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Literature Review of Integrated Water Resources Management (IWRM) in Transboundary River Basins

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Abstrak

Penelitian ini bertujuan untuk mengetahui pengelolaan sumber daya air terpadu (IWRM) di wilayah Sungai lintas batas. Jenis penelitian ini merupakan penelitian literatur review. Sumber data dalam penelitian menganalisis beberapa literature yang relevan. Kata kunci pencarian sumber data adalah sumber daya air, sungai lepas batas; dan aliran Sungai. Teknik analisis data dalam penelitian melalui analisis kualitatif dengan menggunakan aplikasi atlas.id. Hasil penelitian ini menyimpulkan penerapan IWRM di berbagai konteks geografis dan institusional. Hasil tinjauan menunjukkan bahwa IWRM merupakan pendekatan yang krusial dalam mengatasi permasalahan pengelolaan air lintas batas, namun masih menghadapi berbagai kendala seperti kurangnya koordinasi antar negara, konflik kepentingan, dan perubahan iklim. Penelitian ini menyoroti pentingnya kerja sama internasional, partisipasi Masyarakat.

Kata kunci: Sumber daya air; Sungai Lepas Batas; Literatur Review

Abstract

This study aims to determine the management of integrated water resources (IWRM) in cross-border river areas. This type of research is a literature review research. The data sources in the study analyzed several relevant literatures. The keywords for searching for data sources are water resources, off-limits rivers; and river flow. Data analysis techniques in the study are through qualitative analysis using atlas.id application. The results of this study conclude and best practices in the application of IWRM in various geographical and institutional contexts. The results of the review show that IWRM is a crucial approach in overcoming the problem of transboundary water management, but still faces various obstacles such as lack of coordination between countries, conflicts of interest, and climate change. This research highlights the importance of international cooperation, community participation,

Keywords: Water resources; Offshore Rivers; Literature Review

Introduction

Integrated Water Resources Management (IWRM) is a widely recognized approach to managing water resources holistically and sustainably. The concept focuses on integrating all aspects of water use, including surface water, groundwater, aquatic ecosystems, and water quality, in a single coherent management framework. IWRM emphasizes the importance of coordination between various sectors that use water, such as agriculture, industry, housing, and the environment, to ensure that the water needs of all users can be met without compromising ecosystem sustainability(Zeitoun et al., 2013). The IWRM approach also pays attention to the balance between human and environmental needs, taking into account various factors such as equitable water distribution, disaster risk reduction such as floods and droughts, and protection of water quality from pollution. By involving various stakeholders, ranging from governments, communities, to the private sector, IWRM aims to create a water management system that is not only efficient but also inclusive and responsive to changing social, economic, and environmental conditions. This is important to create resilience to climate change and various other pressures facing water resources (Gooch, 2010).

The implementation of IWRM requires an adaptive and flexible approach, which allows for decision-making based on accurate and up-to-date data and careful scientific considerations. In addition, IWRM also emphasizes the importance of a supportive policy framework, where regulations and regulations are directed to encourage sustainable and equitable water use. As such, IWRM serves not only as a technical approach but also as a tool to achieve broader development goals, including poverty alleviation, food security, and environmental protection, all of which are closely related to the availability and quality of water resources(Digna et al., 2017). The management of water resources in cross-border watersheds presents complex and multidimensional challenges. Watersheds that cross national borders are often a source of conflict due to differences in interests and priorities between countries that share these water resources. Although the concept of Integrated Water Resources Management (IWRM) has been recognized as the ideal holistic approach to address these challenges, its implementation in the context of transboundary watersheds still faces various obstacles. Difficulties in coordination between countries, differences in legal and policy frameworks, and lack of effective cooperation mechanisms are often major obstacles to the effective and sustainable implementation of IWRM. In addition, climate change and population growth exacerbate pressures on limited water resources, increasing the risk of conflict and instability in these regions (Chikozho, 2015).

Another problem that arises is the gap between theory and practice in the application of IWRM in transboundary watersheds. Although much of the literature supports IWRM as a solution for better water management, in reality, its implementation is often ineffective due to a lack of accurate data, limited institutional capacity, and deficiencies in financing and technical support. In addition, there are challenges in ensuring the participation of all stakeholders(Ako et al., 2010), including local communities and the private sector, in a transparent and inclusive decision-making process. In the absence of a more integrated and collaborative approach, the IWRM's goal of ensuring sustainable water management in transboundary watersheds may remain a difficult concept to realize, raising questions about the effectiveness of this approach in a situation fraught with geopolitical and environmental challenges (Al-Jawad et al., 2019).

The implementation of Integrated Water Resources Management (IWRM) is very important in facing increasingly complex water management challenges in various countries. With population growth, rapid urbanization, and climate change exacerbating extreme weather conditions, the need for clean water is increasing while its availability is increasingly limited. In many countries, the problem is exacerbated by fragmented water

management, where sectors such as agriculture, industry, and the environment work in isolation without adequate coordination. IWRM offers solutions by integrating all aspects of water use and management in a single framework, enabling a more coherent and efficient approach to addressing these challenges. Through the IWRM, countries can develop more comprehensive policies and more effective strategies for managing water resources sustainably, ensuring that the needs of all stakeholders can be met without damaging ecosystems (Mehta & Movik, 2014).

In addition, IWRM is very important in overcoming conflicts that often arise due to competition for water resources, especially in areas that share cross-border watersheds (watersheds). By providing a framework for cooperation between countries, the IWRM can help defuse tensions and facilitate the drafting of fair and sustainable agreements. The implementation of IWRM also allows for a more adaptive and responsive approach to changing conditions, such as fluctuations in rainfall and shifting land use patterns, which require continuous adjustments in water management strategies(Ngene et al., 2021). By adopting the IWRM, countries can address complex water management challenges more effectively, ensuring that water resources remain available and protected for future generations (Ngene et al., 2021).

Previous research on the implementation of Integrated Water Resources Management (IWRM) in cross-border watersheds has been carried out, focusing on various aspects ranging from policy frameworks to cooperation mechanisms between countries. Many studies highlight the success of the IWRM in overcoming the challenges faced by countries that share transboundary watersheds. For example, some studies have shown that the implementation of IWRM can improve coordination between countries on the use of water resources, reduce potential conflicts, and strengthen international agreements related to water management. Case studies on watersheds such as the Mekong River in Southeast Asia and the Danube River in Europe show that IWRMs can play an important role in facilitating cooperation between countries, despite differences of interests and complex geopolitical challenges.

Research Methods

Previous research on the implementation of Integrated Water Resources Management (IWRM) in cross-border watersheds has been carried out, focusing on various aspects ranging from policy frameworks to cooperation mechanisms between countries. Many studies highlight the success of the IWRM in overcoming the challenges faced by countries that share transboundary watersheds. For example, some studies have shown that the implementation of IWRM can improve coordination between countries on the use of water resources, reduce potential conflicts, and strengthen international agreements related to water management. Case studies on watersheds such as the Mekong River in Southeast Asia and the Danube River in Europe show that IWRMs can play an important role in facilitating cooperation between countries, despite differences of interests and complex geopolitical challenges.

Once the relevant literature has been collected, each article will be analyzed in depth to identify key themes, successes, challenges, and gaps in IWRM-related research in transboundary watersheds. Thematic analysis techniques will be used to categorize findings based on various aspects of the IWRM, such as coordination between countries, sustainable water resources management, and conflict resolution. Furthermore, the results of this analysis will be synthesized to provide a comprehensive overview of the status of IWRM implementation in cross-boundary watersheds, identifying common patterns as well as unique cases that can provide new insights. The findings of this analysis will be presented in the form of a clear and systematic narrative, complemented by relevant tables and graphs

to visualize the data collected. The results of this study are expected to make a significant contribution to the existing literature and offer practical recommendations to improve the implementation of IWRM in transboundary watersheds in the future.

Result and Discussion

Successful Implementation of IWRM

The successful implementation of Integrated Water Resources Management (IWRM) in cross-border watershed management has been in the spotlight in many studies, with several cases standing out as successful examples. One of the key factors in this success is the existence of a robust policy framework that supports the integration of various sectors and stakeholders. For example, in the Danube River basin, effective coordination between 19 countries in Europe has enabled the comprehensive implementation of IWRM(Gooch, 2010). Through frameworks such as the Danube River Protection Convention, these countries have successfully managed water resources together, reduced pollution, and improved river water quality. This success was largely driven by strong political commitment and support from the European Union providing the necessary regulatory and funding framework.

In addition, the success of IWRMs is often closely linked to institutional support and adequate capacity. In the Mekong basin, the Mekong River Commission (MRC) has played a central role in coordinating water management efforts among member countries, including Thailand, Viet Nam, Laos, and Cambodia. The MRC not only provides a platform for discussions and negotiations between countries, but also facilitates data collection and critical scientific research for evidence-based water management planning. This institutional support, along with the existence of a strong technical capacity, allows for more effective implementation of IWRM, especially in the face of challenges such as climate change and increased water demand (Chikozho, 2015).

The success of the IWRM is also influenced by the active participation of various stakeholders, including local communities, the private sector, and non-governmental organizations. In the Zambezi watershed in Africa, for example, the implementation of IWRM has been successful because it involves local communities in decision-making processes related to water management. This participatory approach helps to ensure that decisions are more tailored to local needs and easier to implement. In addition, the involvement of the private sector in water management, such as through corporate social responsibility (CSR) programs, also makes a significant contribution in providing additional resources and technological innovations needed for better water management (Asmamaw, 2015).

The success of IWRM is also determined by flexibility and adaptability in its implementation. In some cases, the ability to adapt IWRM strategies to changing environmental and socio-economic conditions has been a determining factor in success. In the Indus watershed, for example, the implementation of IWRM has succeeded in reducing the risk of flooding and drought through the use of advanced hydrological modeling technology and adaptive management approaches. By taking into account changes in rainfall and land use patterns, managers in the Indus watershed are able to respond proactively to emerging threats, thereby protecting existing water resources and ensuring the sustainability of their management.

The success of IWRM is also determined by effective monitoring and evaluation. A good system for monitoring and evaluating the progress of the IWRM implementation allows managers to identify issues early and make necessary adjustments. In the Colorado watershed, the success of IWRM is largely due to the existence of a comprehensive monitoring system that includes monitoring water quality, water quantity, and the

ecological impact of various management interventions. With accurate, real-time data, managers in the Colorado watershed can make more timely and evidence-based decisions, ensuring that the long-term goals of the IWRM are achieved**.**

Challenges in IWRM Implementation

The implementation of Integrated Water Resources Management (IWRM) in cross-border watersheds faces a variety of complex challenges. One of the main challenges is the difference in policies and legal frameworks between countries that share watersheds. Each country often has different priorities, rules, and regulations in water resource management, which can lead to difficulties in reaching mutual agreements. For example, in the Nile Basin, countries such as Egypt, Sudan, and Ethiopia have different views on the allocation and utilization of river water, which often leads to political tensions. This disagreement makes the implementation of the IWRM more complicated, as it requires policy harmonization that is difficult to achieve in a sensitive geopolitical context (Varis et al., 2008)

In addition, the lack of accurate and transparent data is a significant challenge in the implementation of IWRM. Data on water resources, such as the quantity, quality, and distribution patterns of watersheds, are often not available or publicly accessible to all countries that share watersheds. This is compounded by mistrust between countries that may be reluctant to share the data they have. In the Mekong basin, for example, unequal access to information on water flows and the impacts of dam construction has been a source of conflict and hindered effective cooperation. Without accurate data, it is difficult for countries to make evidence-based decisions that support effective and sustainable implementation of IWRMs (Digna et al., 2017).

Limited institutional capacity is also a major obstacle to the implementation of IWRM. Many countries, especially in developing regions, have limitations in terms of human resources, technical expertise, and infrastructure needed to support the implementation of IWRM. These shortcomings often result in partial or inconsistent implementation, so that the objectives of the IWRM are not fully achieved. In the Zambezi watershed, for example, despite commitments to implement IWRM, limited local capacity in terms of planning, monitoring, and policy enforcement is a major obstacle to achieving the expected results.

Another challenge that has arisen is the issue of funding. The implementation of IWRM often requires significant investments in terms of infrastructure, technology, and training programs. However, many countries face difficulties in securing adequate funding to support IWRM initiatives. Lack of financial resources can hinder the implementation of important projects such as water management infrastructure development, ecosystem restoration programs, and disaster risk reduction initiatives. In some transboundary watersheds, reliance on international assistance for funding can also be problematic, especially if this support is not sustainable or insufficient to address existing needs.

Differences in interests between countries are also one of the main challenges in the implementation of IWRM. Each country that shares a cross-border watershed has different interests and priorities(Ngene et al., 2021), both in terms of economy, social, and environment. This often results in disputes over how water resources should be managed and allocated. For example, upstream countries may focus more on building infrastructure such as dams for power generation, while downstream countries are more concerned about the impact on water flows and ecosystems. These imbalances can lead to impasse in negotiations and hinder fair and sustainable implementation of IWRM.

Finally, the challenge of climate change adds a layer of complexity in the implementation of IWRM in transboundary watersheds. Changes in rainfall patterns,

increasing frequency and intensity of extreme weather, and rising global temperatures affect the availability and quality of water resources(Zeitoun et al., 2013). The impact of climate change is difficult to predict accurately, adding to the uncertainty in water planning and management. In the Indus watershed, for example, changes in water flow patterns caused by melting glaciers and changes in the rainy season have disrupted existing water management strategies. Countries in these watersheds must adapt to changing conditions, which require a more flexible and dynamic scenario-based approach to IWRM (Chikozho, 2015).

Conclusion

From the results of this study, it can be concluded that the application of IWRM in various geographical and institutional contexts. The results of the review show that IWRM is a crucial approach in overcoming the problem of transboundary water management, but still faces various obstacles such as lack of coordination between countries, conflicts of interest, and climate change. This research highlights the importance of international cooperation, community participation.

References

Ako, A., Takem, G., & Nkeng, G. (2010). Water Resources Management and Integrated Water Resources Management (IWRM) in Cameroon. *Water Resources Management*, *24*. https://doi.org/10.1007/s11269-009-9476-4

Al-Jawad, J. Y., Alsaffar, H. M., Bertram, D., & Kalin, R. M. (2019). A comprehensive optimum integrated water resources management approach for multidisciplinary water resources management problems. *Journal of Environmental Management*, *239*, 211–224. https://doi.org/10.1016/j.jenvman.2019.03.045

Asmamaw, D. K. (2015). A critical review of integrated river basin management in the upper Blue Nile river basin: The case of Ethiopia. *International Journal of River Basin Management*, *13*, 1–14. https://doi.org/10.1080/15715124.2015.1013037

Chikozho, C. (2015). Pathways for building capacity and ensuring effective transboundary water resources management in Africa: Revisiting the key issues, opportunities and challenges. *Physics and Chemistry of The Earth*, *76–78*, 72–82.

Digna, R. F., Mohamed, Y. A., Van Der Zaag, P., Uhlenbrook, S., & Corzo, G. A. (2017). Nile River Basin modelling for water resources management – a literature review. *International Journal of River Basin Management*, *15*(1), 39–52. https://doi.org/10.1080/15715124.2016.1228656

Gooch, G. D. (2010). Integrating Water Resources Management: Interdisciplinary Methodologies and Strategies in Practice. *Water Intelligence Online*, *9*. https://doi.org/10.2166/9781780401461

Mehta, L., & Movik, S. (2014). Flows and Practices: Integrated Water Resources Management (IWRM) in African Contexts. *IDS Working Papers*, *2014*(438), 1–34. https://doi.org/10.1111/j.2040-0209.2014.00438.x

Ngene, B. U., Nwafor, C. O., Bamigboye, G. O., Ogbiye, A. S., Ogundare, J. O., & Akpan, V. E. (2021). Assessment of water resources development and exploitation in Nigeria: A review of integrated water resources management

approach. *Heliyon*, *7*(1), e05955. https://doi.org/10.1016/j.heliyon.2021.e05955

Varis, O., Tortajada, C., & Biswas, A. K. (Eds.). (2008). *Management of transboundary rivers and lakes*. Springer.

Zeitoun, M., Goulden, M., & Tickner, D. (2013). Current and future challenges facing transboundary river basin management. *Wiley Interdisciplinary Reviews: Climate Change*, *4*. https://doi.org/10.1002/wcc.228