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Current Trends and Future Perspectives of Integrated Watershed Management

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ABSTRACT

The significance of Integrated Watershed Management (IWM) has increased in recent years due to its ecological, economic, and social implications. To align with these principles and achieve efficiency, watershed management necessitates the evaluation and integration of numerous diverse factors. This literature review aims to examine the current research trend in IWM and its association with various thematic elements. The identified thematic elements include water resources management, decision-making processes, agricultural and forested watersheds, soil management, natural hazards, stakeholder involvement, climate change, policy frameworks, cost management and risk analysis, livelihoods, ecosystem services, habitat and biodiversity conservation, and tourism. The predominant thematic elements were water resource management, decision-making, and agricultural and forested watersheds. The countries that were most frequently referred to in the examined literature were Ethiopia, China, the USA, and Iran. A synthesis of data obtained via the analysis of scientific research trends in the specified domain can serve as a basis for the establishment and strategizing of comprehensive watershed management. While it is important to consider all these aspects combined in IWM practice, it is also essential to have a comprehensive grasp of each factor as a vital step in integrating them. The participants involved in this endeavour, hailing from diverse professional backgrounds, must engage in close collaboration to successfully integrate the aforementioned aspects. The collaborative method can only have a chance of success if all participants involved demonstrate a high level of dedication. The level of dedication required should be grounded in a comprehensive understanding of the difficulties and demands that are mutually shared by all involved parties.

Keywords: water resources; soil management; agricultural and forested watershed; catchment; decision-making; land management; stakeholders

INTRODUCTION

Sustainable watershed management is a way of effectively managing and organising the use of land and various resources to deliver services and goods, while minimising any negative impact on water and land resources (Rambabu et al. 2019). It is not possible to achieve sustainability without preserving and optimising water, soil, pasture, and forest resources (Athari et al. 2018). Achieving such a balance requires preserving the maximum productivity of available arable land with the use of best management practices, while also effectively mitigating the agricultural impact on water quality (Lizotte and Locke 2018). To successfully implement the best management through the application of measures, an equilibrium must be struck between the demands of agricultural practices and the preservation of the environment's integrity.

Integrated Watershed Management (IWM) is described as the process of drafting and executing a strategy that encompasses both natural and human resources within a watershed. It also considers economic, sociopolitical, and institutional aspects that operate in the area of the watershed, as well as other relevant areas to attain certain social objectives (Supangat et al. 2023). Integrated management of water resources is extremely significant for the efficient distribution of water resources, in order to properly meet the necessities of inhabitants, as well as sectors of the economy (Zerkaoui et al. 2018). The concept of IWM involves linking the management of upstream, middle, and downstream parts of watersheds, which often represents the idea of "transmedia management" with an emphasis on the "ecosystem". This approach arose from the experience that separate (sectoral) management proved to be less successful (Heathcote 2009). Given that land and other resource systems are interconnected in a watershed, the necessity for coordinated response and action is critical to foster collaboration among various stakeholders through IWM (Borisavljević and Kostadinov 2012). Applying a holistic approach to IWM enables various stakeholders to preserve and restore the physical, chemical, and biological integrity of ecosystems and people's health, as well as to enhance the foundation for sustainable economic development (National Research Council 1999). When assessing the efficiency of IWM, indicators associated with the quality and quantity of water resources, vegetation cover, ecosystem health, legislation, and the development of livelihoods are used (Wang et al. 2016).

Since at least 200 BC, the IWM approach has developed with regard to definition, broadness, and implementation, gaining greater prominence in the late twentieth century (Bebermeier et al. 2017). IWM strives for new improvements to achieve sustainability and efficiency, and it is essential to keep track of research trends. Therefore, the goal of this paper is to conduct a comprehensive review of the scientific literature in the field of IWM and to determine the key thematic research factors during the period from 2018 to 2023. Furthermore, this research identifies successes, challenges, and gaps to inform future improvements and decision-making in IWM strategies, based on information from the analysed papers.

MATERIALS AND METHODS

A scientific literature search was managed for the scientific papers written in English, Spanish, Portuguese and German language. "Integrated Watershed Management" was used as a topic keyword in the "Web of Science" internet database of scientific papers which have been recognized as a global and authoritative literature database. To conduct a comprehensive literature review on recent trends in the field of IWM, this study focused on analysing papers that were published within the past six years (2018–2023).

The Rayyan (http://rayyan.qcri.org) systematic review application (Ouzzani et al. 2016) was used to perform this review. Search and review were conducted between June 2023 and February 2024. Relevant scientific papers were included in the analysis if they addressed at least one aspect of IWM, as determined by an examination of their abstracts. Reviewed manuscripts included the following types of papers: research papers, review papers, conference papers, and proceedings. Papers were deemed ineligible for inclusion if they had duplicate content, did not align with subject research, or were not highly relevant to the study.

Abstracts were read by at least two authors. A full-text analysis was conducted for publications that were considered relevant, and thematic topics were identified. The interaction among each of the two detected thematic topics was analysed. In cases where two thematic topics appeared together in the same reviewed study, they were counted as one interaction. If two thematic topics did not appear together in the same study, it was considered as zero interaction. Furthermore, the review was supplemented with a backward snowball search, which included a review of the selected references cited in the reviewed articles. The methodology workflow is presented in Figure 1.

RESULTS AND DISCUSSION

Through a search of the database for the term "Integrated Watershed Management" and the time period 2018–2023, 164 articles were identified, and 72 of them were considered relevant. The number of published papers in 2018 and 2019 was the same (10 papers), while a rise in the number of publications has been detected in 2020 (11 papers), 2021 (15 papers), 2022 (14 papers), and 2023 (12 papers) (Figure 2). Such an increasing trend of published papers related to some of the IWM thematic factors may indicate a potential demand for the implementation of IWM practices.

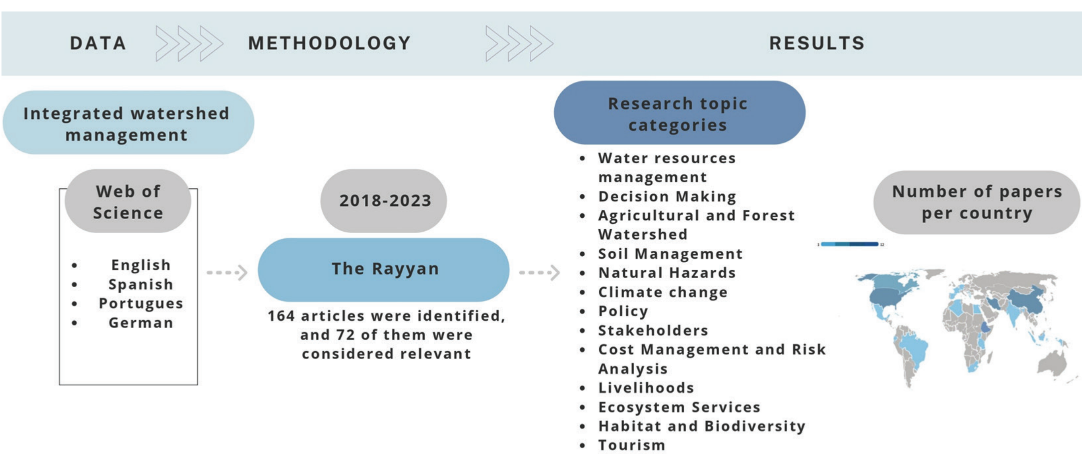

Figure 1. Methodology workflow.

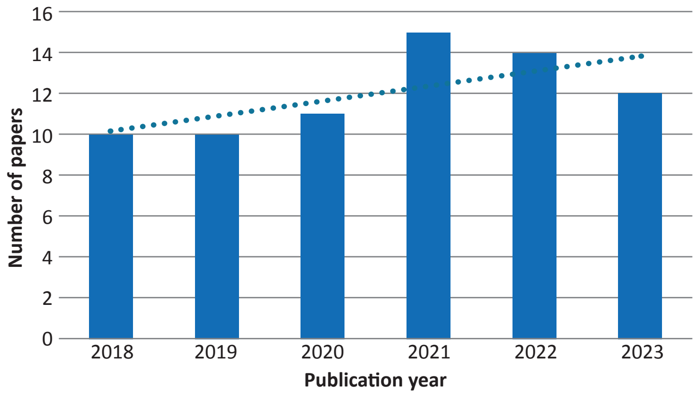

Figure 2. Number of papers by year of publication.

The selected papers refer to IWM in a total of 24 different countries (Figure 3). Among them, Ethiopia, the USA, China, and Iran lead by the number of papers. Given that the USA and China are characterised by the largest number of paper contributions in science (Scimago Journal and Country Rank), a large area, and developed scientific activity, the result is not surprising. On the other hand, the abundance of scholarly articles pertaining to Ethiopia might be attributed to the country's varied climatic and physical-geographical characteristics (Worku and Tripathi 2015). In addition, Ethiopia has been acknowledged as one of the African countries characterised by a substantial amount of land surface water while having a low water ratio of only 0.70% (Cao et al. 2014). Consequently, the management of watersheds in this region may be a notable challenge. Meanwhile, Iran, a large developing country with significant natural and anthropogenic variability, is currently experiencing a variety of hazards such as drought, flooding, landslides, and soil erosion (Sadeghi et al. 2023), which consequently may enhance the need for IWM practices.

The analysis of the papers recognised 13 categories of studies, which include: water resources management, decision-making, agricultural and forested watersheds, soil management, natural hazards, climate change, policy, stakeholders, cost management and risk analysis, livelihoods, ecosystem services, habitat, and biodiversity and tourism. The most abundant are studies on water resources management, decision-making, research within agricultural and forested watersheds, soil management, and natural hazards (Table 1 and Figure 4). Meanwhile, other thematic categories such as livelihoods, ecosystem services, habitat and biodiversity and tourism were less often part of IWM research.

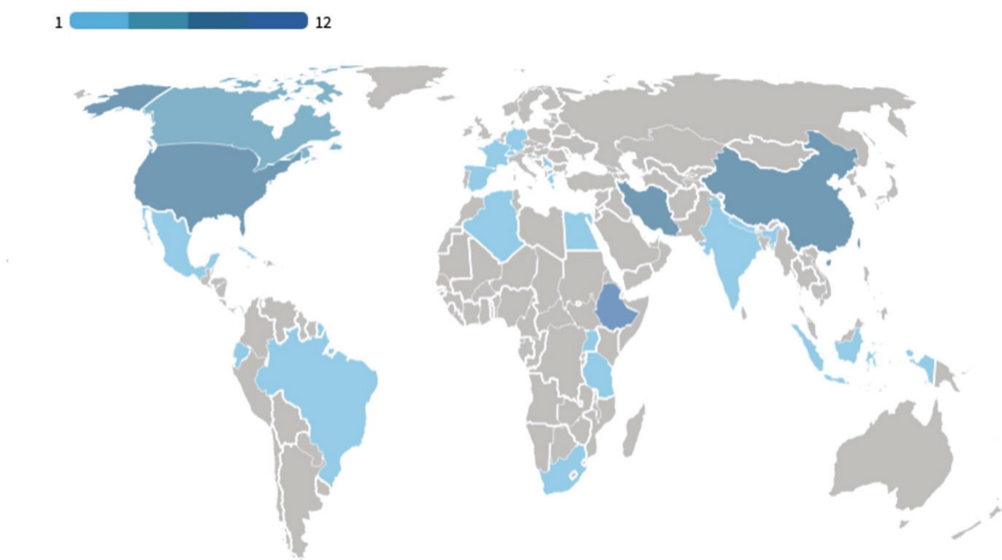

Figure 3. Presentation of the number of papers per country.

Table 1. Representation of certain topics in the analysed scientific papers in the period of 2018–2023.

Reference	WRM	DM	AFW	SM	NH	SH	CC	PL	CMRA	LH	ES	HB	TM
Zerkaoui et al. 2018	x	x											
Lizotte and Locke 2018	x		x										
Athari et al. 2018		x				x							
Kraff and Steinman 2018	x	x						x					
Yu and Lu 2018	x	x											
Brombal et al. 2018		x				x		x					
Behmel et al. 2018	x					x							
García López and Castro Perdomo 2018	x												
Mahajan and Sivakumar 2018	x												
Msuya and Lalika 2018	x		x			x							
Baumgertel et al. 2019		x							x				
Arp et al. 2019	x						x					x	
Moore et al. 2019	x		x										
Alamanos et al. 2019	x	x							x				
Putt et al. 2019	x												
Rambabu et al. 2019	x			x									
Manzano-Solís et al. 2019	x												
Gebremeskel et al. 2019				x									
Martos-Rosillo et al. 2019	x												
Jovanovska et al. 2019												x	
Dodds 2020						x							x
Katusiime and Schütt 2020				x					x				
Arteaga et al. 2020		x		x	x								
Gessesse et al. 2020				x									
Pourghasemi et al. 2020					x								
Teka et al. 2020					x					x			
Lin et al. 2020	x		x										
Wu et al. 2020			x					x					
Zhang et al. 2020	x		x										
Tadese et al. 2020	x						x						
Adhami et al. 2020		x		x		x		x					
Caković et al. 2021					x								
Mekonnen et al. 2021		x		x	x		x			x			
Hamdani et al. 2021	x		x										
Attwa et al. 2021	x				x								
Gaus et al. 2021		x											
Han et al. 2021	x		x										

Table 1. (continue) - Representation of certain topics in the analysed scientific papers in the period of 2018–2023.

Reference	WRM	DM	AFW	SM	NH	SH	CC	PL	CMRA	LH	ES	HB	TM
Gibbs et al. 2021		x					x						
Hansen et al. 2021	x	x	x						x				
Rajaei et al. 2021	x		x	x									
Berlie and Ferede 2021		x						x		x			
Paul et al. 2021	x		x										
Arnillas et al. 2021		x	x								x		
Jaramillo Monroy et al. 2021		x											
Mosaffaie et al. 2021	x			x	x								
Salehpour Jam et al. 2021						x							
Tang et al. 2022	x	x											
Gebregergs et al. 2022				x	x								
Lyra et al. 2022	x		x										
Pascual et al. 2022		x					x				x		
Basuki et al. 2022							x						
Kuraji et al. 2022	x		x								x		
Gessesse et al. 2022			x	x									
Caraminan and de Morais 2022				x	x								
Thapa et al. 2022					x			x					
Tribouillois et al. 2022	x		x										
Ferreira and Fernandes 2022	x		x										
Gebrehiwot et al. 2022				x			x						
Qiu et al. 2022		x											
Cao et al. 2022	x						x	x					
Katusiime and Schüt 2023				x				x					
Yu et al. 2023	x	x											
Barakagira and Ndungo 2023			x				x			x			
Nasiri Khiavi et al. 2023		x				x		x					
Bekele et al. 2023						x							
Gaus et al. 2023						x							
Ikram et al. 2023		x			x								
Li et al. 2023					x				x				
Wolka et al. 2023			x			x	x						
Leykun et al. 2023			x	x	x								
Supangat et al. 2023	x		x	x	x	x	x	x	x		x		
Majeski and Trindade 2023	x					x							

WRM - water resources management, DM – decision-making, AFW - agricultural and forested watersheds, SM - soil management, NH - natural hazards, SH – stakeholders, CC - climate change, PL – policy, CMRA – cost management and risk analysis, LH -livelihoods, ES - ecosystem services, HB - habitat and biodiversity, TM – tourism

We have further analysed the interactions among each of the detected IWM categories (Figure 5). Even though it might be expected that the two most addressed categories, WRM and DM, should be the ones to show the highest interaction, this was not the case. On the contrary, WRM and AFW showed the highest number of interactions. This might indicate that the management of water resources in forested and especially agricultural catchments, received significant attention. As addressing these specific factors might be challenging, it could be expected that further interaction will prolong. Furthermore, WRM and DM were involved in most interactions with other factors. While water could be perceived as the main watershed resource, the influence of the decision-making process is likely to be crucial for other factors. It could also be expected that interactions between WRM and DM with other factors could increase. Further research that integrates DM and other IWM factors will provide a valuable scientific basis, which could contribute to the development of new insights connected to complex decision-making processes.

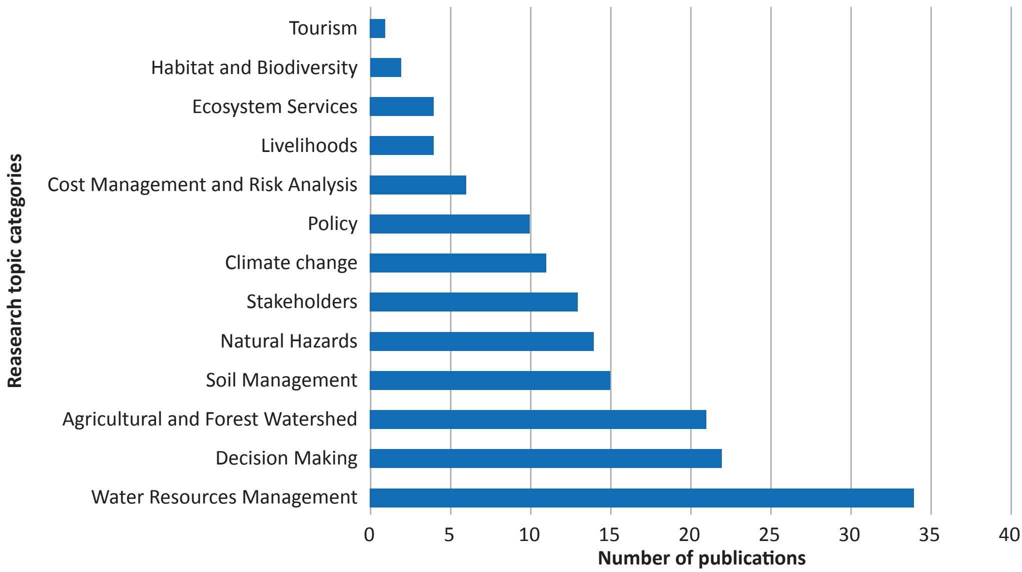

Figure 4. Presentation of the number of papers by research topic for the period of 2018–2023.

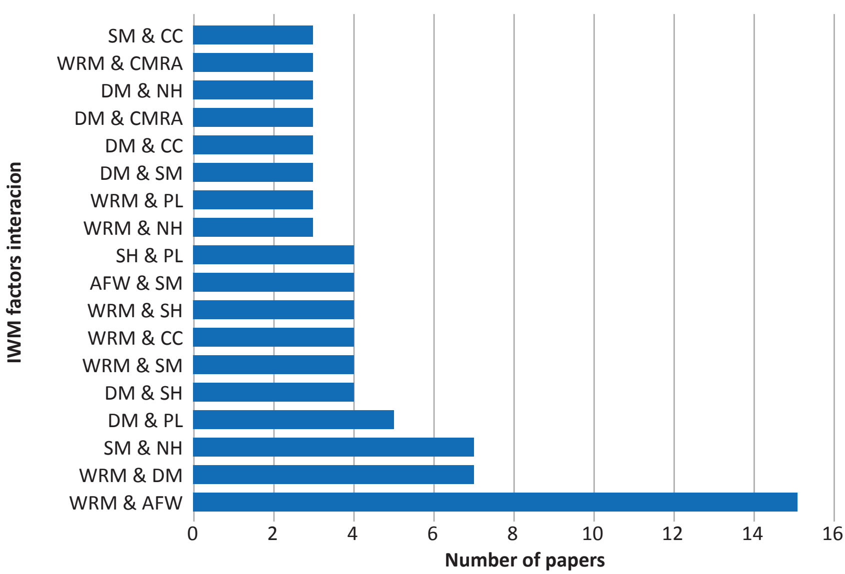

Figure 5. Interaction among each of the two detected IWM categories was analysed and counted. This figure represents only categories that interacted three or more times, as they were recognized as significant.

Fundamental research categories in IWM

The findings of this research have unveiled thirteen pivotal research topic categories that hold significance within the domain of IWM. By delving into these key factors, we were able to acquire a profound understanding and comprehensive insights into the intricacies of IWM. In the following section, we present and discuss findings on the previously mentioned categories, after which we derive a synthesis.

Water Resources Management

Water shortages and degradation of water resources have become increasingly significant problems worldwide due to the growing demand for water and possible conflicts (Lyra et al. 2021). Numerous agricultural watersheds have worryingly low quantities and quality of sources of water. Surface water sources are only exploited in limited quantities, while excessive use of groundwater reserves and the use of fertilisers consequently lead to the lowering of groundwater levels (Sidiropoulos et al. 2021) and pollution (Caković et al. 2023). In this regard, management of water resource approaches in Europe focuses primarily on long-term sustainability (Kourgialas et al. 2018, Leščešen et al. 2022), while also being aligned with the Sustainable Development Goals of the United Nations (Sachs et al. 2019). The idea of advocating for IWM implies that most groundwater resources are better managed at the river basin level (Conservation Ontario 2010). Furthermore, Lyra et al. (2022) propose an approach of using innovative models and simulations of the multiscale dynamics of surface and groundwater systems to potentially solve complex issues connected to water-related management. These goals may be even more challenging in light of recent global warming trends, and therefore, the management of water resources within a watershed should be developed in accordance with other factors.

Decision-Making

IWM became a widely recognised strategy since it considers hydrology and recognises the interdependence of biophysical, socioeconomic, and socio-institutional aspects (Yu et al. 2023). The approach aims to achieve sustainable management by emphasising the proper use and conservation of essential resources like water, soil, and various ecosystem services (Wang et al. 2016). In this context, decision support systems play a vital role in simplifying and improving IWM practices (Arteaga et al. 2020, Qiu et al. 2022). Nevertheless, in spite of the exceptional significance of initiating IWM programmes as a strategy for enhancing rural areas, Wang et al. (2016) assess that so far there has been an insufficient number of studies related to their application and potential impact.

Watershed management institutions should base their decisions on accurate data and spatial analyses. The development of technologies has enabled the use of multi-criteria analytical techniques, as well as scenario generation software, which may be useful in decision-making practices (Yu and Lu 2018). Nonetheless, experience shows that resource decisions are sometimes undertaken arbitrarily, as adequate environmental information is frequently insufficient to identify vulnerable locations for intervention (Arteaga et al. 2020). The complexity of IWM aspects necessitates the involvement of different stakeholders, whose perspectives often vary significantly in terms of breadth and focus (Jacobs and Buijs 2011). Multiple viewpoints represent a specific way through which stakeholders observe a particular case and evaluate its significance from their point of view (Kolkman et al. 2007). The success of shared decision-making procedures relies on a well-crafted design that fosters information sharing and reflection, as the diversity of views can otherwise impede the decision-making process (Menzel et al. 2013). As a result, conflicts can occur, causing problems, delays, or even project failure (Carr et al. 2012). Acknowledging the existence of various viewpoints is critical for carefully designing this procedure, while comprehending the essence and framework of participants' perceptions is essential for effective decisions. In the integrated management of natural resources, especially in terms of participatory decision-making processes, mental model approaches are widely accepted and used in the study of actors' perceptions (Özesmi and Özesmi 2004). A notable example is the research by Hansen et al. (2021), which emphasises that achieving cost-effective river water quality management in intensively managed agricultural systems necessitates a watershed perspective and shared decision-making. However, the studies that have been performed so far are subject to significant limitations (Gaus et al. 2021).

Agricultural and Forest Watersheds

Water quality degradation caused by actively managed agricultural landscapes has an impact on water resource sustainability. Excess nutrient inputs and other contaminants to both surface and subsurface water systems have resulted in aquatic ecosystem degradation (Lizotte Jr. and Locke 2018). Wu et al. (2020) discuss the state of excessive nutrient input, suggesting that policy efficiency should be regularly tested. To provide both ecological and economic viability, novel solutions and compromises should be followed in the management of agricultural watersheds. Both Lizotte and Locke (2018) and Moore et al. (2019) mention the importance of implementing the best management practices in agricultural watersheds. As a part of potential best management practices, Pozdynakov et al. (2020) urge the application of the best available technologies to achieve reductions in nutrient input in agricultural catchments. Moreover, Lin et al. (2020) propose the application of an ecologically based approach for stream quality improvement in agricultural and forested watersheds. Streams that come from forested catchments frequently have greater and more constant runoff than streams draining nonforested watersheds. However, these characteristics were discovered to be caused by forest litter and favourable soil conditions rather than by forest vegetation itself (Ice and Stednick 2004). While reforestation practices can have beneficial impacts, they are not sufficient to completely prevent flooding (France et al. 2019). Ensuring the prevention of slope failures is crucial for preserving the flood mitigation capability of forest ecosystems (Tamai 2022). Strategically planted and well-maintained forests can effectively reduce the risk of flooding and postpone flood peaks (Cooper et al. 2021). Preserving the stability of forests with a high leaf area index is crucial for mitigating outflow rates (de Bastos and Hasenauer 2024). This emphasises the critical importance of forest watersheds being well managed with the goal of fulfilling a flood mitigation service. Nevertheless, the majority of research on the impact of forests on floods has been carried out on local or regional scales, making it challenging to directly apply their findings to other locations without employing suitable extrapolation techniques (Rüegg et al. 2022).

Soil Management

The degradation and reduction of the productive capacity of the land have been recognised as significant problems worldwide. In this regard, IWM, with particular reference to soil management, is of crucial importance to reduce erosion, improve soil fertility, and increase yield (Mekonnen et al. 2021). Some watersheds, particularly those next to mining areas, may be susceptible to pollution. These locations should adopt phytoremediation strategies to reduce contamination of watershed ecosystems (Vasić et al. 2024). Research by Gebremeskel et al. (2019) highlighted that IWM practices had a positive influence on improving soil health, compared to watersheds where IWM practices were not applied. This is in accordance with Gessesse et al. (2020) and Gebrehiwot et al. (2022) findings, which refer to significant soil carbon stock amounts under IWM practice. Besides, Katusiime and Schütt (2020, 2023) refer to the significance of incorporating land tenure practices in relation to IWM, while the adoption of soil conservation strategies is strongly linked to farmers' familiarity with them (Leykun et al. 2023). However, Haregeweyn et al. (2015) emphasise that achieving IWM goals is not equally possible in countries with different levels of economic development. To improve sustainable land management within watersheds, it is necessary to use new technical achievements. In this connection, the use of remote sensing techniques, Geographic Iinformation Systems (GIS), and simulation modelling is extremely important. Nevertheless, these methods should not be applied independently of other factors. It is necessary that they are complemented by a comprehensive understanding of the watershed's spatial dynamics and the regular involvement of stakeholders for management to be effective.

Natural Hazards

In most of the previous research, the study of natural disasters was usually approached separately. Nonetheless, recent research emphasises the importance of considering the risks from a series of natural disasters that should be approached jointly in order to improve knowledge and management, mitigate possible consequences, and increase the resilience of watersheds to natural disasters (Alilou et al. 2019). This has become particularly important in developing countries, where population expansion and economic growth necessitate appropriate management of risks to natural resources, property, and human lives (Karimi et al. 2019). Soil erosion, floods, landslides, and wildfires are the most frequent disasters in watersheds (Ristić et al. 2017, Pourghasemi et al. 2020, Lazarević et al. 2023). Some natural disasters, like wildfires and landslides, are very difficult to prevent, while hazards such as soil erosion and floods can be significantly mitigated by anti-erosion measures in the basin (Petrović et al. 2023). Caković et al. (2021) indicate that potential biological works as part of IWM can significantly restore vegetation cover and contribute to the mitigation of erosion processes. This is in line with a recent study by Ikram et al. (2023), which used biological interventions such as contour furrows with seedling planting, reforestation, channel terraces with tree planting, and agroforestry practices. Therewithal, new advances, and adjustments in rainfall simulation may be of importance in further research regarding soil erosion and torrent floods (Rončević et al. 2022). The scientific and professional research conducted so far, as well as the results obtained by forestry experts, must find a place in the firefighters practice in order to manage potential forest fires as effectively as possible (Barčić et al. 2022, Rosavec et al. 2022). Certainly, for sustainable management of various natural hazards, it is necessary to map the distribution of their frequency to assess the level of risk. The obtained information can be of crucial importance for the management of watersheds and for implementing potential multi-hazard assessments (Pourghasemi et al. 2020). Various natural hazards and risks should involve adequate experts from those fields working together to develop a relevant blueprint as a part of IWM.

Stakeholders

Stakeholders play a critical role in IWM, as their active participation is an essential principle of the method (Adhami et al. 2020). IWM is the process of planning and implementing natural resource management strategies in watersheds, and to be successful, it has to be participatory, adaptable, and experimental, which implies the involvement of all key stakeholders (Athari et al. 2018). Participation of a diverse set of stakeholders requires communication between bureaucrats, experts, and local residents, as well as the promotion of leadership, participatory planning, and motivated citizenry (Nasiri Khiavi et al. 2023, Supangat et al. 2023, Majeski and Trindade 2023). Furthermore, Athari et al. (2018) recognise stakeholder participation as an essential point of IWM that promotes the use of indigenous knowledge and social justice. Participatory watershed management promotes the collaboration of all parties involved in negotiating benefits, establishing priorities, assessing alternatives, implementing actions, and monitoring outcomes to achieve improved sustainable development (Bekele et al. 2023). Participatory practices that include relevant stakeholders may significantly contribute to the co-creation of various adaptation tools, solutions, and policy proposals (Brombal et al. 2018, Behmel et al. 2018). Nevertheless, according to Gaus et al (2023), it should be noted that experienced actors typically possess more extensive viewpoints compared to actors with less experience.

Climate Change

IWM requires planning, monitoring, and evaluation as a way to mitigate and adapt to the recent occurrence of climate change. When any signs of climate change are detected, watershed management strategy and execution have to be modified to account for the mitigation of climate change and resilience (Basuki et al. 2022). Climate change is predicted to trigger flooding in the basin, and such conditions may necessarily require additional investment in flood management infrastructure as well as complete budget revisions for flood management and flood protection infrastructure maintenance (Prodanovic and Simonovic 2010). Furthermore, climate change might also endanger watershed management through more frequent and prolonged drought occurrence, which should be properly followed by IWM adaptive strategies (Mekonnen et al. 2021, Barakagira and Ndungo 2023).

Policy

Environmental policy guidelines are becoming increasingly important in IWM, both at the national and international scale (Correljé et al. 2007). Despite the fact that IWM has been continuously advocated, policymakers or activists are unable to reach a consensus on how exactly watershed legislation should be drafted and implemented (Berlie and Ferede 2021). Furthermore, every decision-making setup may raise political issues, and therefore every decision-making process may be flawed since all institutional frameworks regarding water-related decision-making tend to have various policy perspectives (Blomquist and Schlager 2005). For IWM interventions to be successful, equal emphasis must be placed on policy, enhancing coordination and collaboration between policymakers, infrastructure, marketing, various institutions, and financing innovations (Berlie and Ferede 2021).

Cost Management and Risk Analysis

Despite some accomplishments, little work has been done to demonstrate how costs and benefits can be implemented into an integrated physical, institutional, and economic model to support water resource planning. Nevertheless, a recent study by Alamanos et al. (2019) proposes the application of hydro-economic modelling as a potential base for the long-term management of water resources and an additional useful tool for policymakers. Moreover, a watershed approach and coordinated cross-agency decision-making are required to accomplish cost-effective management (Hansen et al. 2021). By continuously assessing initiatives in terms of society's total environmental and economic impact in financial terms, cost-benefit analysis has significant potential to aid watershed management strategies (Ward et al. 2009, Tričković et al. 2023). The development of novel frameworks for eco-environmental risk assessment within the context of IWM could prove valuable in identifying regions of the highest concern (Li et al. 2023).

Livelihoods

As a sociopolitical-ecological entity, the watershed plays a key part in providing food and income security, along with vital life-sustaining services that boost people's livelihoods (Teka et al. 2020). Combining livelihood security with a strong commitment to natural resource conservation has been the primary challenge recently (Berlie and Ferede 2021). Watershed management is an integrated approach that manages watershed resources by integrating agriculture, forestry, and water management and may be extended to the development of rural areas with a strong connection to local people's livelihoods (Mengistu and Assefa 2020). IWM has proven to be successful in terms of enhancing livelihoods by providing valuable possibilities for land management (Teka et al. 2020). This is of high importance since providing certain benefits to local inhabitants is one of the crucial goals (Barakagira and Ndungo 2023). Berlie and Ferede (2021) furthermore conclude that policy-making might have an important part and effect on potential livelihood support. However, both climate variability and climate change can significantly affect livelihoods, while the decisions individuals make towards adaptation may vary based on various socioeconomic conditions (Wolka et al. 2023). Although landowners may already be aware of multiple factors that might threaten their livelihoods, it is essential for local governments to actively encourage them to adopt IWM techniques as a means of mitigating these risks.

Ecosystem Services

Integrated catchment planning, decision-making, and management must incorporate considerations of watershed ecosystem services to ensure the sustainability and improvement of this vital natural capital (Kaval 2019). Watersheds may provide multiple kinds of ecosystem services. Besides providing ecosystem services, IWM should also strive to protect these services from potential disturbances that might jeopardise them. Enhancement of some ecosystem services might be made through planned management. For instance, it may be assumed that a watershed that contains a larger number of well-planned and organised wetlands might enhance its flood control ecosystem service. Furthermore, both Pascual et al. (2022) and Arnillas et al. (2021) highlight the importance of a modelling approach for the integration of ecosystem services and providing support for decision-making. In addition, although payment for ecosystem services could be an effective option, there were many obstacles to this practice, including a lack of public involvement, insufficient funding, unclear legal frameworks, and difficulties in coordinating and synchronising authority among stakeholders (Supanganet et al. 2023).

Habitat and Biodiversity

Watershed biodiversity is threatened by a variety of factors, such as habitat degradation, pollution, building dams, overexploitation, species invasion, and climate change (He et al. 2017). In response to these challenges, conservationists have recently focused on trying to adapt conservation planning guidelines derived for the protection of terrestrial habitats and species to the unique characteristics of watersheds (Linke et al. 2011). In addition, habitat connectivity issues have been highlighted in recent studies (Arp et al. 2019, Savić et al. 2021). Furthermore, Jovanovska et al. (2019) recommend pursuing the assessment of watershed habitats following ecological integrity.

Tourism

Natural resources are significant attractions in tourism, which is why their preservation is essential to manage. For this purpose, participatory IWM has been recognised as the best approach to determining capacity for sustainable management and helping to establish a conservation and development system in the watershed that supports tourism and recreation (Dodds 2020). Further research in this direction might contribute to the strengthening of tourism's role within IWM practices, which might secure an additional source of income for the local inhabitants.

Synthesis

Our findings highlight the diverse group of factors that have been recognised as specific components of IWM research in recent years. Even though all these factors need to be addressed together within IWM practice, a deep understanding of each may be a crucial step in the synthesis of all these factors. Relevant experts from each necessary field should derive the main points and explain how this can be sustainably implemented in IWM practice. Among the group of various detected factors, water resources were found to be the most addressed part of IWM. They are followed by decision-making, which plays an essential part regarding all recognised factors since it determines how they will be managed. While a non-disturbed or reasonably managed forested watershed may provide multiple benefits, an agricultural watershed, on the other hand, might be complicated to manage following environmental and economic principles. Nevertheless, the IWM concept, supported by thoughtful analysis, offers the best approach to finding a compromise between the two previously mentioned principles. Soil management has also been significantly recognised, and it may play one of the key roles in addressing agricultural watershed problems together with water resources. Natural hazards threaten to endanger watershed resources, which may have further devastating consequences. In coordination with other IWM factors, the potential effects of natural disasters may be significantly mitigated. For all IWM parts to be efficiently applied, policymakers need to be adequately informed regarding related concerns and potential solutions. A well-established policy may considerably support IWM. However, policy makers should further follow new problems, proposals, and solutions to properly improve policy design over time in accordance with new achievements. Climate change brings new challenges, which, in the face of slow worldwide mitigation progress, might be hard to address. Nonetheless, a sustainable and reasonable use of resources under these circumstances could be a strategy to partly cope with the effects of climate change. Engagement of all necessary stakeholders in the IWM process is of vital importance, and therefore their participation should be highly encouraged. Their participation, among other factors, would have important implications for decision-making related to cost management, livelihoods, ecosystem service enhancement, habitat and biodiversity preservation, and the development of tourism.

CONCLUSIONS

The literature analysis pertaining to current topical trends in IWM research has revealed that the advancement and enhancement of IWM should be founded upon the synthesis of diverse facets, including: regular monitoring of watersheds and monitoring trends; the use of advanced remote sensing technologies and models to obtain the necessary data; coordination of economic and environmental needs; conservation of water and soil resources with specific attention to agricultural and forested watersheds; the use of innovative methods for decision-making purposes; serious consideration of climate change and natural disasters; harmonization of laws in accordance with progress in scientific research; involvement of key stakeholders; taking into account important livelihoods; preserving and enhancing watershed ecosystem services; protecting habitat and biodiversity, especially the endangered ones; supporting and developing a tourism blueprint.

The scientific literature we analysed suggests that recent IWM trends are linked to various thematic groups. There is a particular emphasis on three subjects: water resource management, decision-making, and agricultural and forested watersheds. However, the body of research on habitat, biodiversity, and tourism is extremely sparse. Additional investigation in this particular field is recommended.

The respective participants, who originate from many professions, must work closely together to accomplish the synthesis of the aforementioned components. Only if all parties are dedicated to it will this collaborative method have a chance of success. Such dedication must be based on a comprehension of the issues and demands shared by all parties. It is crucial to identify the decision-makers who have the power to affect the tactics and methods because their adherence to this approach is decisive.

Author Contributions

FV, ND, and MZ developed the original idea and conceptualised the manuscript. FV and NJ conducted a review of the scientific literature. FV and MC drafted the manuscript. MC, ND, NJ, VR, NŽ, and MZ reviewed the drafted manuscript version, performed editing, and critically revised the work. All authors have read and agreed to the final version of the manuscript.

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Conflicts of Interest

The authors declare no conflict of interest.

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