RESEARCH ARTICLE OPEN ACCESS

Assessing the Beneficial and Adverse effect of the Impounding System on the Socioeconomic Conditions of Wetland Communities in Candaba, Pampanga: Balancing Wetland Preservations and Local Livelihoods

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Abstract:

The Philippines faces significant challenges with flooding due to its vulnerability to extreme weather events. Addressing these challenges requires efficient flood control measures, such as impounding systems, to mitigate the adverse effects of heavy rainfall and rising water levels. This study assesses the beneficial and adverse effects of the impounding system on the socioeconomic conditions of wetland communities in Candaba, Pampanga, focusing on balancing wetland preservation with local livelihoods. Using a mixed-methods approach, qualitative and quantitative data were collected through surveys, interviews, and participant observations. Thematic analysis revealed insights into community awareness, perceptions of the impounding system, socioeconomic impacts, local livelihoods, political and legal aspects, and environmental effects. The study's respondents were three hundred eighty-three (383) residents residing in the area. The researchers conducted a survey through a questionnaire to collect information about the respondents' profile and locals' perception. The results showed that the residents accepted that the impounded system, socioeconomic impact, local livelihood, political/legal factors, and environmental factors are the leading variables to the acceptability of the proposal, with "political/legal" having the highest mean score out of the six, which indicates strong support and approval from the community towards the acceptability of the system. Candaba, Pampanga, acknowledges the significance of impounding systems and the risks associated with flooding, socioeconomic effects, service accessibility, and the preservation of cultural heritage. Locals request government assistance because they cherish traditional farming. Though they are concerned about soil and habitat, they support impounding systems for improved livelihoods and resilience. It's critical to manage wetlands in a balanced way for the environment and community. Overall, this study emphasizes the necessity of community involvement, sustainable policies, and comprehensive approaches to wetland management to achieve a harmonious balance between socioeconomic well-being and environmental sustainability in Candaba, Pampanga

Keywords **—Community Awareness, Impounding system, Irrigation, Socioeconomic Impact, Wetland Communities**

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I. INTRODUCTION

The threat of flooding is a serious and frequent hazard to communities everywhere, but it is especially noticeable in the Philippines, an archipelagic country vulnerable to a variety of meteorological and topographical conditions. Typhoons, torrential rains, and storm surges are all part of the yearly cycle of extreme weather events that the Philippines, which is situated in the region

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known as the Pacific Ring of Fire as well as the typhoon belt, endures. The lives and economic prospects of communities all around the nation are severely affected by the increased risk of floods brought on by these occurrences. Other various aspects of flooding in communities in the Philippines are some of the main arguments that needed to be addressed, including its origins, effects, and possible ways to mitigate it. To help address the widespread problem of water damage in the Philippines by developing sustainable and practical solutions and being aware of the particular difficulties these communities confront.

This is why lowering the risk of flooding and creating a sustainable and resilient community in those places should be top priorities. Therefore, efficient flood control measures should be implemented when potential floods have been detected using scientific information. Hydrological simulations can be used to quantify flood damages and gain knowledge of flood frequencies. However, because of the diverse model parameters and associated uncertainties, hydrological simulations can occasionally seem perplexing and unfamiliar to residents. Nonetheless, concentrating on the topography of alluvial lowlands and illustrating its features on a map that takes into account the land's history, elevation, and topographical distribution could produce a more thorough and beneficial approach to conveying the area's susceptibility to flooding.

Considering a fundamental part of structural flood prevention strategies, impounding systems are essential for regulating and reducing the negative effects of heavy rainfall and increasing water levels. By cleverly storing extra water temporarily, these systems reduce the chance of flooding downstream and protect infrastructure and populations. Building reservoirs and dams in strategic locations along river basins is one well-known example. By efficiently controlling water flow, these impounding devices lessen peak discharge during periods of intense precipitation. The impounding system is a robust response to the problems presented by unpredictable weather and climate change, and its many advantages serve as a tribute to human ingenuity in cooperating with nature.

The outline and explanation of the intricate relationship between local livelihoods and the viability of the impounding system, which exists between the preservation of wetlands and them, indicate a variety of viewpoints that elaborate on and integrate the significance of the Candaba wetlands and present the impounding system as a crucial intervention. The researchers also highlight the objectives of this study, the methodology employed, and the significance of understanding the dual role of the impounding system in shaping the socioeconomic conditions of the wetland communities in Candaba, Pampanga.By comprehensively aspirations and sustenance of the local population.

1. Review of Related Literatures

- ***Flood Control***

A flood is an abnormal, progressive rise in a stream's water level that may cause water to overflow on the stream's normal boundaries and subsequently inundate areas that are not normally submerged. In its most basic form, a flood happens when a waterway overflows its banks, but more frequently, it is the result of excessive rainfall that is brought on by a typhoon or the South West monsoon. Floods typically also happen in low-lying places that act as settings for natural depositional processes. Notable examples in Luzon are the Pasig delta, where Manila was founded; the Agno River; the Pampanga River basin; and the Marikina River [1].Numerous studies have shown how important it is for the Philippines to implement better flood mitigation and control strategies. Noted the shortcomings in the Metro Manila flood management system, such as insufficient facilities and forecasting systems [2].It underlined the significance of drainagesystem upgrades in Espana Boulevard, Metro Manila [1], while stressing the necessity of successful operations for the Antiao River Control Project in Catbalogan City. All of these studies highlight how urgent it is for the Philippines to improve flood mitigation and control strategies [3].

Researchers and governments are investigating novel flood management strategies in response to the growing frequency and severity of floods worldwide. Implementing impounding systems,

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particularly flood control check dams, is one such strategy. It highlights how important flood prevention check dams are hydrologically. These constructions are intended to restrict sediment transport, lower peak discharges, and manage water flow. By retaining water and allowing for a slow release amid downstream flows, check dams help to reduce the danger of flash floods. Ecosystems and communities downstream may benefit from this hydrological control [4].

- ***Wetland Communities***

The wetlands in the Philippines face various threats and require effective management strategies. An overview of the effects of the Philippines wetlands on the environment and the necessity of conservation may be found in a study on the danger's features, and management of these areas. Wetlands of low quality are the result of insufficient enforcement of municipal and federal rules pertaining to wetlands. The voluntary cooperation of the entire Filipino community can optimize the preservation and exploitation of these wetlands [5]. It is well acknowledged that freshwater biodiversity is declining far more rapidly globally than it is in the marine or terrestrial domains. Additionally, the biodiversity of the freshwater ecosystems in the Philippines has been ignored, just like that of the remainder of tropical Asia. In this review, it aims to highlight areas that require more investigation, highlight underrepresented systems, and highlight neglected creatures. In this study, it critically assessed the body of accessible, peer-reviewed literature to ascertain the nation's present state of knowledge regarding freshwater ecosystems [5].

Considering the sustainability of impounding structures in wetland ecosystems, a number of elements are critical. The requirement for precise impoundment modelling in watershed systems [6]. It draws attention to the negative effects of water impoundment on the ecosystem in the tropics, such as sediment buildup, changed flow patterns, and possible health risks [7]. Examines environmental flow regime design in confined river systems in more detail, with an emphasis on ecological metrics and habitat quality. Together, these studies highlight the necessity of a thorough evaluation that takes into account the socioeconomic and ecological effects of impounding structures in wetlands communities [8].

In wetland communities, impoundment systems have benefits and drawbacks. Positively, they can offer recreational activities, water storage, and flood control. On the other hand, they can also have detrimental effects, such as upsetting sediment and flow regimes, deteriorating the physical habitat, and leading to the direct and indirect death of aquatic biota [9]. The impoundment systems may be used with other treatment methods, including artificial wetlands, to improve treatment effectiveness and meet longer-term treatment objectives, thereby reducing these detrimental consequences [10]. Particularly constructed wetlands have proven to be more cost-effective than traditional treatment plants in the treatment of a variety of toxins from wastewater in underdeveloped nations. Impounding systems can therefore be properly managed and combined with other forms of technology to reduce their negative effects, even though they do have some downsides [11].

- ***Impounding System***

Impounding systems are reservoirs or dams that are used to store water. They can be used for a variety of purposes, including irrigation, livestock drinking, domestic water supply, flood control, and hydropower generation. Impounding systems can play an important role in supporting community-based management of wetlands (CBMW) and climate change adaptation. For example, they can be used to store water for irrigation during the dry season, reduce the risk of flooding during the rainy season, improve water quality, and provide habitat for wildlife [12].

Structures for collecting and storing water, such as earth embankments, spillways, outlet works, and canal amenities, are known as small water impounding projects. It helps preserve soil and water and avoid flooding by gathering as much rainwater as it can throughout the rainy season to use in a useful way during the dry season. It provides more water for irrigation and growth in crops, which could greatly increase farmers' income. Furthermore, aquaculture, electricity generation, recreation, and animal husbandry all depend on

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water, and the water impounding the project helps meet those needs. Small water impounding projects have proven to be successful in regions with separate wet and dry seasons, such as the Northern Philippines. Throughout the wet season, SWIPs collect excess water that is then utilized in the dry season [13].

The significance of cultural knowledge, in conserving biodiversity and promoting sustainable development in these areas is often underestimated by scientists and policymakers. As biodiversity continues to decline at a rate, which is closely linked to poverty and food insecurity it becomes increasingly important to recognize the value of these landscapes for both conservation efforts and human well-being. The term "socio ecological production landscapes" (SEPLs) was created to describe production landscapes that have been shaped over time through interactions, between humans and nature aiming to enhance well-being while preserving biodiversity and ecosystem services [14].

Expanding and intensifying agriculture can have impacts on ecosystems and biodiversity. It can lead to the deterioration of ecosystems causing eutrophication, sedimentation and altered hydrology. Wetlands, such as rivers and estuaries protected under the RAMSAR conventionare particularly vulnerable to the effects of activities. They are susceptible to nutrient, sediment and pesticide runoff, water extraction, as drainage and reclamation [15].

II. METHODOLOGY

A. *Research Design*

This study used a qualitative and quantitative research design wherein the researchers evaluate the feasibility of the impounding system in wetland communities in Candaba, Pampanga, Quantitative data is gathered through surveys, while qualitative data is obtained through interviews and participant observation. Thematic analysis is used to identify patterns and trends in the data. The findings inform policy decisions and interventions that integrate wetland preservation with local livelihoods.

B. *Research Locale*

The study was conducted in Candaba, Pampanga. The researchers conducted a survey through a questionnaire and gather respondents residing in Candaba, Pampanga. The researchers chose the place of implementation because it will give the researchers the needed information on the positive and negative effects of the impounding system, a water management structure that collects and stores water for various purposes, such as irrigation, and flood control.

C. *Respondents of the Study*

The respondents of this study are the residents, primarily farmers, adults aging 18 to 60 years old, and other professionals residing in Candaba, Pampanga, that are near the Candaba wetlands, which represent the lowest point in the Central Luzon Region of Luzon. The municipality ofCandaba is divided into thirty-three (33) barangays.

D. *Research Instrument*

The researchers used a survey questionnaire as the tool to collect data, in order to determine the profile of the respondents and the perception of the residents in Candaba, Pampanga. The type of survey questionnaire is the 4-Point Likert Scale, it consists of four response options: highly acceptable, acceptable, unacceptable, and highly unacceptable. The table below shows the 4-point Likert scale ratings and interpretations of the respondent.

TABLE I
SURVEY QUESTIONNAIRES INTERPRETATION

Rating	Interpretation
4	Highly Acceptable
3	Acceptable
2	Unacceptable
1	Highly Unacceptable

E. *Data Gathering Procedure*

This study was conducted during the Academic Year 2023 – 2024 in Candaba, Pampanga. The data-gathering procedures for the completion of the study were:

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1. The researchers are conducting a thorough investigation by the collected data of the respondents of the survey given in the residence of Candaba, Pampanga. The researchers will conduct a thorough literature review to understand the current state of impounding systems, particularly in Candaba, Pampanga.
2. The researchers determined which respondents were chosen using Rao soft, which are the residents of Candaba, Pampanga. For the survey questionnaires, the researchers asked for the permissions of the respondents.
3. Conducting surveys to gather opinions and feedback from residents and stakeholders is their main objective. Before the researchers start on a full-scale survey, they conducted a pilot test to a few residents of Candaba, Pampanga to ensure the clarity and effectiveness.
4. The targets of their survey are the ones who are affected mostly by the proposed impounding system. This includes few farmers or residents that are near the new project. The researchers implemented their data collection plan by visiting impounding sites, interviewing residents, and administering surveys. Then they ensured the accuracy and the reliability of the data by double checking the responses, performing quality control checks, and ensuring the consistency in data collection.
5. The researchers calculated the entire population of Candaba, Pampanga. By getting the total population of Candaba, Pampanga or the sample mean of 119, 497 and using the Raosoft, the researchers calculated that 383 target respondents represent the sample size for the set population.
6. The calculated Weighted Mean and Standard Deviation were then used by the researchers of the selected respondents to determine the different opinion or voices of the residents of Candaba, Pampanga in the project of the Government which is the impacts of the impounding system on the socioeconomic fabric of the wetland communities in Candaba, Pampanga.
7. Analyzing the collected data through statistical analysis or other relevant methods. Keep detailed records of the data gathering process, noting any challenges, insights, or modifications made during the research. After that they safely store and secure our collected data to protect participants confidentially. Cleaned and organized their data to address any inconsistency or error before analysis. Interpreted the results and reported of their findings in the thesis, discussing their implications for the impounding system in Candaba, Pampanga.

F. *Statistical Treatment*

This study utilized different statistical tools in interpreting the collected data. The data interpreted helped to achieve the purpose of the study. The researchers used the following statistical tools.

- **Weighted Mean, Standard Deviation and Likert Scale**

TABLE III
VERBAL INTERPRETATION OF MEAN LEVELS OF AGREEMENT

Rating	Interval	Interpretation
4	3.26-4.00	Highly Acceptable
3	2.51-3.25	Acceptable
2	1.76-2.50	Unacceptable
1	1.00-1.75	Highly Unacceptable

III. RESULTS AND DISCUSSION

The survey questionnaires findings are shown in this section, along with a description of each section. The findings were produced on the respondents' comments concerning the elements that made the impounding system in Candaba, Pampanga, feasible. To aid in understanding, the researchers employed tables that were followed by an explanation.

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A. ***Residents' Responses on the category of Community Awareness, Impounding System, Socioeconomic Impact, Local Livelihoods, Political/Legal and Environmental***

TABLE IIIII
SUMMARY OF RESPONSES OF CANDABA RESIDENTS IN ALL CATEGORY

Category	Overall Mean	Overall Standard Deviation	Interpretation
Community Awareness	1.99	0.60	Disagree
Impounding System	3.19	0.58	Acceptable
Socioeconomic Impact	2.55	0.80	Acceptable
Local Livelihoods	3.18	0.60	Acceptable
Political/Legal	3.29	0.62	Highly Acceptable
Environmental	2.65	0.57	Acceptable

1. Community Awareness

In the category of "Community Awareness," the study involved 383 residents of Candaba, Pampanga, aged 18 and above, to gather their opinions on the proposed impounding system. The residents were asked various questions related to their awareness of flooding instances, community involvement measures, public forums, funding sources, and overall understanding of the impounding system project.

The findings revealed that while residents strongly agreed on being aware of severe flooding instances, they disagreed or strongly disagreed on aspects like community involvement measures, public forums, funding sources, and the overall understanding of the impounding system project. The mean score for the overall "Community Awareness" factor was 1.99, indicating a general disagreement among the respondents regarding these aspects.

Understanding among communities is a key factor in determining the outcome of wetland management projects. Giving the community information about the impounding system's impacts can encourage them to participate actively in decision-making [16].Furthermore, increased consciousness can promote a sense of accountability and ownership for wetland preservation [17].

2. Impounding System

The statement prioritizing the relocation of affected people received the highest mean score of 3.46, interpreted as Highly Acceptable.This approach aligns with respondents valuing proactive measures for community well-being.

In contrast, the statement about impounding systems contributing to sustainable development received the lowest score of 2.87, interpreted as Acceptable.Concerns about the effectiveness of impounding systems for sustainable development influenced opinions negatively.The study emphasizes the importance of impounding systems, particularly Small Water Impounding Projects, for drainage and water availability crucial for crop growth.

The necessity of impounding systems for the management of water resources is one of the study's main concerns. Impounding systems, particularly Small Water Impounding Projects (SWIP), encourage drainage and water availability, which are essential for crop growth. This emphasizes the significance of impounding systems in maintaining agricultural livelihoods that are based locally, which is a central subject of the thesis [18].

3. Socioeconomic Impact

The highest mean score in Table 6 is for the statement regarding the reduction of flood occurrences benefiting Candaba residents' community and social integration.This statement received a mean score of 2.66, indicating that respondents find the impact acceptable.On the other hand, the feasibility of the impounding system to support community resilience had the lowest mean score of 2.33, suggesting it is considered unacceptable by the community.

The reduction in flood incidents due to impounding systems is expected to enhance community experiences in Candaba, including cultural festivals, volunteer opportunities, and educational workshops.The community perceives this impact as acceptable, as reflected in the overall mean score of 2.55 for the socioeconomic impact.

[19] It emphasizes the relationship between the preservation of the environment and socioeconomic well-being in their investigation of sustainable development. They contend that a number of socioeconomic variables, including employment prospects and income inequality, are critical to the effectiveness of environmental projects. Their

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findings demonstrate how socioeconomic factors are essential to accomplishing future sustainability goals by examining case studies from various geographical areas.

4. Local Livelihoods

The residents of Candaba provided their feedback on various aspects related to local livelihoods. Traditional farming methods were highly acceptable, scoring 3.54, while financial support from the LGU to small-scale farmers was rated acceptable at 2.82. Overall, the perception of local livelihoods had a mean score of 3.18, interpreted as acceptable.

To address community concerns and improve the impounding system project, several recommendations were made based on the survey results. These include organizing public forums, involving the community in decision-making processes, addressing residents' concerns transparently, implementing regular assessments, improving communication channels, and providing capacity-building support to local stakeholders.

The variety of livelihoods among the local population is often made easier by the existence of impounding systems. [20] Communities that are close to water reservoirs or drainage systems can participate in a variety of revenue-generating activities, such as farming, tourism, and small businesses. This diversification encourages creativity and adaptability while also reducing the risks brought on by changes in the environment.

5. Political/Legal

The highest mean score in the Political/Legal statement is for the community members having opportunities to participate in decisions related to the impounding system and the government designating specific areas for fishing and livelihood activities, both rated as Highly Acceptable.On the other hand, the lowest mean score is for the government conducting periodic assessments to evaluate the impounding system's effectiveness, rated as Acceptable.

The residents highly value their involvement in decision-making processes regarding the impounding system and the government's efforts to allocate specific areas for fishing and livelihood activities, showing strong support for these initiatives.However, there is room for improvement in conducting regular assessments to enhance the impounding system's effectiveness, as indicated by the lower rating in this aspect.

Impounding systems are established, run, and managed in large part by political factors. [21] Within impounding systems, political objectives, interests, and ideologies frequently influence how resources are allocated, decision-making procedures are carried out, and enforcement tactics are employed. The structure of authority and government frameworks influence how impounding rules are implemented, resulting in differences in their efficacy and fairness.

6. Environmental

The impounding system is highly acceptable for benefiting natural resources like rice crops, fruit-bearing trees, and poultry, with a mean score of 3.27.Residents find the impounding system acceptable in reducing flooding conditions, scoring 3.14.However, the system's impact on local habitats of animals received an unacceptable rating with a mean score of 2.17.Additionally, the impounding system's ability to reduce and prevent soil erosion caused by floods was also deemed unacceptable, scoring 2.17.

Impounding systems, such as dams and reservoirs, play a crucial role in flood control and water management, providing protection and ensuring a stable water supply for nearby communities.Despite the positive effects on flood control, impounding systems can have negative impacts on local habitats by destroying habitats for birds and other wildlife, leading to reduced biodiversity in the area.

The environmental effects of impounding systems, which are essential for managing water resources, are coming under more and more investigation. [22] The importance of comprehending and reducing these effects, which include altered water management, habitat division, and sedimentation. Furthermore, it is crucial to maintain ecosystem services and water quality, save biodiversity, and take socioeconomic factors into account.

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IV. CONCLUSIONS

In this study, the feasibility or applicability of the proposed impounding system in Candaba, Pampanga, was evaluated. Through this study, it has become evident that the proposed impounding system may present both opportunities and challenges for the local stakeholders, as they express mixed perceptions regarding the overall impact of the impounding system, with some accepting its benefits and others disagreeing that they are aware of the impounding system.

As per the results, residents accepted that the impounding system, socio economic impact, local livelihoods, political/legal factors, and environmental factors are the leading variables to the acceptability of the proposed impounding system, with "political/legal" having the highest mean score out of the six, which indicates strong support and approval from the community towards the acceptability of the impounding system.Meanwhile, the researchers evaluated that the residents responded to the community awareness factor with the lowest mean score, interpreted as disagree, which indicates that residents in Candaba, Pampanga, are not well-informed or aware of significant instances of the proposed impounding system in their area. This lack of awareness may suggest a gap in communication or education regarding the potential risks and impacts of the impounding system, highlighting the need for improved community engagement and information dissemination strategies.

In addition, the study concluded that the political/legal factor has a higher mean score than the other six factors. This high level of acceptance suggests that political backing and legal frameworks play a crucial role in ensuring the success and acceptability of the impounding system.

Furthermore, a favorable opinion of the political/legal factors suggests efficient governance, precise rules, and open decision-making procedures—all necessary for the smooth operation and long-term viability of the impounding system. The impounding system's general acceptability and efficacy are increased when political will and legal frameworks are in line with community needs and environmental objectives. Thus, the researchers used the collected data to develop strategies and recommendations for the feasibility of the impounding system based on the outcomes and discussions in chapter 3.

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