities in India	India
Holland et al	2019	Experience is Key: Examining the relative importance of factors influencing individuals' water conservation	LMICs including India
Koop et al	2019	Enhancing domestic water conservation behaviour: A review of empirical studies on influencing tactics	LMICs including India
Pathway 5 : Citizen contribution and tariff			
Mastaller & Klingel	2017	Adapting the IWA water balance to intermittent water supply and flat-rate tariffs without customer metering	Tamil Nadu
Shen & Reddy	2016	Water pricing in China and India: a comparative analysis	India
Sidhu et al	2020	Power tariffs for groundwater irrigation in India: A comparative analysis of the environmental, equity, economic tradeoffs	India
Sakthi & Chandran	2020	Assessment of Non-Revenue water in water distribution system and strategies to manage water supply	Tamil Nadu
Fuente	2019	The design and evaluation of water tariffs: A systematic review	LMICs including India
Araral & Wu	2016	Comparing water resources management in China and India: policy design; institutional structure and governances	India
Raj	2015	Urbanization and water supply: An analysis of unreliable water supply in Bangalore City, India	Karnataka
Sarkar	2019	The role of new 'smart technology' to provide water to the urban poor: a case study of water ATMs in Delhi, India	Delhi

Findings

Literature categorized under each pathway of drinking and domestic water management has been elaborated upon below.

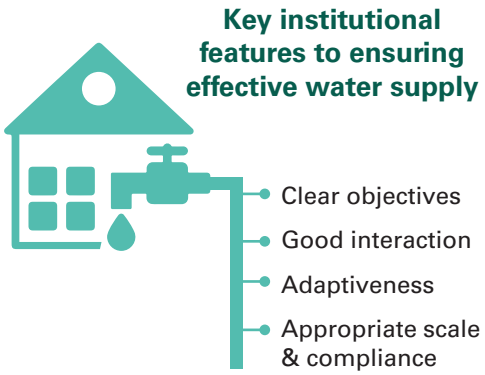
Pathway I: Access to water

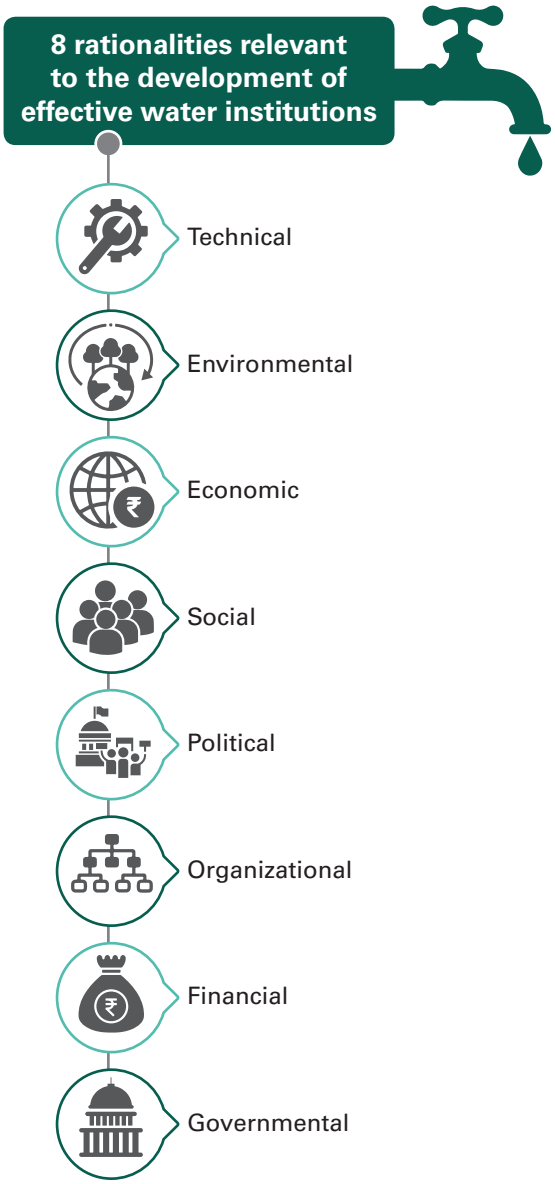
A comprehensive review of the water sector in India was undertaken by Cronin and colleagues in 2014, to provide perspectives on the way forward from the existing water management systems that are in place. The authors conclude that India's water future is in peril if current management practices and trends persist. They recommend that governments should harness community participation, particularly in the contexts of sustainable and safe water supply. They claim that a radical shift is needed among decision makers to recognize the right to equitable service delivery, and that institutional reshaping and strengthening is essential to facing the new challenges that will emerge in India's water sector. (Cronin et al, 2014)

Participative approaches and institutional restructuring in water management and delivery are critical to ensuring equitable water access among populations of India: According to Cronin et al's 2016 paper, India made significant progress in developing its water resources and supporting drinking water infrastructure, in the process successfully meeting its Millennium Development Goal (MDG) target for provision of drinking water. However, rapid development, increasing population and variable resource distribution has led to the current demand for water outweighing supply. The authors call for improved and integrated institutional management of drinking water – with a focus on clear delegation of responsibilities between the numerous institutions that are responsible for the provision of potable water. It states that the prime role of the water governance structure is to formulate people-centric policies and ensure equitable access. The paper also highlights the social, cultural and political challenges of ensuring access to water, and remarks that access is usually inequitably determined by class, caste and gender differentiations. India's adoption of a rights-based approach around water means that communities now have the opportunity to participate in decision-making on water-related projects and plans, and have access to information concerning water quantity and quality. In the face of growing challenges such as climate change, water

scarcity, water pollution and management of wastewater, the authors call for a more participative, rather than techno-centric approach, in order to bring about sustainable and equitable water service delivery. (Cronin et al, 2016)

Addressing inefficiencies in water institutions just as crucial to equitable water access, as infrastructure and sufficient water supply: According to Johnson, 2020, the current crisis in management of water in India is often not about having too little water but about managing it poorly. This paper examines the nature and behaviour of participatory water institutions in Eastern India. It is now being widely recognized that engineering structures and solutions are not enough to ensure equitable access to water, as substantial inefficiencies remain in the management and distribution of water due, due to institutional weaknesses. These result in poor water use efficiency, inequity, conflicts, reduced crop productivity, environmental cost and substantial underutilization of the potential created. Adapting the fundamentals of new institutional economics and management governance theory, the authors present five institutional features and eight rationalities that are relevant to the development of effective water institutions. Based on these features and rationalities, a study was conducted in eastern India, sampling from the states of Assam and Bihar, covering 510 farm households across 51 water institutions. Findings of this study show that overall success of water institutions (as perceived by users and members) is closely related to the goals of production and incomes, equity, environmental sustainability, technical rationality, adaptiveness, and functioning at the appropriate scale. (Johnson et al, 2020)





Rural households' social connectivity and engagement in collective action influence access to piped water connections: Analysis of a panel of rural household water use data from the India Human Development Survey (2005 and 2012 rounds) attempts to empirically investigate whether the extent of social network of a household influences its access to public water supply via tap water connection. Analyses show that the ability to obtain a water connection are influenced by rural households' connection with government officials, level of media exposure, and the availability of groundwater in the vicinity. It was also seen that the households from communities that engage in collective action are more likely to establish connections with the government network, reflecting that the process of decentralization of the water supply network is gaining strength. However, some studies argue that VWSC and other community institutions need further strengthening for successful decentralization of rural water supply in India (Hutchings, 2017). Findings of this study show that households with government network connection have positive significant effects on access to pipe connection, suggesting that obtaining a private connection is indeed linked with social connectivity of households. It finds that if access to public water schemes is contingent on the intensity of social ties, it might exclude asset poor and socially disadvantaged groups from its ambit. The paper thus suggests that strengthening networks including poor households and scaling up of information and communication activities might be effective strategies to ensure increased access to piped water. (Sarkhel and Paul, 2019)

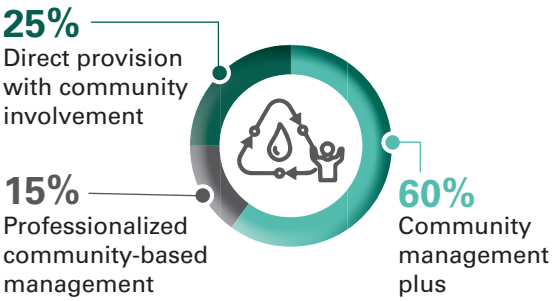
Participatory communication and due deliberation among stakeholders, as well as private contribution to the sector essential to water management: Inukonda, in 2017 analysed how globalization and urbanization pose a variety of challenges for developing countries, including the rapidly accelerating water scarcity crisis. The author analyses the role that Public–Private Partnerships (PPPs) and strategic communications play in pushing forward reforms in water management mechanisms, as well as the approach that PPPs have taken towards improving service delivery across sectors. Though PPPs have demonstrated that there is a strong public demand for better services, this model has been met with some resistance. Concerns exist as to if private participation in infrastructure would reduce government accountability and public interest in water/resource management. This paper argues for a balance to achieve better service delivery for all, while creating opportunities to expand public interest and dialogic space around water management. It calls for the government to create well defined opportunities for the private sector to contribute to the efficiency of the underperforming water management sector, through deliberative and publicly agreed upon PPP models. It argues for the importance of participatory communication, not just in disseminating information among stakeholders, but also in deliberating the making of reforms with the wider public. It states that unless internal and external stakeholders find the model acceptable, the success of the intervention may be compromised. It also calls for governments to be more transparent about the need for such models, the need to address water scarcity and conservation, and municipal revenues around water, and adds that sustainable models and projects can only be created with due deliberation and communication among stakeholders. Also

essential to the success, states the author, is the need for citizens, civil society and media to stay aware and educated around water conservation and management projects, and serve as a monitoring mechanisms to such interventions. (Inukonda, 2017)

Public and private sector to invest in ensuring equitable water access, and addressing water access challenges among urban poor: O'Leary's 2016 paper presents the results of a qualitative analysis of the ties between water availability and poverty, and the linked social systems and developmental struggles that households in Delhi slums are subject to. According to the Centre for Science and Environment, in Delhi, 30% of the city's population that live in slums, have onerous waiting times to access 3% of the city's water allocation. Results of the analysis show that in slums, residents mark the success of their live and the measure of the future by the passing of time in waiting for water. The author calls for the government to acknowledge the legitimacy of the urban poor as productive citizens, and the private sector to value the time of the urban poor by reconfiguring water supply technology to enhance democratic participation and equitable access. The understand of how rapidly urbanizing populations are coping with natural resource scarcity is not only of value to the developing world, rather, the author believes, insights from cities such as Delhi can serve at the forefront of natural resource management solutions which can be applied to cities globally. (O' Leary, 2016).

Three common typologies of community management for water in India that can be applied in different contexts, based on community needs and capacities: In their 2016 paper, Hutchings and colleagues review the history and typologies of community water management for rural drinking water supply in India. Following their analysis, they propose three typologies that might best account for the changing role of the community and external support entities found in successful cases of community management around drinking and domestic water. Each of these typologies are chosen for their scalability, and feature different levels of balance between community led processes and support provided by external agencies. The first, Direct Provision with Community Involvement, entails a model of service delivery whereby an external provider manages the water system and retains ownership of the infrastructure assets, while community representatives (water committees) play a consultative role rather than taking on hands-on management. The second, Community Management Plus, features high levels of voluntary participation from the community and some degree of direct support, with elected community water institutions receiving capacity building and being involved in day-to-day management activities. The third typology, Professionalized Community-Based Management is characterized by a move away from an approach based purely on volunteerism, towards a more professional, effective and transparent model of community management of water service delivery. Common to all three typologies is greater investment in building enabling support environment. This primarily requires external support entities and water institutions to take greater responsibility for providing ongoing support to communities in management, while ensuring continuous and quality service delivery. A review of 92 successful community management programmes

Characterization of 92 successful community management programmes in India into three typologies



in India led authors to characterize 25% as belonging to the first typology (Direct Provision with Community Involvement), 60% to the second typology (Community Management Plus, referred to as the 'classic' form of community management), and 15% to the third (Professionalized Community-Based Management). They predict that as Indian communities experience increased income and wealth, more community management models will move towards following the professional model, and urge governments to prepare themselves to help with this transition as it takes place. (Hutchings et al, 2016)

Significant psychosocial stressors linked with water scarcity, need to better study social and cultural aspects of water insecurity: Bisung's 2016 paper analyses the psychosocial impacts of low access to water by reviewing studies across seven countries, with six studies having been conducted on the topic in India. Authors classified water-related stressors and their psychosocial outcomes into four interrelated categories: financial stressors, stressors related to physical lack of access, social stressors and stressors related to perceived inequities.

Among financial stressors, it was found that in the absence of reliable sources of water, many households tend to buy water from private vendors who usually charge higher amounts, leading to reduced household budgets for other necessities. In addition to this, opportunity costs related to water fetching and the concurrent inability to engage in income-generation activities resulted in distress among households, particularly female members. Stressors related to physical lack of access include unsafe water sources, long distance to water sources, inadequate supplies for daily needs, queuing for water, and insufficient water supply for hygiene. Social stressors include estranged family and neighbourhood relationships, accusations of water theft, fighting in queues, domestic abuse over water, being unable to perform normative standards of propriety and hospitality (providing water to guests, appearing clean), all resulting in frustration and helplessness, particularly negatively impacting female members of households. Among women, several instances of sexual assault were reported in association with water collection. Finally, among stressors of perceived inequities, households' access and price of accessing water were linked with feelings of marginalization, neglect, frustration and resentment against water officials and governance structures. In response to these findings, authors recommend studying psychosocial outcomes as part of water access intervention studies, in order to highlight the sociocultural dimensions of water insecurity and poverty. Neglecting to incorporate these outcomes, and ensure that policy makers address these, may mask a potentially important driver of health and well-being for households, and particularly women in LMICs. (Bisung & Elliott, 2016)

Pathway II: Safe water

Widespread chemical and biological contamination of ground and surface water threatens availability of safe water to households, and impacts public health with frequent and long-term exposure. According to the World Bank, 21% of communicable diseases in India can be attributed to unsafe water, and according to WHO, 97 million Indians lacked access to safe water in 2009 (Sharma, 2017). The World Health Organization estimates that globally 1.5 million children die from diarrhoeal diseases each year, of which 88% are due to inadequate sanitation, hygiene and insufficient quality of drinking water. Access to safe water in particular is evidenced to reduce morbidity and mortality among children and adults alike, and also impact long-term poverty reduction and socioeconomic development. Improving safe drinking water access is a rapidly increasing concern in the country of India. (Sindhura et al, 2018).

Need to address fluoride contamination and fluorosis epidemic through community awareness and demand generation activities: Fluoride pollution is prevalent across the country as the contaminant easily dissolves in waters in aquifers. In rural areas where communities are unable to treat drinking water, prolonged intake of fluoride is seen to impact teeth and bone health, reduce mobility, and potentially leading to permanent disability. As climate change and exploitation of water resources make surface and groundwater more become difficult to access, the authors report that communities dig deeper to find water, resulting in water resources with higher concentrations of fluoride contamination. Skeletal fluorosis, which results from long-term exposure and consumption, has been widely studied for decades, but according to the Fluoride Knowledge and Action Network, "for a problem of this scale, the response has still been inconsistent at the national level". The population at risk due to fluoride prevalence due to fluoride prevalence is officially estimated to be approximately 12 million, although civil society bodies warn that the number may be much larger with approximately 60 million people affected nationwide. India's national programme to address this issue was initiated in 2009, over the years has targeted nearly 200 districts in 17 states with increased diagnostic activities, treatment, and rehabilitation at a village and district level. Data from the implementation of this programme has found that skeletal fluorosis can be reversed among children under the age of 12, when they are provided with safe water, nutritional supplements and health services. Community-level demand generation for improved water quality, as well as awareness around safe water sources must be invested in, in order to curb the growth of the fluoride epidemic. (Del Bello, 2020)

As of 2014, the Government of India has reported fluoride prevalence in:

230 districts

19 states

Decentralized water treatment and management to serve as a partial solution to water contamination, while communities await provision of universalized piped water: Regional variations across the country, expose different communities to a combination of chemical and biological contaminants. According to Delaire, 2016, millions of individuals in rural West Bengal, India, are exposed to groundwater containing toxic concentrations of arsenic, unhealthy levels of iron and non-negligible faecal contamination. The author suggests that prior to publicly provided piped water becoming widely available, contaminated groundwater must be treated in small decentralized plants that sustain themselves by selling water to households at affordable prices. This approach hinges on two hypotheses: first, that groundwater can be treated for all contaminants (arsenic, iron, and microorganisms) at very low-costs and with locally available materials and labour; and second, that a large fraction of households will be willing to purchase treated water in the interest of long-term health and well-being.

Findings of the study show that households react to noticeable water problems more than invisible contaminants that may pose long-term health impacts. In addition, in the current context, water that can be purchased does not eliminate, but rather only reduces ingestion of contaminants such as arsenic and microorganisms. The study concludes that provision of treated water through small independent entrepreneurs can serve as a partial solution to the contamination crisis prior to realization of universalization of piped, however, this approach must be supplemented with awareness generation and decontamination efforts at a larger scale. (Delaire, 2016)

Improved water administration and management key to addressing water pollution and ensuring sufficient access to water safe for consumption: In their 2017 paper, Sharma and colleagues posit that rapid industrialization, urbanization, and population expansion in India are responsible for a number of concurrent environmental crises, with water pollution being a major one. Water pollution has led to deterioration in both the quality and quantity of surface groundwater, thereby affecting the net availability of water for consumptive use. Despite numerous steps taken by government and local communities, and continued investments in the infrastructure of water sanitation, many low-income countries like India, and its rural communities continue to be deprived of safe drinking water. Safe water provision and environmental sanitation are critical for protecting the environment, improving health, and alleviating poverty, and bringing about safe hygiene practices in India. The author states that there is no single cause for the country's water crisis, and rather, a combination of factors including population growth, unaccounted use, and disposal of water, dwindling groundwater supplies, inadequate pricing, insufficient treatment facilities, among other factors, have contributed to the degradation of water quality. This paper highlights the need to fill gaps in the existing management mechanisms and infrastructure, and discusses various opportunities related to water quality and sustainability in India. The author calls for a new approach to water administration, which must be clearly communicated to and understood by all levels of administration and all community groups. The paper also calls for the implementation of low-cost sanitation systems with adaptive pricing mechanisms, greater community

involvement, improved data collection, improved planning and monitoring, and increased engagement of civil society and communities. (Sharma et al, 2017)

Improved two-way communication on water quality and contamination, to have positive impacts on access to safe water: A randomized, controlled trial was conducted in India to determine if information on household drinking water quality could change behaviour and improve microbiological quality as indicated by Escherichia coli counts. It was hypothesized that increased knowledge of the safety of drinking water would result in changes in household water management practices, and lead to reduced exposure risks. The study was conducted in three arms (messaging-only; messaging plus laboratory E. coli testing; messaging plus low-cost E. coli tests that could be used at the household's discretion). Self-reported water treatment increased significantly in both the standard testing arm and the test kit arm between baseline and follow-up one month later. The findings of the study thus indicate that lack of knowledge about water quality and disease risk can be a barrier to the adoption of improved household water management behaviours, and that household-specific water quality information can improve both behaviours and drinking water quality. Providing water quality information directly to communities can help households overcome a key knowledge barrier and facilitate households' decision-making with respect to improving water quality. (Trent et al, 2018)

Success of interventions to improve water quality and safety can be increased through greater community involvement and research around factors influencing uptake: This paper by Francis and colleagues, explores the factors that influence compliance to and adoption of water quality interventions, in order to better understand how to promote acceptance and long-term sustainability of such interventions among communities. Qualitative research conducted among parents of young children and key informants in the state of Tamil Nadu finds that several knowledge gaps exist around drinking water safety – on water treatment, health impacts of consuming unsafe water, quality of locally available water, as well as next steps when experiencing odour, colour and taste differences in water. These factors, in addition to low cooperation and support from male members of households was seen to influence acceptance and sustainability of water quality interventions among communities and mitigate perceived need for such interventions.

The study highlights the need to effectively involve communities at important states of implementation for long-term success

Improved local measures suggested under the new approach

Watershed management programmes

Rainwater harvesting systems

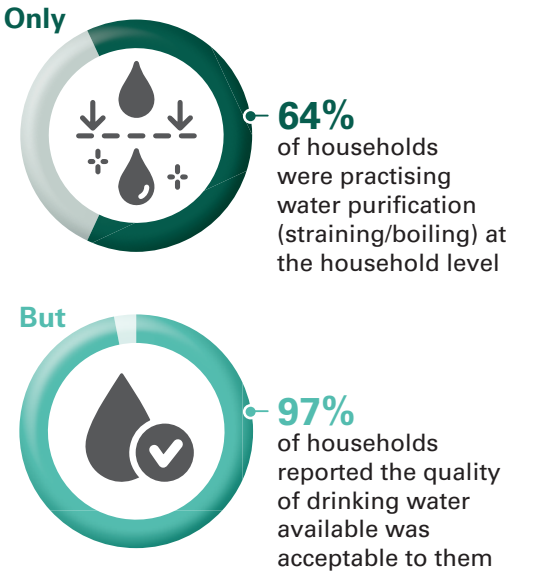
Greywater recycling

Inter-agency coordination among central and state governments to empower local groups with necessary and actionable information around preserving water as a resource

of water quality interventions. Authors recommend similar operations research prior to and during implementation of water quality interventions, to ensure uptake and sustainability of the intervention within the given community. (Francis et al, 2015)

Insufficient knowledge of wastewater treatment prior to reuse, poses biological contamination risks: Falkenberg et al, conducted a cohort study in Ahmedabad, Gujarat, to explore the contribution of wastewater irrigation on household water contamination among urban farming households. Wastewater irrigation is known to increase the risk of reintroducing faecal pathogens as well as harmful chemicals into the environmental and community groundwater sources. Drinking water samples of 204 households in four peri-urban farming communities were collected from the point-of-source (PoS) and point-of-use (PoU) of each household four times over the 12-month follow-up period. Significant positive differences in water quality between PoS and PoU samples were identified in 78% of households. During the monsoon, the peak of contamination, only 6% of households had access to safe drinking water at PoU. The Average Treatment Effect (ATE) of wastewater irrigation indicates an adverse effect on in-household water contamination, larger in effect size than the mitigation effect of access to sanitation or personal hygiene. Water contamination occurring within households is widespread among the sampled population, indicating the continual occurrence of household water contamination. The risks of utilizing wastewater for irrigation are not only limited to households involved in farming activities, but also extend to the entire community. Authors conclude that in order to mitigate transmission of faecal pathogens, significant efforts need to be made to raise awareness and change behaviours around wastewater irrigation, through health education campaigns on household treatment of drinking water, safe storage and treatment of wastewater prior to use for irrigation. In the long term, the paper says, it is essential to ensure continual supply of water through the distribution network, as the intermittent supply of water necessitates storage and drinking water, thus increasing risk of household water contamination. (Falkenberg et al, 2018)

Need for promotion of safe water practices (treatment, handling and storage) of drinking water among households with access to municipal water supply: Sindhura et al's 2018 paper aims to assess the water, sanitation and hygiene practices among households of urban Visakhapatnam. A cross sectional study was conducted among 150 households who have water supply within their household premises, and rely primarily on municipal water supply for drinking water.



The study finds that there is a need to improve drinking water practices among the study community. The author calls for health education on safe handling and storage of drinking water and stresses the need for this to be imparted through SBCC. The paper goes on to explore the interlinkages between water, sanitation and hygiene (WASH) practices, the prevalence of waterborne- and hygiene-related morbidity and mortality. The author stresses the need for promotion for safe water practices among households that gain access to municipal water supply, and the promotion of overall positive health seeking behaviours among these communities. (Sindhura et al, 2018)

High demand for health promotion and awareness around safe water handling, storage and treatment practices: Panda and colleagues conducted a study among urban slums of Visakhapatnam, to understand prioritization of ODF plus behaviours, and found water safety and access to potable water to be primary priorities among the study population. The study emphasized the urgent need to focus on health promotion and education on hygiene, particularly in the handling and storing of potable water. The authors highlight the need to employ systematic SBCC strategies to disseminate actionable information on domestic and drinking water management among communities and administrative personnel alike, in order to ensure sustained access to safe drinking water. This study, considered how household level behaviour change can be achieved with respect to household water treatment and safe storage practices, providing valuable insights into scaling up processes for uptake of safe water practices in future. (Panda et al, 2019)

Pathway III: Demand generation and management

India represents 17% of the total world population, however, it only has access to 4% of the world's freshwater resources. These too, are unevenly distributed among India's vast population. Though demand among more affluent sections of society continues to accelerate rapidly, marginalized sections' reach to these resources, and ability to demand these resources remains low. Community-level demand is critical to ensuring that populations have access to sufficient quantity and quality of water for consumption and use. According to the United Nations World Urbanization Prospects (2014), much of the world's urban population growth in the next century will occur in India, whose urban growth rate is expected to be the fastest in the world, adding a projected 404 million urban residents by 2050. 54% of this population is currently water stressed, and that number will increase as the urban population swells (Shiao T et al, 2015). Therefore, demand for sustainable and optimized water use and domestic and drinking water management must also be established among all key stakeholders, to ensure water availability in the long term. In recent times, with India facing an impending water crisis, water demand modelling has taken on new importance with the need to better understand the role that economic instruments (i.e., water pricing) may play in inducing change in water user behaviours (i.e., reduction of water consumption or improper disposal of greywater). (Reynaud & Romano, 2018)

Household attempts to cope with unmet demand for water results in greater electricity consumption and hidden costs: Ghosh and colleagues' 2016 paper explores how water supply and demand norms have changed in response to evolutions in urban lifestyle and behaviours, and studies the impact that water demand can have on consumption of other resources – namely electricity consumption. In India, as in many countries, water and electricity are resources available in limited supply, and due to India's low per capita income, the state supplies these resources at subsidized prices, relying on consumers to use the resources judiciously. People's behaviour related to resource use was seen to be influenced by their level of awareness, income, price of the resource and perceived risk of resource scarcity and its impact on quality of life. The paper aims to understand how per capita consumption of water at home varies with socioeconomic and demographic status of households, and how erratic supply of water of questionable quality influences the total household consumption of water and electricity. A household survey was conducted among 496 households in Delhi, spanning across high-, middle- and low-income groups and organized and unorganized housing. Among households residing in organized housing, household incomes were seen to have little influence on water consumption. On the other hand, residents of unorganized housing (slums), were seen curtail their use of water even at the cost of their health and hygiene. Water consumption of unorganized housing dwellers was seen to be only 60% of that of organized housing residents, despite the fact that on average, the family size of the latter group was larger. Among households living in organized housing,

unmet water demand was seen to result in 50% greater electricity consumption. A variety of electricity-intensive appliances were seen to be commonly in use among these households, in order to cope with deficiencies in water supply (booster pumps, bore wells) and quality (Reverse Osmosis and other water purification appliances). Thus, water-saving measures are negatively correlated to electricity consumptions at the level of end users. The paper posits that domestic water consumption in Delhi is likely to stabilize at approximately 71 lpcd as the use of appliances such as dishwashers and washing machines (which are more water-efficient) increases and the quality of water supply by the Delhi Jal Board improves; however, these improvements also mean greater electricity consumption. This is thus a hidden cost of coping with deficiencies in water supply. This analysis therefore, strengthens the case for implementing water tariffs with commensurate improvements in service by urban water utilities, and for making a realistic assessment of the current water supply norms. (Ghosh et al, 2016)

Households demonstrate a higher demand for safe water and reductions in water-related health risks, over reductions in any other domain-specific health risk: Shannon's 2019 paper explores the link between the prevalence of diarrheal illnesses and acute respiratory infections, and the willingness to adopt and pay for air and water purification technologies to address these issues. This paper finds that uptake of such technologies remains quite low despite the high incidence of diseases linked with poor water and air quality. This could be explained by the tendency for households in low-income settings that face a multitude of risks across different health domains, having low demand for technologies that only reduce health risks in a single disease domain (as compared to addressing overall mortality/morbidity).

A study among rural households in Rajasthan, assesses how willing households are to make investments in "domain-specific" environmental health technologies when faced with health risks in multiple domains. Results indicate that demand for water-related risk reductions is higher on average than demand for air-related risk reduction. In addition, households' private health benefits from mitigating diarrheal disease risks are higher when community-level air pollution risks, rather than community-level water pollution risks, have previously been mitigated. This suggests that that the broader health environment and the salience of particular risks may be important in households' decision to adopt environmental health technologies. The paper concludes that interventions that aim to promote technological solutions to reduce domain-specific health risks may fail to achieve widespread success in settings characterized by health risks in multiple domains. (Shannon, 2019)

Inefficient application of Non-Pricing Policies can have detrimental effects on populations' demand for water and likelihood of engaging in water conservation efforts: According to Ramsey et al, the water infrastructure systems of most major Indian cities are already unable to provide adequate water supply to meet populations' water demands. This scenario is only expected to worsen as urban populations and demand for water continue to increase. The Indian government has historically responded to growing water demands by either investing

in large scale infrastructure projects to improve supply, or by implementing NPP to influence demand. The authors conclude that supply-side management alone is costly and ultimately unsustainable, and that relatively little attention has been paid to developing effective demand generation and management strategies in government responses to growing demand. This paper aims to explore the potential for developing a comprehensive urban demographic water resources management plan that explores demand management and conservation, as this will be critical to reducing the strain on India's water resources as urban centres continue to grow. The authors describe a well-designed demand management programme as being based on accurate information about end uses, consumer behaviours and beliefs. They conducted a household survey in Jaipur, Rajasthan, and the findings of this study reveal several implications for residential water demand policies in India and the developing world. One such finding from this paper is the demonstration of the disadvantages of providing intermittent supply and reducing water supply duration in times of water scarcity. Reducing supply is the primary demand management NPP followed by governments in the developing world. However, this paper demonstrates that reducing water supply can create a scarcity mindset among populations, making people perversely less likely to engage in water conservation behaviours. This is because consumers believe they are already consuming the minimum amount of water possible and are therefore not willing to further reduce their water consumption.

The paper also proposes the usage of additional NPPs such as public messaging campaigns, education campaigns, efforts to set social norms around conservation, building up community-level concern around water resources etc. Although financial and enforcement capacities limit the government's ability to implement many demand management strategies that are popular among developed nations, authors believe that NPPs such as messaging and educational campaigns may help reduce overall domestic water demands, if targeted effectively. (Ramsey, 2017)

Mix of Pricing and Non-Pricing Policies required to effectively drive water demand, management and conservation: Reynaud et al conducted a review of literature to understand the difference in impact of price policies (PP) and non-price policies (NPP) in shaping residential water use in the context of increased water scarcity. Evidence currently exists on residential water demand and measuring the impact that price policies such as water price increases, use of block rate pricing, peak pricing, etc have on shaping water demand and consumption. This paper concludes that residential water demand is inelastic with respect to water price, but not perfectly. This indicates that pricing schemes may not always be effective tools for modifying household water behaviours. However, such mechanisms continue to be viewed by public authorities as the most direct economic tool for inducing water conservation behaviours. It has recently been argued that domestic water consumption and conservation behaviours can be influenced by non-price polices, such as water conservation programmes, education campaigns, or smart metering. NPPs are designed based on the idea that administrators can implement strategies that will result in water savings via changing

household behaviours. The authors find that attitudinal characteristics and environmental concerns increase the likelihood for households to undertake certain specific and self-reported water saving behaviours.

This study reveals that it is possible to classify households into relatively homogeneous groups based on their water consumption behaviour (environmental preferences, intrinsic motivations, social norms), and concludes that these differences should be taken into account when developing NPPs. All papers included in this review contribute to a better understanding of residential water use and provide relevant insights for policymakers in charge of water management (Reynaud & Romano, 2018)

Water demand forecasting poses various variables and factors that determine domestic water demand, and explores how these can be addressed to drive equitable water supply: Singh's 2017 paper on water demand forecasting speaks to several elements of domestic and drinking water management. Water demand forecasting is quite useful for the assessment and adjustments of water supply, pricing, financial planning, capacity planning, maintenance, and optimal operations. Therefore, effective domestic water demand management offers a promising solution for sustainable urban water supply. In order to execute an effective demand management plan, it is necessary to identify a list of parameters required to estimate the domestic water supply demand accurately. The authors conducted a study to identify significant variables of urban domestic water demand in Ajmer, Rajasthan.

The study is constructed by testing 16 variables, and aims to identify and extract the most pertinent factors (combinations of variables) that can predict and estimate water demand in the study site. (Singh et al, 2017)

6 most influential factors positively correlated with domestic water demand

- Family size
- Monthly mean temperature
- Income per year
- Non-occurence of rainfall
- Number of bathrooms in household
- Age of housing

Pathway IV: Conservation and judicious use

With its rapidly growing populations, India's water demands often exceed its capacity to supply sufficient quantity and quality of water. While local governments may implement management programmes to reduce demand for freshwater, water savings are dependent on the local conservation efforts of communities and administrative personnel. This section of the review on domestic and drinking water management explores publications that discuss how conservation behaviours and judicious use of water are studied and promoted. Until recently, there has been limited empirical knowledge about how communities' behaviour can be changed in relation to their daily domestic water consumption (Katz et al, 2016; Otaki et al, 2017).

Household income, access to water, and knowledge around water scarcity and drought prevention determine willingness to adopt water conservation behaviours: Ramsey and colleagues conducted a household survey to examine residential water end uses and conservation behaviours in Jaipur, India. The survey explored end uses for water, engagement in conservation behaviours, and how these behaviours were influenced by demographic factors, water sources, beliefs about water, and social pressures. Households report engaging most frequently in water conservation behaviours that required little effort or financial investment. The study also found that while the majority of participants recognize the importance of water conservation, they do not necessarily conserve water themselves. Analyses indicate that having higher income, longer water supply durations, and the belief that droughts are preventable are positively correlated with overall amenability to adopt water conservation behaviours. The authors conclude that educational campaigns that teach easy ways to conserve water may increase feelings of self-efficacy, and that this may correlate with willingness to reduce water consumption during drought. An approach that teaches residents about the current strains on water supplies, how much water the average Indian consumes daily, the potential water savings a household could generate by adopting various conservation measures, could increase household adoption of water conservation behaviours. (Ramsey, 2017)

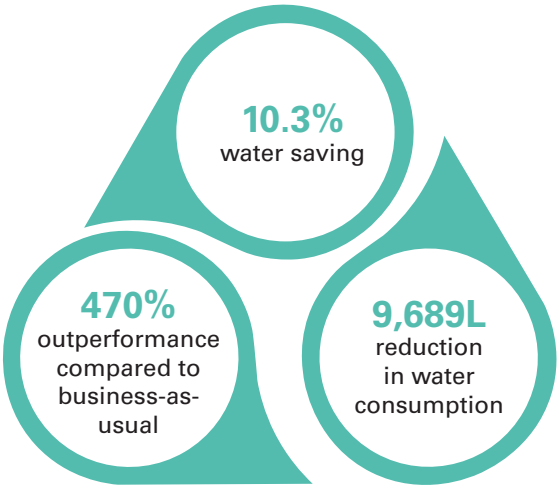
Games to promote social learning and collective action around water, seen to increase community understanding of need for conservation: According to Meinzen-Dick et al, groundwater is one of the most challenging common pool resources to govern, resulting in resource depletion in many areas. This paper presents an innovative use of collective action games to not only measure propensity for cooperation, but to improve local understanding of groundwater interrelationships and stimulate collective governance of groundwater, based on a pilot study conducted over two time periods in Andhra Pradesh. The games aim to help the study subjects understand the interconnectedness of groundwater use, and water usage impacts on local environmental and crop health. After the

games were played, a significantly higher proportion of communities adopted water registers and rules to govern groundwater, compared to other communities in the same NGO water commons programme. Because groundwater levels are affected by many factors, games alone will not end groundwater depletion. However, qualitative assessments by the implementing civil society bodies and community participants indicated that the games were an effective supplement to ongoing community facilitation processes. It was found that the use of games among the community even a year prior, had measurable impacts on the understanding of groundwater-related decision-making within the community, indicating that games leave a 'footprint' in the psyche of the community. Therefore, games are seen to contribute to social learning about the role of collective action in domestic and drinking water management, and to motivate behaviour change towards more sustainable groundwater extraction. (Meinzen-Dick et al, 2018)

Benefits of collective action games on groundwater use and conservation

Incorporating nudging into strategies and public policies targeting water conservation, can help to close the gap between intention and action: When considering the context of water scarcity and poor domestic and drinking water management, behavioural economic theories are gaining recognition in their ability to provide low-cost solutions to address and improve domestic and drinking water management. Nayar's paper highlights how nudges can be implemented among urban Indian populations, by conveying messaging through school children, in order to bridge the gap around intention and action, when it comes to water conservation. Nudging can guide the effective design and delivery of consumer-focused strategies and public policy interventions to improve residential water conservation, particularly solutions that capitalize on message framing, choice architecture and incentivization to shift human behaviour. Historically, water managers have relied on coercive regulation, pecuniary action and awareness campaigns for conserving water, with mediocre outcomes. Consumers are empathetic towards the cause but display a sizeable knowledge–action gap between professed awareness of water scarcity and actual action. The present empirical field study investigates the application of behavioural interventions on the water consumption practices of residents of Chennai City India, using randomized controlled trials. Drawing critical insights from behavioural economics a "Nudge" – 'Shut the Tap' was employed. The Nudge intervention in this study was seen to result in a 10.3 per cent water saving, equivalent to 9689 litres reduction in water consumption. The authors conclude that such nudges provide policymakers an inexpensive and effective intervention to address

Results of nudge intervention



the urban water conservation challenge. These intervention tools were delivered to individual households through reminder stickers at consumption points, resource warnings, cards reiterating social virtue of conserving water, a 'how to conserve' tool kit and a consumption Comparison exercise. The nudge was designed to address behavioural bottlenecks, identified in consumer discussions, underlying the knowledge–action gap. The intervention involved modifying the "choice architecture" around behavioural dimensions of social norms, status quo bias and encouragement. The results of the study indicate that the Nudge intervention outperformed business as usual by nearly 470 per cent. This suggests that Behavioural Nudges can provide policymakers an inexpensive and effective intervention to address the urban water conservation challenge. (Nayar & Kanaka, 2017)

Understanding populations' motivations and attitudes around water conservation is vital to designing water conservation strategies: In this paper, Reddy and colleagues introduce a scale constructed to test the attitude towards water conservation in India, including subscales to measure general attitude, past behaviours and experiences, moral obligations towards conserving water, perceived rights to water and behavioural intentions of conserving water resources. Thus this paper aims to assess the relationship between general and specific environmental beliefs and their effects on pro-environmental behaviour. The authors go on to emphasize that determining people's motives towards saving water is important to designing education water saving strategies, and better understanding consumption behaviours are vital to improving conservation practices.

A 20-item questionnaire with five scales was developed and administered among a sample of 432 respondents across the country. Analysis of responses and reliability tests of the scale reveal an overall positive attitude towards water conservation among the sample, and a substantial potential to improve conservation practices around the resource. Analysis also indicates that people who have a moral obligation towards water conservation or have experienced water shortage in the past, exhibit a positive attitude and behavioural intentional towards conserving water resources. Thus, the paper concludes that effective conservation strategies must be developed based on communities' attitudes and experiences around water conservation and scarcity. (Reddy et al, 2020)

Understanding water user behaviour and its potential outcomes, particularly in India's agricultural context, is crucial to the development of sustainable domestic and drinking water management options: O'Keeffe and colleagues deliberate on the potential to use computational models to assist in decision-making around domestic and drinking water management. While strides have been made in modelling natural processes, the patterns and impacts

of human behaviour in this context are not as well explored. This paper outlines a model that conceptualizes agricultural irrigation practices, highlighting impacts and interactions between the environment and agricultural use behaviour. It is developed using a bottom-up approach, informed through field experience and farmer interaction in the state of Uttar Pradesh. Results suggest that changes in water user behaviour and increased conservation behaviours could have a greater impact on water security, crop yields, stakeholder livelihoods, and farmer incomes than climate change and weather conditions. By simulating the feedbacks and interactions between the behaviour of water users, irrigation officials and agricultural practices, this work highlights the importance of directly including water conservation and user behaviour in policymaking and operational tools to achieve water and livelihood security. (O'Keeffe et al, 2018)

Increased investment in understanding and promoting the Circular Economy (CE) strategy of water management essential to driving water conservation: Kakwani and colleagues conducted a systematic literature review of 98 publications to study how increasing urbanization and rapid depletion of resources have forced authorities to shift from traditional linear systems of water use, to the CE strategy of water management. CE is a sustainable development approach that works along the resource optimization and waste management strategy of reduce-reuse-recycle-reclaim-recover-restore. This subject has remained unexplored in the water sector and is gaining rapid attention due to an increasing imbalance and inequity in access to water resources. The aim of this study was to review the worldwide growth

Key factors hindering the uptake of CE in domestic and drinking water management

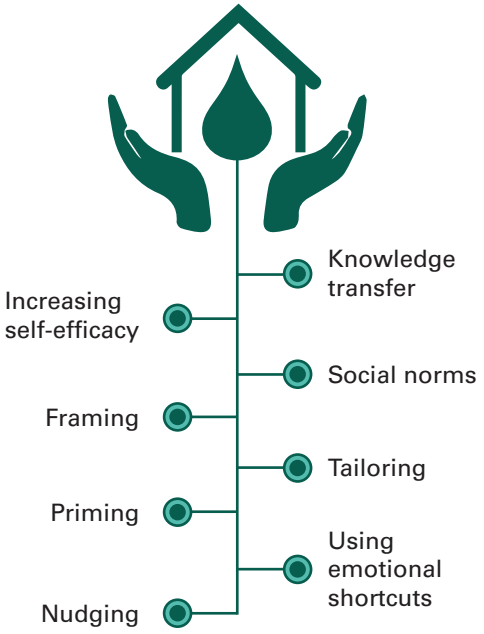
of CE as a concept in the water sector, from an economic, environmental and technical perspective, while highlighting the key behavioural challenges in bringing about CE in the context of water management. Authors present detailed technological, economic and institutional/governance challenges to realizing CE in the Indian water context. The authors conclude by stating that in the current era of deteriorating water resources, there is a need to understand the urban water cycle in a comprehensive manner, calling for the development of a sustainable infrastructure in the water sector (Kakwani & Kalbar, 2020)

Need to incorporate communities' previous experience with water scarcity when framing messaging for water

conservation: Holland et al's 2019 paper seeks to understand and describe how individual factors such as experience with water scarcity, message framing, and ideology can impact perceptions, attitudes, and behaviours related to water conservation. Findings of an online experiment suggest that higher levels of experience with water scarcity predict more concern, more credible and positive perceptions of water conservation messages, and a higher likelihood of conserving water in the future. Message framing, specifically gain frames, predicted more concern and positive perceptions of message credibility, while ideology predicted perceptions of only message credibility. The study contends that both experience and political ideology should be considered when communicating with communities about water conservation. Implications for global communities, resource managers, and policy decision makers are discussed. Findings of this study can be applied by policymakers and administrators, in influencing and promoting residential water conservation. They can also be used to inform and develop messaging campaigns, and drive positive changes in water management practices. (Holland et al, 2019)

Increased research required to understand Behavioural Influencing Techniques' potential for driving and sustaining water conservation behaviours: In light of the imminent drought-related challenges that India faces, establishing universal tap water supply will require increasingly expensive infrastructure enhancement and energy expansion to maintain sufficient service levels. This paper argues that enhancing domestic water conservation provides a promising alternative or necessary addition to reduce costs and to stimulate pro-environmental behaviour in the sphere of domestic and drinking water management. This paper has been developed to provide empirically validated knowledge about the use and effectiveness of different influencing tactics to change behaviour. It identifies eight Behavioural Influencing Tactics (BITs) that target and influence long-term water conservation behaviours within households. These tactics are divided into three information processing routes: the reflective route, the semi-reflective route, and the automatic route. The empirical data suggests that in order to achieve long-term water saving habits, the well-aligned conjunctive use of the three processing routes is crucial. The authors also call for future research on the use of BITs to effectively prolong and reinforce newly formed water conservation routines, taking into particular consideration the potential that repetitive messaging, priming, nudging have to reinforce previously introduced information, in order to sustain water conservation behaviours in the long run. (Koop et al, 2019)

8 behavioural influencing techniques (BITs) to influence long-term water conservation behaviours among households



Pathway V: Citizen contribution and tariff

In India, water was treated as a productive resource rather than as an income-generating economic resource until the 1990s. In response, India's water policy of 1987 stressed that "Water rates should be [set] such as to convey the scarcity of the resource to the users and to foster the motivation for economy in water use." Currently, India is seen to lack a comprehensive pricing approach to water resources (groundwater, surface water etc.) and uses (domestic, irrigation, industry, environment etc.) (Shen, 2016). As the importance of water pricing reforms becomes more apparent in the context of India, it is also essential to consider the social acceptability and impact on domestic and drinking water management behaviours of such pricing policies. The World Bank estimates that it will cost approximately 100 billion USD per year (until 2030) to achieve the SDGs for water and sanitation, globally (Hutton and Varughese, 2016) – however this estimate too does not include the cost of maintenance, repair and investing in climate resilient infrastructure. (Fuente, 2019). Literature broadly calls for improved citizen's contributions, in monetary form, kind and volunteerism to bring about improved quality of water service delivery.

User charges and tariffs essential to building India's water infrastructure, however, several factors determine the success of such pricing policies on the ground: India is one of many LMICs to be investing in their first generation of universalized piped water and sanitation infrastructure. Governments, at this juncture, need to mobilize substantial resources to finance the new water and sanitation infrastructure, and this paper concludes that user charges and tariffs will play an integral role in supporting these efforts. The extent to which consumers respond to average, marginal or other pricing may vary with a range of factors, including the type of tariff, level of prices, salience of prices, and frequency of billing. Insights into these aspect of customer behaviour will be useful to understanding the potential implications of implementing alternative tariffs in different contexts. Additionally, the paper discusses the concept of affordability, in the context of water tariffs, and points that this question ignores the reality that often households without access to piped water services, pay more for these services than those connected to the network. However, as affordability will continue to play an important role in global dialogue about water and sanitation service delivery, authors assert that there is a need to develop an empirically informed definition of affordability and consistent means of measuring it. (Fuente, 2019)

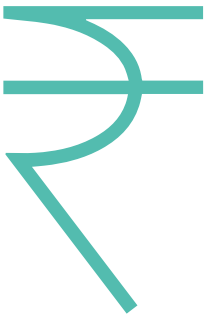
Water balance approach seeks to account for water distribution losses that are not quantified under current customer metering and water tariff mechanisms: Mastaller and colleagues demonstrate and document the application of the water balance approach (utilized by The International Water Association) to determine and analyse losses in water distribution systems up to the point of customer metering in Tiruvannamalai, Tamil Nadu. As water losses occurring before the point of customer metering are at the expenses of

the water utility (while water lost or wasted after the metre is paid for by the customer), this is an important metric in the discussion of water conservation and tariff pricing.

This is of particular interest in systems where customer metering is in place or consumption is charged according to the consumed volumes. However, among water distribution systems that lack customer metres, are operated intermittently, or witness considerable loss of water within private property (e.g., overflows of private tanks), the flat-rate tariff applied might not cover this amount. Thus, in these cases, the authors believe that actual consumption and wastage should be separately quantified or estimated with respect to the utility's water reduction measures and the calculation of revenue water. This paper presents a water balance approach adapted to water distribution systems which are operated intermittently, lack customer metering and charge flat-rate tariffs, as well as a methodology for establishing such a balance. The application of the adapted water balance approach in the case study shows that this approach can be used to initiate contentious monitoring and assessment of the water losses and non-revenue water for water distribution systems that charge a flat-rate tariff without metering and billing of actual consumption. (Mastaller & Klingel, 2017)

India's water pricing should reflect the full cost of administration and operations and maintenance (O&M); water institutions and pricing to actively work towards equitable resource allocation: Shen and Reddy's 2016 paper explores the intricate issues that prompt water pricing reform in China and India. In comparison to China's comprehensive pricing framework, India follows a relatively simple approach of cost

Considerations for effective water pricing



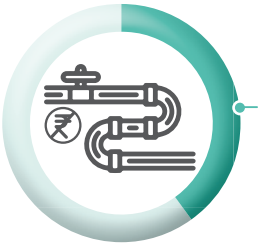
- Establishing a water tariff system
- Fixing the criteria for water charges
- Following the principle that water charges should reflect the full cost of administration and O&M of water resource projects

recovery, though recent policy guidelines are more inclined towards systematic pricing. However, the findings of the study present that both countries fail to realize water pricing policy targets regardless of different pricing structures. The treatment of water resources and its services, and property rights have a significant impact on pricing, and costs (including service, resources and environment) are difficult to recover. The paper recommends that water be priced to promote efficient use and maximize the value of resource. Additionally, authors state the importance of water pricing reforms gaining social acceptability, and the need to ensure this separately from the economic aspects of pricing policies. They believe that pricing in its present form may not result in efficient and equitable resource allocation, and the integration of pricing reforms along with institutional arrangements is necessary to achieving the objectives of equitable and sustainable domestic water availability. (Shen & Reddy, 2016)

Better understanding of the relationship between power and water tariffs is essential to reducing groundwater depletion and promoting sustainable groundwater consumption: Sidhu et al's 2020 paper compares two common

tariff modes to charge consumers for groundwater supply: flat tariffs and metered tariffs, and assesses which of the two will contribute more to water conservation efforts. Groundwater irrigation using electric pumps, plays a key role in India's water supply. Power utilities across different states use two common tariff modes to charge groundwater consumers: flat tariffs, where payments are fixed according to a pump's power rating, and metered tariffs based on units of power actually consumed. This review assesses existing empirical evidence to compare the two tariff structures in terms of three key features: administrative burden on utilities; equity of groundwater access between high-income and low-income farmers; and influence on farmers' pumping behaviour. Analysis shows that flat tariffs have low administrative costs and more equitable distributional outcomes, but provide no incentive to farmers for water conservation. Conversely, metered tariffs have the potential to encourage judicious consumption, but are expensive to manage and disadvantageous to low-income farmers who often buy water from wealthier groundwater well owners. Authors conclude that flawed tariff policies, in conjunction with large subsidies for agricultural power, have caused rapid groundwater depletion in many regions. Since there is considerable heterogeneity in agricultural practices and groundwater availability across India, location-specific strategies are proposed for rationalizing agricultural power tariffs in different regions. While the groundwater-abundant eastern regions can benefit from a hybrid flat-cum-metered tariff that encourages farmer-to-farmer water sales, western states facing unsustainable groundwater exploitation should develop tariff policies that ration power, prioritize its supply during the most critical seasons, and reward farmers who reduce their groundwater consumption. Not only will such tariff policies help conserve groundwater, but also augment government financial resources for social welfare programmes such as education, health, energy access etc. (Sidhu et al, 2020)

Economic, social and environmental measures to be taken into account to ensure sustainable and equitable water tariff systems: Overexploitation and inefficient usage of water, alongside leakages due to poor infrastructure have resulted in an urgent water crisis, that will have impacts on generations to come. India has historically paid little attention to assessing and reducing non-revenue water (NRW), water that is lost in the process of distribution, and unbilled (no revenue raised). Reducing NRW is essential to overall efficiency and financial sustainability of water systems, as it provides additional revenues and reduces costs. Authors call for improved monitoring and data collection around NRW, as well as measures to reduce unbilled and systemic water losses. Water pricing has a unique role to play in managing this resource. This paper assesses the potential for measuring and monitoring and reducing NRW by District Metered Area (DMA). A DMA is defined as a discrete area of a distribution system created by the closure of valves of complete disconnection of pipe work in which the quantities of water entering and leaving the area are metered. Authors recommend that usage of water metres be encouraged not only at the sources and transmission line, and that an optimal tariff structure be put in place, in conjunction with reductions in NRWs. Without these measures, they conclude that



40%
estimated non-revenue water (NRW) in India, resulting in inability to provide continuous supply to water users

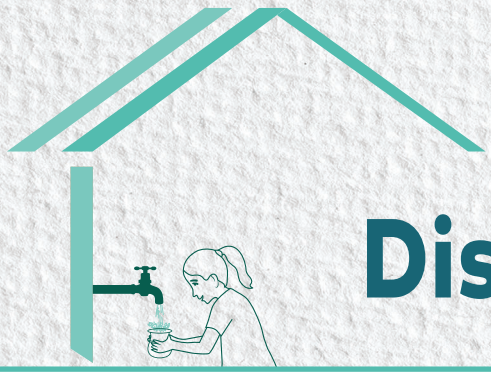
the revenue generated will not be sufficient to recover the investments made and costs incurred in the operation and maintenance of the water supply and service delivery system. (Sakthi & Chandran, 2020)

India's current water policy requires changes in terms of integration with other policies, greater accountability and regulatory mechanisms, and higher prioritization on water poverty issues: Araral's 2016 paper compares domestic and drinking water management in China and India in terms of water laws, policies and administration based on a survey among water experts in both countries. Indian data was collected among personnel from the national level, as well as from nine states. The study speculates that variations in domestic and drinking water management practices could be attributed to differences in political, legal and administrative systems as well as levels of economic development. The authors conclude that China has more nuanced water laws, stronger legal accountability among water sector officials, greater scope for private sector participation, and greater integration of water laws into the broader legal structure. China, compared to India, promotes better integration with other policies (energy, industrialization, urbanization), employs principles of cost recovery, promotes greater private and foreign investor participation in water projects, pays attention to water poverty issues, has more finances available for water investments. In contrast, in India, water policies are often seen to be fragmented from other policies, heavy use of subsidies are seen to encourage inefficient use, feature low prioritization of water poverty issues, and have insufficient financial means to support water investments. In the context of water administration, the authors conclude that India needs to invest in greater functional capacity and balance among water agencies, have independent water pricing and water apex bodies, have relatively stronger accountability and regulatory mechanisms and considerably stronger application of science and technology for water management. (Araral & Wu, 2016)

Urban water institutions to prioritize achieving economic self-sufficiency, and replacing subsidized supply of water with other more profitable market-based interventions: As India experiences globalization, accelerated economic development, improvements in living standards, and demographic growth, provision of reliable and safe water supply to urban habitats is becoming an increasingly essential input for overall economic and social advancement. However, urban local bodies mandated to perform this task in India have been experiencing constant budgetary bottlenecks in mobilizing resources to meet the water consumption targets of the present as well as future population. The urban water supply sector in India and particularly that of the city of Bangalore (the study site for this paper) faces a number of challenges and constraints in ensuring universal supply of adequate potable water. These problems

and constraints include increasing scarcity of water, low pricing, high subsidy, poor cost recovery, high transmission, and distribution losses due to poor maintenance, rising unaccounted-for and NRW outgo. Urban water institutions such as the Bangalore Water Supply and Sewerage Board (BWSSB) are seen to experience poor cost recovery and are unable to generate enough revenue to meet the investment requirements of the growing water needs at the city level. Such institutions also face serious performance gaps such as reliability, financial sustainability, environmental sustainability, and affordability due to deterioration of infrastructure. In the face of these challenges, this author suggests that such urban water institutions must prioritize achieving economic self-sufficiency and replacing subsidized supply of water with other more profitable market-based interventions. It is also critical, says Raj, that communities be educated on the urgent inevitability and economic justification of implementing and increasing water tariffs. It is also proposed that water institutions' government structures be reformed to bring about greater accountability and coordination, and encourage cohesive coordination among political, social, economic, educational and environmental institutions in order to achieve common objectives in the water sector. Thus, urban water crises need to be addressed with improved policy options of both supply and demand side management perspectives in the long term. (Raj, 2015)

Increasing prevalence and popularity of Small Water Enterprises such as water ATMs indicate populations' willingness to pay for safe water: Sarkar's 2019 paper explores the rising popularity of water ATMs (Automatic Teller Machines) as a smart and low-cost technology to provide safe water at nominal rates in India. Urban poor across India are inadequately served by public utility and municipal piped networks, and authors state that the scope for social entrepreneurial and market-based solutions is gaining recognition and investment. While this demand is currently met by the plastic waste intensive bottled water industry, the ATMs provide a lower cost option for purified drinking water. Water ATMs and other Small Water Enterprises currently operate in a Public–Private Partnership model, and have much scope to collaborate with local bodies and promote local stewardship of water. The popularity that ATMs are gaining also highlights communities' willingness to pay for safe water, and suggest populations' likelihood to pay water tariffs for piped water. The author states that since water has traditionally been a free good, citizens do not have the culture of paying for water and its services. However, Sarkar also calls attention to the fact that paying for an essential daily good like water can be particularly challenging for poor and marginalized communities. This paper aims to understand the challenges, opportunities and potential for scale up such water ATMs pose, based on the Delhi case study. The author states that if water ATMS are replicated in large numbers, regulatory mechanisms need to be put in place to monitor their establishment and regular functioning. This includes ensuring no negative environmental externalities, ensuring quality of water, and ensuring reach to the poorest populations, and no leakages during distribution. The author concludes that rather than seeing the ATMs as an alternative to piped water, they should be seen as a temporary and supplementary source of safe water to urban poor, as India awaits achieving universal coverage of piped water. (Sarkar, 2019)



Discussion

As mentioned earlier this review is conducted to better understand and prepare for India's comprehensive domestic and drinking water management efforts under the JJM.

It aims to identify key behavioural insights and approaches outlined in the selected literature that can help to inform SBCC, capacity building and management efforts under the Mission. Each pathway of drinking and domestic water management posited in this review, describes different approaches to ensuring the effective and equitable management of water as a critical resource.

1

In publications considered under the **first pathway: Access to water**, authors call for improved water governance by means of strengthening management capacities and engaging communities in determining equitable water distribution. Essential to this process, is first addressing existing inequities in water access across socioeconomic groups, and investing in collective action and citizen participation in increasing access to water for all.

Authors call for **improved management** practices and greater harnessing of community engagement, to ensure equitable service delivery and institutional reshaping towards improved access to water. Cronin and colleagues describe institutional reshaping to entail improved management, as well role clarity and clear delegation of responsibilities between numerous institutions engaged in water management (Cronin et al, 2016). Johnson et al posit that there are five institutional features that are linked with effective water supply. These are clear objectives, two-way communication between populations and service delivery, adaptiveness, designed appropriately to the available infrastructure and functioning at the appropriate scale. They conclude that institutional weaknesses can lead to inefficient water supply and use, underutilization of infrastructure in place, and inequity and conflicts (Johnson et al, 2020). Authors also call for increased role of private agencies in contributing to the quality and coverage of water service delivery. Inukonda calls for governments to create opportunities with clear boundaries for private participation in water management and infrastructure; and recommends that the process be closely monitored by citizens, civil society and media to ensure equitable and sustainable service delivery (Inukonda, 2017).

Addressing existing inequities and vulnerabilities among populations is essential to achieving access to water for all. Cronin et al call for people-centric policies,

that recognize social, cultural and political barriers (including caste, class, gender) that hinder communities' access to water. (Cronin et al, 2016). Sarkhel and Paul find that social connectivity and networks can influence tap water access; these include, households' connection with government personnel, media exposure, and experience with collective action. Therefore, if access to public water schemes is contingent on the intensity of social ties, it might exclude asset poor and socially disadvantaged groups, and aggravate water scarcity among vulnerable and marginalized groups (Sarkhel and Paul, 2019). The terms of access to water are discussed in O'Leary's 2016 paper. O'Leary states that urban poor experience onerous waiting times to access a disproportionately low fraction of cities' water supply, and that time spent waiting for water is often taken into account when urban poor reflect on their well-being. The paper calls for the government to acknowledge the legitimacy of the urban poor as productive citizens, and for the private sector to enhance equitable access to water among this group. (O'Leary, 2016). Bisung and Elliott classify water scarcity-related psychosocial stressors into four categories: financial, social, physical and in terms of perceived inequity. They found that feelings of marginalization and resentment against government and water management structures were common among water stressed populations (Bisung & Elliott, 2016). Addressing and eliminating these inequities in water access is a crucial part of bringing about improved community engagement and ownership around water.

As building a **participative approach**, harnessing community collective action and strengthening of social networks is seen to be correlated with more equitable access to water as a resource (Sarkhel and Paul, 2019), participatory and rights-based approaches to water governments are proposed by authors. This entails empowering communities to participate in decision-making, and providing them with data on water (Cronin, 2016), investing equally in strengthening participatory water as much as in water supply infrastructure and engineering (Johnson, 2020). Inukonda calls for improved participatory communication between governments and communities. This includes community involvement in the development of reforms, Governments being transparent about external/private support required to improve service delivery and water conservation, as well as citizens staying aware of and monitoring water management (Inukonda, 2017). Hutchings et al discuss three typologies of community management for water in Indi. These are 1. Direct Provision with Community Involvement (government/provider owns and manages water infrastructure, and

community plays consultative role), 2. Community Management Plus (high levels of community participation in day-to-day management), and 3. Professionalized Community-Based Management (communities' capacities built to effectively manage water governance and delivery). Authors state that while currently the majority of India's community management projects take the second approach, it is expected that more and more models will adopt the third model, suggesting the need to invest in capacity building of local water institutions and community groups. (Hutchings et al, 2016)

2

Evidence considered under the **second pathway: Safe water**, references the multiple chemical and biological contaminants that hinder community access to safe water. Authors call for improved demand generation for water quality and awareness around safe water sources. Lack of knowledge is recognized as a major barrier to adoption of improved water handling and storage behaviours. Additionally, evidence suggests the criticality of improving service delivery, and capacity building among water service delivery and management personnel around safe water access to all.

Knowledge dissemination and communication strategies are key to driving **consumer side knowledge and awareness** around water quality. Del Bello in 2020 asserts the need for more awareness and demand generation among communities around water safety, quality, conservation and source protection (Del Bello, 2020).

Alongside strengthening government and private interventions to provide water treatment and potable water, water safety awareness and decontamination practices must be promoted among communities (Delaire, 2016). Trent et al find that improved two-way communication on water quality and contamination, lead to improved household water safety practices and reduced exposure risks. The authors state that providing communities with evidence and data around water quality and safe treatment/handling practices, can help to overcome this key knowledge barrier (Trent et al, 2018). Sindhura et al call for improved drinking water practices among households that have access to municipal water supply, especially on the topics of water purification, safe storage and handling, and preventing waterborne diseases. (Sindhura et al, 2018). According to Falkenberg and colleagues, insufficient knowledge has even been seen to undermine wastewater reuse and recycling efforts – household wastewater that was used to irrigate fields led to increased contamination of local water sources. Thus, there is substantial potential for awareness-raising, education campaigns and social and behaviour change around purification and treatment of water (Falkenberg et al, 2018).

Authors call for **capacity building of service delivery** personnel and increased investment in participatory approaches to improve administration and distribution in regard to safe water. Trent et al state that improved water administration and management are required to address water pollution and improve availability of safe water. They add that inadequate investment in water conservation and wastewater treatment and purification

also add to low availability of water that is safe for consumption (Trent et al, 2018). Sharma et al recommend that any new approach to water administration must be clearly communicated to and understood by all levels of administration and across community groups. This entails greater inter-agency coordination at state and central levels, as well as increased engagement of civil society and communities. (Sharma et al, 2017). Francis and colleagues find that water quality interventions are more successful when community involvement and uptake are prioritized. They highlight the need to effectively involve communities at key stages of implementation to lead to a successful water safety intervention, including conducting through research around factors that can uptake and sustainability. (Francis) Based on these findings, systematic SBCC strategies should be employed to disseminate actionable information on domestic and drinking water management among communities and administrative personnel alike (Panda et al, 2019). Delaire adds that investing in decentralized water treatment by private entities could be a temporary and partial solution to the gap in providing households with safe water. (Delaire)

3

Under the **third pathway: Demand generation and management**, evidence calls for a balanced approach between creating new demand for water and managing existing demand, so as to ensure that water needs are met in an equitable manner. Authors conclude that demand must be created among communities for safe and sustainable water supply, as well as water conservation.

Demand generation among populations around water is a complex issue, as water infrastructure systems of most Indian cities are already unable to provide adequate water supply to meet growing demands (Ramsey, 2017). Shannon finds that there is already a strong demand for safe water and improvements in water-related health risks, as compared to reductions in any other domain-specific health risks (e.g., air pollution) (Shannon, 2019). Ghosh et al find in their study, that among more affluent households, income was seen to have no effect on water demand and consumption, while residents of unorganized housing/ slums were seen to curtail their use of water even at the cost of their health and hygiene (Ghosh et al, 2016). Therefore, there is a need to balance demand generation and management efforts, based on the characteristics of the communities in question, while strengthening demand for

positive water practices such as provision of safe water, treatment of wastewater, and water conservation. Authors call for improved data and measurement around water use, losses during distribution, with the aim that this knowledge will drive improved community demand for sustainable domestic and drinking water management.

As supply-side management alone is costly and ultimately unsustainable in shaping demand and consumption of water among communities, **demand management strategies** need to employed to ensure equitable access to quality water for all. Authors find that economic instruments employed to shape demand are currently inefficiently implemented, and do not succeed in influencing demand. Reynaud and Romano assert that a mix of Pricing and Non-Pricing Policies (NPPs) can more effectively drive water demand, management and conservation. As water demand is inelastic with respect to water price (though imperfectly), pricing mechanisms may not be solely effective for modifying household water behaviours,

even though this is often the most direct economic tool used to induce water conservation behaviours (Reynaud and Romano, 2018). Among Non-Pricing Policies to reduce water consumption, reducing water supply is the most popular among LMICs. However, when this strategy is applied incorrectly, Ramsey finds that it can create a scarcity mindset, increase water consumption and hoarding, and have detrimental effects on populations' likelihood of engaging in water conservation efforts. (Ramsey, 2017). Falkenberg and colleagues note that as inconsistent water supply necessitates water storage, it is often associated with unsafe storage and handling practices and risk of contamination. (Falkenberg et al, 2018). Ghosh and colleagues found that among affluent households, attempts to cope with unmet demand for safe water (using purification and pumping systems) led to increased demand of other resources (electricity) and additional financial strain (Ghosh et al, 2016). Ramsey states that Pricing and Non-Pricing Policies must be designed after taking into account communities' priorities, motivations and social norms, as these factors drive populations' likelihood to curb water consumption and engage in water conservation. Effective NPPs include public messaging campaigns, education campaigns, SBCC strategies to change norms around consumption, and should aim to build up community-level concern and knowledge around water as a resource (Ramsey, 2017). Water demand forecasting is gaining recognition as a critical tool in facilitating decisions around water supply, pricing, financial and capacity planning, operations etc, and can be used to develop context-specific water demand management plans (Singh et al, 2017).

4

Evidence considered under the **fourth pathway: Conservation and judicious use of water** speak to the need for improved knowledge and attitudes around water conservation among communities, as well as improved uptake of conservation behaviours and bridging of the knowledge and action gap.

There is a need to improve quality of **knowledge dissemination and awareness generation**, in order to strengthen populations' knowledge and attitudes around water management and conservation. Authors present several methodologies by which this can be achieved. Meinzen-Dick et al describe the use of innovative collective action games to improve local understanding around interrelations between water sources, stimulate collective governance of groundwater, and improve communities' propensity for water conservation. (Meinzen-Dick, 2018). Kakwani & Kalbar highlight the need to invest in increased knowledge around the CE strategy of water management. According to the authors, understanding of CE is necessary to bringing about optimal water resource and wastewater management, and to driving understanding of need for water conservation. CE has remained relatively unexplored and is now gaining recognition in the context of growing inequity in water access (Kakwani & Kalbar, 2020). Reddy and colleagues posit that attitudes and motivations around water conservation, past behaviours and experiences with water scarcity, moral obligations towards water conservation and perceived rights to water shape populations' intentions to conserve water. Policymakers and administrators

must use this information to develop effective conservation strategies based on research around community attitudes and experiences around conservation and scarcity (Reddy et al, 2020). Holland et al come to the same conclusion that there is a need to incorporate communities' previous experiences with water scarcity when messaging framing for water conservation, as these can impact perceptions, attitudes and behaviours around water conservation. They find that experiences with water scarcity are associated with more credible and positive perceptions around water conservation messages, and higher likelihood of conserving water in the future (Holland et al, 2019).

However, knowledge around importance of water conservation does not necessarily result in water conservation practices (Ramsey, 2017). Closing the **knowledge–action gap** is essential to convert willingness to conserve water into actual water conservation behaviours. T Nayar and Kanaka suggest nudging as a mechanism to help bridge the gap between intention and action, by using message framing, choice architecture and incentivization approaches

to develop consumer-focused strategies around improving water conservation. They conclude that application of behavioural interventions and nudges can be successful in addressing behavioural bottlenecks around realizing water conservation (Nayar & Kanaka, 2017). Households reported engaging most frequently in water conservation behaviours that required little effort or financial investment. Teaching communities about easy ways to conserve and protect water sources can reduce perceived sense of effort around the act and increase sense of self-efficacy. Having higher income, longer water supply durations and the belief that droughts are preventable were positively correlated with water conservation efforts. (Ramsey, 2017). O'Keeffe recommends that water conservation efforts be developed through a bottom-up approach, based on consumers' experiences, and user experiences with water conservation and scarcity be included in policymaking to achieve water security (O'Keeffe et al, 2019). To understand how people manage the risk of water scarcity and growing pressures of increased climate variability, exploring perceptions of risk and how these perceptions feed into response behaviour and willingness to adapt is critical (Singh et al, 2018). Koop et al enlist eight Behavioural Influencing Techniques (BITs) that they believe can drive domestic water conservation. These are knowledge transfer, increasing self-efficacy, changing social norms, message framing, message tailoring, using emotional shortcuts, priming and nudging. The authors call for research in different contexts on how BITs can not only lead to uptake, but can also effectively reinforce, prolong and sustain conservation behaviours (Koop et al, 2019).

5

Under the **fifth pathway: Citizen contribution and tariffs**, evidence indicates the criticality of a well-developed tariff system, to mobilize sufficient resources to finance water infrastructure, and sets out different characteristics of pricing strategies that consumers may respond to. Authors compare different pricing mechanisms to understand which is best suited for India's heterogenous population, and to understand which is more likely to promote the conservation of water, and which will provide more resources to the government to ensure universalization of drinking and domestic water.

Building **social acceptability around tariffs** and citizen contributions is a pre-requisite to implementing user chargers among water consumers. As India is one of many LMICs to be investing in their first generation of universalized piped water, it needs to mobilize substantial resource to finance this scale of infrastructure and service delivery. Consumers' response to user charges and tariffs are central to this, and their responses can vary based on the type of tariff, pricing level, frequency of billing etc. It is therefore essential to study such aspects of consumer behaviour prior to applying tariffs (Fuente, 2019). Sidhu et al conduct a comparison of flat tariffs and metered tariffs, and how they relate with water conservation efforts, and find that metered tariffs have the potential to encourage judicious consumption of water, though they are more expensive to administer among populations. The authors therefore call for location-specific strategies based on evidence, regarding the implementation of

flat, metered or hybrid tariffs (Sidhu et al, 2020). Increasing popularity of Small Water Enterprises such as water ATMS indicate populations' willingness to pay for safe water, and suggest populations' likelihood to pay for water tariffs for piped water. This makes the case for implementing water tariffs with commensurate improvements in service by water utilities (Sarkar, 2019). It is critical that communities be educated on the urgent inevitability and economic justification of implementing and increasing water tariffs. (Raj, 2015)

Another key step prior to implementing user charges, is defining what **equitable citizen contribution and water tariff** mean in the current context. Fuente asserts that the concept of affordability is essential to consider in the water tariff conversation, and points out that this question ignores the reality that households without access to piped water services (poorer households) often pay more for water services than households connected to municipal supply. Though this indicates a willingness to pay for safe water even among the most disadvantaged households, an empirically informed definition of affordability and an equitable approach to water user charges must be made in this context (Fuente, 2019). Paying for an essential daily good like water can be particularly challenging for poor and marginalized communities, says Sarkar, and adds that as water has traditionally been a free good, citizens do not currently have the culture of paying for water and its services (Sarkar, 2019).

Shen & Reddy find that India's current **revenue and pricing model** around water features a relatively simple approach to cost recovery, and fails to realize water pricing policy targets. The authors recommend that water be priced to promote efficient use and reflect the critical value of the resource. This will require water tariffs and systematic pricing to cover the full cost of administration and O&M of water management (Shen & Reddy, 2016). Raj sheds light on the financial problems that plague water institutions currently: low pricing, high subsidies, poor cost recovery, high transmission and distribution costs and losses, all seen to lead to deteriorating infrastructure and service delivery. Raj calls for water institutions to prioritize achieving economic self-sufficiency and replacing subsidized water supply with more profitable market-based solutions (Raj, 2015). Sakthi & Chandran find that NRW (water that has been lost in the process of distribution, and no revenue is raised from this expenditure) is estimated to be as high as 40% in India. The authors call for administrations to take more initiative in developing water metering and pricing schemes that reflect and account for NRW losses, thereby driving systemic water conservation and judicious use (Sakthi & Chandran, 2020). The water balance approach, tested by Mastaller & Klingel, seeks to determine and analyse losses in water distribution systems, and asserts the need to incorporate this data into discussions with communities around water conservation and tariff pricing (Mastaller & Klingel, 2017).

Conclusion and recommendations

This evidence review assesses 36 publications from multiple databases, to understand the roles that the five pathways of domestic and drinking water management can play in India's progress towards the sustainable use and management of water.

In light of the Jal Jeevan Mission, the ambitious and impactful flagship programme envisioned by the Government of India, it is critical that administrators and communities alike be engaged along these five pathways, through awareness generation, capacity building and demand generation efforts. Understanding factors that influence communities' and implementers' motivations and practices around each of these pathways is vital to the success of policy reform around all of these elements.

Pathway I: Access to water

IMPROVED MANAGEMENT:

- Need to **reshape water institutions**: Greater role clarity and clear delegation of responsibilities between numerous institutions, two-way communication between service delivery and communities, adaptiveness, management designed appropriately for existing infrastructure and functioning at appropriate scale.
- Governments need to **create opportunities for private participation** in water management and infrastructure. These collaborations should be closely monitored by citizens, civil society and media to ensure equitable service delivery.

ADDRESSING INEQUITIES AND VULNERABILITIES:

- Need for **people-centric policies** that recognize social, cultural, political barriers to equitable water access. This includes understanding the experience of asset poor, socially disadvantage groups with accessing water.
- Importance of addressing **psychosocial stressors** of water scarcity: financial, social, physical, and in terms of perceived inequity.

PARTICIPATORY APPROACH:

- Need to **empower communities to participate in decision-making**, and strengthening participatory water institutions is just as important as investing in water infrastructure.
- **Governments to be more transparent** about support required to improve service delivery, and citizens to stay aware of and monitor water interventions.

Pathway II: Safe water

CONSUMER SIDE KNOWLEDGE AND AWARENESS:

- Need to drive **communities' awareness around safe water** handling and storage, treatment, conservation and source protection.
- Increased **communication and access to data around water quality** seen to result in improved household water safety practices.
- Need to conduct **research among users** to understand factors that will influence uptake and sustainability of safe water practices.

CAPACITY BUILDING OF SERVICE DELIVERY SIDE

- **Improved water administration** and management required to improve water pollution and availability of safe water.
- Reforms in water management to be communicated to and understood by **all levels of water administration**, and to lead to greater inter-agency coordination.
- Need to **involve communities at key stages of implementation** seen to lead to successful water safety interventions.

Pathway III: Demand generation and management

DEMAND GENERATION:

- Indian water infrastructure already **unable to provide adequate supply** to meet growing demands.
- **Differences in demand** noted between affluent and disadvantaged households, highlighting the need for demand management alongside demand generation.

DEMAND MANAGEMENT:

- Supply-side management as well as **demand management strategies required** to manage growing demand.
- **Economic instruments currently inefficiently used** to manage water demand and consumption. A mix of pricing and non-pricing policies can effectively drive water demand.
- Communities' priorities and social norms to be taken into account when creating strategies to shape demand for water.

Pathway IV: Conservation and judicious use

KNOWLEDGE DISSEMINATION AND AWARENESS GENERATION

- Need to use innovative methodologies and concepts (collective action games, Circular Economy) to **drive community understanding and social learning around water conservation** and interconnectedness of water resources.
- **Previous experience, motivations and moral obligations** around water conservation and scarcity drive intention to conserve water.
- Need to **conduct research among communities** on attitudes, experiences and perceived rights around water to develop messaging and communications strategies for water conservation.

CLOSING THE KNOWLEDGE–ACTION GAP

- **Nudging** (message framing, choice architecture and incentivization approaches) and **Behavioural Influencing Techniques** (knowledge transfer, increasing self efficacy, changing social norms, message framing, message tailoring, using emotional shortcuts, priming and nudging) can be used to improve water conservation practices.
- Teaching communities about easy ways to conserve and protect water can **reduce perceived sense of effort** around the act and **increase sense of self-efficacy**, both associated with higher practice of conservation behaviours.
- Water conservation efforts to be developed through **bottom-up approach**, based on consumers' experiences, attitudes and priorities.

Pathway V: Citizen contribution and tariff

SOCIAL ACCEPTABILITY AROUND TARIFFS

- Consumers' **response to user charges and tariffs** can vary based on the type of tariff, pricing level, frequency of billing. Consumer behaviour must be studied, and location-specific strategies based on evidence must developed for each context.
- Increasing popularity of Small Water Enterprises indicate populations' willingness to pay for safe water, and makes the case for **implementing water tariffs with commensurate improvements** in service by water utilities.

EQUITABLE CITIZEN CONTRIBUTION AND TARIFFS

- Poorer households without water connectivity often **pay more for water services than households with water supply**. Though this indicates a willingness to pay for safe water even among the most disadvantaged households, an empirically informed definition of affordability and an equitable approach to water user charges must be decided upon.
- As water has traditionally been a free good, citizens do not currently have the **culture of paying for water** and its services Paying for an essential daily good like water can be particularly challenging for poor and marginalized communities.

REVENUE AND PRICING MODEL

- **Low pricing, high subsidies, poor cost recovery**, high transmission and distribution costs and losses, deteriorating infrastructure characterize India's current water institutions and revenue model
- Water to **systematically priced** such that it promotes efficient use and reflects the critical value of the resource. Full cost of administration and O&M of water management to be covered in systematic pricing.
- **Water balance approach** seeks to determine and analyses losses in water distribution systems, and highlights the need to incorporate this data into participatory discussions around citizen contribution, tariffs and water conservation.

The evidence considered under this literature review can be utilized to strengthen management and decision-making around domestic and drinking water resources and can drive equitable and sustainable water access among India's populations.

By investing in better understanding of the behavioural factors that influence community and administrative motivations and practices around each element of water management, we can bring about stronger programming and service delivery of water management through effective SBCC strategies.

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