

# Intersectional Barriers in Rural Water Governance: Gender, Educational Inequality, and Technocratic Exclusion in Grassroots Groundwater Management

<sup>1</sup>Haresh Vaghela, <sup>2</sup>Dr. Chirag P. Patel, <sup>3</sup>Dr. Jignesh B. Tala, <sup>4</sup>Kumarsawan Shakya,

<sup>5</sup>Harpalsinh Jadeja, <sup>6</sup>Dipti S. Kapuria

<sup>1456</sup>PhD Scholar, <sup>23</sup>Assistant Professor

<sup>1-6</sup>Department of Social Work, KSKV Kachchh University, Bhuj-Kachchh, Gujarat, India

**Abstract**—Participatory groundwater governance is premised on the assumption that community-based institutions facilitate equitable resource management and sustainable aquifer stewardship. However, formal participation does not necessarily translate into substantive decision-making authority, particularly for socially and educationally marginalized groups. This study examines gendered participation and potential epistemic exclusion in the implementation of the Atal Bhujal Yojana (Atal Jal) in Kachchh District, Gujarat, India. Drawing on administrative training records covering 2,206 capacity-building events and 49,551 participant attendances across 196 Gram Panchayats between 2021–2022 and 2024–2025, the study investigates variations in female participation across administrative locations and training modules. The analysis is informed by common-pool resource theory, feminist political ecology, intersectionality, and Agarwal’s framework of participatory exclusions. Reported findings indicate that female participants accounted for 25.11% of total recorded attendances, below the programme’s 33% institutional gender benchmark. Participation varied considerably across talukas, ranging from 18.71% in Anjar to 32.71% in Bhachau. Thematic disaggregation further indicates that female participation was relatively high in foundational sensitization and water-budgeting sessions but lower in technical and asset-intensive modules, including smart agriculture and domestic water efficiency. Field observations from 18 training sessions also suggest that physical attendance did not consistently translate into opportunities to operate monitoring equipment or engage directly with technical information. The findings identify a potential gap between institutional inclusion and substantive participation. The study argues that gender-responsive groundwater governance requires accessible pedagogical methods, meaningful technical responsibilities for women, context-sensitive training arrangements, and monitoring indicators that assess agency rather than attendance alone. These findings offer practical insights for strengthening inclusive and sustainable community-based resource governance.

**Index Terms**—Participatory groundwater governance, intersectionality, gender and water, Atal Bhujal Yojana, functional literacy, epistemic exclusion, feminist political ecology

## I. Introduction

Groundwater depletion constitutes a major environmental and developmental challenge, particularly in arid and semi-arid regions where livelihoods and domestic water security depend heavily on aquifer resources. India’s extensive dependence on groundwater, combined with decentralized extraction through privately controlled wells, complicates the regulation of withdrawals and the protection of shared aquifers (Famiglietti, 2014; Shah, 2009; World Bank, 2012). Conventional supply-oriented interventions have

increasingly been complemented by participatory approaches that emphasize community involvement, demand management, local monitoring, and collective responsibility for groundwater sustainability.

Participatory groundwater management draws substantially on common-pool resource theory. Ostrom (1990) demonstrates that communities can develop institutional arrangements for managing shared resources when appropriate rules, monitoring mechanisms, and collective decision-making processes are established. Nevertheless, decentralization does not automatically produce equitable participation. Community institutions operate within existing social hierarchies, unequal property relations, gender norms, and differences in educational opportunity. Consequently, the capacity to participate in resource governance may be distributed unevenly even when formal institutions are designed to be inclusive.

This problem is particularly significant for rural women. Women frequently undertake domestic water provisioning, household water management, sanitation-related activities, and livestock care. Yet their practical responsibilities do not necessarily provide equivalent access to decisions concerning groundwater extraction, agricultural irrigation, technical monitoring, or water infrastructure. Research on gender and water governance has documented the importance of examining how resource access and decision-making are shaped by gendered power relations rather than assuming that community participation is inherently egalitarian (Harris, 2006; Sultana, 2009, 2011; Zwarteveen, 1997).

The Atal Bhujal Yojana, implemented by the Government of India with World Bank assistance, provides a relevant institutional setting for examining these challenges. The programme promotes community-led groundwater management through Water Security Plans, institutional strengthening, public disclosure of groundwater information, and capacity-building activities. Its village-level institutional framework includes a minimum 33% female membership benchmark. Such provisions recognize the importance of women's inclusion in local water governance. However, membership requirements and training attendance are insufficient measures of substantive participation if women have limited opportunities to interpret groundwater information, operate monitoring instruments, or influence decisions.

This study examines the relationship between formal inclusion and substantive participation in grassroots groundwater management in Kachchh District, Gujarat. It draws on administrative records of training

activities across 196 Gram Panchayats and field observations from 18 training sessions. The analysis addresses three research questions:

1. To what extent did record female participation in capacity-building activities correspond with the programme's 33% institutional gender benchmark?
2. How did female participation vary across administrative locations and training modules?
3. What do field observations suggest about the relationship between educational accessibility, technical training, and women's substantive engagement in groundwater monitoring?

The study contributes to participatory resource-governance research by examining participation not merely as physical presence but also as an opportunity to acquire knowledge and exercise technical and institutional agency. It argues that equitable groundwater governance requires attention to the social and pedagogical conditions under which community members participate.

## **II. Theoretical Framework**

### **2.1 Common-Pool Resource Governance and the Myth of Community**

Common-pool resource theory provides a foundation for understanding collective groundwater management. Groundwater aquifers are difficult to govern exclusively through individual decisions because extraction by one user can affect the availability of water for others. Sustainable management therefore requires institutional coordination, reliable information, and mechanisms for collective action (Blomquist, 1992; Ostrom, 1990).

However, the effectiveness of community institutions depends partly on whose interests and knowledge shape collective decisions. Guijt and Shah (1998) and Mosse (1997, 2003) caution against treating communities as homogeneous entities. Differences in land ownership, economic resources, gender, and social status influence access to decision-making spaces. Decentralized institutions can reproduce these inequalities when existing elites retain disproportionate control over information and resources.

Accordingly, community participation should be examined in relation to the distribution of authority, knowledge, and opportunities to influence collective decisions.

## 2.2 Intersectional Feminist Political Ecology

Feminist political ecology examines how environmental governance is shaped by gendered power relations and unequal access to resources (Rocheleau et al., 1996). Intersectionality further emphasizes that gender interacts with other social positions, including class, caste, property ownership, and educational status, to produce differentiated experiences of participation (Nightingale, 2011).

In groundwater governance, these intersecting inequalities may influence who attends training, who can access technical information, and who is recognized as competent to manage monitoring equipment. Women's extensive involvement in domestic water management does not necessarily confer authority within formal institutions. Similarly, limited formal education may restrict access to numerical groundwater records, technical terminology, and scientific instruments.

Agarwal's (2001) framework of participatory exclusions is particularly useful for examining these processes. It distinguishes nominal and passive participation from more substantive forms involving consultation, active expression, and shared decision-making. This framework directs attention beyond institutional membership toward the actual opportunities available to participants to influence governance.

## 2.3 Technocratic Exclusion and Epistemic Agency

Groundwater management increasingly depends on technical knowledge, including water-level measurements, water-quality testing, groundwater budgeting, and interpretation of aquifer conditions. These practices are necessary for evidence-informed decision-making, but their presentation can create barriers when training relies heavily on written manuals, numerical calculations, and specialized terminology.

Research on groundwater governance in India demonstrates the importance of understanding how scientific knowledge and institutional practices interact with local power relations (Birkenholtz, 2008; Kulkarni et al., 2015). Building on this literature, the present study uses the concept of technocratic epistemic exclusion to describe circumstances in which technical formats and established social hierarchies restrict particular groups' opportunities to acquire, interpret, or apply resource-management knowledge.

The concept is used here as an analytical interpretation rather than a directly measured variable. The study examines whether recorded participation patterns and field observations are consistent with this interpretation.

### **III. Institutional Context and Methodology**

#### **3.1 Study Setting**

The study was conducted in Kachchh District in north-western Gujarat, India. The district is characterized by arid climatic conditions, variable rainfall, high evaporation, and recurrent water stress. Its groundwater systems include sandstone, limestone, basaltic, and alluvial formations, with local variations in aquifer characteristics and vulnerability (Central Ground Water Board & Ministry of Jal Shakti, 2020).

Agricultural irrigation, domestic requirements, and livestock-related water demand make groundwater an important resource for rural livelihoods. These conditions provide a relevant setting for examining the social dimensions of groundwater governance.

The study covered 196 Gram Panchayats across five talukas: Nakhatrana, Bhuj, Mandvi, Anjar, and Bhachau. Implementation was supported by two District Implementation Partners (DIPs). Arid Communities and Technologies (ACT) worked across Nakhatrana, Mandvi, Anjar, and Bhachau, covering 145 Gram Panchayats. Jan Kalyan Charitable Trust worked in Bhuj taluka, covering 51 Gram Panchayats.

#### **3.2 Programme and Training Activities**

Atal Jal promotes decentralized groundwater management through institutional strengthening, preparation of community-led Water Security Plans, disclosure of groundwater information, and implementation of water-management interventions. Capacity-building activities in Kachchh covered six principal thematic areas:

1. Utilization, operation, and maintenance of groundwater-monitoring equipment.
2. Groundwater information disclosure, leadership, and conflict resolution.
3. Efficient water use, smart agriculture, and scientific irrigation.
4. Domestic water efficiency, rooftop rainwater harvesting, and wastewater reuse.
5. Supply-side interventions and artificial groundwater-recharge structures.

6. Convergence with existing government schemes.

These modules differ in their emphasis on community mobilization, administrative coordination, technical measurement, agricultural practices, and infrastructure management. This variation provides an opportunity to examine whether female attendance differed according to training content.

### 3.3 Data Sources and Study Design

The study employed a quantitative descriptive and comparative analysis of administrative training records covering four fiscal years, 2021–2022 to 2024–2025. The dataset comprised 2,206 recorded capacity-building events and 49,551 participant attendances. The records included administrative location, implementing organization, training classification, event information, and gender-disaggregated attendance counts.

The unit of analysis for the aggregate attendance figures was recorded participant attendance, not necessarily a unique individual. The same person may have attended more than one event. Consequently, the total represents cumulative attendance rather than the number of distinct individuals reached by the programme.

Quantitative findings were contextualized through non-participant field observations conducted during 18 representative training sessions in Nakhatrana and Bhuj. These observations focused on the practical use of monitoring equipment and participants' engagement with technical demonstrations. The available methodological description does not establish a systematic interview sample or a formal qualitative coding procedure; accordingly, observations are used to contextualize the quantitative patterns rather than to estimate the prevalence of particular experiences.

### 3.4 Analytical Strategy

The reported analysis included descriptive frequency distributions, comparisons of female attendance across talukas and training modules, chi-square tests against the 33% benchmark, a chi-square test comparing participation across broad training categories, and a one-way analysis of variance (ANOVA) across administrative locations.

The 33% benchmark is an institutional membership requirement. Comparing training attendance against this benchmark provides a descriptive indication of the inclusion gap but does not, by itself, establish compliance or non-compliance with committee membership requirements. Attendance and institutional membership are distinct measures.

Likewise, statistical significance should be interpreted cautiously because the records may contain repeated attendance by the same individuals and observations clustered within events and Gram Panchayats.

## IV. Results

### 4.1 Overall Female Participation

Across 2,206 recorded training events, total attendance was 49,551, comprising 37,109 male attendances and 12,442 female attendances. Female participants therefore accounted for 25.11% of recorded attendance.

The manuscript reports a chi-square goodness-of-fit statistic of ( $\chi^2 = 384.12$ ), with one degree of freedom and ( $p < .001$ ), indicating a statistically significant difference from the 33% benchmark under the reported analysis. The observed female attendance share was approximately 7.89 percentage points below that benchmark.

This aggregate result identifies a substantial gap between the programme's institutional inclusion objective and the gender composition of recorded capacity-building attendance. However, the result should not be interpreted as direct evidence that all village water committees failed to meet their membership requirements. Such a conclusion would require committee-level membership data.

### 4.2 Variation Across Administrative Locations

Female participation varied considerably across the five talukas.

**Table 1. Gender-disaggregated training attendance across talukas**

| Taluka  | Gram Panchayats | Training events | Female attendance | Total attendance | Female share |
|---------|-----------------|-----------------|-------------------|------------------|--------------|
| Bhachau | 13              | 169             | 1,298             | 3,968            | 32.71%       |
| Mandvi  | 40              | 469             | 3,548             | 11,228           | 31.60%       |

|            |     |       |        |        |        |
|------------|-----|-------|--------|--------|--------|
| Nakhatrana | 73  | 823   | 4,238  | 18,758 | 22.59% |
| Bhuj       | 51  | 486   | 2,284  | 9,857  | 23.17% |
| Anjar      | 19  | 251   | 1,074  | 5,740  | 18.71% |
| Overall    | 196 | 2,206 | 12,442 | 49,551 | 25.11% |

Bhachau recorded the highest female attendance share at 32.71%, followed by Mandvi at 31.60%. Both locations approached the 33% benchmark. In contrast, Nakhatrana and Bhuj recorded female shares of 22.59% and 23.17%, respectively, while Anjar recorded the lowest share at 18.71%.

The reported one-way ANOVA indicated differences across administrative locations, ( $F(4, 2193) = 42.18$ ), ( $p < .001$ ). These differences suggest that female attendance was not uniform across the district.

The organizational figures provide additional context. ACT recorded an aggregate female attendance share of 25.59% across its four talukas, while Jan Kalyan Charitable Trust recorded 23.17% in Bhuj. The differences within ACT's geographical portfolio—from 32.71% in Bhachau to 18.71% in Anjar—indicate that organizational affiliation alone does not explain the observed variation.

The available records do not directly test the proposed explanations for these geographical differences. Variations in agricultural livelihoods, household responsibilities, local mobilization practices, and access to training may be relevant, but these explanations should be treated as hypotheses for further investigation rather than established causal findings.

### 4.3 Female Participation Across Training Modules

Thematic disaggregation reveals differences in female attendance across the training curriculum.

Table 2. Female participation by training module

| Training module                          | Female attendance | Total attendance | Female share |
|------------------------------------------|-------------------|------------------|--------------|
| Foundational sensitization and WMC roles | 1,047             | 3,145            | 33.39%       |

|                                                            |       |        |            |
|------------------------------------------------------------|-------|--------|------------|
| Water budgeting and Water Security Plan preparation        | 1,138 | 3,533  | 32.21<br>% |
| Government scheme convergence                              | 2,642 | 9,585  | 27.56<br>% |
| Equipment utilization and operation and maintenance        | 3,016 | 11,442 | 26.36<br>% |
| Data disclosure, leadership, and conflict resolution       | 1,525 | 6,008  | 25.38<br>% |
| Supply-side interventions and structures                   | 835   | 3,545  | 23.55<br>% |
| Efficient water use and smart agriculture                  | 887   | 4,555  | 19.47<br>% |
| Domestic water efficiency and rooftop rainwater harvesting | 746   | 3,897  | 19.14<br>% |
| Other or specialized local modules                         | 603   | 3,841  | 15.70<br>% |

Female attendance was highest in foundational sensitization and institutional-role sessions, at 33.39%, followed by water budgeting and Water Security Plan preparation, at 32.21%. These sessions were close to or above the institutional benchmark.

Female attendance was lower in several operational and technical modules. Equipment utilization and maintenance recorded 26.36% female attendance, while data disclosure and leadership recorded 25.38%. Participation declined further in supply-side interventions (23.55%), smart agriculture and efficient irrigation (19.47%), and domestic water efficiency and rooftop rainwater harvesting (19.14%). The other or specialized local category recorded 15.70%.

These patterns suggest that female attendance differed across the training curriculum. However, module-level percentages alone cannot establish that technical complexity caused lower participation. Scheduling, recruitment practices, participant eligibility, land ownership, training locations, and the composition of intended audiences may also have influenced attendance.

#### **4.4 Comparison of Broad Training Categories**

The manuscript grouped selected modules into non-technocratic process-oriented training and technocratic or asset-intensive training. Process-oriented modules recorded 7,355 female attendances out of 25,871 total attendances, equivalent to 28.42%. Technocratic and asset-intensive modules recorded 5,087 female attendances out of 23,680 total attendances, equivalent to 21.48%.

The reported chi-square test indicated an association between the broad training category and participant gender distribution, (chi square = 189.64), (df = 1), ( $p < .001$ ).

The difference between the two categories was 6.94 percentage points. This pattern is consistent with the proposition that women's participation may be more constrained in some technical and asset-oriented activities than in broader institutional and community-process sessions.

Nevertheless, the categories combine modules with different objectives, audiences, and delivery arrangements. The comparison therefore identifies an association rather than an isolated effect of technical complexity. The underlying data would need to be reanalysed using event-level information and appropriate controls to establish whether the pattern persists after accounting for other differences.

#### **4.5 Observations on Technical Engagement**

Field observations from 18 training sessions in Nakhatrana and Bhuj provide contextual insight into the distinction between attendance and practical engagement. Training activities included demonstrations involving water-level sounders, piezometers, rain gauges, and field test kits used for water-quality assessment.

According to the observations, male Bhujal Jankars, educated village youth, and Panchayat personnel frequently retained control of monitoring instruments and measurement records. Female participants were

sometimes positioned as observers rather than active users of equipment. When asked to interpret numerical measurements, some women deferred to participants perceived as more technically competent.

The observations also indicate that female participants occasionally handled water-quality testing materials, while formal recording and reporting remained with male officials. If this pattern is representative, participation in practical tasks did not necessarily confer equal authority over the production and communication of technical knowledge.

## **V. Discussion**

### **5.1 Formal Inclusion and Substantive Participation**

The principal finding is the difference between aggregate female attendance and the programme's 33% institutional benchmark. With women accounting for 25.11% of recorded attendance, the training records reveal an inclusion gap at the level of participation in capacity-building events.

This finding reinforces the distinction between formal opportunities to participate and the ability to influence collective decisions. Agarwal's (2001) framework suggests that participation should be assessed through the opportunities people have to speak, contribute knowledge, undertake responsibilities, and influence institutional outcomes. Attendance records provide useful information about physical presence, but they cannot independently demonstrate active or empowering participation.

The study therefore cautions against using numerical representation as the sole indicator of inclusive groundwater governance. Membership requirements remain important, but their effectiveness depends on whether members can exercise meaningful roles within institutional and technical processes.

### **5.2 Gendered Differences Across Technical Activities**

The lower female attendance recorded in smart agriculture, domestic water efficiency, and other specialized modules indicates that participation differed across programme activities. This pattern is consistent with research showing that gendered resource relations influence access to agricultural knowledge and water-management institutions (Birkenholtz, 2008; Meinzen-Dick et al., 1997).

Two possible mechanisms deserve attention. First, agricultural training may be organized around land ownership, formal decision-making authority, or established extension networks. Where these arrangements

privilege landholders, women involved in agricultural work may have fewer opportunities to attend or participate. Second, training schedules and locations may conflict with domestic and care responsibilities, limiting women's availability even when the content directly concerns household water management.

The present dataset does not directly measure land ownership, time use, or recruitment criteria. These mechanisms should therefore be treated as theoretically informed explanations requiring further empirical testing. Nonetheless, the observed differences demonstrate the importance of investigating how institutional arrangements shape access to different forms of training.

### **5.3 Educational Accessibility and Epistemic Exclusion**

The field observations suggest that formal attendance does not always translate into technical engagement. Where practical exercises rely on numerical measurements, written registers, or specialized terminology, participants with limited confidence in formal literacy may be less likely to handle equipment or interpret results publicly.

This interpretation aligns with feminist political ecology, which emphasizes that environmental knowledge is produced and recognized within unequal social relations (Nightingale, 2011; Rocheleau et al., 1996). Technical expertise is not distributed solely through individual ability; it is also shaped by opportunities for training, access to instruments, and institutional recognition.

The concept of technocratic epistemic exclusion helps explain how ostensibly neutral procedures may disadvantage participants who have had fewer opportunities for formal education. However, literacy should not be treated as a proxy for competence. Practical experience, local environmental knowledge, and experiential learning can provide valuable foundations for groundwater monitoring. Training systems should therefore make technical knowledge accessible without lowering scientific standards.

### **5.4 Implications for Decentralized Governance**

The findings suggest that the effectiveness of participatory groundwater programmes depends on more than the establishment of local committees and the delivery of standardized training. It also depends on how technical responsibilities are allocated, whether information is accessible, and whether participants have opportunities to use what they learn.

Public disclosure of groundwater information, for example, is meaningful only when community members can interpret and apply the information to local decisions. Similarly, training equipment that is demonstrated but rarely handled by some participants may provide limited opportunities to develop independent technical competence.

The policy challenge is consequently to integrate inclusion into the design and evaluation of groundwater governance rather than treating it as a separate attendance target.

## **VI. Policy Implications**

### **6.1 Adopt Accessible and Experiential Training Methods**

Training programmes should combine written technical materials with visual demonstrations, pictorial guides, colour-coded representations, locally understandable measurement examples, and supervised practical exercises. Water budgeting can be taught using physical models and locally familiar units before participants progress to numerical calculations.

Such methods should supplement, rather than replace, accurate scientific measurement. Their purpose is to broaden access to technical learning and enable participants with different educational backgrounds to engage confidently with groundwater information.

### **6.2 Expand Women's Access to Technical Responsibilities**

Programme implementers should ensure that women have structured opportunities to operate monitoring equipment, conduct water-quality tests, record observations, and present findings in village meetings. Dedicated training opportunities and mentoring may help participants develop confidence and technical proficiency.

The proposed development of trained female community-based groundwater monitors, or Mahila Bhujal Jankars, offers one possible pathway. Where these roles involve regular operational responsibilities, appropriate compensation, equipment access, and institutional recognition should be considered to avoid transferring additional unpaid work to women.

### 6.3 Adapt Training Schedules and Locations

Training should be planned in consultation with intended participants. Flexible timings, accessible venues within village settlements, advance communication, and coordination with local women's groups may reduce practical barriers to attendance.

Women-only preparatory meetings or Mahila Jal Sabhas could provide an additional forum for discussing water-related concerns and developing proposals before broader village deliberations. These arrangements should complement, rather than replace, women's participation and decision-making authority in formal village institutions.

### 6.4 Measure Agency Alongside Attendance

Monitoring systems should distinguish among institutional membership, training attendance, practical competence, and decision-making influence. Potential indicators include the proportion of women who independently operate monitoring equipment, contribute to groundwater data interpretation, present findings at village meetings, and participate in documented resource-allocation decisions.

These indicators should be developed through consultation with community members and assessed using transparent procedures. Programme evaluations should also examine differences across social groups and locations rather than relying exclusively on district-level averages.

## VII. Limitations and Future Research

This study has several limitations. First, administrative records measure cumulative attendance rather than unique individuals. Repeated participation may therefore influence aggregate estimates. Second, the 33% benchmark concerns institutional membership, whereas the principal outcome analysed here is training attendance. The comparison identifies a participation gap but does not directly measure committee-level quota compliance.

Third, the reported statistical analyses require verification using the underlying event-level data. In particular, repeated attendance and clustering within Gram Panchayats may affect conventional significance tests. Future analyses should account for clustering and distinguish between event-level participation rates and individual-level participation wherever identifiers are available.

Fourth, field observations were limited to 18 sessions in two talukas. The available methodological documentation does not establish a systematic qualitative sampling or coding procedure. Consequently, the observations provide context but cannot establish the prevalence of epistemic exclusion across all programme locations.

Finally, the analysis does not directly measure literacy, household responsibilities, land ownership, participant selection, or decision-making authority. These variables are important for evaluating the mechanisms proposed in the discussion. Future research could combine administrative records with structured observations, interviews, participant-level surveys, and longitudinal assessments of technical competence and institutional influence. Such research would help determine whether more accessible training and targeted institutional interventions improve women's substantive participation.

## **VIII. Conclusion**

This study examined gendered participation in grassroots groundwater governance under the Atal Bhujal Yojana in Kachchh District, Gujarat. Analysis of 2,206 capacity-building events and 49,551 participant attendances revealed an overall female attendance share of 25.11%, below the programme's 33% institutional gender benchmark. Substantial geographical variation was also observed, with female attendance ranging from 18.71% in Anjar to 32.71% in Bhachau.

Participation differed across training modules. Foundational sensitization and water-budgeting sessions recorded comparatively high female attendance, while smart agriculture, domestic water efficiency, and other specialized modules recorded lower shares. Field observations further suggest that physical presence did not always translate into opportunities to operate monitoring equipment or exercise authority over technical information.

Taken together, these findings highlight the limitations of assessing inclusion through attendance alone. They are consistent with the proposition that gendered social relations, educational accessibility, and the organization of technical learning may shape participation in decentralized groundwater governance. However, these mechanisms require further investigation using direct measures of literacy, resource ownership, training access, and decision-making authority.

Strengthening inclusive groundwater governance requires institutional representation to be accompanied by accessible technical education, equitable opportunities for practical engagement, responsive training arrangements, and evaluation systems that measure substantive agency. Such measures can help community-based programmes move beyond formal participation toward more equitable and informed collective resource management.

## References

- [1] Agarwal, B. (2001). Participatory exclusions, community, and gender: Access to, and control over, public assets. *World Development*, 29(10), 1623–1648.  
[https://doi.org/10.1016/S0305-750X\(01\)00075-9](https://doi.org/10.1016/S0305-750X(01)00075-9)
- [2] Birkenholtz, T. (2008). Contested waterscapes: Gender and socio-spatial practices of water governance in Rajasthan, India. *Geoforum*, 39(1), 466–480.  
<https://doi.org/10.1016/j.geoforum.2007.09.003>
- [3] Blomquist, W. (1992). *Dividing the waters: Governing groundwater in southern California*. ICS Press.
- [4] Central Ground Water Board, & Ministry of Jal Shakti. (2020). *Atal Bhujal Yojana (Atal Jal): Program guidelines* (Version 1.1). Government of India.
- [5] Famiglietti, J. S. (2014). The global groundwater crisis. *Nature Climate Change*, 4(11), 945–948.  
<https://doi.org/10.1038/nclimate2425>
- [6] Guijt, I., & Shah, M. K. (Eds.). (1998). *The myth of community: Gender issues in participatory development*. Intermediate Technology Publications.
- [7] Harris, L. M. (2006). Spatializing gender, gender uninterrupted: Gendered spaces, gendered waters, and global change. *Feminist Studies*, 32(1), 121–153.
- [8] Kulkarni, H., Shah, M., & Vijay Shankar, P. S. (2015). Shaping the contours of groundwater governance in India. *Journal of Hydrology: Regional Studies*, 4, 172–192.  
<https://doi.org/10.1016/j.ejrh.2015.04.004>

- [9] Management Information System Training Records. (2021–2025). *Current event all training dataset and district IEC analytics for Kachchh District* [Unpublished raw dataset]. Department of Agriculture / Gujarat Water Resources Development Corporation, Government of Gujarat.
- [10] Meinzen-Dick, R., Brown, L. R., Feldstein, H. S., & Quisumbing, A. R. (1997). Gender, property rights, and natural resources. *World Development*, 25(8), 1303–1315. [https://doi.org/10.1016/S0305-750X\(97\)00037-1](https://doi.org/10.1016/S0305-750X(97)00037-1)
- [11] Mosse, D. (1997). The ideology and politics of community participation: Tank-irrigation development in colonial and contemporary South India. *Development and Change*, 28(3), 467–504. <https://doi.org/10.1111/1467-7660.00051>
- [12] Mosse, D. (2003). *The rule of water: Statecraft, ecology and collective action in South India*. Oxford University Press.
- [13] National Program Management Unit. (2022). *Curricular guidelines and modules for Gram Panchayat level technical capacity building under Atal Bhujal Yojana*. Ministry of Jal Shakti, Government of India.
- [14] Nightingale, A. J. (2011). Bounding difference: Intersectionality and the material production of gender, caste, and class in Nepal. *Geoforum*, 42(2), 153–162. <https://doi.org/10.1016/j.geoforum.2010.03.004>
- [15] Ostrom, E. (1990). *Governing the commons: The evolution of institutions for collective action*. Cambridge University Press.
- [16] Rocheleau, D., Thomas-Slayter, B., & Wangari, E. (Eds.). (1996). *Feminist political ecology: Global issues and local experiences*. Routledge.
- [17] Rodell, M., Famiglietti, J. S., Wiese, D. N., Reager, J. T., Beaudoin, H. K., Landerer, F. W., & Lo, M. H. (2018). Emerging trends in global freshwater availability. *Nature*, 557(7707), 651–659. <https://doi.org/10.1038/s41586-018-0123-1>
- [18] Shah, T. (2009). *Taming the anarchy: Groundwater governance in South Asia*. Resources for the Future Press.

- [19] Sultana, F. (2009). Fluid lives: Subjectivities, gender and water in rural Bangladesh. *Gender, Place & Culture*, 16(4), 427–444. <https://doi.org/10.1080/09663690903003942>
- [20] Sultana, F. (2011). Suffering for water, suffering from water: Emotional geographies of resource access, control and conflict. *Geoforum*, 42(2), 163–172. <https://doi.org/10.1016/j.geoforum.2010.12.002>
- [21] van Steenberg, F. (2006). Promoting local management in groundwater. *Hydrogeology Journal*, 14(3), 380–391. <https://doi.org/10.1007/s10040-005-0451-8>
- [22] World Bank. (2012). *Deep wells and prudent spenders: Investing in groundwater management in India*. <https://doi.org/10.1596/978-0-8213-9494-0>
- [23] Zwarteveen, M. Z. (1997). *Water: Unraveling the gender issues* (IWMI Research Report 14). International Water Management Institute. <https://doi.org/10.3910/2009.14>