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# Combining Approaches for Systemic Behaviour Change in Groundwater Governance

RESEARCH ARTICLE

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## ABSTRACT

Over-extraction of groundwater is a prominent challenge in India, with profound implication for food security, livelihoods, and economic development. As groundwater is an 'invisible' and mobile common pool resource, sustainable governance of groundwater is complex, multifaceted, requiring coordination among various stakeholders at different scales. It remains an open question as to what can be done to strengthen the governance of groundwater, particularly on the scale necessary to address widespread depletion of resources. The growing competition over groundwater resources calls for systemic changes towards sustainable water management. These require understanding the behaviours of actors in the system network, as well as the institutions that shape the direction in which the system moves. In this paper, we offer a behavioural perspective to system transformation and apply it to the example of an Indian NGO working on sustainable natural resource governance. The organisation, Foundation for Ecological Security (FES), has been co-designing and using various institutional tools for groundwater governance with the collaboration of other NGOs and government partners, academic and research organisations towards strengthening governance of water. At the local level, these include groundwater monitoring and crop water budgeting, combined with experiential learning tools such as games for demand management, and supply side interventions to support water harvesting and recharge. These tools are combined with efforts to strengthen multi-actor platforms, building coalitions and capacity of government, civil society and private sector actors to support groundwater governance at scale. By combining local and systemic approaches, the aim is to influence water governance on a larger scale and contribute to the sustainable management of water resources in India. Our reflections illustrate how conceptual thinking can inform multi-methods approaches which consider that sustainably improving groundwater management at large scale requires inter-linked behavioural changes of diverse actors. Our approach constitutes critical reflection and conceptualization, based on situated knowledge which contributes to designing better adapted and more powerful intervention strategies through informed argument.

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## INTRODUCTION

Groundwater, a critical resource for sustaining life, livelihoods, ensuring food security and economic development on the planet, is rapidly declining in many countries (UNESCO World Water Assessment, 2022). With annual extraction of around 230 km$^3$ per year, India extracts more groundwater than US and China put together (Margat & Gun, 2013). The Green revolution in the 1970s bolstered food production in India also through the development of groundwater-based irrigation. The area under groundwater irrigation increased from less than 6 million hectares (MHA) in 1950–51 to 44 MHA in 2016–17 (Narayanamoorthy, 2022). Today almost 60 percent of irrigation and 85 percent of drinking water needs of rural India is met from groundwater (Pahuja et al., 2010) and about 89% of the groundwater extracted in India is used for irrigation (GoI, 2020).

Groundwater can serve as an important buffer against fluctuations in rainfall and surface water flows, which become more serious with climate change, but climate change can also disrupt groundwater recharge patterns and lead to further depletion. The impact of climate change can vary based on the aquifer characteristics that determines the economic accessibility of the groundwater, its sustainability, and buffering capacity to seasonal variations and climatic shocks (Rodella et al, 2023). Recent studies show that declining groundwater levels are associated with significant reductions in yield, cropped area, and production of major crops like wheat, rice, and maize in the winter season (Bhattarai et al., 2021). Hydrological models show that even in the event of stronger monsoon in the face of increasing temperature, continued groundwater pumping will hamper groundwater recovery (Dangar & Mishra, 2023). Increased withdrawals due to warming can result in three times current rate of net groundwater loss for the period 2041–2080 (Bhattarai et al., 2023). Coupled with this, there is growing evidence of declining water quality. At least 60 percent of India's districts face problems of over-exploitation or severe contamination (Shankar et al., 2011). Declining water tables also diminish the quality of ecosystem services (Griebler & Avramov, 2015).

The growing competition over groundwater resources calls for systemic changes towards sustainable water management, including actions related to water supply and demand and institutional service provision (Falk et al. 2009). These, in turn, are influenced by water governance – the combined societal processes organising water supply and demand including market, state, and self-organisation mechanisms (Ostrom 2009). While there is growing attention to governance and how it influences the behavior of different actors, what is not established is what can be done to strengthen groundwater governance, particularly on the scale necessary to address widespread depletion of resources. Growing over-exploitation trends indicate that neither community, nor market, nor government governance efforts alone were effective to ensure sustainable groundwater management (Molle and Closas 2020). Historically, government regulations failed to support especially local governance. Measures like reducing energy subsidies are not likely to result in changes away from water-intensive crops (Bhattarai et al., 2021). In addition, water governance has to be adaptive to changing environments in the face of climate change (Dangar & Mishra, 2023).

Foundation for Ecological Security (FES), an Indian non-governmental organization (NGO) works on strengthening collective governance of water resources by working with diverse decision makers exercising authority in different areas of the system. In the past decade, FES co-developed various tools, strategies, and approaches towards strengthening groundwater governance, in collaboration with other NGOs, government partners, academic and research organisations. The efforts aim at improving recognition of the shared nature of water resources, and highlight the importance of collective action to manage water equitably and sustainably for all of nature and humans (at present, and in future). Tools and approaches for demand-side management such as community monitoring of groundwater levels, trendline analysis, experiential learning games and debriefing, crop water budgeting, are complemented with supply side interventions such as identifying where to construct water recharge and harvesting structures, watershed conservation activities, and other ecosystem restoration activities. The efforts at the local level are complimented by improving knowledge and building the capacity of other stakeholders such as government agencies, private entities, and civil society actors. By combining local and systemic approaches, the aim is to contribute to the sustainable governance and management of water resources on a larger scale.

Systemic changes would require understanding the behaviours of actors in the system network, as well as the institutions that shape the direction in which the system moves (Abson et al., 2017). We thereby understand systems as patterns of behaviour and interactions of actors in an ecological, social, political, economic, technical, and cultural context maintaining or creating changes in stocks and flows including feedback to the context (inspired by McGinnis and Ostrom 2014, and Woltering et al., 2019). In the past decade, FES combined demand and supply side interventions at the community level with engaging with actors at higher-level decision making.

In this paper, we conceptualize and document the strategic perspective taken by FES in working at scale

and taking into consideration the polycentric complexity of water governance. Thereby, we offer a behavioural perspective to system change by assuming that changes in socio-technical-ecological systems are the result of behavioural changes of system actors (Duru, Therond, and Fares 2015; Pahl-Wostl et al. 2010). This perspective is not limited to an often-narrow focus on technology adoption by producers and the scaling of such technologies (Rogers, 2003; Fishman et al., 2015). A systems perspective requires attention to wider, societal dynamics (Leeuwis et al., 2021; Woltering et al., 2019) and whose behavioural change is required to change these dynamics. This perspective assigns responsibility for change to specific actors with very different roles. In a next step, this allows to dive deeper in exploring what may be required to change critical behaviour (Petit 2019). This approach helps clarifying assumptions on how interventions lead to system changes. In this way more effective intervention strategies can be developed.

Inspired by conceptual thinking embedded in the Institutional Analysis and Development (IAD) Framework (Ostrom, 2011) we illustrate how the interplay of behaviour of different actors affects system outcomes. System changes are essentially about people and organisations, and their actions determined by their mindsets, social relations, resources, as well as the bio-physical, economic, social, and institutional environment (Abercrombie et al., 2018). We apply this thinking to make transparent how various interventions geared towards changing the behaviour of different actors can support more sustainable groundwater governance and management at large scale. Our reflections illustrate how conceptual thinking can inform multi-methods approaches. Identifying what drives their behaviours is key for developing powerful intervention strategies and to understand the pathways to influence changes in the wider system. Our experience offers lessons for other initiatives around the world.

## CONCEPTUAL BACKGROUND

### INSTITUTIONAL DIVERSITY AND GROUNDWATER MANAGEMENT

Groundwater governance is complex, multi-faceted and fraught with several challenges and opportunities. Groundwater is characterized by high subtractability and often low excludability, where each person's use depletes what is left for others and access is hard to control. Hidden in underground aquifers, groundwater is a mobile resource with flows of recharge and discharge that are often not adequately understood (Meinzen-Dick et al., 2018). Consequently, the impact on other users is often unclear. In many places, groundwater is also contaminated (Shankar et al., 2011). Unresolved social dilemmas associated with the common pool resource nature of water often result in declining water availability and quality even if all users would be better off balancing withdrawals with recharge and keeping the water clean. Ultimately, what is needed is behaviour change. The question is how to motivate such changes.

Typical policy recommendation for managing water are water prices, licenses and restrictions on well drilling and water withdrawal, in other words establishing a strong set of laws and regulations that are supposed to apply to all users (Woodhouse & Muller, 2017). However, experience shows that it is often difficult to enforce externally imposed rules and regulations (Molle & Closas 2020, Janssen et al. 2023). Wells are often on private land, land and water rights are coupled, and use is hard to monitor or control.

India has a long-lasting history of community-based water management for surface irrigation (Vani, 2009), but these have rarely developed for groundwater. Surface irrigation has visible infrastructure and flows, with activities to operate and maintain the system connecting the users. By contrast, groundwater is less visible, users more dispersed, and users usually have no established activity to bring them together, though improving groundwater recharge or lobbying for government support sometimes offer an opportunity for collective action (Shah 2009). Thus, while local involvement in groundwater governance is needed, it has not emerged on a broad scale, nor have government agencies been effective, a situation which Shah (2009) refers to as anarchy.

Andersson and Ostrom (2008) highlight that addressing such challenges requires awareness of the polycentric nature of governance. Polycentric governance acknowledges that multiple authorities with overlapping jurisdictions each hold rights to establish, change and enforce rules within a specific domain of authority—even if they do not always do so. In most cases, water governance is de-facto polycentric. Focusing only on some and neglecting other authorities may risk or limit the potential for sustainable change.

### ANALYTICAL FRAMEWORK

We use the Institutional Analysis and Development (IAD) framework (Ostrom, 2011) to structure our reflections on the FES's systems approach to support polycentric water governance. IAD is a conceptual map of structural variables that shape institutional arrangements. In our simplified version of IAD, we focus on action situations, which are structured social spaces where actors learn, take decisions, and interact to create outcomes. The action

situation is shaped by the context including the biophysical environment, attributes of the community as well as the rules in use (governance arrangements). We acknowledge feedbacks from the outcomes to the action situations as well as the context (Ostrom, 2011). To show how FES intervenes in the action situation to change interactions and create more sustainable outcomes, we add an Intervention box (Figure 1).

## METHODS

We present a case study of a multi-methods systemic approach to groundwater governance and management in India. Based on the conceptual framework, the assessment started with collective reflection on the theory of change of the intervention strategy by the implementation team of FES, partners, and scientists at International Food Policy Research Institute (IFPRI). The entry points are the intervention outcomes, formulated as actor-specific behavioural change towards sustainable management of groundwater, including limiting demand and augmenting supply. The same group then mapped the different intervention mechanisms used to target these behavioural changes. To add depth to the assessment, FES team along with scientists at the IFPRI formulated explicit behavioral assumptions that underly expectations that an intervention will lead to behavioural change. We then conducted an exercise to map the expected outcomes, revealing the interwoven effects of the interventions (figure presented in the Discussion section). We combine qualitative insights of field staff with monitoring and evaluation data of the implementing organization, and findings from related published studies. Our approach constitutes critical reflection and conceptualization, based on situated knowledge. The approach demonstrates a subjective perspective analysis of the case which contributes to designing better adapted and more powerful intervention strategies through informed arguments (Greenhalgh et al. 2018). The experience-based assessment demonstrates that the structured reflections based on conceptual thinking can guide the designs of intervention strategies.

## RESULTS: INTERVENTIONS, TARGETS, AND BEHAVIOURAL CHANGE

FES applies a systems approach that takes into account the interlinkages within socio-ecological systems. It does not see groundwater in isolation but promotes conjunctive use of surface and groundwater for irrigation, with both supply and demand-side interventions. The approach combines various strategies like harnessing data and information technology for informed decision making with experiential learning, capacity building, multi-actor platforms, partnerships, participatory planning and monitoring, strategic communication, and influencing policy and program spaces.

Behavioural change—i.e., a long-lasting change in the way people act—requires clarity about which actors need to change which behaviour. For the analysis in this paper, we are focusing on behavioural change of actors in two action arenas: firstly, a local action arena at the community level that focuses on the direct and indirect interactions especially of farmers, community leaders, and local government; secondly, a wider arena that includes actors at multiple scales. Clarifying the behaviour assumptions at both these levels and the interaction between these arenas is important. The next section discusses how different strategies and tools are combined in the two action arenas.

### INTERVENTIONS TARGETING LOCAL COMMUNITIES

The government, private sector, and civil society often address the country's water shortage using supply-side interventions (Shah et al., 2003). Production is increased by expanding the area under irrigation through subsidising energy supply for pumping, constructing and rehabilitating

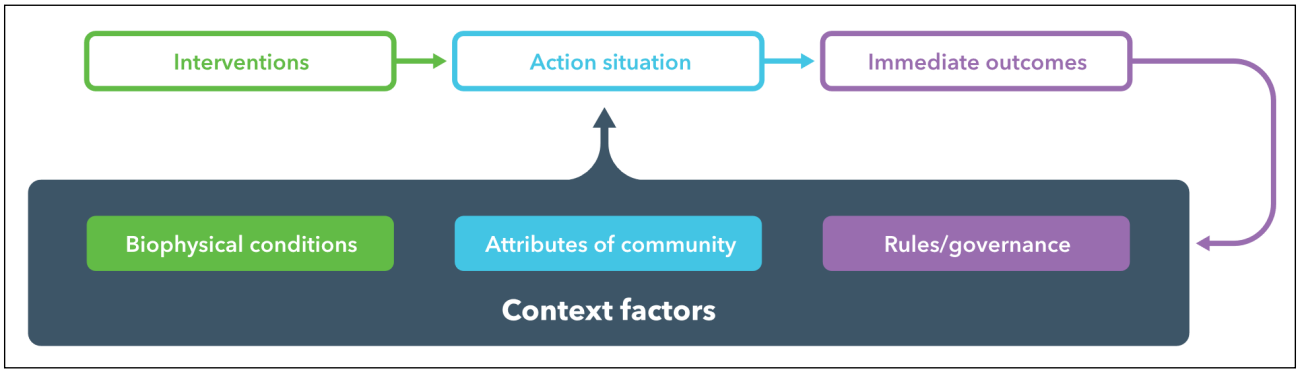


**Figure 1** Conceptual framework for assessing a system approach to support polycentric water governance (Based on Ostrom, 2011).

water harvesting structures, or redistributing water through canals (Bhattarai et al., 2021). This results, however, in an acceleration of water use further contributing to the water crisis (Shah et al, 2021). Further, as water rights are associated with land rights, groundwater is often perceived as a private property, allowing unregulated extraction by individuals who own the land.

As agricultural groundwater use is responsible for the major share of groundwater extraction in India, FES intends to change the behaviour of farmers and local communities, who directly use the water by promoting sustainable demand management practices such as growing water efficient crops and varieties and supply augmentation through water harvesting. The strategies for influencing these actors include social learning, improving access to information for better decision making, and capacity building. These are targeted through experiential learning tools, collective groundwater monitoring, crop water budgeting, participatory planning for leveraging government programs and capacity strengthening of community resource persons and government frontline workers in different sectors. Influencing local leaders plays an important role in catalysing this process. The following section describes the mechanisms of different tools and strategies for shifting behaviour towards sustainable groundwater governance and management.

### Collective resource monitoring through Groundwater Monitoring Tool (GWMT)

The GWMT, an open-source mobile application, enables community involvement in collecting water level data of wells and collation on a web platform. FES mobilises community members twice a year to record data on the water depth measured with a tape and GPS coordinates for up to three wells per village in the app (for details see: https://www.indiaobservatory.org.in/tool/gmt). The wells are geotagged, allowing monitoring the same wells over time. With the help of community facilitators, the data is turned into maps that illustrate the trend of water levels for the communities pre- and post-monsoon (view the dashboard at: https://wmt.indiaobservatory.org.in/dashboard/map-dashboard). With the help of various partner organizations, around 40,000 wells have been monitored across 11 states of India as of 2023.

The exercise gives visibility to the groundwater resources, allowing communities to gauge water level trends over the years. By being able to monitor the resource, the community gains improved knowledge about the changing water situation, stimulating discussion on factors responsible for these changes, including how individual actions affect the resource base. The 'visibility' of the resource supports deliberation on groundwater issues and enables collective action for water governance. The ultimate intended behaviour shift is discussion on evolving norms and rules for better groundwater governance at the community level.

### Experiential learning games and debriefings

Experiential learning games and debriefings are simulations of real-world social dilemma on groundwater extraction for irrigation. The targeted actors are farmers and village leaders. The players can choose between a water intensive and a water efficient crop. If everyone uses groundwater for water-consumptive crops to increase their short-term incomes, water tables fall, threatening the long-term viability of the whole system of groundwater irrigation. The games are followed by a debriefing session where all members of the village are invited to discuss the game, connect it to their real-life water management challenges, and develop ideas for possible management and governance strategies. (For details of the game, see https://gamesforsustainability.org/practitioners/#groundwater-game).

Games and debriefing are intended to influence the behaviour of farmers by reinforcing the understanding of water as common pool resources, of the interlinkages between groundwater and crop choice, and of the mutual influence of individual decisions, activating equity norms, and allowing the community members to experiment with rules and regulations for self-governance. Experiencing how these choices affect the water table over multiple rounds of play enables the participants to see trade-offs between their short-term benefits and long-term sustainability. The debriefing or subsequent village meetings provide space for social learning in the community and wider changes, such as adopting rules for groundwater.

In 2013 and 2014, a study in Andhra Pradesh compared members of 17 randomly selected communities where the groundwater game was played with members of nine control communities. One year after the intervention, respondents in treated communities more likely reported beliefs supporting sustainable water management than respondents in control communities. In addition, treated communities more likely introduced water registers or groundwater management-related rules compared to control sites (Meinzen-Dick et al. 2018).

Subsequently, games were rolled out in an additional 184 communities between 2014 and 2017. A Social Return on Investment Assessment undertaken in 40 sample villages showed that the communities treated with games, crop water budgeting and other supply side interventions were more appreciating and affirming groundwater as a

shared resource, evolving rules such as ban on drilling of borewells for irrigation and sharing of water from wells. In 2017–18, more than 1100 farmers were reported to have shifted to water saving agricultural practices subsequent to the interventions ([FES 2016, 2017, 2018). Between 2020 and 2023, the games were rolled out in 1779 additional communities by FES and in 4802 communities through various partners.

### Crop Water Budgeting (CWB)

The CWB tool assists communities to balance water demand especially for irrigation with supply through rainfall, stream flows, and surface water storage using a mobile application. Through a participatory exercise, community members collectively determine whether the community will have deficit or surplus. If there is deficit water availability for the present cropping plan, the community members discuss possible crop changes to avert water deficits. (For details see https://www.indiaobservatory.org.in/tool/cwb).

The CWB exercise creates shared knowledge of water availability vis-à-vis demand for various uses. It raises awareness for interactions between farmers' crop choices and brings these decisions from the individual to the collective domain. This helps farmers develop shared strategies towards more efficient and equitable water use. The intended behavioural shift is changes in cropping pattern towards more water efficient crops, jointly agreeing on community water allocation, sharing of water resources for equitable outcomes.

In the period between 2014–2019, FES monitored a 20% sample of farmers who adopted the practices (4,389 total) from 266 habitations across four states. Based on comparing these farms with control plots, an estimated 6,504 million litres of water and 148,464 pumping hours were saved because of better water allocation and shifts to water efficient crops (monitoring system maintained by FES). Between 2020 and 2023, Crop Water Budgeting has been rolled out in 5424 villages through direct interventions and partners.

### Sensitization to leverage government funds

Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) is a large-scale government program with dual focus on improving rural livelihoods through creation of durable assets and strengthening local governance. MGNREGS allows communities to demand financial support for investments in construction and maintenance of natural resource management assets on public and individual lands.

FES helps communities to effectively leverage MGNREGS for maintaining water harvesting structures and treating the catchment areas of watersheds by mobilizing communities for planning, getting government approval, and strengthening the capacity of community members to oversee implementation of MGNREGS works.

The targeted behaviour changes are that communities set priorities for MGNREGS investments supporting sustainable groundwater use, developing rules for water sharing and maintenance of structures. Community participation is important to ensure that the quality of works will be high, and structures will be maintained. By focusing water assets on community lands and ensuring community participation, a wider number of people benefit from the investments through improved groundwater recharge. From 2018–2023, around 41.89 million USD[1] have been channelled through MGNREGS for land restoration and creation and repair of water harvesting structures in 12 blocks in seven states through the efforts of FES and partners (MGNREGA website https://nreganarep.nic.in/netnrega/MISreport4.aspx).

## SCIENTIFIC AND PARTICIPATORY PLANNING THROUGH COMPOSITE LANDSCAPE ASSESSMENT AND RESTORATION TOOL (CLART)

CLART is a GIS-based android application developed to plan for soil and water management (see https://www.indiaobservatory.org.in/tool/clart). Based on biophysical features of the area under consideration (e.g., topography, soil and rock type, recharge potential, surface and sub-surface flows), CLART proposes which type of water harvesting structures are most suitable at which location, along with cost estimates for proposed investments. Recommended interventions are visualized with colour codes on maps which semi-literate people can easily decipher, enabling their participation in a context where education levels are low. CLART is targeted to aid local planning authorities such as panchayat functionaries, trained community leaders or community resource persons who are involved in planning interventions to take informed decisions on construction and maintenance of water recharge and harvesting structures.

CLART facilitates joint participation of technical experts and the community in the planning of works, which eventually results in increased water supply. It enables scientific planning of structures by considering hydrological and lithological parameters, contributing to improving the efficiency of structures and preventing poorly planned structures from being built. The proposed plan for the activity, along with the estimated budget can then be downloaded for further action, such as through including them in MGNREGS (see https://www.indiaobservatory.org.in/tool/clart-det). Importantly, this enables communities to

take informed decisions and brings them into the center of decision making instead of relying exclusively on engineers. Participation in planning activities establishes planning authorities regarding use of public funds and enables the communities to monitor the implementation of the work, creating transparency and accountability.

The Governments of Karnataka (Department of Water Resources), Chhattisgarh (Panchayati Raj & Forest Departments), Odisha (Panchayat Raj and Agriculture Departments), Rajasthan (Udaipur Zila Parishad), Andhra Pradesh (Panchayat Raj Department), and Meghalaya (MGNREGS and several other programs), have been using CLART for planning of works. By 2023, 350,000 water assets have been planned in six states covering more than 21,000 villages using CLART. The governments of Karnataka, Andhra Pradesh and Meghalaya have institutionalised the tool for planning in their current programs.

### Develop capacity of community resource persons (CRPs) and government cadres

Improving water management requires both technical and institutional expertise that is often lacking at the local level. To bridge this gap FES provides training to community resource persons (CRPs) and frontline workers in technical skills, groundwater governance, and facilitation of effective communication and collaboration. This includes understanding resource mechanisms, collecting and analysing data, and aiding in informed decision-making processes. FES trains CRPs, who are nominated and paid by the community organization responsible for the management of resources based on the terms of reference prepared with the community organization. They act as intermediaries, helping communities make sense of the collected data and providing support for informed decision-making, and play a key role in facilitating interventions such as games and CWB, which promote participatory approaches to water management. Additionally, they share information with citizens regarding sustainable agriculture measures and other relevant practices. From 2020 to 2024, FES trained 1086 CRPs (including 386 women) in five states, who became key functionaries in water governance related activities.

In addition, FES trains government field staff working at the local level. For example, in Odisha, FES partnered with the state government to develop the capacity of local functionaries of the Odisha Livelihoods Mission in facilitating participatory development of water governance and sustainable agriculture practices including water demand and supply interventions. From 2020–2023, 4330 local functionaries (including 2496 women) received training. By inclusion in programs that provide additional resources for implementation, it increases the likelihood that the trainees can apply the lessons.

## INTERVENTIONS TARGETING HIGHER-LEVEL ACTORS

Influencing actors with influence beyond the local communities can be instrumental to change water users' behaviour. Laws, policies, regulations, and how they are implemented provide incentives, disincentives, and action resources that influence how water users manage the resources. FES therefore collaborates with political decision makers, government actors, NGO partners, private sector representatives, donors, research, and academic organisations. In the section below, we describe some of the approaches used to influence the actors in the wider arena, which behavioural changes of these groups are envisioned, and how they can be achieved.

### Multi-actor Platforms (MAPs) and bilateral interactions

FES supports MAPs at the subdistrict (block/taluk) level to facilitate more responsive, inclusive, and equitable decision-making. MAPs create space for several stakeholders, including village federations (a collection of villages), NGOs, civil society organizations, local governments and departments, and private entities to exchange expertise, views, and perspectives, deliberate, build a shared vision, identify opportunities for collaboration, cross-learn and raise awareness about the need for joint action. MAPs also provide opportunities for bilateral interaction between different actors convened. By bringing together actors from different organisations at the subdistrict level, MAPs aim to foster convergence in planning and decision-making processes, especially related to implementation of policies related to water and other resources.

The most important intended behaviour change is to enable and encourage aforementioned stakeholders to coordinate actions towards improving water governance and management at large scale. The MAPs aim to shift water governance towards a more collaborative and coordinated approach.

FES has established six MAPs at the sub-district level in Rajasthan, Madhya Pradesh, Gujarat, Odisha and a state level MAP in Nagaland. A study of two MAPs (in Gujarat and Odisha), provides insights on the tangible and intangible benefits of multi-stakeholder engagements (ElDidi et al., 2024). The MAPs facilitated inter-community collaboration and learning, strengthening local voices, and building trust between stakeholders over time. By including diverse authorities, it enabled changes in the polycentric water governance space on the landscape level. The cases also

highlight how external actors like NGOs play important roles as facilitators and through mobilizing communities to help them claim their agency. MAPs in Gujarat and Rajasthan have taken up issues of water governance at the subdistrict level. The Kadana MAP of Gujarat carried out block level vision building, and watershed planning for natural resource management. Village federations and government departments have collaborated to develop watershed development plans, including channelling MGNREGS for new water harvesting, rejuvenation of traditional surface water bodies like tanks, using tools like CLART.

### Building Coalitions

The different states that FES works in represent diversity in terms of resource systems, demographics, economic development, political will, and civil society engagement. This contextual diversity highlights different challenges and opportunities – and how these might be tackled through distinctive state-level approaches to systems change. To advance the agenda of sustainable water governance and improve coordinated planning, action and policy engagement, FES works towards strengthening coalitions and around cross-cutting issues such as resilient livelihoods, water management, gender inclusion, resource system integration and climate action. Through coalitions, FES intends to initiate a deeper narrative shift toward recognition of water as commons, with corresponding policy and programmatic attention to the finite nature of water, equitable access, and people's capacity to govern water.

Building coalitions is a more intense way of collaboration between FES and development partners, such as other civil society partners, government entities, private sector actors, and international development and research organisations. It shall support coordinated actions between these partners and FES.

FES facilitates field visits for policy makers, planners, donors, and NGOs working on water to areas where communities have successfully managed their water resources through local collective action and collaborative engagement with government and NGOs. These visits provide firsthand exposure to live examples of effective resource management, highlighting the significance of local-level engagement and collaborative action. By generating evidence, showcasing successful case studies, strategic communication, promoting knowledge sharing, and facilitating collaborations, the approach aims to create momentum for joint actions that contribute to improved water governance. In addition, FES provides geo-spatial and scientific planning using data and technology to coalitions.

As a result of these efforts, partnerships have been established with the State Governments of Rajasthan, Karnataka, Odisha, and Meghalaya to implement various water governance initiatives. In several states, the respective coalition is actively channelling efforts for policies on commons. In Rajasthan, a coalition of NGOs and CSO networks have come together to work with the government to strengthen MGNREGA implementation, with particular focus on demarcation and development of pastureland and water bodies, which has led to a draft Rajasthan State Policy on Commons that aims to give recognition for community rights over common lands (Puppala et al, 2015).

In Karnataka, government and civil society partners have come together to support convergence in the planning and implementation of the Jala Sanjeevini Programme aimed at improving water governance in the state. This engagement contributed to the Karnataka government allocating a budget of 69.23 million USD[2] in 2023–24 for restoring more than 20,000 hectares pastureland (Government of Karnataka, Rural Development Commissionerate https://shorturl.at/efpI4).

### Training civil society, government, and private sector actors in application of innovative approaches

Another strategy to influence key actors is the development of comprehensive training modules on water governance for NGO partners, government agencies, and private sector interested in working on water-related issues. The conceptual part of the training helps participants viewing water resources as shared assets that require collective responsibility and collaborative management. This section also emphasizes the interconnectedness of different resource systems and the need for holistic approaches to water governance. The practical part of the training equips participants with knowledge and skills related to various tools and approaches used for water governance. This includes techniques for community engagement, participatory decision-making processes, sustainable water management practices, mechanisms for resolving conflicts and ensuring equitable resource allocation, and the application of specific tools such as CLART, experiential learning games or crop water budgeting.

Such training programs have helped actors to apply the water governance tools and approaches on a larger scale. The MAPs and coalitions can create the basis for the training interventions. Convincing senior managers of organisations of the potential of the approaches is a key step to motivate them to train their staff in these innovative approaches and integrate use of the tools in large scale

government programs to improve local water governance and management. As an example, a partnership was established with the Government of India's Atal Bhujal Yojana (ABY) program, which aims at strengthening participatory management of groundwater in 8551 Gram Panchayats from 80 districts across 7 states. At the core of the program is strengthening community participation in groundwater management and behaviour change of water users. FES supports ABY in integrating local level behavioural change approaches into their intervention strategy.

In 2022, 3,624 government extension agents (55 percent women) from eight districts in Odisha participated in trainings on games, CWB, and sustainable agriculture practices. According to FES's monitoring data, 17 NGO or private partners and six government partners across India are actively using demand-side management tools such as CWB or water games. Six state governments are using CLART for better participatory planning of watershed interventions.

## DISCUSSION

An important aspect of FES's strategy is the acknowledgement of how interwoven the behaviour of different actors is. Different interventions target different actors but eventually, they are designed to lead to a change in water use. There are different intermediary outcomes, which again influence actors' behaviour leading to next level outcomes. The many arrows in Figure 2 illustrate the interconnections between actors and interventions. The interventions are not isolated but create a web of influences.

Sharing knowledge about the management challenges and social dilemmas related to groundwater is one critical mechanism to contribute to system actors' behavioural change. Especially the games and the crop water budgeting emphasise inequalities in fairness issues which is intended to activate relational values (Janssen et al. 2023). Strengthening intrinsic motivations for sustainable and fair water management, combined with growing awareness of the need to change management, policy, implementation, business, and support is, in turn, intended to affect individual multi-faceted actions of actors. The interactions of these individual actions create new dynamics in the system.

Nevertheless, leaving system change to uncoordinated individual actions would be risky and inefficient. Therefore, supporting collaboration among actors is another critical mechanism to improve water governance and management in a systemic way. Better understanding each other's interests and perspectives, for instance in the MAPs and as coalitions are built, can potentially create a sense of common goals and aligning each other's individual actions. It can also help in building on the complementary strengths of different actors. For example, one objective of building coalitions is to complement the strengths of government, civil society and research organizations to mobilize the government extension system to make use of innovative community development facilitation tools such as games or CWB. Once this mobilization is successful, lead extension officers may be willing to get their staff trained in these innovative approaches. Once this has been done, they can integrate use of the tools in large scale government programs, which in turn can motivate farmers and community leaders to improve local water governance and management.

But it is not all top down. For example, the Groundwater Monitoring Tool generates granular data on groundwater level. In the local sphere, this can be used by communities for monitoring their water resources and planning of local interventions. However, this is also generating information about groundwater on a large scale that is useful for multiple actors working in the system.

Combining interventions is essential. Information-based tools such as groundwater monitoring and crop water budgeting alone have proven to be ineffective if farmers are not motivated to use them or act on the basis of the information generated (Garduño et al., 2009). The games and debriefing increase that motivation by showing how the information can be useful, but the games alone would not provide enough guidance to act, such as on when and how farmers can reduce groundwater extraction or increase recharge; the informational tools provide that guidance. The combination of tools therefore is intended to contribute to knowledge, motivation, and agency [Bruns and Meinzen-Dick, this collection on Crafting combinations to govern groundwater].

Similarly, neither supply side nor demand side interventions alone will work. Demand management is necessary to reduce excessive groundwater withdrawals, but it is hard to motivate people to only cut back on use of such a critical resource. Judicious combination with supply side interventions to increase recharge, such as through using CLART to effectively mobilize MGNREGS resources for water harvesting structures can provide incentives for people to come together in managing the resource.

Even with these combinations of approaches, there is no guarantee of achieving the intended effect. FES has experienced many successes, but not universally across the areas where they have been working to address groundwater depletion. Different conditions must be fulfilled for achieving change. First, there must be a serious water management issue in the area. It is difficult to

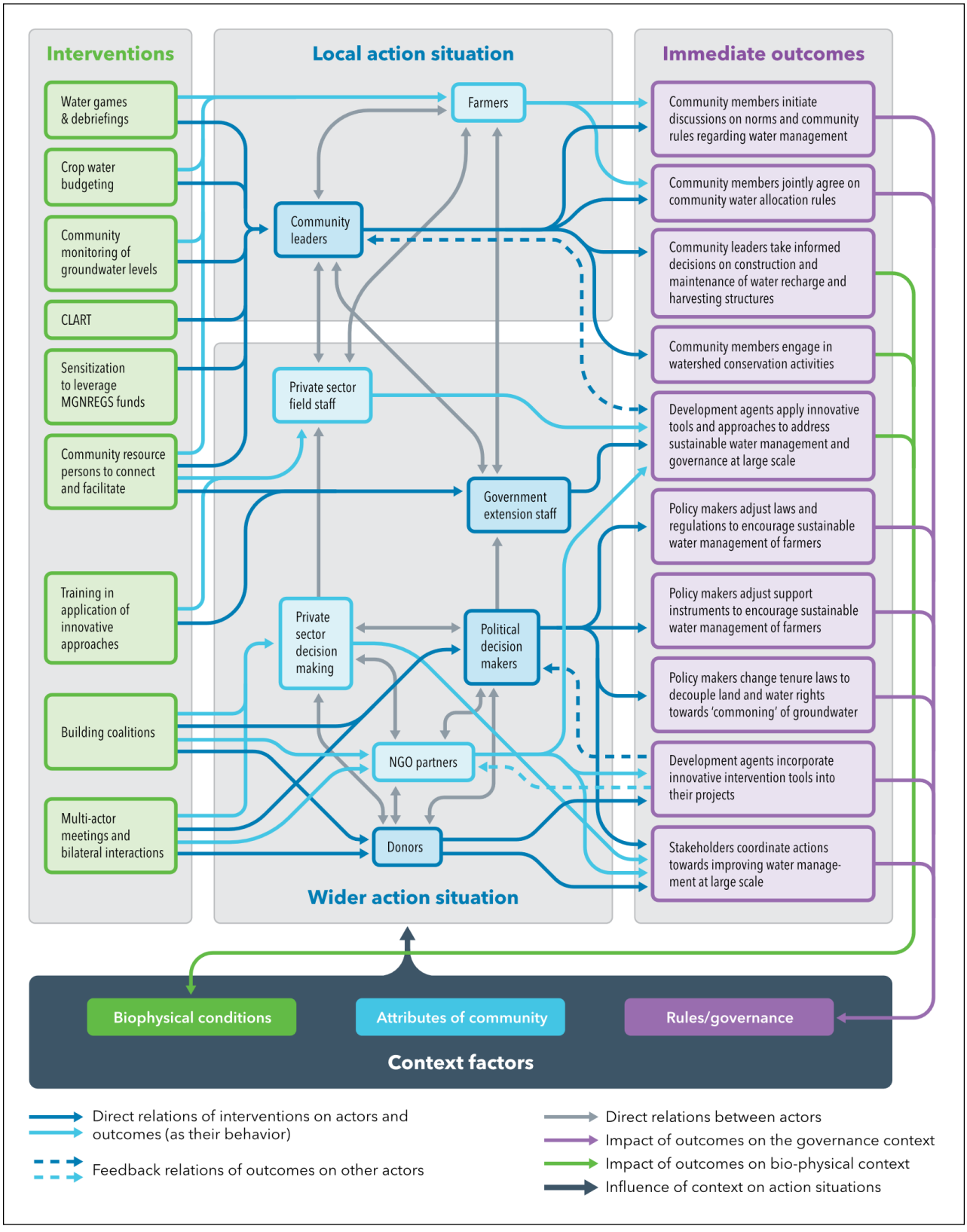


**Figure 2** Interconnections between actors and interventions.

create a sense of high priority if there is no evidence for the issue. Second, change is more likely if there are attractive opportunities to improve the situation. For instance, water harvesting must address at least temporal water needs or there must be cropping system options that can save substantial amounts of water but are not substantially less

profitable. FES and partners developed a rapid assessment tool for field facilitators to check these conditions and plan interventions according to the results of this rapid assessment. Third, implementation of the approach at the local level strongly depended on the establishment of the network of community resource persons and fostering spaces for peer-learning and responding to the challenges that they were facing during implementation. In the work with wider system actors, it is important to consider their interests and perspectives, and to identify people in the system who are open for transformative ideas and who are influential enough to trigger a debate in their organisation or sector. Especially, engaging with government officials at state and national levels and integrating the approaches for strengthening groundwater governance in the existing government programmes can help institutionalize these approaches and create a long-term impact. Generating evidence and improving visibility of water stewardship efforts can also play an important role.

Another challenge in the implementation of the approach are power imbalances. At the local level, the wealthy and influential are likely to have borewells and use the most groundwater; getting them to curtail their use is a challenge. The experiential learning and debriefing can help shape norms about equity and use, but without strong consensus, rules will not be adopted or enforced. Interactions with wider actors also have strong power dynamics, with government organizations having more influence than communities. NGOs such as FES can play a brokering role, and showing examples of how community engagement can contribute to the objectives of the government organizations can help find common ground for agreement.

Gender norms and women's workloads limit women's participation in public discussions. The experiential learning addresses this by having women and men play the groundwater game separately so that women gain experience and then calling on them to relate their experience in the community-level debriefing. Finding convenient times for women to attend the games and meetings remains critical. The MAPs have additional problems for women's participation because they require more time and travel, which is difficult for women. Efforts to arrange transport or ensuring that women eat first at MAP meetings can help, but do not fully overcome the barriers (ElDidi et al. 2024).

We acknowledge that water management happens in a larger context which needs to be considered. For instance, climate extreme indices show a positive trend across India and the vulnerability to precipitation extremes is likely to grow (Dash and Maity 2021, Kumar et al. 2021). This will increase the importance of reliable water supply even in the Kharif season. In addition, well-managed water harvesting structures can mitigate some negative effects of floods. Changes in relative agricultural commodity prices are another example, influencing incentives to grow water saving crops. The experience with the shocks of COVID-19 and Russia-Ukraine war confirmed the strong resilience of most Indian food systems, mainly as the result of strong government support systems (Varshney et al. 2023). However, the support price system also influences the profitability of water-consumptive vs water-saving crops. FES's interventions in the wider action arena also intend to influence such reforms.

## CONCLUSIONS

Groundwater depletion in India is a systemic problem. System change requires that different actors make changes in how they do their business. In the above analysis, by applying this systemic behavioural perspective to FES's work at multiple scales (from local to national) with different actors engaging with different resource systems, we examine which are the actors that need a behavioural shift and what strategies can affect their behaviour. How can they be motivated or enabled to change their behaviour toward sustainable resource management? This approach enables us to identify the specific assumptions about why actors behave the way they do. Identifying what drives their behaviours is key for developing powerful intervention strategies and to understand the pathways to influence changes in the wider system. FES's combination of approaches is the result of this assessment.

Ultimately, farmers' behaviour in using groundwater and communities' behaviour in developing and enforcing rules regarding groundwater, together with their construction and maintenance of water harvesting and groundwater recharge structures, will determine whether water tables are depleted. The interventions described here are designed to motivate those behavioural changes through improved understanding of the resource dynamics (through the groundwater monitoring and experiential learning) and tools to respond (e.g. CWB, CLART).

But effective groundwater governance requires a larger ecosystem of support, from trained community resource persons, capacity to use the MGNREGS resources, government policies, and programmatic interventions by government, NGO, and private sector programs. These different actors require different types of support and motivation to make these changes. Creating an actor network through MAPs provides a promising way to make these linkages explicit. Careful examination of the behavioural assumptions underlying each intervention can

identify gaps in the theory of change, and what may be required to make the pieces come together.

As important as these linkages are, the level of interactions makes it difficult to provide evidence of the effectiveness of each intervention. While monitoring and evaluation systems can document the delivery of interventions and the responses of different actors or the resource system itself, research is needed to more carefully analyse the conditions under which changes do or do not happen, and in critically questioning what can motivate or enable actors to undertake desirable behaviour.

What can others learn from FES's experiences in fostering groundwater governance? First, many of the local-level tools are available and can be directly applied in Indian states where FES works, or with minor modifications in other states and countries. But the bigger lesson is that no single tool will provide for sustainable groundwater use. A combination of supply and demand tools that provide technical information and social learning is needed. It is also necessary to identify the system of actors that can support groundwater governance at scale, and what they need to align their mental models, norms, and behaviour accordingly.

## NOTES

1 Rs 3,183,458,618; conversion rate = 76.2 average exchange rates between 2018–2023.

2 Rs 5,769,859,000; current conversion rate 1 USD = Rs 83.6.

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## COMPETING INTERESTS

The authors have no competing interests to declare.

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