Industrial Water Use and Women's Capabilities in Bengaluru Rural

A business ethics inquiry into water security and household adaptation

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Critical integrative review and conceptual analysis with a proposed empirical study

Abstract

Water stewardship is commonly communicated through withdrawals, recycling, efficiency and replenishment. These measures are necessary, but cannot establish whether people living around an industrial operation retain reliable access to water or meaningful control over their time. This paper develops a capability-based account of the gendered burdens of adapting to water insecurity, using Bengaluru Rural as a proposed research setting. It brings official groundwater and rural water-service assessments into conversation with the capability approach, gender and water scholarship, corporate disclosures and human rights standards. The evidence establishes a water-stressed setting and reasons to investigate household adaptation; it does not establish that a particular manufacturer caused women's deprivation. Indeed, official estimates identify irrigation as the dominant recorded groundwater use in the district's four taluks. The paper therefore distinguishes direct extraction, purchased water, public allocation and pollution as separate causal pathways. Apple provides an information-rich disclosure case rather than a proven case of local harm. The principal contribution is a framework connecting corporate water decisions to involuntary household labor, temporal autonomy, substantive participation and remedy. A proposed mixed-method study would test these relationships through hydrological source tracing, repeated household observation and participatory research. Ethical water stewardship should demonstrate whose opportunities improve, who continues to bear adaptation costs and how affected people can challenge and change water decisions.

Keywords: water security; women; business ethics; capability approach; unpaid labor; Bengaluru Rural; corporate accountability

1 The research problem

A factory can improve its water efficiency while a woman in its wider supply area spends more time securing water. This is a possibility to investigate, not a conclusion that follows automatically from industrial growth. It matters because the units used to describe corporate success and household well-being are different. A volume of water saved does not reveal whether a woman can leave home for a predictable work shift, attend a meeting, obtain adequate drinking water or rest without waiting for a tanker. The ethical question is how production decisions affect these opportunities, through which mechanisms, and with what responsibilities for prevention and repair.

The proposed inquiry asks: **Under what conditions do industrial water arrangements transfer the work and cost of adaptation to women, and what would count as adequate corporate responsibility for the resulting loss of capabilities?** The phrase “industrial water arrangements” deliberately includes more than a factory's borewell. Water may arrive through public infrastructure, private tankers, suppliers or off-site sources. Its acquisition may affect household access through allocation, price, reliability or quality as well as through groundwater levels.

The central argument is that water insecurity can operate as a transfer of adaptation burdens. Institutions and businesses maintain continuity partly because households compensate for unreliable services. Someone waits for supply, stores water, cleans containers, coordinates deliveries, negotiates payments and rearranges care. If gender norms assign this work disproportionately to women, apparently modest service failures can restrict their choices substantially. Such work can remain invisible in both a factory's water accounts and a household-level access statistic.

This argument does not assume that industrial employment and women's well-being are incompatible. Manufacturing may provide income, technical skills, infrastructure and greater independence. The research must examine these benefits alongside burdens, including whether the same women receive the benefits and bear the costs. An employment opportunity is less valuable if unreliable water makes regular attendance impossible. Conversely, improvements in wages, services and household bargaining power could expand capabilities despite growing industrial demand. Both possibilities belong in the analysis.

The intended contribution to business ethics is therefore more specific than a general appeal for corporate social responsibility. It identifies a potentially overlooked mechanism of harm, develops criteria for assigning responsibility, and proposes observable evidence through which claims about equitable stewardship can be tested.

2 Scope and evidentiary method

This is a critical integrative review and a conceptual research paper, not a completed field study or a systematic review of every publication. Sources were selected for five functions: establishing local conditions; interpreting gendered water burdens; defining ethical responsibilities; examining corporate reporting; and designing an empirical investigation. Official reports and standards anchor factual and institutional claims. Original academic publications supply concepts and relevant prior research. Corporate publications establish what a company reports. News accounts identify events and questions requiring corroboration.

These source types are not interchangeable. An official assessment estimates resource conditions but may not identify individual users' causal effects. A corporate report is evidence of a disclosure, rather than

independent proof of every claimed outcome. A resident's account can reveal an experience that a numerical indicator misses, while a news story alone cannot establish an aquifer-wide causal relationship. The analysis distinguishes reported facts, calculations from published tables, interpretations and proposals throughout.

The principal local baseline combines a 2024 groundwater assessment with a 2022 household tap-functionality survey. Neither should be presented as a measurement of conditions in September 2026. Later corporate reporting and news are used to identify developments, not to manufacture a continuous time series from unlike sources. A new empirical study would need updated official records and a fresh baseline before drawing present-day conclusions.

“Bengaluru Rural” refers here to the four-taluks geography used in the local datasets: Devanahalli, Doddaballapura, Hoskote and Nelamangala. An official Karnataka district report records its 2025 renaming as Bengaluru North. Historical labels are retained to keep the evidence traceable. Anekal, Bengaluru city and Bengaluru Rural must not be treated as the same research location. [1, 2, 3]

3 Why Bengaluru Rural is a significant setting

3.1 Groundwater stress and the importance of competing explanations

The 2024 Karnataka assessment classifies all four Bengaluru Rural taluks as over-exploited. Its extraction-stage indicator compares annual extraction with annual extractable groundwater resources; it is not the percentage of an aquifer that has disappeared. Table 1 reproduces the relevant estimates. [1]

Table 1. Groundwater extraction in the four Bengaluru Rural taluks in 2024

Taluk	Irrigation	Industrial	Domestic	Total	Extraction stage
Devanahalli	3,951.4	218.6	538.1	4,708.1	169.13%
Doddaballapura	5,699.4	312.8	800.2	6,812.3	153.45%
Hoskote	6,475.8	168.9	761.6	7,406.3	163.72%
Nelamangala	3,368.0	353.0	516.7	4,237.7	105.80%
Sum of published values	19,494.6	1,053.3	2,616.6	23,164.4	Not averaged

Source: CGWB and Karnataka Ground Water Department, Annex IXB, printed p. 104, PDF p. 115. Extraction quantities are hectare-metres per year; one hectare-metre equals 10,000 cubic metres. Minor inconsistencies between summed sectors and totals reflect published rounding. [1]

Calculated from these entries, irrigation represents approximately 84.2% and industrial use approximately 4.5% of recorded extraction. This is important counterevidence to a sweeping claim that factories explain the district's groundwater stress. It does not establish that every factory has a negligible local effect: administrative totals cannot resolve a particular source, season or community's exposure. Classification and purchased-water pathways also require examination. [1]

A credible business ethics paper should preserve this inconvenient evidence. Its question becomes sharper: can an identifiable industrial withdrawal or allocation intensify deprivation in a particular place, even where agriculture dominates the aggregate? A small district-wide share might matter at a heavily contested source

during a dry period. Alternatively, household problems might be explained mainly by irrigation, deficient maintenance, intermittent electricity, rainfall variation or distribution failures. Industrial responsibility must be investigated within this wider system.

Hydrological measurements also need conceptual discipline. A newly drilled borewell's depth is not a direct measurement of the water table. A dry household well does not by itself identify the user responsible. Distance between a village and a plant cannot establish groundwater connectivity. Site-specific hydrogeological expertise is necessary before converting a map of nearby factories and stressed communities into a claim of causation.

3.2 Infrastructure access and lived reliability

The district's Jal Jeevan Mission functionality assessment surveyed 378 households in 11 villages during February-April 2022. All sampled households had received tap water at least once in the preceding week, but only roughly one quarter met the report's combined functionality criteria. The factsheet gives 27%, whereas the detailed figure and text give 26%. In addition, 94% reported reduced collection time and effort. The sample concerns households in selected piped-water villages, not a census of every district household. [2]

These findings support two conclusions simultaneously. Infrastructure can produce meaningful relief, and a connection or recent delivery does not guarantee a sufficiently reliable service. The reported time savings are not sex-disaggregated estimates of employment, schooling or agency, and the survey does not attribute remaining service problems to industry. [2]

This distinction creates a productive research opening. Access should be assessed as a chain: infrastructure exists; adequate, safe water arrives reliably; household members can use it; and people gain opportunities they value. Failure at any link can limit the benefit of the preceding investment. The ethical evaluation should therefore investigate both achievements and the work households still perform to make the system function.

3.3 Industrial development and changing allocation

A July 2025 report described KIADB's plans to supply Cauvery water from Yelahanka to the information technology investment region associated with the Devanahalli industrial area, including the Foxconn project. It reported an allocation of 0.25 tmcft and a proposed pipeline of approximately 25 kilometres. This is evidence of a reported infrastructure and allocation plan, not evidence that the facility depleted nearby wells. It directs research toward the conditions of public supply, actual delivery, alternative sources and competing uses. [4]

Reporting on Bengaluru's 2024 water crisis also illustrates why geographically precise evidence matters. Reuters described rising tanker prices and effects on businesses in the city. Associated Press documented residents' struggles to organize daily life around restricted supplies. These accounts help identify mechanisms and interview questions, but neither establishes the prevalence of those experiences among women in the four rural taluks. [5, 6]

The locality is consequently valuable as a research setting because stressed resources, changing industrial demand and incomplete household service reliability can be studied together. Its significance does not depend on presuming misconduct by a named company.

4 A capability-based account of gendered water insecurity

4.1 From resources to substantive opportunities

The capability approach evaluates well-being through people's real opportunities to achieve lives they have reason to value. Functionings are achievements; capabilities concern the substantive freedom to achieve them. Sen's account and Nussbaum's development of central capabilities shift attention from the possession of a resource to what that resource enables. The Stanford Encyclopedia of Philosophy synthesis also emphasizes personal, social and environmental conversion factors. [7, 8, 9]

Applied here, two households with nominally similar water access may have very different opportunities. A household with storage, money and flexible working hours may absorb an interruption. A tenant without storage, a woman with a disability, or a worker facing penalties for lateness may experience the same interruption as a serious deprivation. The analytical task is to explain these differences rather than assigning equal welfare value to equal volumes.

This inquiry distinguishes operational water performance from human capabilities. Capacity has other meanings and can be confused with infrastructure capacity or personal ability. Withdrawals and recycling are resource and operational measures. They are useful evidence, but are not substitutes for measures of what people can actually do.

The water-related capabilities proposed for this study are bodily health; bodily integrity and safe movement; access to education and decent work; rest and discretionary time; social participation; and meaningful influence over one's material environment. These are an application of capability reasoning to the research question, not a claim that a single water indicator measures Nussbaum's entire account of human flourishing.

4.2 Shadow work and the household adaptation burden

Borremans's “Technique and Women's Toil,” published in CrossCurrents in Winter 1982-83, provides a historical point of reference for inquiry into technology and women's work. This paper uses shadow work as an operational research category and does not present its definition as a quotation from Borremans. The bibliographic verification and full-text limitation are identified in the references. [10]

For this inquiry, **water-related shadow work means involuntary additional labor through which households compensate for unreliable, inaccessible, unaffordable or unsafe water**. This is an explicit operational definition proposed for the study. It includes collection and carrying, but also waiting, monitoring delivery times, negotiating with vendors, arranging credit, treating water, maintaining storage and coordinating repairs. Unpaid work should not automatically be classified as harmful: chosen care or collective activity can be valued. The ethical concern is constrained, unequally assigned adaptation that displaces valued alternatives.

Three distinctions improve the concept. First, physical effort and organizational effort may fall on different people. Second, money spent by a household and time spent by a woman should not be treated as identical burdens. Third, additional labor needs a comparison: additional to what season, service arrangement or plausible alternative? Without a baseline, every domestic water activity risks being incorrectly attributed to an industrial user.

Time-use evidence supports taking gender seriously without establishing a local effect. India's 2024 Time Use Survey reports 289 minutes per day for female participants and 88 for male participants in unpaid domestic services, among persons aged six and above. These are averages among participants in that activity, not averages for every woman and man, and the category extends beyond water. The WHO/UNICEF 2023 gender-focused report identifies women and girls aged 15 and older as the principal collectors in seven in ten households lacking water on premises globally. Neither figure is a Bengaluru Rural industrial-impact estimate. [11, 12]

4.3 Temporal autonomy and the uncertainty of supply

The proposed concept of temporal autonomy concerns a person's ability to plan and use time in ways she values. An hour of predictable collection before work and an hour distributed across unpredictable interruptions need not have equivalent consequences. In the latter case, uncertainty may prevent accepting a shift, travelling to a class or leaving a child with a caregiver, even if recorded collection minutes are unchanged.

This distinction creates a measurable extension to conventional time-use analysis. Diaries should record when supply was expected, when it arrived, whether a person remained available to receive it and which activities were abandoned or postponed. Interviews should ask whether another household member could substitute without penalty. A reduction in mean collection time should not be called empowerment if responsibility remains non-negotiable and women gain no discretion over the time released.

Emotional consequences also deserve attention. Sultana's research on water access and conflict shows the analytical importance of emotional experience and social power. This does not authorize a claim that women near a particular Bengaluru factory suffer a diagnosed mental health condition. It does justify investigating anxiety, humiliation, conflict and insecurity through carefully framed accounts rather than restricting the inquiry to metres walked and litres delivered. [13]

4.4 Gender without treating women as a single group

The World Bank's Rising Tide report frames water through assets, services and spaces, emphasizing intersecting inequalities. That perspective directs attention to who owns a borewell, controls a tanker payment, enters a committee meeting and benefits from an industrial job. [14]

The field study should compare experiences across caste, class, migration status, disability, age, household composition and tenure without assuming these categories explain every difference. Women who own land or a water business may have interests different from women buying water. A salaried worker, an agricultural worker and a woman doing unpaid care may lose different opportunities. Household questionnaires should therefore ask individual members about decision-making and labor rather than taking the household head's account as a complete description.

Women should also participate as researchers and decision-makers. The framework would contradict itself if it represented women only as sufferers while giving officials and companies exclusive authority to define successful water governance.

Ranganathan's ethnographic work on Bangalore's water suppliers provides a further corrective: water markets and public authority cannot be understood through a simple separation of private vendors from the state. Her account examines exploitation alongside political mediation and welfare provision. It supports investigating actual relationships among vendors, officials, landowners and residents instead of assuming

every informal provider has the same role. The historical urban study is conceptual context, not a description of current rural vendors. [33]

Capability analysis itself needs scrutiny. Focusing exclusively on individual choices can obscure collective infrastructure and the political power required to sustain it. Conversely, accepting expressed satisfaction as the only criterion may overlook expectations shaped by longstanding deprivation. This paper therefore combines individual accounts with publicly defensible service thresholds and scrutiny of collective decision-making. A woman should be able to identify her own priorities while also being entitled to challenge unsafe or systematically unreliable provision. Neither a predetermined indicator list nor a satisfaction survey can settle that balance alone.

5 The causal framework and its testable propositions

The proposed causal sequence is: **industrial water decisions -> changes in resource conditions or allocation -> changes in household service and cost -> gendered adaptation work -> changes in capabilities**. Each arrow is a hypothesis requiring evidence. Rainfall, irrigation, public investment, migration, household resources and social norms can affect several stages independently.

Table 2. Mechanisms that must be distinguished

Possible pathway	Evidence needed	Main competing explanation
Direct industrial abstraction affects a shared groundwater source	Metered withdrawals, well-level monitoring, hydrogeological connectivity and timing	Irrigation pumping, rainfall and other users
Purchased tanker water transfers pressure to an off-site source	Vendor source records, quantities, delivery destinations and source-area monitoring	Household demand, seasonal pricing and vendor practices
Public allocation affects household reliability	Allocation orders, delivered volumes, network constraints and service schedules	Leakage, power failure and distribution management
Industrial pollution reduces usable water	Repeated laboratory tests and credible source attribution	Sewage, agricultural pollution and naturally occurring constituents
Land conversion changes recharge or access	Land-use history, drainage and recharge assessment, access documentation	Wider urbanization and unrelated infrastructure

The framework yields five propositions. **P1:** Where an industrial arrangement demonstrably worsens household reliability, adaptation labor will increase most among those already assigned responsibility for domestic water. **P2:** Unpredictability will explain restrictions on paid work and participation beyond the effect of average collection duration. **P3:** Storage, income, secure tenure and intra-household substitution will moderate the relationship between service failure and capability loss. **P4:** Improvements in corporate water efficiency will be insufficient to predict household outcomes without information about source, season, allocation and distribution. **P5:** Participation connected to enforceable decisions and remedy will be associated with better outcomes than representation without effective authority.

These propositions are not insulated from contrary findings. If industrial water is sourced without affecting household supply, the proposed industrial pathway may be absent. If men absorb additional coordination work equally, the expected gender pattern may not hold. If a more reliable service reduces waiting but fails to

improve women's choices, household norms or employment conditions may be the binding constraint. A strong study should report these findings rather than treating every result as confirmation.

6 Apple as a disclosure case

Apple is useful because its public materials provide a developed water strategy and repeated reporting. This makes it an information-rich case for examining the relationship between corporate metrics and community outcomes. It is not a “best-case proof” that a gap in one company's reporting must be universal across industry.

Apple's 2025 Water Strategy expressly addresses availability, quality and equity and locates more than 99% of its water footprint in its supply chain. This is a statement about the distribution of its footprint, not a claim that 99% of Indian extraction is measured. The document provides a stronger starting point than an assumption that the company understands water solely as a factory input. [15]

Its 2025 Environmental Progress Report reports 14 billion gallons of supplier freshwater savings in 2024 and an average reuse rate of 42% among more than 250 participating facilities. Those are global program figures, not Bengaluru Rural savings or benefits received by local women. [16]

The 2026 report updates supplier savings to 17 billion gallons for 2025, describes reuse exceeding 43%, and reports work with AWS and Frank Water on infrastructure and community needs in the Bengaluru and Chennai basins. It also distinguishes supplier initiatives from corporate-operation replenishment and certification of Apple-owned data centres. These scopes should remain separate. [17]

Apple's 2023 announcement describes community surveys and hydrological work with Frank Water in Anekal. The project is relevant evidence of community-oriented activity, but Anekal belongs to Bengaluru Urban in the groundwater dataset. It cannot serve as a measured intervention in the four-taluks rural study area without a separate geographical justification. [18, 1]

The critical question is what additional evidence would establish a capability outcome. The reviewed public documents do not supply a repeated, sex-disaggregated series connecting an identified Bengaluru Rural manufacturing site's water sources to nearby women's adaptation work and opportunities. That is a limit of the reviewed public evidence, not proof that the company collects no community information or that its programs fail.

Efficiency also requires careful interpretation. When water used per unit of output falls but production grows, absolute withdrawals may still rise. Reported savings depend on a defined comparison and do not automatically become additional household supply. Withdrawal and consumption are different measures, while discharge quality, timing and destination affect whether returned water remains usable. A local evaluation therefore needs absolute quantities and source conditions alongside intensity ratios. This is an accounting requirement, not a finding that Apple's reported savings are invalid. [20]

Four additions would make the corporate case analytically stronger. First, define the facility, suppliers and water-source area. Second, disclose a dated baseline and changes in both corporate demand and household services. Third, explain who benefits, including differences among women. Fourth, show whether women can influence decisions and obtain remedy for verified adverse effects. Corporate reporting could then connect environmental performance to lived outcomes without implying that a global volume metric has already established that connection.

7 What existing frameworks provide and where this inquiry adds value

The UN-Water framework already combines drinking water and well-being with economic activities, ecosystems and resilience to water-related hazards. Governance, cooperation, finance and political conditions support those dimensions. Its breadth is a strength: the household, factory and watershed can be considered within one account of security. Its limitation for this inquiry is that a conceptual framework does not itself specify how to attribute a particular burden or resolve competing claims. [19]

Gender mainstreaming should operate across these dimensions. Drinking-water interventions should track health, safety and time; economic allocation should consider women's livelihoods and unpaid labor; ecosystem decisions should consider dependence on local sources; and drought planning should identify who performs emergency adaptation. Gender should also shape budgeting, consultation, monitoring and remedy rather than appearing as an isolated final indicator.

It would be inaccurate to claim that all current corporate standards ignore communities. GRI 303 includes reporting about water-related impacts, local context and engagement with stakeholders and suppliers, alongside withdrawal, discharge and consumption data. The 2019 AWS Standard 2.0 incorporates catchment and stakeholder considerations and safe water, sanitation and hygiene. These are important foundations for the proposed approach. [20, 21]

The added contribution is an explicit and auditable connection between those commitments and individual opportunities: disaggregated labor, reliability, discretionary time, effective voice and remedy. The paper does not assert that these outcomes are absent from every implementation of existing standards. Its claim is that reviewing litres or stakeholder meetings alone cannot establish them. AWS now presents Version 3.0 on its official site; the historical discussion of Version 2.0 should not be mistaken for an assessment of every current requirement. [22]

India's BRSR Core framework provides a relevant disclosure context, but its applicability must be checked by entity and reporting year. SEBI's 2025 FAQ describes value-chain ESG disclosure as voluntary for the top 250 listed entities from financial year 2025-26. A proposal for stronger supplier-level reporting is therefore not a statement that every factory already has that precise obligation, or that an Indian listed-entity rule directly governs Apple in the same way. [23]

8 Business responsibilities and the ethical threshold

8.1 Compliance is evidence rather than a complete ethical verdict

A defensible ethical threshold must distinguish substantive harm from procedural exclusion. Harm can remain ethically significant even when consultation has occurred, and an absence of voice is not a necessary condition for recognizing deprivation. Participation cannot legitimize a household's inability to obtain essential water merely because a meeting was held.

The proposed threshold is an industrial decision that **causes or contributes to a foreseeable and avoidable impairment of essential water access or related capabilities**, especially where costs are transferred to people with limited power to avoid them. Severity, vulnerability, alternatives and the company's relationship to the impact determine the response. Procedural exclusion aggravates the problem; it does not create the only route to an ethical claim.

This threshold is a sufficient reason for heightened scrutiny, not an exhaustive test. Serious adverse impacts can require a response even when prior knowledge or intention is absent. Once evidence of harm is available, uncertainty about the original decision does not justify ignoring continuing effects.

Legal compliance and ethical adequacy answer different questions. A permit may establish a legal entitlement subject to its terms, while the operation still requires examination for cumulative impacts, distributional effects and changed conditions. Conversely, the existence of local hardship does not prove that an operator breached a permit. Karnataka's groundwater statute, including subsequent amendments, must be read with applicable notifications and actual authorization documents before making any facility-specific legal assertion. This review does not certify a site's compliance or noncompliance. [24]

8.2 Assigning responsibility across the business relationship

The UN Guiding Principles distinguish causing an adverse impact, contributing to it and being directly linked through a business relationship. They call for prevention and mitigation through human rights due diligence; causing or contributing to harm entails providing for or cooperating in remediation. Direct linkage calls for an appropriate response using leverage, without automatically making the buyer the sole remediator. The UN Working Group's gender guidance extends this analysis through gender-responsive assessment, measures and remedy. [25, 26]

Applied to water, a plant's direct pumping, a buyer's purchasing pressures, a tanker vendor's sourcing and a public authority's allocation may generate different responsibilities. An analysis should identify the relationship instead of assigning the entire system's failure to the most recognizable brand. Responsibility can be shared without becoming so diffuse that nobody acts. Relevant evidence includes contracts, sourcing requirements, knowledge of impacts, influence over decisions and the feasibility of alternatives.

Three further ethical principles are proposed. **Local relevance:** improvements elsewhere should not be assumed to repair losses suffered by a specific community. **Distributional visibility:** aggregate jobs, tax revenue or water savings do not establish that those bearing costs have benefited. **Restoration of agency:** compensation should aim to restore secure access and meaningful options, not merely pay a low estimated wage for continuing deprivation.

States retain responsibilities for public services, regulation and rights protection. Corporate participation should strengthen accountable institutions rather than turn an essential service into discretionary philanthropy. A community water fund may be useful, but its rules, financing, maintenance and complaints process matter as much as its launch.

9 From disclosure to capability-sensitive governance

The proposed governance model joins operational records with independently reviewable household evidence. It should use a concise dashboard rather than claim that a single composite score captures justice. Table 3 identifies a core set. These are research and governance proposals, not newly discovered mandatory indicators.

Table 3. Proposed indicators and their interpretation

Domain	Measure	Interpretation safeguard
Resource and source	Monthly withdrawals by source, season and intended use; monitored groundwater levels	Do not equate drilled well depth with groundwater level
Household service	Supply frequency, predictability, usable quantity and tested quality	A connection is not continuous safe service
Adaptation labor	Minutes collecting, carrying, waiting, treating and coordinating, by person	Report distribution and peaks, not only the mean
Temporal autonomy	Activities forgone; ability to leave home; choice over time released	Time saved is not automatically empowerment
Affordability	Incremental water expenditure and coping debt relative to household resources	Distinguish quantity, tanker capacity and displaced baseline costs
Opportunity	Water-related missed work or classes, rest and participation	Record the stated mechanism and other causes
Voice	Participation, speaking opportunities and documented changes to decisions	Attendance and committee quotas do not prove influence
Remedy	Complaint accessibility, time to resolution and independently checked restoration	Closure of a case does not prove restoration

Women should help choose priorities and interpret results before a public dashboard is finalized. Governance also needs practical conditions for participation: accessible meeting times, language, childcare, safe travel and payment for substantial research or monitoring work. Recruiting women into unpaid committee responsibilities can otherwise reproduce the burden the intervention is meant to reduce.

Representation should extend to technical and paid positions. The World Bank's study of women in water utilities identifies barriers to recruitment, retention and advancement; its findings support examining who controls operational expertise and institutional decisions. Participation is more substantive when women can be operators, technicians, procurement decision-makers and regulators as well as volunteer community representatives. [27]

A proportionate response would begin with transparent sources and an independent baseline, followed by prevention measures matched to the identified mechanism. These might include reducing a harmful withdrawal, improving supply schedules, substituting an appropriate non-potable source, repairing distribution losses or funding reliable household service under public oversight. Reuse options require health and environmental assessment. A remedy should be evaluated through restored access and opportunity, with a mechanism for reopening complaints when a temporary solution fails.

9.1 What the Tanzania case contributes

The World Bank's 2008 completion report for Tanzania's Rural Water Supply and Sanitation Project records collection-time reductions from two hours to 15 minutes in Manyoni and from six hours to one hour in Morogoro/Mvomero. It describes benefits for women and girls, but these project accounts should not be converted into experimentally established effects on school attendance or violence. Its financial-sustainability findings also raise concerns about records and cost recovery in sampled schemes. [28]

The case illustrates the promise of infrastructure alongside the importance of maintenance. It cannot predict the size of a Bengaluru Rural benefit. The transferable question is whether reliable services continue to release time and whether women gain discretion over that time. A study should therefore follow an intervention beyond construction, examining downtime, finance, repairs and the allocation of household labor.

10 A feasible empirical research program

10.1 Establish the source and the comparison before expanding the sample

The first phase should map a small number of industrial water arrangements in one selected taluk. It should establish facility boundaries, water sources, authorizations, withdrawal or purchase records, service networks, major agricultural use and candidate communities. Selection should be based on a plausible, documented exposure pathway rather than choosing villages simply because they are close to a recognizable company.

A pilot in four to six communities could test recruitment, diaries, translations and source tracing. A subsequent design might follow approximately 240-320 households across 12-16 communities for a full hydrological year, with four seasonal rounds and shorter diary periods. These are provisional feasibility parameters, not a statistical power calculation or a claim that this sample can identify small causal effects. The final design requires variance estimates, expected attrition, clustering and a justified minimum effect size.

Comparison communities should resemble exposed communities in pre-existing water conditions, rainfall, irrigation, wealth and service infrastructure, while lacking the specific industrial pathway being studied. Matching on distance alone is inadequate. Source-area spillovers could expose a nominal comparison village to the same tanker extraction or aquifer pressure, weakening any apparent contrast.

10.2 Combine household accounts with independent measurements

The household panel should document source combinations, service schedules, expenditure, storage, employment arrangements and the division of water work. Short time diaries should distinguish active collection from waiting and coordination, and record changes in planned activities. A woman's account should not be replaced by a single household respondent's estimate.

The HWISE and IWISE scales offer established instruments for experienced household and individual water insecurity. They should be used with their appropriate respondent populations, wording and recall periods. Translation and cognitive testing are necessary; modifying an instrument does not preserve its validation automatically. The original diary and capability questions should remain a separate module so that their contribution can be evaluated rather than hidden within an altered “validated” score. [29, 30]

Qualitative work should include repeated interviews with women in varied circumstances, selected interviews with other household members, and discussions with public operators, farmers, vendors, employers and regulators. Approximately 30-40 in-depth interviews might be a starting point, adjusted for diversity and analytical saturation. Interview topics should include bargaining over water work, missed opportunities, experiences of consultation, preferred remedies and cases where industrial activity improved access or independence.

Hydrological evidence should include rainfall, repeated source and well observations, relevant pumping records and expert interpretation of connectivity. Water-quality concerns require laboratory testing and a source-attribution strategy. A corporate extraction series and household distress series rising together are insufficient evidence if both respond to the same drought.

10.3 Estimate effects without overstating identification

Repeated observations can establish seasonal patterns and identify which households experience persistent or exceptional burdens. If a clearly timed change in industrial sourcing, public allocation or service delivery occurs, a quasi-experimental comparison may be possible. A difference-in-differences design would require credible comparison trends, adequate pre-change observations and examination of simultaneous interventions. It should not be promised in advance when those conditions are unknown.

With few communities, conventional standard errors may imply more precision than the design supports. The analysis should address clustering, report uncertainty and use appropriate small-sample methods where justified. If identification remains weak, a carefully triangulated account of mechanisms and associations is preferable to an unjustified causal coefficient. Negative cases and explanations supplied by affected residents should be examined alongside the quantitative results.

10.4 Make economic costs visible without pricing away rights

An accounting exercise can estimate incremental household costs as **additional purchased-water expenditure + annualized adaptation expenditure + the value assigned to additional time**. Adaptation expenditure may include storage, treatment or well-related investment only where a defensible comparison identifies an additional cost. Capital items should be annualized over an explicit useful life, and financing costs should be treated consistently.

The calculation must avoid double counting. If an hour's foregone earnings are counted directly, the same hour should not also be charged at a replacement wage. Tanker spending should be compared with displaced baseline water expenditure and equivalent usable quantities. A tanker “load” has no stable price meaning without capacity, date, route and quality information. Borewell expenditure requires local invoices and a clear distinction between construction depth and water-level change.

Time valuation should be reported as a sensitivity range alongside unmonetized hours. Using women's lower observed wages as the sole value of their time risks reproducing the inequality the analysis critiques. Health, dignity, education, safety and autonomy also cannot be reduced to a compensation total. Monetary estimates describe one part of a burden; they do not establish permission to impose it.

10.5 Make the research itself accountable

The project requires appropriate ethics review, informed consent, privacy safeguards and procedures that reduce risks of household or employer retaliation. Individual testimony and identifiable household data should not be shared with employers or vendors. Precise source locations may also require controlled disclosure. Questions about violence or sensitive household conflict need specialized protocols and should not be added casually to a general water survey.

Community researchers should be trained and compensated. Participants should have an opportunity to challenge interpretations and review accessible summaries. This does not mean allowing any stakeholder to suppress adverse findings. It means recognizing participants as contributors to knowledge and returning results in a form useful for decisions, rather than extracting accounts of hardship for an academic publication.

11 Limitations and conclusion

The evidence assembled here has several limits. Local official datasets describe different years and different populations. Administrative extraction estimates cannot identify every source or user. Public corporate reporting does not disclose every operational or community record. The review does not establish factory-specific legality, exposure or harm, and it contains no original interviews. Several theoretical mechanisms, including temporal autonomy, remain proposals to be operationalized and tested in the selected setting.

These limitations define the paper's contribution rather than invalidate it. It establishes why a capability-sensitive inquiry is necessary, identifies the evidence that would make attribution credible, and shows how governance could respond to burdens that conventional volume metrics cannot independently evaluate. It also corrects a potentially misleading industrial narrative by treating agriculture, infrastructure and public allocation as integral to the explanation.

For women in Bengaluru Rural, the relevant achievement is a dependable ability to obtain safe water while retaining meaningful choices about work, learning, health, rest and collective life. For business, the corresponding ethical question is whether production arrangements preserve those opportunities, how companies know, and what happens when evidence reveals an adverse effect. A rigorous paper should make that relationship visible without claiming more than its evidence can establish.

Appendix A Evidence audit of the original poster

The following audit concerns publication readiness. Claims requiring a local study should be presented as research questions or proposed mechanisms until supported.

Original claim	Evidence assessment	Recommended treatment
India extracts 241 billion cubic metres annually	Undated figure; a December 2025 official release reports 247.22 BCM for the 2025 assessment	Prefer the local 2024 table; if national context is retained, attach the 2025 date and source [31]
63% of districts have declining water tables	Not verified in the reviewed sources	Remove; do not confuse districts, wells and groundwater's share of irrigation
85% of rural drinking water depends on groundwater	A broad figure used on CGWB information pages; not a current local estimate	Retain only with its national scope and source limitations [32]
Women and girls walk 5-20 km daily	Not established for the proposed study population	Replace with measured local distance, duration, frequency and respondent distribution
Borewell work costs INR 150-300 per foot; tankers INR 500-1,500 per load	Missing local dates, specifications and invoices	Gather comparable local costs; do not use city crisis prices as a district estimate
Legally compliant factory extraction causes the listed externalities	No facility-level compliance or causal evidence supplied	State a hypothesis; verify permits, water sources, timing and contribution
Current frameworks ignore people	Contradicted by community and stakeholder provisions in existing frameworks	Argue for stronger operational links to gendered outcomes [19-21]
Seven southern Indian electronics factories received AWS training	Specific claim not substantiated in the documents reviewed	Omit pending a site list and dated source; training is not certification
Apple's 14 billion gallons saved establish local benefit	Global program figure for 2024, not a local impact measure	Preserve year and scope; distinguish updated 2025 reporting [16, 17]
Apple's Frank Water project is evidence about Bengaluru Rural women	The 2023 announcement identifies Anekal	Keep as a separate example with the correct geography [18]
Lost schooling follows from industrial extraction	Plausible mechanism, no demonstrated local effect here	Measure attendance, reasons and alternatives before attributing an effect
Tanzania sanitation rose 7% and 10%	Reported levels move from 5% to 12% and 52% to 62%	Express as 7 and 10 percentage points; avoid claiming identified causal effects [28]

The reference list also needs correction. Publisher names such as “MDPI,” “ScienceDirect” or “Harvard Law Journals” are not adequate references. Each item needs an author or institution, exact title, year and retrievable publication record. The Borremans item should retain the Winter 1982-83 issue information, and any quotation or close interpretation should be checked against the full article. The unspecified “World Bank Water and Development Report” should not remain as a source without identifying the actual publication used.

Appendix B An actionable route from concept to submission

Paper identity. Position this as a business ethics paper on gendered adaptation burdens and substantive opportunity, with Bengaluru Rural as the empirical setting. “Industrial Water Use and Women's Capabilities in Bengaluru Rural” is more defensible than a title naming a company as the cause of harm before that relationship has been established.

First empirical milestone. Select one taluk and one clearly documented industrial water arrangement. Produce a source map, a timeline of industrial and public supply changes, a register of competing explanations, and a pilot household instrument. If access to reliable source data is impossible, narrow the empirical claim to service insecurity and governance rather than continuing to promise industrial attribution.

Publication contribution. Develop temporal autonomy as the theoretical extension, test the transfer of adaptation burdens as the mechanism, and evaluate differentiated responsibility as the normative contribution. The paper becomes stronger when these three tasks support each other; a long collection of statistics alone would not establish originality.

Minimum evidence for a named case. Obtain a dated facility water-source profile; authorization and monitoring records where accessible; a plausible pathway to household exposure; repeated observations before and after a relevant change where possible; and accounts from affected residents, operators and authorities. Document requests for comment and distinguish unavailable evidence from contrary evidence.

Poster revision. Use three verified local anchors: the four taluks' over-exploited classification; the distinction between a working tap and full service functionality; and the dominant role of irrigation in recorded extraction. The central graphic should show hypothesized pathways with confounders, not an unconditional sequence from a named factory to girls leaving school. Include one compact panel explaining what the proposed field study could confirm or disconfirm.

Decision rule. Advance the industrial-impact argument if evidence supports a specific contribution to household deprivation. Revise it if the dominant mechanism is distribution failure, agricultural pumping or an unrelated service problem. A business ethics contribution can still examine the responsibilities of firms participating in a shared water system, but must clearly distinguish responsibility for causing harm from the capacity to help address it.

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