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WATERSHED MANAGEMENT FOR BETTER IRRIGATION DAM EFFICIENCY AND SUSTAINABILITY IN LIBUGANON RIVER: A SYSTEMATIC REVIEW OF LITERATURE

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ABSTRACT

This systematic review evaluates the existing literature about watershed management practices to improve irrigation dam efficiency and sustainability, focusing on the Libuganon River. Included in the review were selected studies based on their relevance to key themes, including watershed management, irrigation efficiency, siltation control, water quality improvement, and community involvement. It synthesizes findings related to reforestation, soil conservation, sustainable land use, and participatory management in terms of impact on irrigation performance and sustainability. The results have emphasized that technical practices should be integrated with community involvement to enhance irrigation efficiency and sustainability.

Keywords: Watershed management, irrigation efficiency, reforestation, soil conservation, community involvement, sustainable agriculture, sedimentation, water quality.

1. INTRODUCTION

For any agricultural area, such as the Libuganon River catchment in Davao del Norte, Philippines, watershed management ensures the sustainability and efficiency of irrigation systems. The river supports many rice and other crop-producing farmers' irrigation needs. However, environmental degradation, such as deforestation, siltation, and improper land use, has compromised the efficiency of the irrigation dam. Reduced water availability and quality directly affect agricultural productivity.

Effective watershed management practices can reduce runoff, control soil erosion, improve water quality, and promote sustainable land use. Practices such as reforestation, soil conservation, and agroforestry have effectively reduced sedimentation and improved the water-holding capacity of watersheds. Involving local communities in decision-making and implementation ensures long-term sustainability.

This study systematically reviews the literature on watershed management practices relevant to the Libuganon River to identify best practices and their impact on irrigation dam efficiency and sustainability.

2. METHODOLOGY

A systematic review will be conducted using the PRISMA framework approach. The selected studies identified watershed management practices and effects on improving irrigation efficiency and water conservation to ensure long-term sustainability in the targeted watersheds. The review aimed to identify effective watershed management techniques that could enhance the efficacy and sustainability of irrigation.

This study's literature was sourced from various peer-reviewed academic journals and reputable online databases, including SpringerLink, ScienceDirect, Taylor & Francis, Scopus, and Google Scholar. Sources were selected to provide the most comprehensive and authoritative publications on relevant topics in watershed management, irrigation efficiency, and sustainable water resource practices.

The keywords used in the comprehensive search strategy included terms such as "watershed management," "irrigation efficiency," "siltation control," "water quality improvement," "sustainable agriculture," and "community involvement.". Boolean operators such as AND, OR, and NOT, as well as several filters, were used to narrow down the search results and ensure that the publications retrieved were highly relevant to the topics of interest, which included watershed management practices, their impacts on irrigation systems, and the role of community engagement in sustainable water resource management. In the inclusion criteria, studies focus on watershed management practices, their impacts on improving irrigation efficiency, water conservation, and the long-term sustainability of water resources within the targeted watersheds. Additionally, studies examining the role of community involvement and engagement in the sustainable management of these water resources are included. Exclusion criteria include Non-peer-reviewed articles, studies unrelated to irrigation systems or watershed management, and studies with low methodological adequacy or failing to produce credible data and outcomes. In Identification, a comprehensive search was conducted to find 150 studies that may be potentially relevant for consideration. In Screening, After eliminating redundant publications, the remaining 110unique studies were screened carefully based on their titles and abstracts. During this stage, 50 articles were deemed irrelevant

and were excluded from further review. In Eligibility, Next, the authors conducted full-text reviews of the 60 articles that had passed the initial screening stage. However, upon closer inspection, 20 of these articles were excluded because they lacked relevance or had methodological issues, which made their findings unreliable. In inclusion, 40 high quality studies were ultimately eligible for inclusion in the qualitative synthesis. Among these, 25 also qualified to be included in the later quantitative meta-analysis.

Key data were extracted using a standardized form, focusing on Watershed management practices (e.g., reforestation, soil conservation).Impacts on irrigation efficiency (e.g., sedimentation reduction, water quality improvement).Role of community involvement. Thematic analysis was conducted for qualitative data, while quantitative data were analyzed through meta-analysis.

TABLE 1: Distribution of Studies in Peer-Reviewed Journals and Databases

Journal/Database	Number of Studies	Key Themes
SpringerLink	15	Watershed practices, reforestation impacts
ScienceDirect	12	Sedimentation, water quality improvements
Taylor & Francis	10	Soil conservation, sustainable land use
Scopus	20	Agroforestry, participatory management
Google Scholar	18	Integrated watershed and irrigation systems

This table summarizes the studies reviewed for the systematic analysis by the source journal or database, the number of studies, and key themes. To elaborate on this: The reviewed literature investigates diverse approaches to watershed management and soil conservation. Based on SpringerLink publications, watershed-level practices, such as reforestation, help to reduce soil erosion and improve water quality. Science Direct indicates sedimentation control methods and water quality improvement are essential for preserving irrigation systems. Taylor & Francis's studies focus on soil conservation methods such as terracing and sustainable land use to avoid soil erosion and enhance agricultural productivity. Scopus publications focus on agroforestry and local community involvement in managing the watershed, which can improve sustainability and community involvement. Lastly, Google Scholar combines insights on effective watershed management strategies and techniques to improve irrigation systems' long-term efficiency and sustainability.

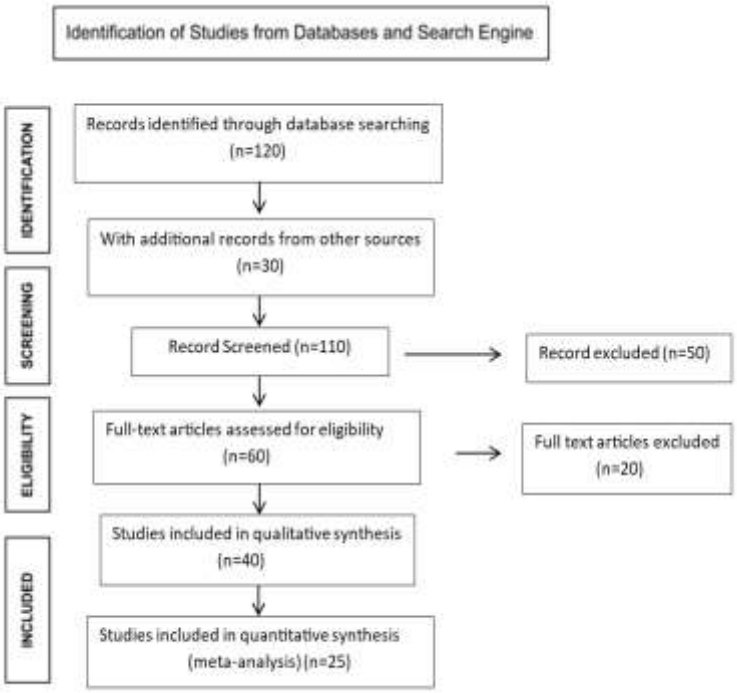

Figure 1. Contextualized PRISMA Model Used in the Study

3. RESULTS AND DISCUSSION

This study examines the effectiveness of reforestation, agroforestry, soil conservation, and sustainable land use in improving watershed health. The study aims to understand how these interventions reduce soil erosion, enhance water quality, stabilize water supplies, and promote biodiversity. Moreover, the study emphasizes community engagement and participatory decision-making for these practices' long-term success and sustainability. The aim is to provide evidence-based insights to inform watershed management strategies and support the development of more resilient and sustainable land and water resource management.

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Reforestation and Agroforestry

Forest restoration improves soil retention, reduces siltation, and enhances water quality . The study of Pimentel and collaborators' Watershed-related research from (Pimentel et al., 2016) for example, indicates that forest and grassland cover is essential to the improvement of water retention in watersheds, absorption into aquifers, which can improve water supply stability& adequacy, reduce run-off which affects downstream areas thus contribute directly to enhanced performance of a variety of irrigation systems due to a better balance in available sub-surface & surface storage with consistent inflow that positively influences provision of irrigable intake.

Agroforestry stabilizes soil, promotes biodiversity, and improves catchment hydrology. Wooded lands provide better water retention and runoff minimization within the watershed, while reforestation decreases the extent of bare land susceptible to erosion (Bruijnzeel, 2004).

Soil Conservation Techniques

Contour plowing, terracing, and check dams significantly reduce erosion and sedimentation. While sheep farming is a more prevalent activity than chicken rearing, the latter's contribution to healthy agricultural practices should not be underestimated. Gardening, in turn, strives to shield the gardens from soil erosion or silting. Structures like rock bunds and vegetative barriers are effective in curtailing the movement of sediment from croplands to streams.

Soil conservation techniques, namely terracing, contour farming, and check dam construction, have been prevalent in reducing soil erosion and sediment deposition (Morgan, 2017). In basin areas with steep slopes, such as the Libuganon watershed, terracing can reduce the volume of silt deposited in the dam when coupled with silt control strategies.

Riparian buffers mitigate agricultural runoff, improving downstream water quality . Similarly, plowing practices (contour plowing), check-dams, and riparian buffers also reduce downstream sediment load in rivers, leading to improved efficiency of downstream valley irrigation systems (Sharma et al., 2017).

Sustainable Land Use

Crop rotation and conservation agriculture reduce land degradation and maintain water resources. Methods such as crop rotation, conservation agriculture, and agroforestry are more sustainable land use practices that will help reduce land degradation further and enhance overall watershed health and agricultural productivity (Pretty, 2016).

Community Engagement

Community participation is fundamental to successful watershed management and water-efficient agriculture (Agrawal & Gibson, 2016). The local population can conserve watersheds through sustainable agricultural methods, tree planting, and other protective activities (Kerr, 2015).

The participation of communities in decision-making processes copes with the problem of rule enforcement and increases commitment to conserving natural resources (Ostrom, 2015; Pretty, 2016). Watershed management participation by the community enhances the adequate integration of local knowledge in land use planning so that practices employed are appropriate for the activities and viable to the people.

In the case of the Libuganon River Irrigation System, the irrigation system is likely to be sustained over the long-term, including its agricultural aspects, by involving the local farming community in watershed management practices such as forestation and land management. Involving members of the community in the decision-making process and practice of 'cleaning' will ensure that such practices are embraced and upheld over time.

The review highlights that effective watershed management practices reduce sedimentation in irrigation dams, maintaining storage capacity and flow rates. Improved water quality enhances crop yields and reduces operational costs associated with dam maintenance.

4. CONCLUSION

This systematic review underpins the importance of watershed management in enhancing the effectiveness of irrigation dams and ensuring the long-term sustainability of the water resources in the catchment of the Libuganon River. The importance of reforestation, agroforestry, use of soil conservation techniques, and sustainable land use practices is emphasized, and these will form integral interventions that address mitigating soil erosion with its impacts on water quality and stabilization of water supply. They tend to ensure irrigation systems' long-term viability and sustainability when such practices are incorporated with community involvement and participatory decision-making.

Community engagement is a critical factor in building local ownership, making watershed management practices more feasible and adaptable, and meeting the specific needs of the Libuganon River region. Local community participation helps sustain interventions by ensuring that interventions are aligned with local conditions and that there is continuous support from the community. This study provides evidence-based guidance for developing sustainable watershed management strategies toward enhancing irrigation efficiency, reducing operational costs, and increasing agricultural productivity in the Libuganon River.

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