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Water Users' Association and Innovation in Irrigation Water Management: A Case Study of Peikulam Village

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ABSTRACT

This paper examines the evolution, achievements, and ongoing challenges of the Water Users' Association (WUA) in Peikulam Village, Tamil Nadu, as a case study of participatory irrigation management in semi-arid South India. Drawing on ethnographic fieldwork, stakeholder interviews, and a critical review of recent literature, the study explores how local actors responded to acute water insecurity, the decline of traditional tank management, and policy shifts towards decentralization by forming a WUA in 1991. The analysis highlights how the Peikulam WUA blended traditional water-sharing customs with institutional innovations such as rotational water scheduling, maintenance committees, and inclusive dispute resolution mechanisms. These efforts led to notable improvements in water distribution equity, cropping intensity, and community cohesion, particularly during the 1990s and early 2000s. However, the paper also documents persistent challenges, including elite capture, gender inequity, leadership fatigue, and limited legal authority, which have constrained the long-term sustainability of the WUA. The findings are situated within broader trends in Indian irrigation governance over the past two decades, including the formalization of WUAs, integration with rural development schemes, and the growing impact of climate variability. The Peikulam experience underscores the importance of legal empowerment, inclusive participation, technological innovation, and climate adaptation for the future of decentralized water governance. The paper concludes with practical recommendations for policy and community action aimed at strengthening WUAs and enhancing the resilience of rural irrigation systems in South Asia.

Keywords: Water Users' Association, participatory irrigation management, institutional innovation, Peikulam, decentralized governance, water equity.

1 INTRODUCTION

The governance of irrigation water in India's semi-arid regions has long been a critical concern for both policymakers and rural communities. State-led irrigation systems, particularly since the Green Revolution, have suffered from over-centralization, inefficiency, and neglect, prompting a paradigmatic shift in the 1990s towards Participatory Irrigation Management (PIM) and the formation of Water Users' Associations (WUAs). This paper investigates the case of Peikulam Village in Tamil Nadu, where a WUA was established in 1991 in response to repeated droughts, the decline of communal tank desilting (kudimaramathu), and the withdrawal of effective state support. The Peikulam WUA represents a hybrid governance model that integrates traditional water-sharing norms with modern organizational practices, aiming to address water scarcity, equity, and local conflict.

The study is situated within the broader context of institutional and policy developments in Indian irrigation management over the past three decades, including the formalization of WUAs under state legislation, the integration of WUAs with rural development and watershed programs, and the increasing challenges posed by climate variability. Drawing on qualitative fieldwork, interviews, and a critical review of recent literature, the paper assesses the institutional and technological innovations introduced by the Peikulam WUA, their impact on water equity and agricultural productivity, and the socio-economic and environmental outcomes of WUA-led interventions. It also critically analyses the constraints faced by the WUA, such as elite capture, gender exclusion, leadership succession issues, and limited statutory authority. By examining the Peikulam experience, the paper seeks to contribute to ongoing debates on the effectiveness, sustainability, and replicability of decentralized water governance in India and similar agro-ecological settings.

2 BACKGROUND OF THE STUDY

The challenge of managing irrigation water equitably and efficiently in semi-arid regions of India has long been a concern for both policymakers and rural communities. State-led irrigation systems, especially since the Green Revolution, have suffered from over-centralization, inefficiency, and neglect. In response, the 1990s witnessed a paradigmatic shift towards Participatory Irrigation Management (PIM), emphasizing user-led water governance through Water Users' Associations (WUAs) [3].

Peikulam Village, situated in the southern agro-climatic zone of Tamil Nadu, presents a compelling case of institutional innovation in irrigation water management. Traditionally reliant on tank irrigation and seasonal rainfall, Peikulam farmers faced mounting water insecurity by the late 1980s due to tank siltation, reduced monsoon reliability, and bureaucratic apathy. In this context, a group of progressive farmers formed a Water Users' Association in 1991, catalysing a new approach to irrigation governance that blended traditional wisdom and modern organizational practices.

3 OBJECTIVES OF THE STUDY

This study aims to:

1. Investigate the evolution and functioning of the Water Users' Association in Peikulam Village.
2. Assess the institutional and technological innovations introduced in local irrigation water management.
3. Analyze the socio-economic and environmental outcomes of WUA-led interventions.
4. Identify challenges and prospects for the sustainability of community-based water management.

5. Offer recommendations for strengthening WUAs in similar rural contexts.

4 RESEARCH QUESTIONS

1. What motivated the formation of the Water Users' Association in Peikulam in 1991?
2. What innovations were introduced by the WUA in irrigation practices and governance structures?
3. How did the WUA impact water distribution equity, agricultural productivity, and community cohesion?
4. What constraints did the WUA face in sustaining its activities over time?
5. What lessons can be drawn for the future of decentralized water governance in India?

5 CRITICAL REVIEW OF LITERATURE

The 1990s marked a transformative period in irrigation governance literature in South Asia. Influenced by the global turn towards decentralization and participatory development [2], scholars and institutions began exploring alternatives to state-led water management.

Ostrom's Common-Pool Resource Theory was foundational during this time. Ostrom [4] argued that communities could sustainably manage common resources, such as irrigation water, without external intervention, provided institutions followed locally legitimate norms. This theoretical base informed several empirical studies in India [3].

In Tamil Nadu and Andhra Pradesh, PIM experiments were documented extensively [6]. These studies revealed that while WUAs could be effective in the initial stages, their performance depended on internal equity, external facilitation, and legal clarity.

Tank irrigation systems in southern India received particular attention. Studies by Reddy and Syme [5] and Barker and Molle [1] explored how colonial-era tank systems were crumbling under pressure, yet showed potential for revival through collective desilting, bund repair, and silt markets.

The role of NGOs and civil society in catalysing WUAs was another major theme. Moench [3] noted that where WUAs emerged organically or with NGO support, they were more likely to integrate local knowledge and adapt traditional practices.

Gender and caste dynamics, however, remained underexplored in early WUA literature. Women's roles were often seen as peripheral, and caste hierarchies were assumed to be neutralized by participatory structures—an assumption later challenged by post-2000 critiques.

The literature between 1990 and 2005 offered both optimism and caution. While WUAs were recognized as potential agents of irrigation reform, their success was seen as contingent on social capital, leadership, inclusivity, and legal support. The Peikulam case provides an empirical lens through which these themes are further interrogated.

A 2003 study of WUAs in Odisha found that participatory irrigation management improved water distribution and livelihoods, but performance varied based on member awareness, leadership quality, and government support. Similar findings have been reported in Tamil Nadu, where effective WUAs correlate with strong local leadership and external facilitation. National reviews highlight the importance of integrating WUAs with Self-Help Groups (SHGs), watershed committees, and Panchayati Raj Institutions to enhance resilience and inclusivity.

6 METHODOLOGY

This study employs a qualitative case study methodology, integrating primary and secondary data.

Primary Data Collection

- **Field Visits:** Conducted in 2004 and 2005 across two cropping seasons.
- **Interviews:** Semi-structured interviews with 22 stakeholders including WUA members, small and marginal farmers, local officials, and NGO representatives.
- **Focus Groups:** Two focus group discussions with male and female farmers separately to gauge participatory dynamics.
- **Participant Observation:** Participation in WUA meetings and water allocation planning.

Secondary Data

- Government records on tank rehabilitation schemes.
- NGO reports from the Tamil Nadu Watershed Development Agency (WDA).
- Scholarly literature on PIM and WUAs in South India.

7 THEMATIC ANALYSIS: PROBLEMS, INNOVATIONS, AND OUTCOMES

7.1 Formation of the WUA: Drivers and Enablers

The WUA was formed in 1991 following two consecutive droughts and the decline of traditional *kudimaramathu* (communal desilting). The WUA received support from a local NGO, Gram Seva Sangam, and informal technical advice from retired irrigation engineers. The Panchayat and the Revenue Department also provided initial recognition.

7.2 Motivation in the Formation of the Water Users' Association in Peikulam

The formation of the Water Users' Association (WUA) in Peikulam in 1991 was primarily motivated by acute water scarcity, institutional decline, and the need for more equitable and efficient irrigation management. By the late 1980s, Peikulam's traditional tank irrigation system was in crisis due to repeated droughts, siltation, and unreliable monsoons. The decline of the customary *kudimaramathu* practice and reduced state involvement further exacerbated the situation, leaving local farmers vulnerable to crop failures and intra-community conflicts over water allocation.

A group of progressive farmers, recognizing the limitations of both state-led and informal management, initiated the WUA to address these challenges. Their efforts were catalysed by support from a local NGO, Gram Seva Sangam, which provided organizational guidance and access to technical expertise. The initial endorsement from the Panchayat and Revenue Department lent further legitimacy to the initiative.

This local response mirrors broader trends in India during the 1990s, when participatory irrigation management (PIM) emerged as a policy response to the inefficiencies of centralized systems. The theoretical underpinning for such community-led initiatives draws from Ostrom's [4] work on common-pool resource management, which argues that communities, when empowered with appropriate institutions, can sustainably govern shared resources. In Peikulam, the WUA was envisioned as a hybrid model, blending traditional water-sharing norms with modern collective action strategies, aiming to improve water equity, resolve disputes, and foster community cohesion.

8 SOCIO-ECONOMIC AND GENDER DYNAMICS

8.1 Elite Capture and Social Exclusion

Persistent concerns about elite capture have been validated by recent studies. Larger landowners often dominate WUA leadership, influencing water allocation and marginalizing smallholders and tenant farmers. This has sometimes exacerbated local inequalities, particularly in regions with entrenched caste hierarchies.

8.2 Gender Mainstreaming

While women's participation in WUAs has increased, often through Self-Help Groups (SHGs), their influence in decision-making remains limited. Token representation is common, but a few successful cases have emerged where women played significant roles in water management and conflict resolution.

8.3 Youth Engagement and Leadership Succession

The aging of WUA leadership and migration of rural youth continue to threaten institutional sustainability. Some WUAs have proactively involved youth in digital monitoring and maintenance activities, but widespread youth engagement remains a challenge.

9 CLIMATE CHANGE AND ENVIRONMENTAL CHALLENGES

9.1 Increased Climate Variability

The last two decades have seen more frequent and severe droughts, erratic monsoons, and extreme weather events, intensifying water insecurity in semi-arid regions like southern Tamil Nadu. WUAs have struggled to adapt, with many reverting to traditional coping strategies or seeking external support.

9.2 Tank Rehabilitation and Watershed Approaches

Tank rehabilitation has been a major focus, supported by both government and NGOs. Community-driven desilting, silt markets, and bund strengthening have shown positive results, but long-term sustainability depends on regular maintenance and collective action.

10 CRITICAL DEBATES AND LESSONS LEARNED

10.1 Institutional Sustainability

Many WUAs experience “institutional fatigue” after initial enthusiasm wanes. Leadership succession, regular member engagement, and financial sustainability are recurrent challenges.

10.2 Legal and Policy Gaps

The lack of clear legal backing and enforceable rights continues to hamper WUA effectiveness. Formal registration under state PIM acts is often bureaucratic and does not guarantee autonomy or resource access.

10.3 Replicability and Scaling Up

Successful WUAs remain the exception rather than the rule. Replication efforts have faltered due to context-specific factors, such as local leadership, social capital, and external facilitation.

10.4 Integration with Livelihoods

There is growing recognition that WUAs must address broader livelihood concerns such as crop diversification, market access, and credit, in addition to water management.

11 POLICY AND INSTITUTIONAL DEVELOPMENTS

11.1 Expansion and Legalization of WUAs

Following the Tamil Nadu Farmers Management of Irrigation Systems Act (2000), there was a nationwide push to formalize WUAs, with states such as Andhra Pradesh, Maharashtra, and Gujarat adopting similar legal frameworks. However, the effectiveness of these acts has been mixed, with many WUAs struggling with limited statutory authority and inconsistent state support.

11.2 Decentralization and State Withdrawal

The trend toward decentralization continued, but with uneven results. While some states empowered WUAs with greater autonomy, others maintained bureaucratic control, limiting genuine farmer participation.

11.3 Integration with Rural Development Schemes

WUAs have increasingly been linked to broader rural development and watershed management programs, such as the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) and the Pradhan Mantri Krishi Sinchayee Yojana (PMKSY), facilitating tank desilting, canal repair, and micro-irrigation.

12 INNOVATIONS INTRODUCED BY THE WUA IN IRRIGATION PRACTICES AND GOVERNANCE STRUCTURES

The Peikulam WUA introduced several notable institutional and technological innovations to address water scarcity and governance challenges. Among the most significant was the adoption of a rotational water scheduling system (turn system), which allocated irrigation turns based on a calendar to ensure head-to-tail equity and minimize disputes. This system was supported by seasonal water audits, where farmer volunteers estimated supply and demand before and after harvests, allowing for more adaptive and transparent management.

The WUA also established maintenance committees responsible for tank bund repair and canal desilting, institutionalizing the previously informal *kudimaramathu* practice. A formal dispute resolution board, comprising respected elders from all major castes, was created to mediate allocation conflicts, thereby reducing the risk of escalation and fostering inter-caste collaboration.

A pioneering step was the inclusion of women's Self-Help Group (SHG) members in managing household-level irrigation for kitchen gardens and nurseries, marking an early attempt at gender mainstreaming in local water governance. These innovations collectively contributed to increased cropping intensity, improved tank storage, and reduced water-related conflicts.

The Peikulam experience aligns with broader findings in Tamil Nadu and India, where WUAs that adopt transparent, inclusive, and locally adapted innovations tend to perform better in terms of efficiency and equity. However, the sustainability of these innovations often hinges on continued community engagement, leadership renewal, and legal recognition.

Institutional Innovations

Key innovations included:

- **Rotational Water Scheduling (Turn System):** A calendar-based system prioritized head-to-tail equity, minimizing disputes.
- **Water Audits:** Seasonal pre- and post-harvest audits to estimate supply and demand, supported by farmer volunteers.
- **Maintenance Committees:** Subgroups formed to handle tank bund repair and canal desilting.
- **Dispute Resolution Board:** Comprised of senior villagers from all major castes to mediate allocation conflicts.
- **Women's Participation:** A pioneering innovation in 1998 allowed women SHG members to co-manage household-level irrigation for kitchen gardens and nurseries.

13 IMPACT OF THE WUA ON WATER DISTRIBUTION EQUITY, AGRICULTURAL PRODUCTIVITY, AND COMMUNITY COHESION

The establishment of the WUA in Peikulam led to measurable improvements in water distribution equity, agricultural productivity, and community cohesion. The rotational scheduling system ensured that both head-

and tail-end farmers received a fair share of water, significantly reducing allocation disputes. According to field interviews, 80% of stakeholders reported a decline in water-related conflicts following the WUA's interventions.

Agricultural productivity also increased, with cropping intensity rising from an average of 1.3 to 1.8 between 1992 and 2003. This was attributed to more reliable and extended tank storage, achieved through regular desilting and maintenance activities organized by the WUA. The collective approach to resource management also encouraged the adoption of improved agricultural practices and diversification of crops, further boosting yields.

Community cohesion was strengthened as the WUA's inclusive decision-making processes brought together members across caste and gender lines, especially during periods of water scarcity. The formation of maintenance committees and dispute resolution boards fostered a sense of shared responsibility and mutual trust. While challenges such as elite capture and gender gaps persisted, the overall effect was a revitalization of collective action and social capital within the village.

These outcomes are consistent with broader research from Tamil Nadu, which finds that WUAs, when effectively supported, can enhance equity, efficiency, and social inclusion in irrigation management.

Outcomes and Achievements

- **Increased Cropping Intensity:** From an average of 1.3 to 1.8 between 1992 and 2003; the intensity further improved thereafter.
- **Improved Tank Storage:** After annual desilting, average water availability extended from 3.5 to 5.2 months.
- **Conflict Reduction:** Disputes over water reduced significantly, according to 80% of interviewees.
- **Community Cohesion:** Collective decision-making increased inter-caste collaboration during crises.
- **Replicability:** Two nearby villages adopted similar WUA structures by 2000 and continued to work in a similar way in the years after formation.

14 CONSTRAINTS THE WUA FACES IN SUSTAINING ACTIVITIES OVER TIME

Despite its early successes, the Peikulam WUA encountered several constraints that threatened its long-term sustainability. Institutional fatigue emerged as a major challenge; by 2004, participation in meetings had declined, and the absence of leadership succession planning led to a vacuum as founding leaders aged or migrated. This loss of momentum is a common issue in community-based organizations, where sustained engagement is often tied to charismatic or committed individuals.

Elite capture also became evident, with larger landowners increasingly influencing water distribution to favour cash crops, thereby marginalizing smallholders. Gender gaps persisted, as women's participation, though recognized, remained largely symbolic and did not translate into substantive decision-making power.

The lack of formal legal backing further constrained the WUA's authority, as it operated without registration under the Tamil Nadu Farmers Management of Irrigation Systems Act (2000). This limited its ability to enforce decisions and secure state support for infrastructure upgrades. External shocks, such as erratic monsoons and insufficient state investment in tank modernization, exposed the fragility of local arrangements. These constraints are echoed in recent literature, which highlights weak governance, social exclusion, and

financial instability as persistent barriers to WUA effectiveness across Tamil Nadu. Addressing these issues requires legal empowerment, inclusive governance, and adaptive strategies to cope with environmental variability.

Problems and Limitations

Despite its achievements, the Peikulam WUA faced several challenges:

- **Institutional Fatigue:** By 2004, participation in meetings had declined. Key founding leaders had aged or migrated, and succession planning was absent.
- **Elite Capture:** Larger landowners began influencing water distribution for cash crops, marginalizing smallholders.
- **Gender Gaps:** Though women's participation was nominally recognized, they remained excluded from key decision-making roles.
- **Lack of Legal Backing:** The WUA functioned without formal registration or linkage with the Tamil Nadu Farmers Management of Irrigation Systems Act (2000), limiting its ability to enforce decisions.
- **External Shocks:** Erratic monsoons and lack of state investment in tank modernization added pressure. The 2004 monsoon failure exposed the fragility of local arrangements.

15 LESSONS FOR THE FUTURE OF DECENTRALIZED WATER GOVERNANCE

The Peikulam case underscores several critical lessons for the future of decentralized water governance in India. First, legal recognition and statutory authority are essential for empowering WUAs to enforce collective decisions and access state resources for infrastructure and capacity building. Without formal backing, even the most innovative and inclusive associations remain vulnerable to elite capture and external shocks. Second, technological integration—such as remote sensing, digital water budgeting, and mobile-based scheduling—can enhance transparency and efficiency, provided digital divides are addressed. Third, gender-sensitive governance must move beyond tokenism to ensure meaningful participation of women and marginalized groups in leadership and decision-making roles. Fourth, sustaining WUAs requires deliberate succession planning and youth engagement, leveraging their digital literacy and openness to innovation. Finally, climate resilience must be mainstreamed into WUA planning, with a focus on watershed management, drought adaptation, and flexible allocation rules.

These lessons align with recent systematic reviews, which call for policy reforms, inclusive participation, and innovative financing models to enhance the resilience and effectiveness of WUAs in managing India's water resources.

16 PROSPECTS AND FUTURE DIRECTIONS

The Peikulam case offers important insights for rural irrigation governance in India:

- **Scaling Up through Legal Recognition:** Formal registration under the Tamil Nadu PIM Act could empower WUAs with statutory authority, enabling partnerships with irrigation departments. Streamlining WUA registration, clarifying rights, and ensuring statutory authority are essential for long-term sustainability.
- **Technological Integration:** Use of remote sensing and mobile-based scheduling tools could modernize allocation planning and transparency. Scaling up digital tools for water monitoring, scheduling, and transparency can enhance efficiency, provided digital divides are addressed.
- **Gender-Sensitive Governance:** Future efforts should focus on empowering women in core leadership roles within WUAs, beyond tokenism. Moving beyond tokenism to genuine empowerment of women and marginalized groups is critical for equitable water governance.
- **Youth Engagement and Leadership Succession:** Sustaining WUAs requires grooming younger leaders and incorporating their digital literacy and innovation skills.
- **Climate Resilience Planning:** WUAs must integrate watershed-level planning and water budgeting to build resilience to extreme rainfall variability and prolonged droughts. Integrating climate resilience, through watershed planning, drought-resistant crops, and flexible allocation rules, will be vital as climate risks intensify.

17 CONCLUSION

The case of the Peikulam Water Users' Association provides valuable insights into the promise and limitations of decentralized, community-based irrigation management in rural India. The WUA's early years were marked by significant achievements: the introduction of rotational water scheduling, establishment of maintenance and dispute resolution committees, and efforts to include marginalized groups led to improved water distribution equity, higher cropping intensity, and enhanced community cohesion. These successes were facilitated by strong local leadership, NGO support, and the blending of traditional and modern governance practices.

However, the long-term sustainability of the WUA has been challenged by several persistent issues. Elite capture and social exclusion have limited the benefits for smallholders and women, while leadership fatigue and the migration of rural youth have weakened institutional continuity. The lack of formal legal authority and inconsistent state support have further constrained the WUA's ability to enforce decisions and secure resources for tank rehabilitation and modernization. Climate change—manifested in more frequent droughts and erratic rainfall—has intensified water insecurity and tested the adaptability of local management systems.

The Peikulam experience underscores the need for a multi-pronged approach to strengthening WUAs: legal empowerment, inclusive and gender-sensitive governance, technological modernization, and integration with broader rural development and climate adaptation strategies. Policy reforms should focus on streamlining WUA registration, clarifying statutory rights, and providing sustained capacity-building support. Community initiatives must prioritize leadership renewal, youth engagement, and the meaningful participation of women and marginalized groups. As India and other countries in South Asia continue to grapple with water scarcity and rural transformation, the lessons from Peikulam offer a nuanced perspective on the complexities and potential of participatory irrigation management in the 21st century.

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