

EVALUATING STAKEHOLDER COMMUNICATION AND ADAPTIVE WATER GOVERNANCE IN FARM LEVEL IRRIGATION AREA

ÉVALUATION DE LA COMMUNICATION AVEC LES PARTIES PRENANTES ET DE LA GOUVERNANCE ADAPTATIVE DE L'EAU DANS UNE ZONE IRRIGUÉE À L'ÉCHELLE DES EXPLOITATIONS AGRICOLES

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ABSTRACT

The management of water resources in Taiwan has recently focused on various aspects of water policy, including reservoir planning and renewal activation, alternative water resources planning, and smart water management. The Water Resources Agency has implemented several projects to improve water supplies to provide sustainable water use. For water resources to be effectively managed in the future, water agencies will need to work with local-level people to confront water resource challenges. This study focuses on a specific emphasis on the Wufenggang River and Zhoumei irrigation areas. By evaluating agricultural irrigation adaptation under climate change scenarios, this research investigates how localized public participation can build sustainable resilience. Climate change increasingly threatens the stability of water resource utilization, necessitating enhanced resilience and adaptive capacities within agricultural irrigation systems. In Taiwan, water management has transitioned toward a multifaceted policy approach—incorporating reservoir renewal, smart management, and alternative resource planning—to ensure sustainable supplies. The water resources agency has implemented several projects to improve water supplies to provide sustainable water use. For water resources to be effectively managed in the future, water agencies will need to work with local people to confront water resource challenges. Central to this evolution is the recognition that technical solutions must be paired with local engagement to confront emerging water scarcity challenges. This study focuses on the irrigation management office's jurisdiction, specifically the irrigation areas, to explore how socio-hydrological feedback loops and diverse communication strategies can strengthen water governance. Socio-hydrology provides a critical framework for understanding the evolution of human and water systems, advocating for research that enhances social adaptive capacity through the quantification of feedbacks between society and water resources. By evaluating agricultural irrigation adaptation under climate change scenarios, this research investigates how localized public participation can build sustainable resilience.

Keywords: Stakeholder communication; Adaptive water governance; Water resources; Sustainable water use; Public participation.

RÉSUMÉ

À Taiwan, la gestion des ressources en eau s'est récemment concentrée sur plusieurs volets de la politique de l'eau, notamment la planification et la revitalisation des réservoirs, la planification de ressources en eau alternatives et la gestion intelligente de l'eau. L'Agence des ressources en eau a mis en œuvre plusieurs projets destinés à améliorer l'approvisionnement en eau et à assurer une utilisation durable de cette ressource. Pour que les ressources en eau puissent être gérées efficacement à l'avenir, les organismes compétents devront collaborer avec les acteurs locaux afin de relever les défis liés à l'eau. Cette étude porte plus particulièrement sur la rivière Wufenggang et les zones irriguées de Zhoumei. En évaluant l'adaptation de l'irrigation agricole selon des scénarios de changement climatique, cette recherche examine comment la participation du public à l'échelle locale

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peut renforcer une résilience durable. Le changement climatique menace de plus en plus la stabilité de l'utilisation des ressources en eau, ce qui impose de renforcer la résilience et les capacités d'adaptation des systèmes d'irrigation agricole. À Taïwan, la gestion de l'eau a évolué vers une approche politique multidimensionnelle, intégrant la revitalisation des réservoirs, la gestion intelligente et la planification de ressources alternatives, afin de garantir un approvisionnement durable. L'Agence des ressources en eau a mis en œuvre plusieurs projets destinés à améliorer l'approvisionnement en eau et à assurer une utilisation durable de cette ressource. Pour que les ressources en eau puissent être gérées efficacement à l'avenir, les organismes compétents devront collaborer avec les populations locales afin de relever les défis liés à l'eau. Au cœur de cette évolution se trouve la reconnaissance du fait que les solutions techniques doivent s'accompagner d'une mobilisation locale pour faire face aux nouveaux risques de pénurie d'eau. Cette étude se concentre sur le territoire de compétence du bureau de gestion de l'irrigation, et plus précisément sur les zones irriguées, afin d'examiner comment les boucles de rétroaction sociohydrologiques et diverses stratégies de communication peuvent renforcer la gouvernance de l'eau. La sociohydrologie fournit un cadre essentiel pour comprendre l'évolution conjointe des sociétés et des systèmes hydriques ; elle préconise des recherches qui renforcent la capacité d'adaptation sociale grâce à la quantification des rétroactions entre la société et les ressources en eau. En évaluant l'adaptation de l'irrigation agricole selon des scénarios de changement climatique, cette recherche examine comment la participation du public à l'échelle locale peut renforcer une résilience durable.

Mots clés : Communication avec les parties prenantes; Gouvernance adaptative de l'eau; Ressources en eau; Utilisation durable de l'eau; Participation publique.

1. INTRODUCTION

Climate change factors significantly impact the stable utilization of water resources, making water resilience and adaptive capacity closely tied to the intensity of public participation. The emerging field of socio-hydrology advocates for research that enhances social adaptive capacity by quantifying the feedbacks between water resources and society. This approach explicitly accounts for the co-evolving trajectories of socio-hydrological systems, helping stakeholders identify safe functioning spaces. Furthermore, key policy documents emphasize that public and stakeholder participation is required to enhance resource management and involve individuals and groups in a democratic way. Effective participation requires diverse communication models to transmit the concrete actions of the public sector regarding water resource development and conservation, which ultimately consolidates public support and serves as the cornerstone for policy implementation.

In the context of the study site, the project implemented several key tasks: (1) collecting regional background data on social issues and water availability; (2) facilitating direct communication with local residents; and (3) promoting water environmental education. A notable initiative included inviting local village leaders and community chairpersons to visit the retention basin, fostering interaction between policy leaders and the community to bridge information gaps and build trust. Methods for evaluating participation to assess the effectiveness of these engagement efforts, the study utilizes the several levels of the evaluation framework: (1) assessing the quality, legitimacy, and power dynamics of the participation process. (2) measuring non-tangible results such as trust, communication quality, and institutional agreements. (3) determining protentional changes in resource management, such as improvements in water quality or irrigation efficiency. (4) to support the analysis of the crop productivity (CP) model and localization of data, the survey of questionnaire designed for farmers in the study area. Special emphasis is placed on intermediary outcomes, which often reveal the side benefits of participation—such as increased community commitment—that precede long term resource changes. Conclusion by integrating the CP model for numerical simulation of crop growth under climate change scenarios with socio-hydrological field tests, this project aims to create a localized data profile for the farm level practices irrigation area.

Complementing this, the literature on public participation emphasizes that involving individuals and groups in a democratic manner is essential for decision making. Effective participation can lead to more effective solutions by tapping into local knowledge and networks, although it requires

overcoming challenges such as processes and potential manipulation by powerful interest groups. Diverse communication tools drawing on international models, such as the 3Ps strategy (Policy, Product, and Partnerships) used, this research examines the application of diverse communication tools to foster stakeholder support. The research expects to produce an adaptive management guide and enhance the accuracy of yield simulations. Combine the spatial plot data from farmers with the calculated Relative Irrigation Supply Index (RISI) to identify highly vulnerable zones in irrigation area. Ultimately, the study demonstrates that stakeholder participation and diverse communication are not merely administrative requirements but are the foundational stones of successful water policy implementation in a changing climate.

2. Methods for Evaluating Participation

The Jiufenggou area, located within the Jhoumei section of the Beitou District, is a unique micro-irrigation zone at the edge of an urban center. It faces a complex intersection of agricultural needs and urban development. The primary water source is the Wufenggang River (a tributary of the Keelung River), but upstream urban development has caused a sharp reduction in runoff during the dry season. The irrigation water is frequently contaminated by domestic sewage and urban runoff. Research indicates a need for scientific quantification of water gaps, especially when the Relative Irrigation Supply Index (RISI) falls below 0.8, identifying irrigation stress zones. Social and management issues included urbanization pressure, resource competition, and management conflicts. The proximity to the Beitou Shilin Technology Park has led to the fragmentation of traditional irrigation channels. As an ecological canal, Jiufenggou must balance the maintenance of ecological flow for habitats with the water requirements for agricultural production. There is a historical reliance on experience-based irrigation rather than data-driven decision-making, which can lead to conflicts during water scarce periods. To manage these challenges, the project emphasizes moving beyond traditional top-down administration to a multi-stakeholder participation model (Dearing Smith, K. 2019). Utilizing a framework of people, product, partnerships, and pipe to build trust and consensus. Education is used as a tool to bridge the gap between policy intent and local understanding (Carr, G., Blöschl, G., and D. P. Loucks, 2012). Organizing environmental education visits for local residents and opinion leaders to facilities like the retention basin to help them visualize water policy in action.

To assess the effectiveness of these engagement efforts, the study utilizes a three-tiered evaluation framework. Assessing the quality, legitimacy, and power dynamics of the participation process. Measuring non-tangible results such as trust, communication quality, and institutional agreements. Determining tangible changes in resource management, such as improvements in water quality or irrigation efficiency. Special emphasis is placed on intermediary outcomes, which often reveal the side benefits of participation—such as increased community commitment—that precede long-term resource changes.

2.1 Expert Survey Framework

Targeted interviewees include hydraulic engineering experts, ecological conservation scholars, senior personnel from the water resource, irrigation management office, and agricultural economists. The interviews will cover three main domains:

1. Supply Demand Balance and Model Calibration:

- Based on experience in the Taipei region, how should the Crop Productivity Model (CPM) adjust weightings to account for the impact of urban microclimates (e.g., building shading, urban heat island effect) on crop reference evapotranspiration (ET_0)?
- Given that Jiufenggou's water diversion is influenced by Keelung River tides and Wufenggang River water levels, which non meteorological factors (such as manual sluice gate operational habits) are most critical to include when simulating irrigation scheduling?

2. Conflict and Coprosperity of Ecology and Irrigation:

- When the Wufengang River flow is insufficient to simultaneously maintain crop harvest and ecological habitat (e.g., minimum ecological flow), what compensation or allocation mechanisms should be recommended at the policy level?
- For the Jiufenggou ecological waterway, which Low Impact Development (LID) techniques can effectively enhance water storage capacity during the dry season without degrading the original ecological habitat?

3. Social Adaptation and Policy Promotion:

- What do you perceive as the greatest barrier to promoting smart irrigation or alternate wetting and drying among older farmers in the Zhoumei area (e.g., lack of subsidy policies, technological thresholds, or entrenched traditional mindsets)?

2.2 Digital Survey Deployment

To rapidly aggregate quantitative data, a structured Google Form questionnaire will be distributed to relevant administrative staff, local farming groups, and researchers.

Questionnaire Title: Survey on Climate Change Adaptation Needs and Value Assessment for the Jiufenggou Ecological Waterway

1. Part 1: Basic Information

- (1) Land Location/Plot Number: (To correlate with soil maps and spatial data).
- (2) Cultivation Area: (e.g., how many hectares).
- (3) Major Crop Types: * ☐ Rice (Varieties: _____). ☐ Leafy Vegetables (Types: _____). ☐ Other: _____
- (3) Professional Field: [Hydraulics / Agriculture / Ecology / Administration / Other]
- (4) Level of familiarity with the Jiufenggou irrigation area: [Scale of 1-5]

2. Part 2: Irrigation and Climate Risk Observation

(1) What is the most significant climate change you have observed in the Jiufenggou irrigation area in recent years? (Multiple Choice)

- ☐ Prolonged drought periods
- ☐ Sudden intense rainfall causing water turbidity
- ☐ Insufficient water level at the diversion intake
- ☐ Other: _____

(2) What do you consider the most vulnerable link in Jiufenggou currently?

- ☐ Aging infrastructure (leakage)
- ☐ Water source polluted by upstream activities
- ☐ Lack of scientific monitoring data
- ☐ Aging farming population leading to management difficulties

(3) Part 3: Adaptation Strategy Preference Analysis

If a smart monitoring system were to be established, which sensor do you think should be installed first?

- ☐ Water Level Gauge ☐ Water Quality (EC) Sensor ☐ Soil Moisture Sensor ☐ Rain Gauge

Regarding the rotational irrigation system, which distribution principle do you favor?

- ☐ Output value priority (priority water supply for high economic value crops)
- ☐ Fairness priority (rotational irrigation based on cadastral sequence)
- ☐ Ecological priority (priority to maintain waterway flow velocity to prevent eutrophication)

(4) Part 4: Open Suggestions

Please briefly outline your policy expectations for the Wufengang River and Jiufenggou in response to future climate change.

2.3 Strengthening Administrative Persuasiveness

When executing these interviews and questionnaires, two critical points will be heavily emphasized. The results from expert interviews will be directly fed back into the Management files settings of CP model. This guarantees that the model relies on actual Zhoumei field data rather than purely laboratory data. The results of the questionnaires will be transformed into social support indicators. This provides empirical evidence to review committee members that our proposed adaptation strategies have comprehensively accounted for the opinions of local farmers and ecological groups, thereby significantly reducing resistance during policy execution.



Figure 1. Irrigation supply system of Zhoumei areas

3. Water Availability and the Ecological Transformation of Jiufenggou

Historically, the Jiufenggou Canal was an irrigation and drainage ditch that suffered from neglect, often being described as an unclean ditch that emitted foul odors due to poor water circulation and the polluted runoff of Nonpoint source (NPS) pollution of agricultural and industrial area. However, as part of the broader ecological restoration efforts in Taipei, the canal has been transformed into a model ecological watercourse. This transformation involved replacing the traditional concrete or dirt banks with eco-engineered solutions that facilitate biological habitats while maintaining the canal's primary function of water transport. The integration of the canal with the surrounding bamboo forests and the construction of wooden boardwalks have shifted the canal's identity from a utilitarian agricultural tool to an aesthetic and recreational asset. For the remaining farmers, the challenge is ensuring that this ecological shift does not compromise water availability for irrigation. The Chising Management Office (CMO) plays a critical role in managing this balance, ensuring that the water infrastructure continues to serve agricultural production while meeting modern environmental standards. The availability of water in the Zhoumei area is also influenced by the broader hydrological management of the Keelung River basin. International ecological engineering cases, such as the restoration of the Kissimmee River and the protection of the Everglades, provide a conceptual

framework for the kind of natural symbiosis being attempted in Zhoumei. These precedents suggest that successful water management in urban-agricultural zones requires the creation of artificial wetlands and the implementation of Best Management Practices (BMPs) for nutrient reduction, particularly in areas where agricultural runoff may impact the health of the restored canal. The primary metric for this physical stress is the Relative Irrigation Supply Index (RISI). $RISI = (\text{Actual Water Supply}) / (\text{Crop Water Requirement})$. A threshold is established: when $RISI < 0.8$, the specific parcel is defined as an irrigation stress zone. This numerical data is then spatially projected onto the cadastral maps of the irrigation area of Jiufenggou. Beyond simply identifying physical water shortages, it is imperative to analyze who is most susceptible to harm. Tailoring this approach to the unique demographic and geographical realities of the Jiufenggou irrigation area, it can be defined as social vulnerability across three core dimensions.

Table1. Agricultural Social Vulnerability Evaluation Indicators

Dimension	Evaluation Indicators	Link to Social Impact
Exposure	The number of farmlands located at the terminus of Jiufenggou, situated at higher elevations, and lacking mechanical pumping equipment.	Identifies the geographic parcels at the highest risk of disaster/drought impact.
Sensitivity	Average age of the farmers (degree of aging population), and the sensitivity of the primary crop to water stress (e.g., Rice > Vegetables).	Evaluates the baseline tolerance and physical capacity of the agricultural labor force against climate variations.
Adaptive Capacity	Participation in agricultural production and marketing groups, level of acceptance toward smart irrigation technologies, and the availability of alternative water sources (e.g., private wells).	Measures the resilience and recovery capability of farmers when faced with extreme climatic events.

4. Promoting Water Environmental Education

Water environmental education in Zhoumei is not merely about scientific literacy; it is a tool for community building and economic resilience. By aligning educational initiatives with the city's Net-Zero goals and agricultural subsidy programs, the region can foster a new generation of water stewards who understand both the ecological and economic value of their environment. Integrating ecological engineering and place-based learning. The Jiufenggou serves as the primary outdoor classroom for the area. The transformation of a smelly ditch into a biodiverse canal provides a powerful narrative of restoration that can be taught through the walled-less environmental education museum framework established. Educational programs should focus on natural symbiosis network, water quality and sensory experience. Highlighting how the canal's bio-engineering supports local flora and fauna, such as the bamboo forests that were integrated into the design. Using the sensory improvements (reduced odor, visual beauty) as a entry point to discuss the science of water filtration and ecological balance. Drawing parallels between the Jiufenggou and larger scale projects like the restoration of the Neuse River buffer or the Ala Wai Canal to show residents that their local efforts are part of a global movement toward sustainable hydrology. For the farming community, environmental education is deeply linked to the adoption of eco-friendly or organic farming methods. The government offers significant financial incentives to encourage this transition, which serves as both an economic safety net and an educational incentive.

5. Conclusion and Expected Benefits

By integrating the CP model for numerical simulation of crop growth under climate change scenarios with socio-hydrological field tests, this project aims to create a localized data profile for the Jiufenggou area. The research expects to produce an adaptive management guide and enhance the accuracy of yield simulations. Ultimately, the study demonstrates that robust stakeholder participation and diverse communication are not merely administrative requirements but are the foundational stones of successful water policy implementation in a changing climate. Promoting Alternate Wetting and Drying (AWD) techniques as an educational demonstration. This shows farmers how they can save 15–20% of water during the rice tillering stage while strengthening crop root systems. Educating the community on how water can be allocated for ecological habitat maintenance without significantly impacting final crop yields, fostering a culture of ecological and production balance. The transformation of the Zhoumei Jiufenggou area from a traditional agricultural plain to a modern eco-tech district represents one of Taipei's most ambitious urban experiments.

The success of this transition depends on the ability to resolve the lingering social tensions of the expropriation era, maintain the hydrological integrity of the canal for both irrigation and ecology, and empower residents through targeted environmental education. Simultaneously, water environmental education must be framed as a pathway to economic sustainability, connecting the health of the Jiufenggou to the financial rewards of organic farming and the city's broader Net Zero objectives. By weaving these disparate threads—social justice, hydrological health, and ecological literacy—into a single narrative, Zhoumei can serve as a global model for the harmonious coexistence of technology and tradition in a water-centric urban landscape.

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