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Abstract: The integration of human rights-based approaches (HRBAs) into water resource governance has gained significant momentum, particularly in regions facing complex water security challenges. It is now recognized that to address water security, we must address the human side of insecurity, and the HRBA endeavors to do this. Importantly, research projects are primary drivers of water management innovation. As research methodologies directly influence subsequent water management practices, the integration of HRBA in research becomes crucial for ensuring human rights considerations in future water governance. This study examines HRBA implementation in water research programs within the Mekong sub-region, where water insecurity significantly impacts local communities dependent on the Mekong River basin. Through an analysis of six research projects under the Sustainable Mekong Research Network, we assessed HRBA implementation using five dimensions: accountability, transparency, policy engagement, participation, and empowerment. Our mixed methods approach combined document analysis with semi-structured interviews. Projects revealed a spectrum of HRBA implementations from ‘thick’ to ‘thin’ applications, with political sensitivities and varying institutional capacities influencing implementation depth. This study introduces a novel framework for evaluating HRBA in water research, offering practical guidance for researchers and policymakers working in regions with complex socio-political dynamics. The resulting frameworks provide actionable tools that can be immediately applied in research design, stakeholder engagement processes, and policy development, enabling more equitable and effective water governance practices across diverse institutional contexts.

Keywords: Mekong; thick and thin; water governance; research capacity building; policy influence strategies



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1. Introduction

Water research increasingly demands approaches that can bridge the technical, social, and governance dimensions while ensuring research outcomes benefit communities facing water insecurity [1–3]. Despite methodological advances in hydrology, water resources management, and water sanitation and hygiene, researchers continue to struggle with connecting scientific findings to community needs and policy implementation [4–6]. This challenge is particularly evident in regions facing complex water security issues, where traditional research approaches often fail to capture the interplay between the technical, social, and political dimensions of water management [7,8].

1.1. Problem Statement: Transforming Water Research Practices

Research projects constitute a central pathway through which water management and governance practices evolve, particularly in regions facing complex water security challenges like the Mekong basin. These projects serve as both testing grounds for new approaches and templates for future water management practices, directly influencing how issues of water access, quality, and governance are addressed. In the Mekong context, where water management decisions impact millions of lives, research methodologies significantly shape the development and implementation of water governance solutions.

Three key limitations currently constrain this research-to-practice pathway. First, despite the growing recognition of the need for integrated approaches [9,10], research methods often remain siloed within disciplinary boundaries [11,12], creating a fragmented knowledge base that impedes effective water governance. In the Mekong region, this fragmentation particularly affects our understanding of interconnections between water quality, access, and governance. Second, while participatory approaches have enhanced stakeholder engagement [13,14], they frequently lack systematic frameworks for ensuring equitable and ethical research practices [15,16], limiting their ability to drive transformative changes in water management approaches.

Third, existing tools for rights-based implementation, developed primarily for development interventions, have shown significant limitations when applied to research contexts. These tools, while valuable for project implementation, lack the methodological specificity required for research practice [17–19]. They often prioritize programmatic outcomes over research processes, failing to address crucial aspects of research design, data collection, and analysis [20,21]. Their application in water research contexts has proven particularly challenging due to the need to integrate technical, social, and governance dimensions [22–24].

By examining water research projects as drivers of innovation, this study contributes to both the theoretical understanding and practical application of human rights-based approaches in water governance. By acknowledging the methodological challenges of using research projects as data points, including varying timelines, institutional contexts, and implementation capacities, this approach provides unique insights into how rights-based principles can be systematically integrated into water research and subsequent management practices. This analysis is particularly relevant for the Mekong region, where water research directly influences the development of equitable and sustainable water management solutions.

1.2. Theoretical Framework and Research Gaps

Human rights-based approaches (HRBAs) emerged from development practices in the 1990s [17,25], building on established human rights frameworks (see Broberg & Sano, 2018 [17] for a comprehensive review), and offered potential pathways for enhancing water research through the structured integration of community perspectives and governance considerations [26–28]. The theoretical foundation of HRBA rests on core human rights principles, including participation, accountability, non-discrimination, and empowerment [29,30]. Miller and Redhead's (2019:703) [31] concept of 'thick' and 'thin' rights-based approaches provides analytical value for understanding implementation depth, building on earlier examinations of rights-based implementation across contexts [32].

The current literature reveals significant gaps in understanding how HRBA can enhance water research practices:

1. Methodological Integration: a limited understanding of how to combine rights-based approaches with established water research methods [8,33,34].
2. Cross-disciplinary Application: insufficient guidance for bridging technical and social science approaches in water research [9,35–37].
3. Research Process Adaptation: a lack of frameworks specifically designed for research rather than development contexts [38–40].

These gaps persist due to disciplinary silos, limited integration frameworks, and challenges in navigating political sensitivities in water governance. While studies demonstrate HRBA's value in natural resource management [24,41,42] and outline principles for rights-based research [22,43,44], specific guidance for water researchers remains lacking [7,45,46].

1.3. Research Objectives and Context

This study addresses these gaps through three focused objectives:

1. Examine how HRBA principles can be systematically integrated into water research practices.
2. Analyze the spectrum of HRBA implementation across different water research contexts.
3. Develop practical frameworks for water researchers seeking to enhance their practice through rights-based approaches.

The Mekong region provides an ideal context for examining HRBA integration in water research [47–49]. Despite a strong technical research capacity, water governance faces challenges in meaningful community engagement [5,50,51] and policy implementation [52,53]. These challenges are compounded by complex hydro-social relationships [54,55] and varying institutional capacities across the region [49,56,57]. These challenges are exacerbated by climate change impacts on water resources.

Through an analysis of six water research projects under the Sustainable Mekong Research Network (SUMERNET), this study examines how rights-based approaches transform research practice across different contexts and methodologies. This analysis provides insights into both the challenges and opportunities of integrating HRBA into water research.

1.4. Significance and Contributions

This study makes three specific contributions to advancing water research practices:

The methodological framework develops a continuum of practice for integrating HRBA into water research, thereby addressing gaps identified in existing frameworks [8,58,59]. This contribution responds to calls for more systematic approaches to rights-based water research [22,24,60].

Cross-disciplinary integration demonstrates how rights-based approaches can bridge the technical and social dimensions of water research [7,23,61], supporting more integrated research design and implementation [62,63].

Implementation guidance offers evidence-based strategies and frameworks for researchers seeking to enhance their practice through rights-based approaches [46,47,64] while acknowledging the challenges and limitations of such integration [65–67].

This study provides structured frameworks for enhancing water research through the systematic integration of human rights principles, responding to calls for more rigorous and equitable water research methodologies [8]. While not presenting a universal solution, it offers practical pathways for researchers seeking to transform their practice through rights-based approaches [68,69].

2. Materials and Methods: Uncovering Patterns in Water-Based Research

Our investigation into how human rights-based approaches transform water research practices emerged from within the SUMERNET 4 All program, where our roles as a research fellow, a research manager, and a human rights advisor during 2019–2021 provided unique insights into the evolution of research methodologies. This positioning enabled what Finlay [70] describes as “critical self-reflective practice,” allowing us to observe and analyze how research teams understood, adapted, and operationalized HRBA principles across different contexts and challenges.

The decision to examine research projects as analytical units emerged from our observation that these projects serve as both testing grounds for new approaches and templates for future water management practices. Through the careful consideration of SUMERNET's mandate to "improve policies and practices in reducing water insecurity through collaborative research", we identified six water research projects that represented diverse approaches to water management across Cambodia, Myanmar, Lao PDR, Thailand, and Vietnam. The six projects operated across multiple sites in five countries at various scales. For detailed project locations, readers are directed to the SUMERNET project database (www.sumernet.org/publication/sumernet-4-all-project-profiles-2019%E2%80%932023 accessed 5 May 2025), which provides a comprehensive mapping of all project sites. This geographic and methodological diversity provided rich comparative insights while maintaining sufficient commonality for meaningful analysis.

The data collection strategy evolved in two distinct phases. In our professional capacities within the SUMERNET 4 All program (2019–2021), we routinely reviewed the project documentation, including initial proposals from December 2019, progress meeting notes, and ongoing discussions between the program and project teams. This professional engagement provided a valuable contextual understanding of how projects were implementing research approaches.

In September 2021, we obtained Human Ethics Clearance from the SUMERNET program's ethics committee to formally analyze these existing materials as research data and to conduct dedicated research interviews. Following ethics approval, we approached project leads for their consent to participate in this study. We then conducted in-depth interviews throughout September 2021, exploring their deeper understanding of how HRBA principles transformed their research practice. These conversations revealed how projects adapted their approaches during COVID-19 restrictions while maintaining a commitment to rights-based principles, supporting van Buuren et al.'s [1] observations about adaptive research management. Following Ponterotto's [71] principles for thick description, we carefully documented these experiences, paying particular attention to how teams navigated complex political contexts while maintaining research integrity.

Our analytical approach, implemented after obtaining ethics clearance, combined systematic examination with iterative reflection, allowing patterns to emerge while maintaining methodological rigor. Through careful coding of project documentation and interview transcripts, we identified recurring themes in how teams integrated HRBA principles into their research practice. These initial patterns were refined through cross-project comparisons, revealing both common challenges and successful strategies for rights-based research implementation.

The development of our analytical frameworks emerged organically from this investigation, which was grounded in project experiences while responding to a broader theoretical understanding of rights-based approaches. This two-phase approach, professional engagement followed by formal research, allowed us to analyze the evolution of research methodologies over time while ensuring ethical research practice. Regular team reflection sessions during the formal research phase enabled us to test emerging frameworks against new data, while member checking with project leads ensured our interpretations resonated with their experiences. This iterative process created what Roque et al. [2] describe as a "bridge between scientific inquiry and rights-based practice," enabling systematic analysis while maintaining both technical rigor and normative requirements of human rights investigation.

Ethics and Research Integrity

Given the complex political contexts of water governance in the Mekong region, ethical considerations were central to our research design and implementation. Our study received

Human Ethics Clearance from the SUMERNET program's ethics committee (2021) and followed Smith's [43] framework for rights-based research. We paid particular attention to the following:

- Informed consent and voluntary participation;
- Confidentiality and data protection;
- Cultural sensitivity in data collection;
- Power dynamics in research relationships;
- The protection of vulnerable participants;
- The responsible representation of findings;
- Regular ethical reflection sessions with the research team ensured ongoing attention to ethical considerations as the study evolved, which was particularly important given the COVID-19 adaptations required. This commitment to ethical practice aligned with our broader focus on rights-based approaches, ensuring our research process embodied the principles we were studying.

3. Results: Transforming Water Research Through Rights-Based Approaches

Our analysis of six Mekong region water research projects demonstrates how the integration of human rights-based approaches systematically transforms water research practices, creating new pathways for addressing complex water security challenges. Through systematic analysis of project experiences, we uncovered patterns in how research teams moved from initial understanding to the meaningful implementation of rights-based principles.

3.1. Systematic Integration of HRBA Principles (Objective 1)

Our analysis revealed five critical dimensions through which HRBA principles were systematically integrated into water research practices. These dimensions emerged through the careful examination of how projects transformed their research approaches to incorporate rights-based principles.

Political sensitivity emerged as a foundational consideration, requiring careful attention to local contexts and power dynamics. As one project leader explained: "We must understand their perspectives and work with them at a level that they feel comfortable" (P6). This understanding was operationalized through structured engagement with multiple governance levels, as evidenced by another team's approach: "We have already invited collaboration from different levels from local government to the central government. . . We continue with the commune level, the President of the village. And we try to invite key mass organizations like farmers' association and women's Union to know about the local problems of water insecurity" (P5).

Community engagement revealed fundamental shifts in research practice. One project leader noted: "Local groups are included to co-design research activities through participatory action research" (P1). This transformation was further demonstrated through teams' systematic attention to diverse stakeholder needs: "Our research team worked directly with local communities, local officials, and non-government organizations. . . We are mindful of the specific needs, values, and beliefs of ethnic minorities and vulnerable groups in the field study approaches" (P3).

Knowledge integration emerged as teams developed approaches that combined technical and social elements. This integration was exemplified by innovative approaches to research design: "We are trying to encourage local people to be part of multidisciplinary research. . . We are setting up a local committee for discussion and for exercising local knowledge. It had never happened before; it is a kind of scaling up equality compared to the past" (P1).

Research impact pathways evolved to ensure research influence while maintaining rights-based principles. Teams recognized the transformative potential of HRBA, as one leader noted: “The contribution of HRBA is to increase people’s voices, gaining access to the dialogue” (P4). This was particularly evident in efforts to enhance the participation of marginalized groups: “Women and minorities have been encouraged to express the reasons for the limited participation in wetlands management institutions. . . which later translates into more responsive decision-making by leaders and officials” (P3).

This systematic integration was further reinforced by teams’ recognition of HRBA’s fundamental role in water governance: “HRBA gives a framework for water resource management. Water belongs to everyone for basic needs, and the government manages it on behalf of the people. . . So, if we want to have a fair investigation process about the impacts of current water management, we must use the concept of HRBA” (P4).

3.2. Spectrum of HRBA Implementation (Objective 2)

Systematic analysis of project experiences revealed distinct patterns in how research teams understood and applied HRBA principles. This progression manifested through three identifiable stages, each characterized by specific approaches to research practices and community engagement.

The compliance stage represented teams’ initial engagement with HRBA principles, characterized by procedural approaches to implementation. At this stage, teams viewed HRBA primarily as a project requirement, as evidenced by one project leader’s observation that “HRBA is one of the mandates from S4A to include the most vulnerable marginalized communities in the project” (P6). This stage typically involves basic stakeholder consultation and formal documentation processes.

The evolution stage emerged as teams began recognizing the value of rights-based approaches beyond mere compliance. This stage showed increasing depth of engagement, as demonstrated by the growing recognition of complex water management challenges. As one project leader noted, “It is not so easy to solve water resources problems just by applying models. . . important to understand real issues” (P2). Teams at this stage demonstrated a more sophisticated understanding of stakeholder relationships, as evidenced by their efforts to build “close relationships. . . especially regarding local culture, values, customs” (P3).

The evolution stage also revealed deeper analytical insights into water governance challenges. As one project team reflected:

“We now understand who the different stakeholders are and how they’re positioned via accessibility to groundwater in a potentially changing scenario, as well as in terms of resource availability in terms of costs. But now we try to set the foundation for future work to ask questions such as whose perception of equality are we talking about? How did the idea of equality work in communities? In the end, it is the capacity of communities themselves to deal with these issues” (P6).

The transformation stage represented fundamental shifts in how research was conceptualized and conducted. Teams at this stage fully integrated rights-based principles into their research design, as exemplified by approaches where “local groups are included to co-design research activities through participatory action research” (P1). This stage was characterized by a deeper understanding of stakeholder engagement needs and the recognition of HRBA’s broader implications for project outcomes:

“With the application of HRBA, the project will be able to establish the situation and identify entry points for policies and further research to try to establish a proven case for gaining better and more productive access opportunities for those who might be left behind in the Lower Mekong region. . . HRBA helps minimize future conflicts by improving the policies and regulations in groundwater resources management” (P6).

The progression through these stages was marked by increasing sophistication in how teams approached stakeholder engagement and policy influence. As teams evolved in their implementation, they began to recognize HRBA's potential for enhancing policy dialog, with one team noting that "the contribution of HRBA is to increase people's voices, gaining access to the dialogue" (P4).

The identification of these distinct stages, supported by clear evidence of progression in team approaches and outcomes, pointed to the need for a more systematic framework for understanding and supporting HRBA implementation. Project experiences demonstrated that movement between stages was neither automatic nor linear, suggesting the value of structured guidance for research teams seeking to deepen their rights-based practice.

3.3. Framework Development (Objective 3)

The analysis of implementation patterns led to the development of two complementary frameworks for supporting rights-based water research. These frameworks emerged through systematic analysis of project experiences, documentation, and interview data, responding to clear needs identified in project implementation.

Challenge–Response Framework

The challenge–response framework emerged through a systematic analysis of how projects navigated implementation challenges while maintaining research integrity. Through a careful analysis of project experiences, we identified five key dimensions where teams encountered significant challenges and developed effective responses (Table 1).

Table 1. Human rights-based approach analyzed through a challenge–response framework in water research.

Challenge Dimension	Evidence Base	Research Challenge	Response Strategy	Research Outcomes
Political Sensitivity	Documented across projects, particularly evident in technical expert-led teams expressing a need for context-sensitive approaches	Navigating complex political contexts while maintaining research integrity	Graduated approaches to rights dialog in research design	Enhanced research access and sustained relationships
Community Engagement	Multiple projects demonstrated evolution from basic consultation to collaborative approaches, particularly in social science-led projects	Moving beyond extractive research to meaningful participation	Development of collaborative research processes	Community-validated findings and enhanced data quality
Knowledge and Method Integration	Evidenced in projects bridging technical and social approaches to water management	Combining technical and rights-based approaches in research design	Mixed-methods frameworks and the integration of social and technical methods	Enhanced research validity and methodological innovation
Research Team Capacity	Documented team evolution across project implementation periods	Developing interdisciplinary skills for rights-based water research	Building capacity for integrated research approaches	Enhanced research capability and cross-disciplinary understanding
Research Impact Pathways	Analysis of project policy engagement strategies and outcomes	Creating pathways from research to action	Development of multi-stakeholder engagement processes	Enhanced research uptake and policy influence

Political sensitivity required the careful navigation of complex contexts, as evidenced by one project's recognition that "we must understand their perspectives and work with them at a level that they feel comfortable" (P6). Teams also demonstrated how HRBA implementation could transform existing power dynamics, as exemplified by one project's experience: "We are trying to encourage local people to be part of multidisciplinary research. . . We are setting up a local committee for discussion and for exercising local knowledge. It had never happened before; it is a kind of scaling up equality compared to the past. So, the locals become part of the negotiating process on hydropower decision-making" (P1).

Community engagement demanded the transformation of traditional research approaches, as demonstrated by projects where "local groups are included to co-design research activities through participatory action research" (P1). This transformation ex-

tended to ensuring the meaningful participation of marginalized groups: “Women and minorities have been encouraged to express the reasons for the limited participation in wetlands management institutions. . . which later translates into more responsive decision-making by leaders and officials, eventually leading to more equitable, sustainable and just outcomes” (P3).

Knowledge integration required bridging technical and social approaches, with teams recognizing that “it is not so easy to solve water resources problems just by applying models. . . important to understand real issues” (P2). Teams developed innovative approaches to “recognize and value multiple forms of data from different knowledge and values” (P1).

Research team capacity evolved through practice, with teams developing deeper relationships with stakeholders. One team noted they had “built close relationships. . . especially regarding local culture, values, customs” (P3). This evolution was reflected in changing research approaches, where “the research team also views the local communities as agents of change, the local groups are included in the research proposal to co-design the field research activities through a participatory action research process” (P5).

Research impact pathways demanded innovative approaches to policy engagement, as evidenced by one team’s observation that “HRBA gives a framework for water resource management. Water belongs to everyone for basic needs, and the government manages it on behalf of the people. . . So, if we want to have a fair investigation process about the impacts of current water management, we must use the concept of HRBA” (P4).

Continuum of a Practice Framework

The continuum of a practice framework maps the implementation depth across five key dimensions (Figure 1), with clear evidence of progression in each area. This framework emerged from the analysis of how different projects evolved in their implementation of human rights-based approaches and principles.

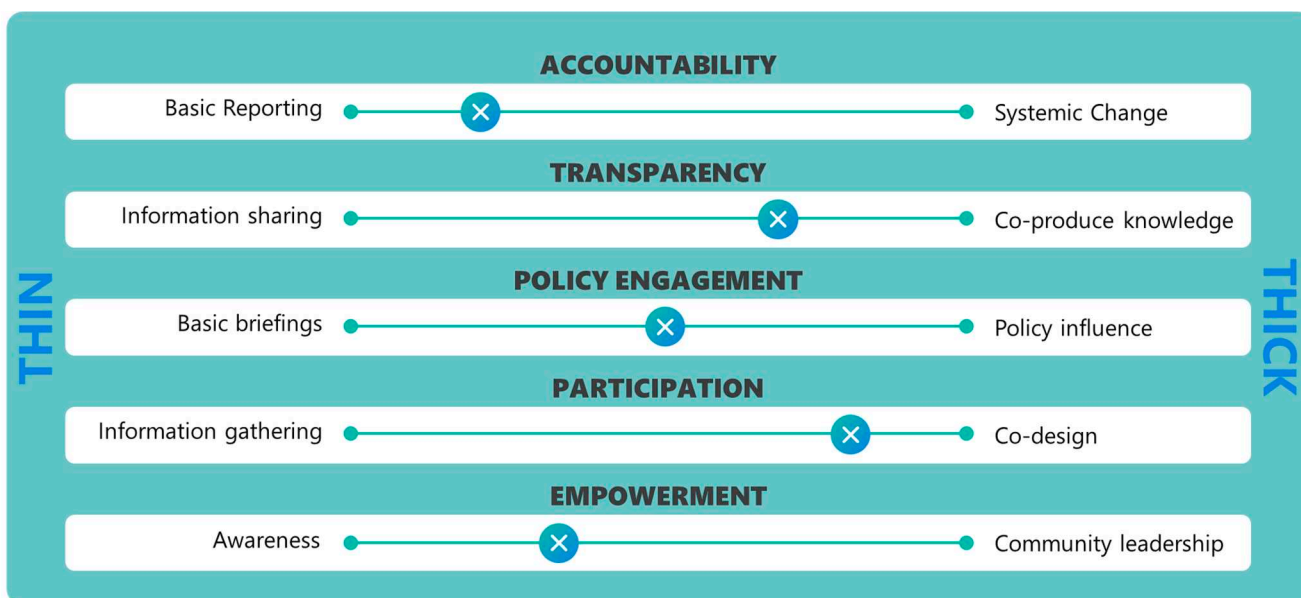


Figure 1. Continuum of practice in implementing human rights-based approaches (original figure developed by the authors).

Accountability emerged as a fundamental dimension of rights-based research, progressing from basic reporting to systemic changes. This evolution reflects a growing understanding of responsibility in research relationships.

Transparency represents the evolution of information-sharing practices in research, moving from basic dissemination to co-produced knowledge. Teams demonstrated varying levels of engagement with stakeholders, from formal consultation to deeper collaborative relationships.

Policy engagement reflects the growing sophistication of research–policy interactions. The depth of engagement ranged from basic mandate fulfillment, as seen in teams who viewed HRBA as “one of the mandates from S4A to include vulnerable communities” (P6), to more sophisticated approaches focused on enhancing community voice in policy dialog.

Participation demonstrates the deepening of community involvement in research, progressing from basic consultation to genuine co-design. This evolution reflects fundamental changes in how research is conceptualized and conducted, as exemplified by projects that moved toward collaborative research designs with local communities.

Empowerment captures the transformation of community roles in research, evolving from passive awareness to active leadership. This progression represents perhaps the most fundamental shift in research relationships, with teams developing approaches that enhanced community voice and agency in the research process.

The framework provides a practical tool for assessment and planning. Projects can use it to reflect on their current implementation depth by marking where they sit along each dimension’s continuum with an ‘X’, indicating position between ‘thick’ and ‘thin’ implementation. This assessment can be conducted at multiple points throughout project implementation, such as during mid-term reviews or final evaluations, to track a project’s progress in HRBA integration. At a program level, managers can use the framework to assess their portfolio’s overall HRBA implementation by marking different projects’ positions, helping identify areas needing additional support or attention.

These frameworks provide complementary guidance for researchers implementing HRBA principles. The challenge–response framework offers specific strategies for common challenges, while the continuum of a practice framework helps researchers assess and plan their integration depth. Together, they offer practical tools for enhancing rights-based water research implementation.

4. Discussion

The integration of human rights-based approaches into water research represents a significant transformation in research practice, extending beyond traditional methodological frameworks to create more inclusive and impactful water research. Our analysis reveals several key insights that contribute to understanding how HRBA can enhance water research while addressing what Zeitoun et al. [8] identify as crucial gaps between technical research and governance implementation. This transformation particularly resonates with the need to connect research to practical water security solutions.

4.1. Research Projects as Windows into Water Governance

Our decision to examine research projects as analytical units builds on Grassini’s [4] observation that research methodologies directly influence subsequent management practices. While acknowledging the methodological challenges of using projects as data points, this approach provides unique insights into how water governance practices evolve, supporting what van Buuren et al. [1] describe as adaptive research management.

Three distinct pathways emerged through which research projects influenced water management practices:

1. **Methodology Transfer:** Project teams demonstrated how HRBA elements could be incorporated into local water management practices, supporting Roque et al.’s [2] assertion that participatory approaches can significantly enhance the research impact.

This was particularly evident in how teams developed collaborative platforms for stakeholder engagement and decision-making processes.

2. Capacity Development: Research projects served as training grounds for water management practitioners, addressing what Hong [52] identifies as crucial gaps in technical capacity for rights-based implementation. The evolution of team capabilities and stakeholder relationships throughout project implementation demonstrated the value of experiential learning in rights-based approaches.
3. Policy Development: Research findings contributed to policy development through structured engagement with decision-makers and stakeholders. Projects demonstrated how rights-based research approaches could inform policy recommendations while maintaining sensitivity to local political contexts.

4.2. From Research Practice to Management Transformation

Building on Miller and Redhead's [31] conceptualization of 'thick' and 'thin' rights-based approaches, our analysis reveals how varying depths of HRBA implementation influence management practice transformation. This extends Vandenhoe and Gready's [19] work on the development of rights-based approaches by demonstrating specific pathways through which research methodologies influence management practices.

The transformation of research methods into management practices emerged as a key pathway for innovation in water governance. Projects demonstrated how research approaches could evolve into sustained management practices, supporting what Zeitoun and others [8] describe as the co-production of water governance knowledge. Teams developed participatory monitoring protocols and implemented structured stakeholder dialogue approaches that became integrated into local water management frameworks. This evolution addresses what Rachinsky-Spivakov [5] identifies as limited grassroots participation in water management while providing specific methodological solutions for enhancing community engagement in water governance.

The integration of different knowledge systems emerged as another crucial dimension of research practice transformation. Teams recognized the need for approaches that bridged the technical and social dimensions of water management. Building on Woodhouse and Muller's [3] call for more systematic approaches to rights-based water research, projects developed monitoring systems that respected local knowledge while maintaining technical rigor. These systems were complemented by multi-stakeholder platforms for decision-making that integrated rights-based considerations into technical assessments.

The pathway from research to policy implementation represented a third significant area of innovation. Projects demonstrated how rights-based research approaches could inform policy development while maintaining sensitivity to local political contexts. As one team noted, "the contribution of HRBA is to increase people's voices, gaining access to the dialogue" (P4). This engagement led to the development of revised water allocation protocols and regional consultation guidelines that incorporated rights-based indicators. These outcomes address what Lynch et al. [60] identify as crucial gaps in research methodology, demonstrating how rights-based research can directly contribute to policy development.

The synthesis of these transformations suggests that rights-based approaches can fundamentally alter how water research informs management practices. The progression from basic stakeholder consultation to integrated knowledge systems and ultimately to policy influence demonstrates the potential for research methodologies to drive systematic improvements in water governance. This is particularly significant in contexts where traditional technical approaches have struggled to address complex socio-political dimensions of water management.

4.3. Implications for Future Water Governance

Our findings reveal significant implications for the future of water governance, particularly in regions facing complex water security challenges. The transformation of research methodologies through HRBA integration serves as a catalyst for broader systemic changes in water governance systems. This transformation extends beyond methods to influence institutional practices and policy frameworks, supporting Boelens et al.'s [7] vision for more integrated approaches to water governance while addressing practical implementation challenges.

The evolution of stakeholder engagement practices represents a fundamental shift in how water management decisions are conceptualized and implemented. Projects demonstrated that when research teams moved beyond traditional technical approaches to embrace rights-based principles, they created new pathways for community participation in water governance. This aligns with Kabir et al.'s [42] findings on rights-based approaches in natural resource management while providing specific mechanisms for implementation in water governance contexts. The development of structured engagement protocols and rights-based indicators has particular significance for regions where traditional governance approaches have struggled to address complex socio-political dynamics.

Research methodology innovations show potential for driving broader systemic changes in water governance, particularly in how technical expertise interfaces with local knowledge systems. Building on Zwarteveen et al.'s [46] work on maintaining technical validity while enhancing social engagement, our analysis reveals how research projects can create frameworks that integrate multiple knowledge systems while maintaining scientific rigor. This integration becomes particularly significant when considering Zinzani and Menga's [58] emphasis on systematic approaches to rights-based research design.

The policy implications of these methodological transformations are substantial. Building on Smith's [43] framework for rights-based research impact, our findings demonstrate how research methodologies can influence a policy through multiple pathways: the development of rights-based indicators for water management, the integration of participatory approaches in decision-making processes, and the creation of new accountability mechanisms. These pathways are particularly important in contexts where traditional policy development processes have struggled to effectively incorporate community perspectives.

The institutional implications extend beyond individual projects to suggest broader changes in how water management decisions are made and implemented. The integration of rights-based principles in research methodology has led to the development of new institutional practices that better reflect community needs and rights in water governance. This supports Lynch et al.'s [60] emphasis on systematic approaches to policy engagement while demonstrating practical mechanisms for institutional change.

Looking forward, these transformations suggest a need for continued evolution in how water governance research is conducted and applied. The development of rights-based research methodologies provides a foundation for more equitable and effective water governance approaches, particularly in regions facing complex water security challenges. This evolution requires ongoing attention to both technical rigor and social engagement, supporting what Woodhouse and Muller [45] identify as crucial elements of effective water governance research.

5. Conclusions: Transforming Water Research Practice Through Rights-Based Approaches

This study advances our understanding of how human rights-based approaches transform water research practice, offering critical insights for addressing water security challenges in complex socio-political contexts. Through a systematic examination of six water research projects in the Mekong region, we demonstrate how the integration of rights-

based principles enhances both research quality and practical outcomes while revealing specific pathways for implementation.

Our investigation establishes that research methodologies directly influence water management practices, particularly in regions facing complex water security challenges. The integration of HRBA principles occurs along a continuum of practice, from basic compliance to transformative implementation. This progression supports Miller and Redhead's [31] conceptualization of rights-based approaches while demonstrating specific applications in water research contexts. The varying depths of integration lead to different practical outcomes, with implications for both research methodology and water governance.

This study makes three significant contributions to advancing water security research and practice. First, we extend the theoretical understanding of HRBA implementation in research contexts, providing specific markers for research practice transformation that maintain technical validity while enhancing social engagement. Second, our challenge–response framework offers practical guidance for researchers navigating complex socio-political contexts, addressing key implementation barriers identified throughout our investigation. Third, we demonstrate specific pathways for bridging technical and social dimensions of water research, creating integrated approaches that honor both scientific rigor and human rights principles. These contributions directly address the objectives of examining HRBA integration, analyzing implementation patterns, and developing practical frameworks for enhancing water research practice.

Several limitations of our study must be acknowledged, each suggesting important directions for future research. While our focus on the Mekong region provided rich insights into HRBA implementation in complex contexts, the applicability of our findings to other regions requires further investigation. Additionally, the complex political dynamics of water governance in the region necessitated a careful consideration of how rights-based principles were introduced and implemented, suggesting the need for a context-specific adaptation of our frameworks.

These limitations point to three critical directions for future research. First, longitudinal studies are needed to examine how HRBA research methodologies influence water management outcomes over extended periods. This addresses Sultana's (2020) [26] call for a deeper understanding of long-term impacts. Second, an investigation of scaling mechanisms could reveal how successful approaches might be adapted across different geographical and political contexts, thereby building on Kelly's [25] work on HRBA implementation variation. Third, a systematic analysis of institutional and political barriers to HRBA adoption would support more effective research implementation, addressing what Corson et al. [42] identify as crucial needs in natural resource management research.

Looking forward, our findings suggest that the transformation of water research practice through rights-based approaches represents a crucial step toward more equitable and effective water governance. The frameworks developed provide practical guidance for researchers while acknowledging the complexities of implementation across different contexts. As water security challenges become increasingly complex, the integration of human rights principles in research methodology offers pathways for enhancing both scientific rigor and practical impact.

Our study demonstrates how systematic attention to research methodology can drive improvements in water management practice, particularly in regions facing complex water security challenges. While focused on the Mekong context, our findings offer valuable insights for researchers worldwide seeking to enhance their practice through rights-based approaches, contributing to the broader goal of advancing water security through more inclusive and rigorous, and impactful research methodologies.

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