ANDMEJ
ASEAN Natural Disaster Mitigation and Education Journal
ANDMEJ 2(1): 1–23
ISSN 3025-0285

Institute for Advanced Science, Social and Sustainable Future
MORALITY BEFORE KNOWLEDGE

Public policies on sustainable flood risk management: Study cases of the Netherlands and Malawi

Precious Douglas Maulana[1*], Raldi Hendrotoro Seputro Koestoer[1], Mahawan Karuniasa[1]

[1] *School of Environmental Science, Universitas Indonesia, Salemba Raya Street No. 4, Central Jakarta 10430, Indonesia.*

*Correspondence: premaulana@gmail.com

Received Date: June 25, 2024 Revised Date: July 15, 2024 Accepted Date: July 18, 2024

ABSTRACT

Background: This study compares flood management strategies in Malawi and the Netherlands, emphasizing their respective advantages and disadvantages. The Netherlands is renowned globally for its flood defense, prioritizing prevention, stakeholder involvement, and nature-based solutions through sophisticated infrastructure and proactive approaches. However, future challenges may arise from economic expansion and climate change pressures. In contrast, Malawi, despite having fewer resources, is making strides with its National Resilience Strategy, focusing on risk mitigation, sustainable agriculture, and early warning systems to combat flooding and hunger vulnerabilities. Yet, it faces significant issues with financing, management, and the long-term sustainability of community-based projects. **Methods:** This study utilized bibliometric analysis and a Systematic Literature Review (SLR), employing a comparative approach to evaluate Malawian and Dutch public policies on flooding disasters. The aim was to identify similarities and differences in their approaches to flood risk management. **Findings:** The Netherlands' proactive flood management strategy, characterized by advanced infrastructure and integrated policy frameworks, is a model for high-capacity settings. Its emphasis on nature-based solutions and stakeholder engagement further strengthens its resilience. Malawi's approach, while resource-constrained, shows promise through its National Resilience Strategy, which targets risk reduction, sustainable agricultural practices, and robust early warning systems. Nevertheless, Malawi continues to grapple with financing, effective management, and the sustainability of its flood risk mitigation initiatives. **Conclusion:** The experiences of the Netherlands and Malawi illustrate the need for continuous policy adaptation and the challenges of managing flood risks in diverse socioeconomic contexts. This research clarifies the relative benefits of different flood control strategies and emphasizes the importance of tailored approaches to address the complexities of flood dangers. Both countries demonstrate the ongoing need for regulatory reform to enhance flood risk mitigation efforts. **Novelty/Originality of this Study:** This study uniquely compares the flood risk management policies of Malawi and the Netherlands, highlighting the differences between a developing nation's reactive, community-focused approach and a developed country's proactive, infrastructure-intensive strategy. By analyzing their respective strengths and weaknesses, it identifies potential improvements and opportunities for both nations to enhance their flood management and resilience.

KEYWORDS: community resilience; early warning systems (EWS); Malawi; public policies; sustainable flood risk management.

1. Introduction

Floods pose a worldwide risk with the potential for severe impacts on communities,

Cite This Article:
Maulana, P. D. Koestoer, R. H. S., & Karuniasa, M. (2024). Public policies on sustainable flood risk management: Study cases of the Netherlands and Malawi. *ASEAN Natural Disaster Mitigation and Education Journal*, 2(1), 1-23. https://doi.org/10.61511/andmej.v2i1.2024.953

economies, and ecosystems. Adopting systematic risk mitigation strategies to reduce casualties, safeguard livelihoods, and avoid hindrances to developmental advancements is imperative. A study conducted by Rentschler et al., (2022), estimated that 1.24 billion individuals globally are at risk of flooding, with a significant concentration in South and East Asia. China and India alone contribute 395 million and 390 million people to this total, representing over one-third of the global flood-vulnerable population (Rentschler et al., 2022), highlighting the need for effective flood risk management strategies in densely populated regions like South and East Asia. The complexity of flood risk management arises from various sources of risk contributing to flooding events, including fluvial flooding from river overflow, tidal flooding due to high tides and storm surges, coastal flooding caused by storm surges and sea-level rise, urban runoff from impervious urban surfaces, and local drainage failure leading to localized flooding in urban or rural areas (Cea and Costabile, 2022).

Managing the various sources of flood risk necessitates implementing a variety of strategies, such as constructing infrastructure like levees and flood barriers, planning land use through zoning regulations, conserving natural resources like wetlands, establishing early warning systems for monitoring and alerts, and engaging local communities in planning and response activities. Flooding is a notable and frequently occurring natural disaster in the Netherlands due to the country's geographical characteristics. The Netherlands is known for its low-lying land, with a significant portion of its territory situated below sea level, as a result, the country is highly susceptible to flooding from rivers, coastal areas, and heavy rainfall (Diaz et al., 2024). Recent flood events in the Netherlands, the Caribbean, and the US have brought attention to the risks posed by flooding from both pluvial (rainfall-induced) and fluvial (river-induced) sources. While these regions have experienced similar challenges with flooding, they adopt unique approaches and flood management strategies due to variations in governance structures and scales of operation (Diaz et al., 2024).

Tropical cyclones (TCs) and extratropical cyclones (ETCs) are among the most destructive natural catastrophes, with the potential to cause enormous mortality and socioeconomic losses to the major continents (Wang et al., 2021). These cyclones have the potential to cause floods in both inland and coastal areas by bringing strong winds and a lot of rain. The eastern coast of southern Africa, home to nations like Mozambique, Malawi, and Madagascar, is the area most frequently hit by floods brought on by storms. Even though Cyclone Ana in 2022 caused disastrous flooding (Mailosi et al., 2022), cyclone Freddy in 2023 caused the greatest floods in Malawi, and the flood was declared a national disaster, breaking all records, and killing several people, underscoring the need for community-level disaster management. Examining what went wrong and what lessons may be drawn from the catastrophe resulted in a study to explore the public policies regarding flood management including early warning systems (EWSs) and other disaster prevention strategies. To strengthen resilience, safeguard vulnerable populations, and advance sustainable development, immediate and ongoing action should be guided by the lessons learned from Tropical Cyclone Freddy (Aderinto, 2023).

Given the rising sea levels and changing precipitation patterns due to climate change, it is crucial to learn from the Dutch experience in flood risk management. This study compares the governmental policies of Malawi and the Netherlands in managing sustainable flood risks. By analyzing their approaches, the study aims to identify key strategies, challenges, and successes in mitigating flood risks and promoting sustainability. The Netherlands takes a proactive approach to disaster management, emphasizing spatial planning, modern infrastructure, and community interaction. Malawi, on the other hand, frequently responds to disasters as they happen and concentrates on early warning systems, disaster response, and international cooperation. The paper assesses the advantages and disadvantages of the policies and makes recommendations on how to manage floods in Malawi, including strengthening flood warning systems, raising public awareness, and standardizing downstream flood channel management. Through the

integration of international best practices with regional requirements, these recommendations seek to improve Malawi's flood control.

2. Methods

2.1 Study area

A large portion of the population in nations with extensive river systems, flatlands, and coasts is at flooding risk (Figure 1). Only two countries in the world, the Netherlands and Bangladesh, with 59% and 58% of their respective populations at risk from floods have more than half of their populations at risk from flooding. Myanmar (40%), Vietnam (46%), and Egypt (41%) make up the remaining five places. Only two other European countries, Austria (18th at 29%) and Albania (20th at 28%), rank among the top 20 by the percentage of people in danger, aside from the Netherlands (Rentschler et al., 2022).

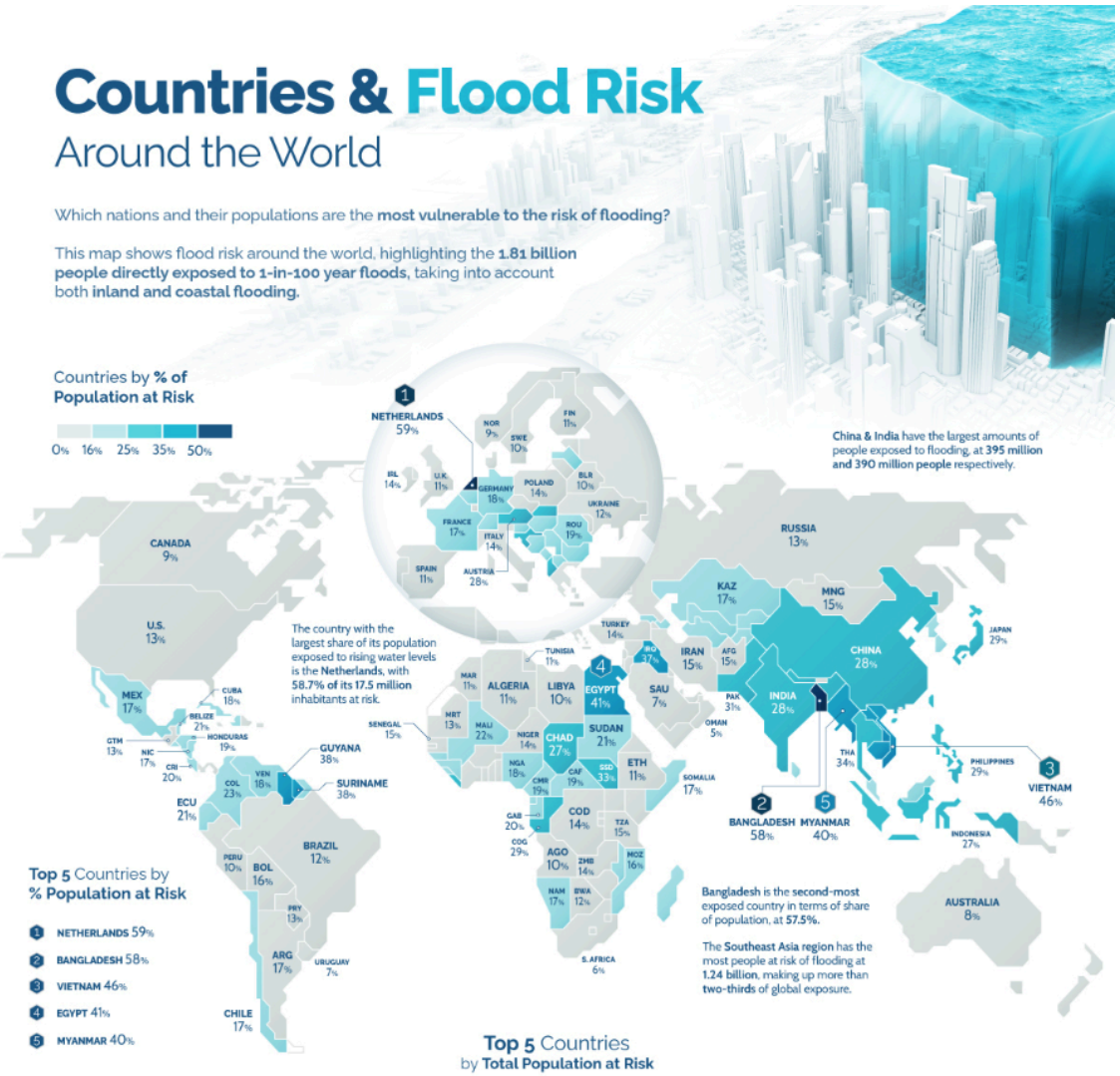

Fig. 1. Mapped: countries with the highest flood risk
(Conte and Kostandi, 2022)

The study locations for this work are Malawi and the Netherlands. The Netherlands is in Northwestern Europe, bordered by Germany to the east, Belgium to the south, and the North Sea to the northwest. It is known for its flat landscape, with about a quarter of the country lying below sea level. The capital city of the Netherlands is Amsterdam. Being in a low-lying area along the North Sea coast, The Netherlands is prone to flooding and shaping

its distinctive landscape with polders and dikes (Haasnoot et al., 2020). Despite these geographical challenges, the country has developed advanced water management systems to successfully manage flood risks. With a population of approximately 17 million, the Netherlands is densely populated. Its strong economy, with a gross annual domestic product of around 800 billion Euros, is supported by key sectors like agriculture, trade, manufacturing, and services, establishing the Netherlands as a prosperous and economically influential country in Europe (Katsman et al., 2011). A picture of flood-prone areas in the Netherlands (blue shading) and features of the water management system can be seen in Figure 2.

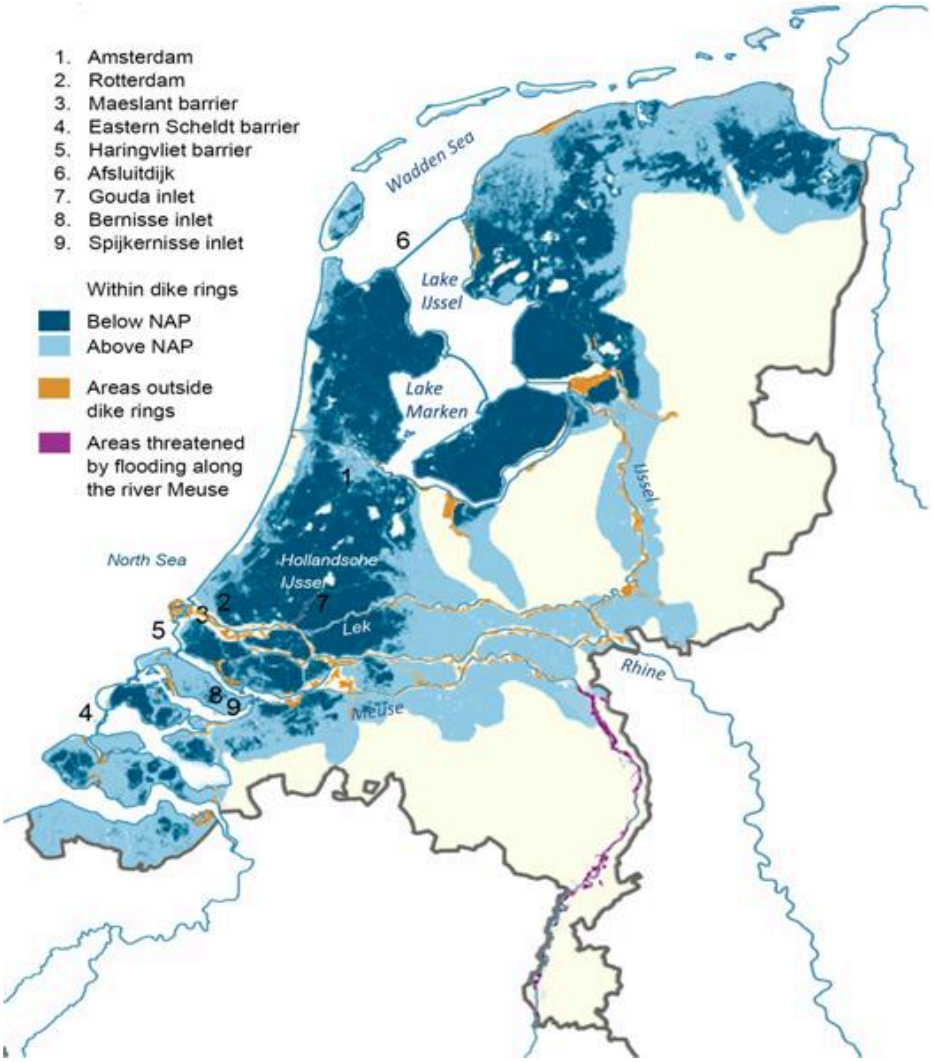

Fig. 2. Flood-prone zones in the Netherlands (blue shadings) and features of the water management system (Haasnoot et al., 2020)

The country of Malawi experiences flood disasters due to two distinct phenomena: cyclone-induced floods and locally concentrated, excessive seasonal rainfall and runoff that frequently causes rivers to overflow. Seasonal floods are the most common, typically occurring in January or February during the height of the rainy season. In recent years, the frequency and intensity of cyclones affecting Malawi have been increasing, leading to more significant flood events and challenges for disaster preparedness and response efforts in the country. Chikwawa, Nsanje, Balaka, Salima, and Karonga districts are listed as the most vulnerable districts to the effects of climate change on droughts, floods, and cyclones in the Malawi National Adaptations Programs of Action (NAPA) report on Disaster Management for Malawi (Mwase et al., 2014). The southern part of Malawi, particularly the Chikwawa

and Nsanje districts, is at high risk of flooding because of their low elevation below sea level. These areas are situated in a valley where the Shire River runs, linking Lake Malawi to the Zambezi River. Flooding is frequent during the rainy season when a significant rise in Lake Malawi's water level leads to overflow. Despite the recurring floods, around 900,000 people live in these districts, with a considerable number opting to reside close to the riverbanks due to the fertile soil in the region (Mailosi et al., 2022). Figures 3 show all districts in Malawi and the location distribution of districts affected by flooding in Malawi respectively.

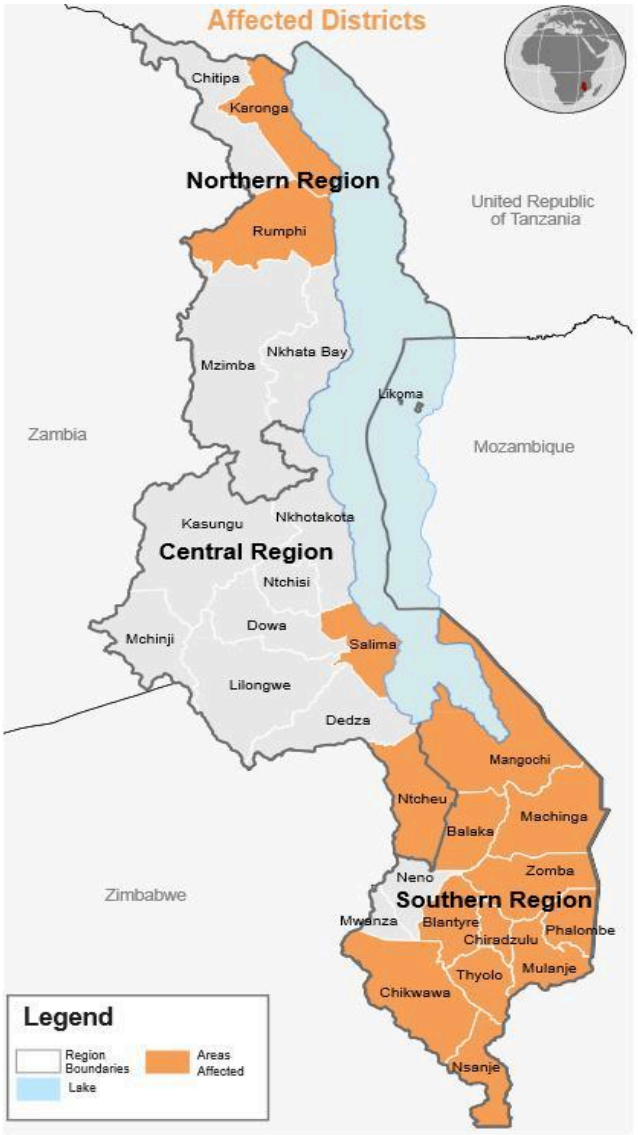

Fig. 3. Location distribution of districts affected by flooding in Malawi: Image taken from OCHA (Humanitarian Situation Report, 2015)

2.2 Commonalities between the nations

Physical, topographical, and meteorological similarities between Malawi and the Netherlands can be used to guide flood risk management plans in Malawi. Adverse climate hazards, such as heavy rainfall and flooding, are common in these two countries. The Netherlands and Malawi are in areas that frequently flood. Situated in the southeast of Africa, while not below sea level, Malawi is susceptible to flooding from Lake Malawi, the Shire River, and other bodies of water (Zuzani et al., 2019), and the annual rainy season increases the risk of riverine and flash floods. In the same way, the Netherlands is a low-lying nation in the Rhine-Meuse delta along the North Sea coast which has a large

amount of its land below sea level, making it extremely vulnerable to floods from the North Sea and other waterways (Haasnoot et al., 2020). Similarities exist between Malawi and the Netherlands in terms of heavy precipitation that might cause floods.

The subtropical climate of Malawi is typified by cyclical wet (November to April) and dry (May to October) conditions and it experiences a distinct rainy season typically occurring from November to April, with the peak of rainfall usually in January and February (Vincent et al., 2014), on the other hand, the Netherlands is characterized by a year-round moderate marine climate with significant and heavy rainfall and storms, particularly in autumn and winter, which can cause river flooding (Lukić et al., 2018). These common weather patterns offer Malawi important information for developing flood risk management plans, especially regarding anticipating and comprehending the effects of heavy precipitation and possible floods.

This paper used a Systematic Literature Review (SLR), qualitative description, and Bibliometric analysis. Using SLR, one can gather pertinent information on a given subject in compliance with predetermined eligibility requirements and find the answers to research questions that have been developed (Mengist et al., 2020). In line with this paper, the SLR method incorporated a comprehensive review of existing literature related to public policies and flood risk management in the Netherlands and Malawi. SLR is a methodical, explicit, thorough, and repeatable process that researchers, academics, and practitioners use to find, assess, and synthesize a body of finished and documented works (Okoli and Schabram, 2012). This review informs the choice and application of specific methods, ensuring alignment with established practices and innovative approaches in the field.

The Netherlands was selected for this study due to its extensive history of grappling with flooding challenges and its successful implementation of adaptation measures (Diaz et al., 2024). The analysis of data was conducted using a qualitative description approach to explore both the positive and negative aspects of public policies in each country. This method involves delving into the perceptions, values, opinions, and community norms to gain insight into the impact and consequences of public policies.(Sandelowski, 2010). Additionally, the analysis aimed to identify important similarities and differences in the observations and explore the possible bases for these patterns in different contexts. This approach provides a comprehensive understanding of the effectiveness and implications of the public policies in each country.

2.3 Bibliometric analysis

In recent years, bibliometric analysis, a quantitative technique and potent statistical tool for handling a large number of publications and scientific literature mapping has been employed more and more in a variety of academic domains, including open innovation and sustainable development (Du et al., 2021; Gao et al., 2020). The present study employed VOS viewer version 1.6.16 for the bibliometric analysis. By offering an inclusive representation of relationships across articles, journals, keywords, citations, and co-citations networks, bibliometric analysis helps academics quickly identify potential research directions within a field of study (Feng et al., 2017).

2.4 Method of data searching

The initial search focused on documents published in international scientific journals from 2001 to 2024 across various subject areas, including environmental science, social sciences, engineering, energy, economics, econometrics and finance, earth and planetary sciences, business, management and accounting, biochemistry, genetics and molecular biology, and agricultural and biological sciences. The search utilized keywords such as "public policies", "sustainable", "flood", "risk", and "management" in the SCOPUS database, yielding 115 publications. Figure 4 shows a flowchart of the systematic bibliometric review.

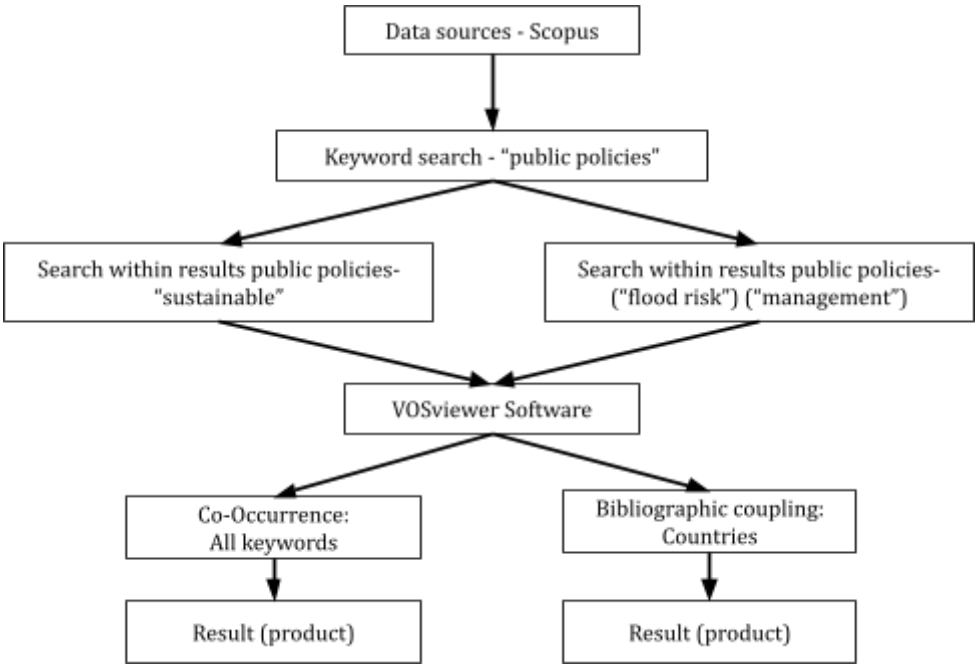

Fig. 4. Flowchart of the systematic bibliometric review

The relationships between various author-defined keywords are shown in the keyword co-occurrence network maps (Figure 5), which are based on how frequently certain terms occur together. The co-occurrence criterion for a keyword was set to a minimum of 1 to generate a network map. Flood risk, risk assessment, and floods have been referenced in the literature under a variety of titles, and over time, they have emerged as the top terms. Figure 5 is a network visualization of articles with the keywords "public policies", "sustainable", "flood risk" and "management" across the world. Figure 6 is a bibliographic coupling network of public policy research towards flood risk management while Figure 7 represents the co-occurrence network of the keywords from 16 articles with the keyword "Netherlands" included in the search.

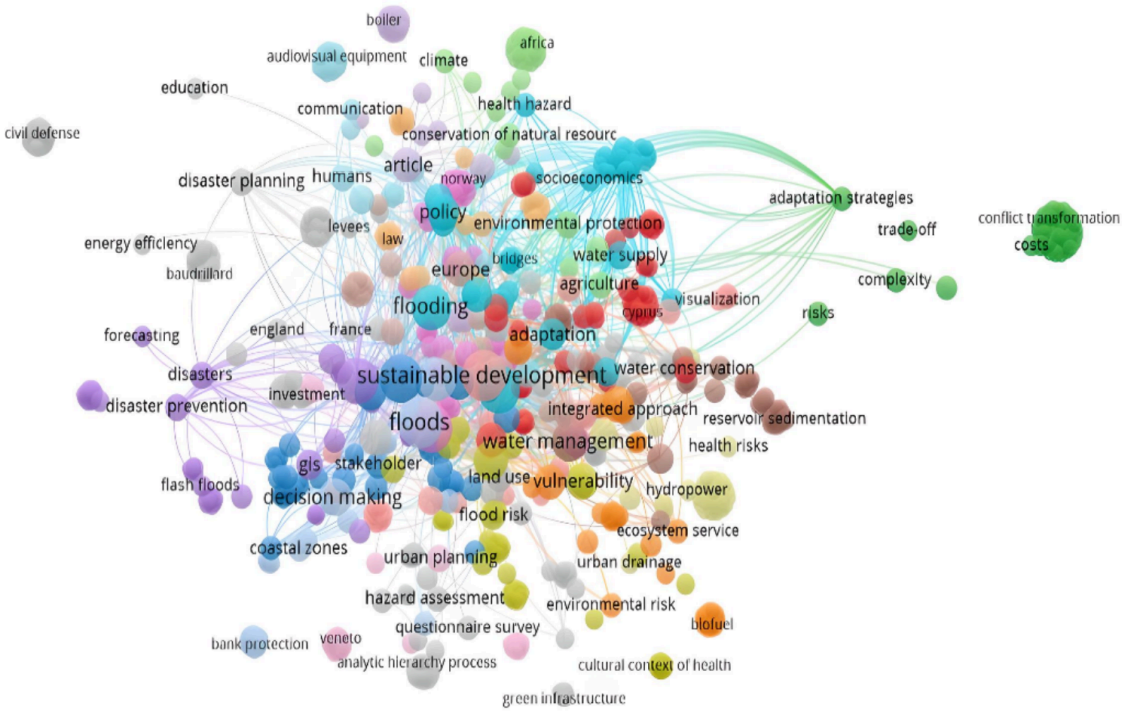

Fig. 5. Network visualization of keywords in public policy research towards flood risk management

Each node stands for a keyword, and the size of a node indicates how many times a keyword appears. The co-occurrence relationship between two nodes is indicated by the link between them; the strength of the relationship is indicated by the link's width, and the degree of relationship between two nodes is determined by their distance from one another.

2.5 The criteria for inclusion and exclusion

To complete the systematic review, 30 articles published between 2001 and 2024 that dealt with "public policies," "flood risk management," and "the Netherlands" were found through the search. Book chapters, editorials, conference papers, and novels were not included in the selection of 16 English-language articles from 2014 to 2024 for data extraction and analysis. These selected texts provided important insights into flood risk management and Dutch governance. The literature review on flood risk management and governance in the Netherlands, based on 16 English-language publications from 2014 to 2024, provides valuable insights into several key areas.

Figure 6 illustrates a significant rise in publications between 2014 and 2024, indicating a growing understanding of the significance of efficient flood risk management for several reasons. Because of the Netherlands' particular geographic vulnerability to flooding, policy and practice have continuously advanced. The North Sea and European floods in 2014 and 2013 also brought attention to the need for more effective flood risk management strategies, which sparked a wave of new research and policy development in this field. The increasing frequency and severity of extreme weather events due to climate change have emphasized the importance of flood risk management. This has led to a greater focus on flood risk management, adaptation strategies, and resilience-building measures. (Klijn et al., 2012) Hence an increase in the literature from 2014 to 2024.

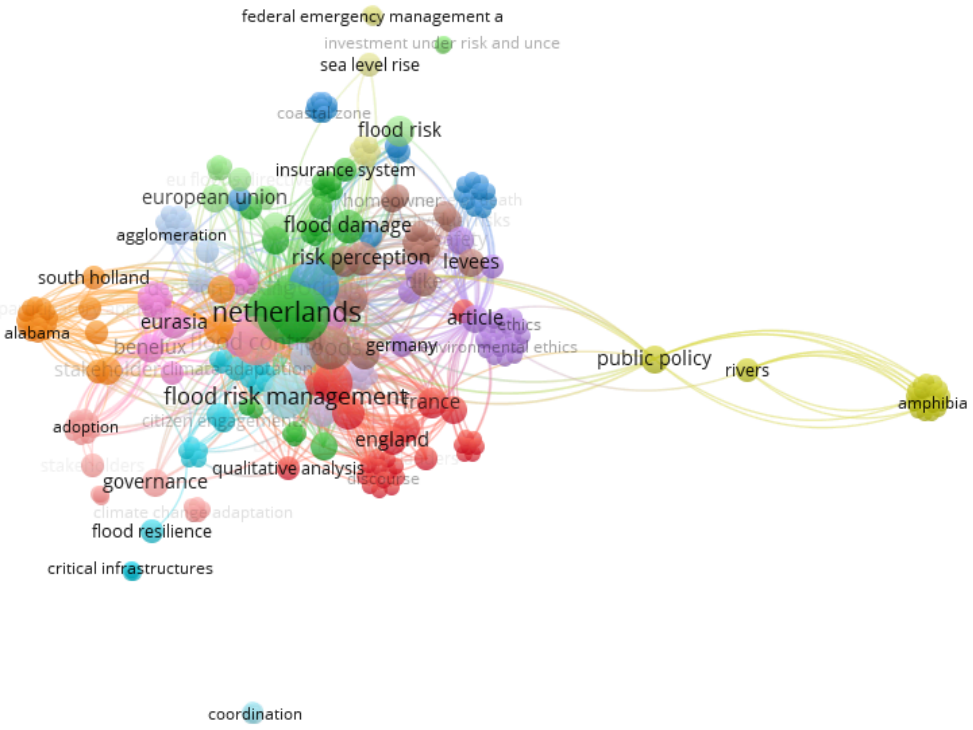

Fig. 6. Bibliographic coupling network of public policy research towards the flood risk management

The implementation of policies like the Delta Decision has stimulated continuous investigation and assessment, guaranteeing that flood risk control tactics continue to be efficient and current. The Netherlands' governance frameworks and policies for managing flood risk underwent substantial changes between 2014 and 2024. Research interest in

assessing the success of these policy measures and identifying areas for improvement may have increased due to changes in institutional arrangements, funding sources, and regulatory frameworks. The Netherlands has led the way in technological innovations for flood risk reduction, including the creation of smart infrastructure and early warning systems, which have greatly increased the nation's capacity to reduce flood hazards. (Klijn et al., 2012).

Figure 7 presents the keyword co-occurrence network derived from the analysis of the 16 chosen articles. This network identifies the key topics that the Netherlands' flood risk management research is focusing on. The linked keywords provide an understanding of the main ideas and techniques stressed in the context of flood risk management, reflecting the core topics and areas of concentration of the literature that have been evaluated.

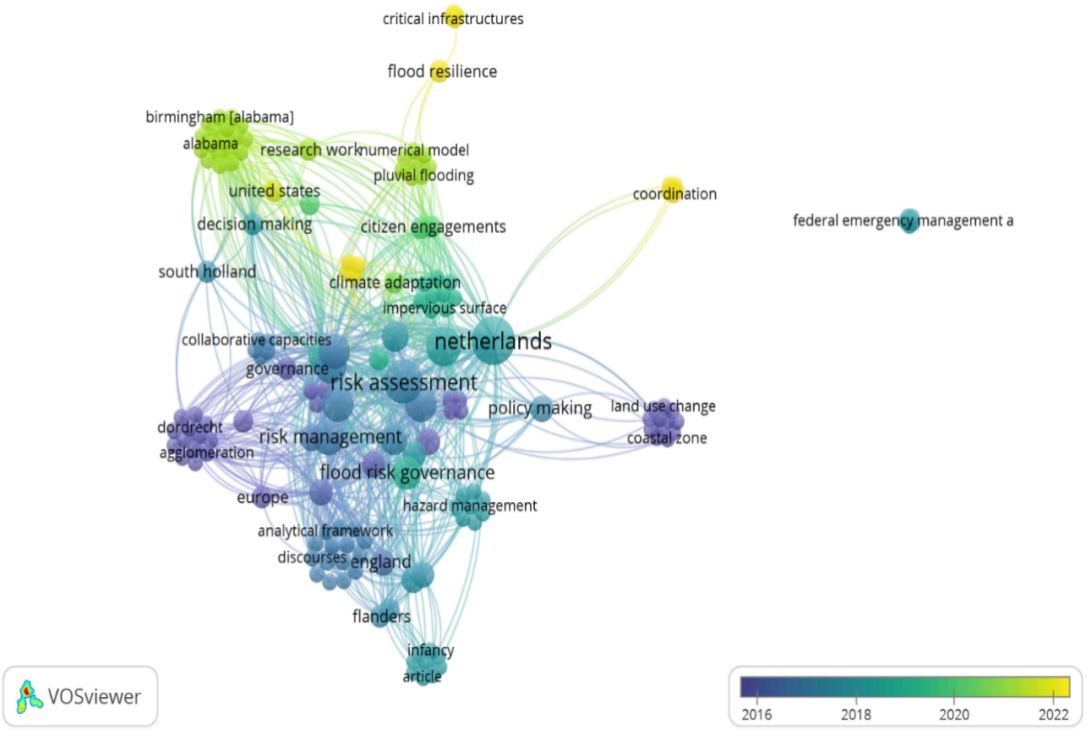

Fig. 7. Co-occurrence network of the keywords from 16 articles

The network offers a visual depiction of the state of research and its objectives by assisting in determining the connections and frequency of important terms. The size of each node in the network indicates the significance of the area in research, with larger nodes representing more frequently occurring and thus more significant keywords. According to the analysis, risk assessment, risk management, governance, hazard management, policymaking, and climate adaptation are the main keywords. These keywords denote the main topics covered in the literature review, including the policy framework, risk assessment, stakeholder involvement, adaption tactics, creative solutions, and global best practices. This demonstrates the thorough strategy used in the Netherlands and Malawi to comprehend and control flood risk, emphasizing the significance of various ways and cooperation in reducing flood-related difficulties.

The literature review explores the policy framework that oversees flood risk management in the Netherlands, emphasizing the institutional arrangements, regulatory frameworks, and targeted policy interventions that are intended to reduce the danger of flooding. It also looks at risk assessment techniques, such as risk modeling, vulnerability analysis, and hazard mapping, which are essential for guiding the creation of policies and decisions. The assessment discusses the different adaptation tactics used in the Netherlands, including community resilience projects, infrastructural improvements, and

nature-based solutions. The participation of stakeholders in the governance of flood risk management is also covered, outlining the functions of governmental bodies, regional communities, businesses, and non-governmental groups in cooperative decision-making processes.

Furthermore, the review compares international best practices in flood risk management, drawing lessons from other countries and identifying transferable strategies for enhancing resilience in the Netherlands and Malawi. It also addresses the challenges and barriers encountered in the implementation of flood risk management policies, such as funding constraints, conflicting priorities, regulatory complexities, and the need for effective stakeholder coordination. Innovative approaches and technologies utilized in flood risk management, including early warning systems, smart infrastructure, and data-driven decision support tools, are explored as well. It also considers climate change adaptation strategies integrated into flood risk management policies, emphasizing the importance of addressing the increasing frequency and intensity of extreme weather events and their implications for flood risk.

Every node is a country; the size of a node reflects the number of publications published by that country; the link between two nodes indicates the strength of the relationship between two countries in terms of bibliographic coupling; the distance between two nodes indicates the degree of relatedness between the two countries; and the colors indicate the clusters based on bibliographic coupling to which the countries belong. The Netherlands has a larger node than other nations engaged in comparable research on flood risk management, as seen in Figure 8 above. The Netherlands has a sizable advantage in terms of the number of publications on this subject, according to a bibliometric analysis done on flood risk management papers from 2001 to 2024. The quantity of scholarly papers, book chapters, and other works published by Dutch writers and organizations is indicative of this supremacy. A rising number of publications over the years reflects the depth of research and policy development in flood risk management conducted in the Netherlands. The links in the figure indicate that the Netherlands has been a leader in international efforts to address flood risk management, sharing its expertise and best practices with other countries. This collaboration has led to the development of new strategies and the exchange of knowledge.

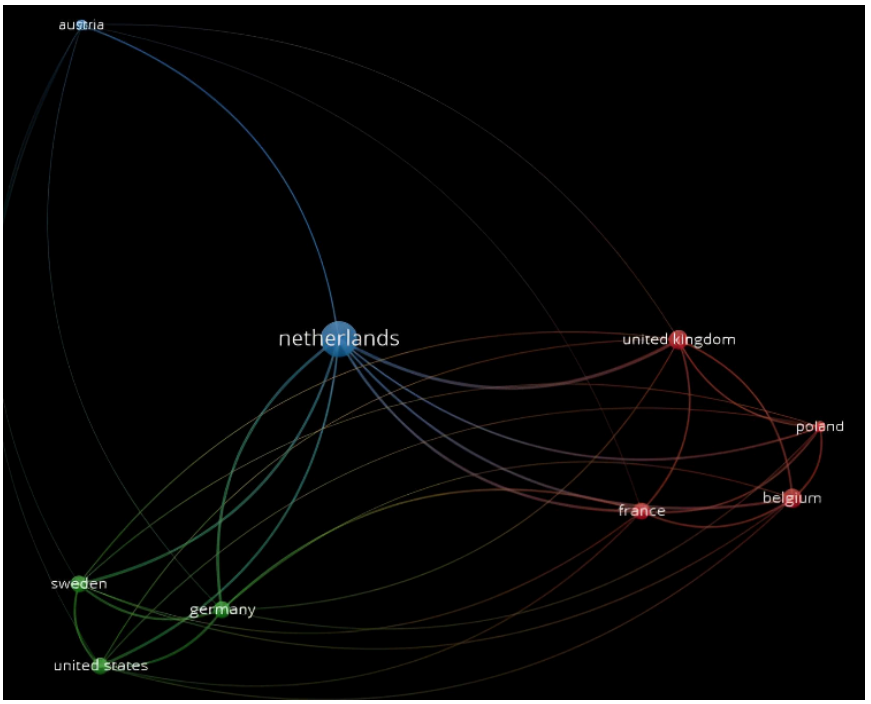

Fig. 8. Collaboration network between countries in the public policy research towards flood risk management

The Netherlands' high number of publications on flood risk management attests to the nation's dedication to ongoing research and innovation in this field. This ensures that the nation's flood risk management strategies remain resilient and effective in the face of changing challenges, and it also makes it a relevant nation for this research, as Malawi, a developing nation facing flood management challenges, can learn from the Netherlands.

3. Results and Discussion

3.1 Study of benchmark conditions in the Netherlands

The Netherlands, a nation well-known for its tulips and windmills, has a complicated and lengthy history with water. Much of the area is vulnerable to floods because of its low-lying topography and closeness to sea level. The Netherlands has created a thorough flood strategy that is based on two key pillars: prevention and spatial planning, to tackle this persistent menace (Molenveld and van Buuren, 2019). To physically stop rising waters, a strong network of dikes, dams, and storm surge barriers is necessary for prevention. With initiatives like the Delta Plan seeking to guarantee a high degree of flood protection for the entire nation, the Netherlands is continuously inventing and bolstering these defenses. Recognizing that total avoidance may not always be achievable, the Netherlands also places a strong emphasis on spatial design (Lee and Whang, 2020). This entails managing land use and development with caution, giving higher ground priority when building, and using flood-resistant building techniques in regions that are vulnerable to flooding.

The Netherlands serves as a model for flood management worldwide due to its innovative and effective policies.(Lambrechts et al., 2023). These policies reflect a proactive and integrated approach to managing water and preventing flood disasters, combining technological solutions with ecological and spatial planning. The National Water Plan 2016-2021 in the Netherlands serves as a comprehensive guide for the country's flood risk management and freshwater supply strategies. (Wuijts et al., 2023). It outlines specific approaches tailored to water-rich regions like the Rhine-Meuse delta and coastal areas. At the core of the Dutch strategy lies the Delta Program, an intricate system of infrastructure including a complex network of dikes, storm surge barriers, sluice gates, dams, and other protective structures (Britannica, 2022). This program functions through a collaborative framework involving water management experts, civil society representatives, and authorities at different government levels. By embracing this inclusive approach, a diverse range of stakeholders contribute their knowledge and insights to the development and execution of initiatives aimed at safeguarding the Netherlands from water-related hazards and bolstering its resilience against potential threats.(van Doorn-Hoekveld et al., 2022).

The roles and obligations of the federal government, the provinces, district water boards, and municipalities in water management are outlined in the Water Act of the Netherlands. (Heer et al., 2004). This strategy is evident in policy domains such as environment, nature, and spatial planning. (Zeilsta, 2009). The Water Act places a strong emphasis on integrated water management using the "water system approach," which takes into account all relationships within water systems, including those between groundwater, surface water, and quality, as well as those between water, land use, and water users. (De Lange et al., 2014). Water management in the nation, including an appropriate supply, wastewater purification, and preventing flooding, is the responsibility of Rijkswaterstaat and the district water boards. The Netherlands' Water Act is an important legal document that specifies the specific responsibilities of different governmental bodies when it comes to managing water resources, addressing issues related to water, and putting policies into action that will guarantee sustainable water resource management in the nation. (Environment and Planning Act, 2021).

In the Netherlands, a policy change has been noted, leading to more adaptable and sustainable measures, including the "Room for Water" policy, which entails giving rivers

more room to prevent flooding.(Busscher et al., 2019). The shift in policy reflects a broader trend in addressing flood risk and water management as it emphasizes the importance of nature-based solutions and innovative approaches to mitigate the impact of flooding. The "Room for the River" initiative in the Netherlands, for example, focuses on creating additional space for rivers to prevent flooding, moving away from traditional approaches to controlling rivers through dams. (van Doorn-Hoekveld et al., 2022). This approach is flexible and aligns with sustainable adaptation to climate change, demonstrating a shift towards more holistic and nature-centric strategies for flood prevention and water management (Edelenbos et al., 2017).

3.2 Study of benchmark conditions in Malawi

Over time, disaster risk management (DRM) and resilience techniques have seen major changes in Malawi. The Disaster Risk Management Bill of 2023 was passed by the Malawian Parliament on April 12, 20231. This bill aims to repeal and replace the Disaster Preparedness and Relief Act of 1991. It seeks to align the law with current developments in disaster risk reduction, response, and recovery and establishes a National Disaster Risk Management Committee (National Council for Law Reporting Library, 2023). The Disaster Risk Management Bill of 2023 comprehensively addresses floods within disaster risk reduction and response by incorporating key provisions. These include requirements for flood risk assessments to identify vulnerable areas and assess impacts on communities and infrastructure, with emphasis on establishing effective early warning systems for timely evacuation. The bill provides guidelines for flood preparedness encompassing response plans and supply maintenance, provisions for enhancing infrastructure resilience such as flood defenses, drainage systems, and water management facilities, stress on community engagement through awareness-raising and training, and procedures for post-flood recovery and rehabilitation focusing on damage assessment, aid provision, and infrastructure reconstruction with resilience in mind.

The Disaster Preparedness and Relief Act of 1991 played a pivotal role in establishing the framework for Disaster Risk Management (DRM) in Malawi until it was replaced by the DRM Bill of 2023. This act was instrumental in structuring DRM by instituting key entities such as the Office of the Commissioner for Disaster Preparedness and Relief and the National Disaster Preparedness and Relief Committee(GoM Disaster Act, 2014). The Committee oversaw strategic planning, policy creation, and national disaster response activity coordination, while the Commissioner's office managed the coordination and execution of disaster preparedness and relief actions. Under the terms of the 1991 Act, these organizations played a critical role in guaranteeing a coordinated and successful approach to disaster management in Malawi.

For Malawi's Early Warning Systems (EWS), the National Disaster Risk Management Policy (2015) acts as the main legislative foundation(Hollis, 2015). This policy is designed to address disaster risk reduction comprehensively, emphasizing the significance of preparedness, mitigation, and early warning mechanisms to minimize the impact of disasters, including floods. By focusing on proactive measures such as preparedness and mitigation, the policy aims to enhance the country's resilience to disasters and reduce the associated risks. The Meteorological Services Act (Cap 74:04) plays a crucial role in supporting the implementation of EWS in Malawi. This legislation empowers the Department of Climate Change and Meteorological Services (DCCMS) to collect, analyze, and disseminate weather data essential for flood forecasting (Venäläinen et al., 2016). By leveraging the capabilities of the DCCMS, Malawi can access timely and accurate weather information, enabling authorities to issue early warnings and advisories to communities at risk of flooding.

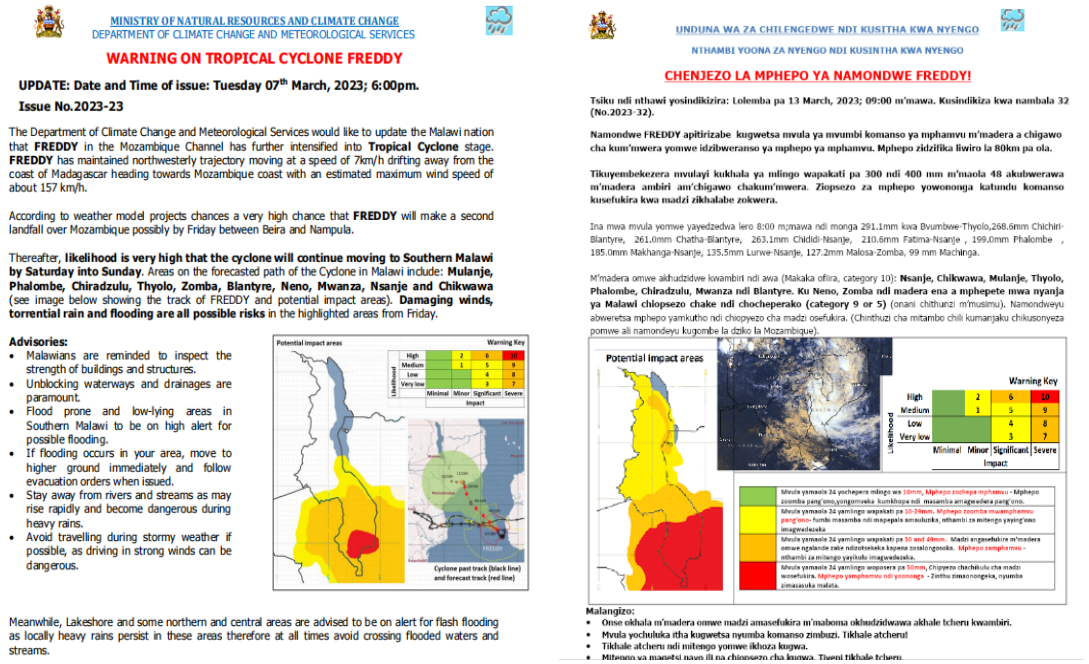

Fig. 9. Illustrations of flood warning issued by DCCMS; adapted from (Department of Climate Change and Meteorological Services, 2022)

The combination of the National Disaster Risk Management Policy and the Meteorological Services Act provides a comprehensive framework for disaster risk reduction in Malawi, with a specific focus on flood preparedness and early warning systems. By emphasizing the importance of proactive measures, data collection, and dissemination, these legal instruments aim to enhance the country's capacity to respond effectively to flood events and minimize the impact on vulnerable populations. An illustration of the warnings issued by DCCMS in English and local language (Chichewa) during Cyclone Freddy can be seen in Figure 9.

By combining development and humanitarian activities, the Malawi National Resilience Strategy (2018–2030) offers a comprehensive strategy to address the persistent problem of food insecurity in the nation. Providing dependable and customized livelihood assistance packages to vulnerable households is the cornerstone of this approach (The Government of Malawi, 2018). The plan, which places a strong emphasis on providing help consistently, aims to break the cycle of food insecurity and increase the resilience of communities throughout Malawi. This tactic emphasizes the value of long-term solutions that address both the pressing needs and the long-term capacities to withstand and recover from the many stresses and uncertainties associated with food security (Musa et al., 2024). Regarding tackling issues of food and nutrition security, inclusive resilient growth for all Malawians, and poverty reduction, the strategy marks a significant turning point in the country's approach. To interrupt the cycle of food insecurity in Malawi, this all-encompassing approach combines development and humanitarian actions to give vulnerable households more consistent help (Pangapanga-Phiri et al., 2022).

The strategy seeks to build a more solid and long-lasting framework for addressing food insecurity in Malawi by combining development and humanitarian efforts, giving priority to targeted assistance, and encouraging predictability in aid delivery. It is divided into four main sections: Human Capacity, Livelihoods, and Social Protection, which covers consumption support, resilient livelihoods, shock-sensitive social protection, and nutrition; Resilient Agricultural Growth, which includes sustainable irrigation development, drought mitigation, agricultural diversification, market development, and strategic grain reserves; Risk Reduction, Flood Control, and Early Warning and Response Systems, which focuses on mainstreaming disaster risk management across sectors, flood prevention and control, and establishing early warning systems; and Catchment Protection and Management (The Government of Malawi, 2018; Government of Malawi, 2016).

Malawi has been a signatory to the Hyogo Framework for Action (2005-2015), which was adopted by the United Nations World Conference on Disaster Reduction. Malawi's DRM policy and other policies have been aligned with the Hyogo Framework which aimed to build the resilience of nations and communities to disasters (Hollis, 2015). Malawi's commitment to disaster risk reduction is indeed reflected in its alignment with the Hyogo Framework for Action (2005-2015). The National Disaster Risk Management Policy of Malawi is aligned with the Hyogo Framework, emphasizing the need for a systematic approach to reducing vulnerabilities and risks associated with disasters.

Establishing comprehensive systems for disaster risk identification, assessment, and monitoring; mainstreaming disaster risk management into sustainable development; and fostering a culture of safety and resilience are just a few of the priority areas outlined in the DRM policy that align with the goals of the Hyogo Framework. The creation and reinforcement of people-centered early warning systems is a crucial aspect of the policy since it directly addresses the Hyogo Framework's demand for efficient emergency response and disaster preparedness systems. The strategy also emphasizes lowering underlying risks, which is consistent with the Hyogo Framework's focus on resolving disasters' underlying causes to prevent or lessen their effects (GoM, 2010).

3.3 Comparing the positives and constraints of the public policies related to flood management in the Netherlands and Malawi

A risk-based strategy is used in Dutch flood management, and acceptable safety requirements are determined for the entire nation. There are numerous benefits to the public policies that the Dutch administrations have instituted. The Netherlands has adopted innovative strategies, such as the "room-for-rivers" policy, to enhance its flood management approach (Klijn et al., 2012). This policy focuses on creating additional space along major rivers to mitigate flood risks effectively. By allowing rivers to overflow into designated areas during periods of high-water levels, the "room-for-rivers" policy helps reduce the probability of floods and promotes a more balanced distribution of risk across the country (Endendijk et al., 2023). The Netherlands continuously invests in research and development of innovative flood protection technologies, like multifunctional dikes, ensuring their systems stay ahead of potential threats (Ministry of Infrastructure and the Environment & Ministry of Economic Affairs, 2015). This innovative approach not only enhances the country's resilience to flooding but also demonstrates a proactive and sustainable method of managing water resources in the face of climate change challenges.

The combined effort of water management specialists, representatives of civil society, and authorities at different government levels characterize the Dutch approach to flood risk control (Wiering and Winnubst, 2017). This multi-stakeholder approach emphasizes how crucial it is to involve a variety of stakeholders in the process of implementing policies. To provide a comprehensive and inclusive approach to mitigating flood hazards, the Netherlands fosters collaboration among specialists, community members, and government officials. In addition to utilizing the knowledge and viewpoints of various stakeholders, this strategy encourages accountability, openness, and shared responsibility in tackling the problems caused by floods.

The Netherlands takes a proactive approach to reducing flood risks by emphasizing both prevention and adaptation in its flood management strategy (Mann, 2022). Initiatives like the creation of evacuation plans and the promotion of sustainable housing practices demonstrate the nation's dedication to prevention and readiness. The Netherlands successfully reduces flood damage and saves lives by giving priority to flood prevention systems such as strong dikes, dams, and storm surge barriers(Chan et al., 2022). This proactive approach highlights the nation's commitment to sustainable and successful flood adaptation and mitigation activities while also enhancing its resistance to floods.

Flood risk management policy in the Netherlands heavily relies on spatial planning, which directs land-use decisions away from high-risk locations and promotes flood-resistant building practices in vulnerable zones (Oukes et al., 2022) supported by

significant investments in flood protection measures, including the construction of dikes, dams, and storm surge barriers. This proactive strategy encourages long-term resilience to flood dangers and lowers the possibility of losses from flooding disasters. Through the implementation of spatial planning strategies that give precedence to resilient infrastructure and sustainable development, the Netherlands successfully mitigates the effects of flooding on infrastructure and communities. This deliberate emphasis on spatial design strengthens the nation's resilience to flood hazards and highlights its dedication to catastrophe risk reduction and sustainable urban development (Wouw, n.d.).

The measures in spatial planning adopted by the policy in the Netherlands are expensive to maintain and upgrade, with the costs primarily borne by the government and taxpayers (Van Alphen, 2016). The necessity of putting in place flood diversion zones and temporary flood defenses, among other flood mitigation and protection measures, adds to the cost burden. The Netherlands' limited flood management budget makes it difficult for the government to finance all the necessary steps to keep the nation safe from flooding. The high cost of maintaining and updating significant flood prevention systems places a heavy burden on the nation's budget (Klijn et al., 2015). The trade-offs between flood protection and other priorities, such as economic development, social welfare, and environmental protection, present further challenges in effectively allocating resources for flood management. To ensure the sustainability and efficacy of flood risk management activities, a comprehensive strategy for managing and financing flood protection systems is important due to the financial burden that floods inflict (Driessen et al., 2016).

There are ecological concerns when dikes are built and land is reclaimed because these actions might disturb natural water flows and the habitats of sensitive species (Duc Tran et al., 2018). Careful design is required to balance environmental sustainability and flood protection. To maintain environmental sustainability, the effects of massive dike construction on peak flood levels, flood retention capacity, and the water balance in particular areas should also be thoroughly evaluated (Ferreira et al., 2022).

Malawi's flood risk management strategy emphasizes how local communities actively participate in many facets of readiness and response (Chinguwo and Deus, 2022). This entails including communities in data gathering, training exercises, and warning distribution to promote a sense of accountability and ownership for reducing the risk of flooding. In keeping with the larger global emphasis on combining disaster risk reduction and climate change adaptation, this community-centered strategy aims to protect one billion people from disasters by 2025. The prioritization of community interaction and data collecting plays a crucial role in augmenting the precision and efficacy of early warning systems, hence facilitating more efficient flood risk mitigation (Chinguwo and Deus, 2022). The use of low-cost technologies and conventional observation techniques also emphasizes how strategies may be adjusted to settings with limited resources, guaranteeing that flood risk management measures can be successfully implemented in resource-constrained places.

Institutional frameworks, such as the DCCMS and Meteorological Services, to coordinate flood management efforts have been established in Malawi (Osti, 2019). To implement flood management policies and incorporate them into development plans across sectors and administrative levels, these frameworks are essential for directing institutional arrangements and administrative procedures for operations within flood risk zones and in surrounding areas (Osti, 2019). The institutional frameworks and responses of the nation are in line with international initiatives and best practices for integrated flood management, with a focus on capacity building, coordination, and the incorporation of climate change considerations into development planning and efforts to reduce the risk of disaster.

The flexibility of Malawi's strategies, using low-cost technologies like rain gauges in addition to traditional observation methods is essential to guaranteeing that flood risk control measures may be successfully implemented in resource-constrained locations (Trogrlić et al., 2019; Chinguwo and Deus, 2022). This flexibility is in line with the more general focus on organizational capacities that support quick adaptation, making it

possible to successfully navigate shifting demands and uncertainties. In this context, the capacity to oversee intricate and interdependent systems involving numerous stakeholders is crucial, underscoring the necessity of adaptable methods to resource constraints and environmental circumstances. This adaptability is especially important for long-term flood risk management plans since uncertainties are a major source of concern and necessitate the creation of flexible strategic plans that can consider the effects and inherent unpredictability of flood events.

Malawi is confronted with noteworthy obstacles arising from insufficient financial and technological means to execute efficacious flood mitigation strategies (Šakić Trogrlić et al., 2018). The lack of resources makes it difficult for the nation to invest in the knowledge and infrastructure needed to effectively reduce the risk of flooding. Malawi is also more vulnerable to flood-related disasters due to a lack of infrastructure, particularly early warning systems and flood defense systems (Šakić Trogrlić et al., 2022).

The lack of these essential components makes it more difficult for the nation to respond to flood hazards, putting its citizens in danger of the devastation caused by flooding and other water-related disasters (Dewa et al., 2023). Malawi's high susceptibility to climate change also makes the country's already few resources even more vulnerable. The country's ability to adapt to and recover from flood occurrences is further complicated by the rising frequency and intensity of floods, which are linked to climate change and worsen the already severe resource restrictions (Coulibaly et al., 2015). The combination of scarce resources, inadequate infrastructure, and susceptibility to climate change highlights the pressing requirement for focused initiatives and assistance to enhance Malawi's ability to withstand floods and other climate-related issues. Table 1 below provides a clear comparison of flood risk management strategies in the Netherlands and Malawi.

Table 1. Flood risk management: Netherlands vs. Malawi

Factors	Netherlands	Malawi
Flood risk	Major rivers like the Rhine and Meuse and coastal flooding brought on by sea level rise are the main causes of flooding.	Flooding is caused primarily by seasonal, severe rainfall on large rivers, such as the Shire.
Policy focus	A comprehensive approach combining structural and non-structural measures. Strong emphasis on long-term planning and adaptation.	Focus on managing immediate flood risks with limited resources and increased emphasis on community-based approaches in recent years.
Structural measures	Extensive network of dikes, levees, and storm surge barriers. Investment in flood-resistant infrastructure and building standards.	Limited hard infrastructure like dikes. Some localized riverbank stabilization projects.
Non-structural measures	Spatial planning regulations to restrict development in floodplains. Public awareness campaigns and education programs on flood preparedness.	Early warning systems using basic technologies (e.g., rain gauges). Community-based disaster risk reduction initiatives.
Investment	Large government funding for initiatives to reduce the risk of flooding. cooperation for technological improvements with research institutes.	Limited resources are available to the government. There is a greater reliance on foreign funding for initiatives to mitigate flooding.
Institutional framework	Clear division of roles and responsibilities between national and local authorities. Established flood management agencies with expertise.	Challenges in governance and coordination between different levels of government. Limited technical capacity for flood risk management.

There are notable similarities between Malawi and the Netherlands' approaches to flood management, despite their differing geographic and socioeconomic factors. The importance of controlling flood risk is firstly acknowledged by both countries, which

shows that they are aware of the significant social and economic implications that come with floods. Both counties employ a mix of structural and non-structural measures to manage and mitigate flood risks effectively. This comprehensive approach encompasses infrastructure development alongside non-physical strategies such as land-use planning and policy implementation. Additionally, there is an increasing emphasis on engaging local communities in flood preparedness and mitigation initiatives, showing the growing recognition of community involvement as a major component of flood management strategies. Furthermore, the implementation of early warning systems is increasing in both countries, enabling timely alerts and responses to potential flood events. Lastly, international collaboration plays a role in supporting flood risk management efforts in both Malawi and the Netherlands, potentially involving partnerships with international organizations and aid from other countries to enhance their flood management capabilities indicating the importance of global partnerships in addressing complex challenges related to flooding.

4. Conclusions

Both the Netherlands and Malawi have developed flood management policies tailored to their specific contexts. The Netherlands excels in preventative measures and infrastructure, while Malawi emphasizes community engagement and adaptable solutions. By learning from each other, both nations can improve their flood management strategies. The Netherlands can explore community-based approaches for wider coverage, while Malawi can benefit from technological advancements and infrastructure development, where feasible, to complement its existing strategies. While both the Netherlands and Malawi have established flood management policies, there's room for improvement. By learning from each other's strengths and weaknesses, they can build more resilient flood defenses.

The Dutch government can further integrate ecological considerations into flood protection strategies. Exploring nature-based solutions and minimizing disruptions to natural water flows and habitats can ensure long-term environmental sustainability alongside flood protection. Exploring international partnerships or knowledge-sharing programs can assist developing nations like Malawi in adopting adaptable and cost-effective Dutch technologies for flood prevention. Diversifying funding sources beyond government budgets, such as public-private partnerships or exploring disaster risk financing instruments, can ensure the long-term financial sustainability of Early Warning Systems (EWS). Investing in weather monitoring stations, communication networks, and basic infrastructure maintenance in remote areas is crucial to improve EWS coverage and effectiveness. The Malawian government can prioritize training programs for local government staff and community leaders on EWS management, data analysis, and communication protocols. This fosters local ownership and expertise in managing flood risks.

A successful flood management strategy requires a multi-pronged approach. By combining preventative measures, community engagement, technological advancements, and a focus on long-term sustainability, both the Netherlands and Malawi can create a safer future for their citizens in the face of flood risks. By fostering stronger collaboration through knowledge exchange and exploring potential technological adaptations, the Netherlands and Malawi can learn from each other's approaches. Sharing best practices, exploring financial sharing mechanisms, and investing in capacity building can significantly enhance flood preparedness and resilience for both nations.

Acknowledgement

Not available.

Author Contribution

Conceptualization, P.M.; Methodology, P.M.; Validation, P.M.; Formal Analysis, P.M.;

Investigation, P.M.; Resources, P.M.; Data Curation, P.M.; Writing – Original Draft Preparation, P.M.; Writing – Review & Editing, P.M., R.K., M.K.; Visualization, P.M.; Supervision, R.K., M.K.

Funding
This research received no external funding.

Ethical Review Board Statement
Not applicable.

Informed Consent Statement
Not available.

Data Availability Statement
Not available.

Conflicts of Interest
The authors declare no conflict of interest.

References
Aderinto, N. (2023). Tropical Cyclone Freddy exposes major health risks in the hardest-hit Southern African countries: lessons for climate change adaptation. *International Journal of Surgery: Global Health*, *6*(3), 1–3. https://doi.org/10.1097/gh9.0000000000000152

Busscher, T., van den Brink, M., & Verweij, S. (2019). Strategies for integrating water management and spatial planning: Organizing for spatial quality in the Dutch "Room for the River" program. *Journal of Flood Risk Management*, *12*(1). https://doi.org/10.1111/jfr3.12448

Cea, L., & Costabile, P. (2022). Flood Risk in Urban Areas: Modeling, Management and Adaptation to Climate Change: A Review. *Hydrology*, *9*(3). https://doi.org/10.3390/hydrology9030050

Chan, F. K. S., Yang, L. E., Mitchell, G., Wright, N., Guan, M., Lu, X., Wang, Z., Montz, B., & Adekola, O. (2022). Comparison of sustainable flood risk management by four countries - the United Kingdom, the Netherlands, the United States, and Japan - and the implications for Asian coastal megacities. *Natural Hazards and Earth System Sciences*, *22*(8), 2567–2588. https://doi.org/10.5194/nhess-22-2567-2022

Chinguwo, D. D., & Deus, D. (2022). Assessment of community-based flood early warning system in Malawi. *Jamba: Journal of Disaster Risk Studies*, *14*(1), 1–10. https://doi.org/10.4102/jamba.v14i1.1166

Conte, N., & Kostandi, C. (2022). Mapped: Countries With the Highest Flood Risk. https://elements.visualcapitalist.com/mapped-countries-with-the-highest-flood-risk/

Coulibaly, J. Y., Mbow, C., Sileshi, G. W., Beedy, T., Kundhlande, G., & Musau, J. (2015).

Mapping Vulnerability to Climate Change in Malawi: Spatial and Social Differentiation in the Shire River Basin. *American Journal of Climate Change*, *04*(03), 282–294. https://doi.org/10.4236/ajcc.2015.43023

De Lange, W. J., Prinsen, G. F., Hoogewoud, J. C., Veldhuizen, A. A., Verkaik, J., Oude Essink, G. H. P., Van Walsum, P. E. V., Delsman, J. R., Hunink, J. C., Massop, H. T. L., & Kroon, T. (2014). An operational, multi-scale, multi-model system for consensus-based, integrated water management and policy analysis: The Netherlands Hydrological Instrument. *Environmental Modelling and Software*, *59*, 98–108. https://doi.org/10.1016/j.envsoft.2014.05.009

Department of Climate Change and Meteorological Services. (2022). 2023. https://www.metmalawi.gov.mw/

Dewa, O., Makoka, D., & Ayo-Yusuf, O. A. (2023). Measuring community flood resilience and associated factors in rural Malawi. *Journal of Flood Risk Management*, *16*(1), 1–21. https://doi.org/10.1111/jfr3.12874

Diaz, N. D., Lee, Y., Kothuis, B. L. M., Pagán-Trinidad, I., Jonkman, S. N., & Brody, S. D. (2024). Mapping the Flood Vulnerability of Residential Structures: Cases from The Netherlands, Puerto Rico, and the United States. *Geosciences (Switzerland)*, *14*(4). https://doi.org/10.3390/geosciences14040109

Driessen, P. P. J., Hegger, D. L. T., Bakker, M. H. N., van Rijswick, H. F. M. W., & Kundzewicz, Z. W. (2016). Toward more resilient flood risk governance. *Ecology and Society*, *21*(4). https://doi.org/10.5751/ES-08921-210453

Du, H. S., Xu, J., Li, Z., Liu, Y., & Chu, S. K. W. (2021). Bibliometric mapping on sustainable development at the base-of-the-pyramid. *Journal of Cleaner Production*, *281*, 125290. https://doi.org/10.1016/j.jclepro.2020.125290

Duc Tran, D., Van Halsema, G., Hellegers, P. J. G. J., Phi Hoang, L., Quang Tran, T., Kummu, M., & Ludwig, F. (2018). Assessing impacts of dike construction on the flood dynamics of the Mekong Delta. *Hydrology and Earth System Sciences*, *22*(3), 1875–1896. https://doi.org/10.5194/hess-22-1875-2018

Edelenbos, J., Van Buuren, A., Roth, D., & Winnubst, M. (2017). Stakeholder initiatives in flood risk management: exploring the role and impact of bottom-up initiatives in three 'Room for the River' projects in the Netherlands. *Journal of Environmental Planning and Management*, *60*(1), 47–66. https://doi.org/10.1080/09640568.2016.1140025

Endendijk, T., Botzen, W., De Moel, H., Aerst, J., Duijndam, S., Slager, K., Kolen, B., & Kok, M. (2023). Experience From the 2021 Floods in the Netherlands: Household Survey Results on Impacts and Responses Thijs. *Journal of Coastal and Riverine Flood Risk*, *2*, 1–27. https://doi.org/10.59490/jcrfr.2023.0009

Environment and Planning Act. (2021). *The Environment and Planning Act of the Netherlands*. *June*. https://iplo.nl/publish/pages/191405/environment-and-planning-act-of-the-netherlands-june-2021.pdf

Feng, Y., Zhu, Q., & Lai, K. H. (2017). Corporate social responsibility for supply chain management: A literature review and bibliometric analysis. *Journal of Cleaner Production*, *158*, 296–307. https://doi.org/10.1016/j.jclepro.2017.05.018

Ferreira, C. S. S., Potočki, K., Kapović-Solomun, M., & Kalantari, Z. (2022). Nature-Based Solutions for Flood Mitigation and Resilience in Urban Areas. *Handbook of Environmental Chemistry*, *107*(May 2021), 59–78. https://doi.org/10.1007/698_2021_758

Gao, H., Ding, X. H., & Wu, S. (2020). Exploring the domain of open innovation: Bibliometric and content analyses. *Journal of Cleaner Production*, *275*, 122580. https://doi.org/10.1016/j.jclepro.2020.122580

GoM. (2010). *Government of Malawi National Disaster Risk Reduction Framework*. *June 2010*. https://www.dodma.gov.mw/index.php/downloads/category/4-other-downloads?download=9:malawi-national-drr-framework

GoM Disaster Act. (2014). *Laws Africa Legislation Commons Malawi Disaster Preparedness*

and Relief Act. *December 2014*. www.laws.africa

Government of Malawi. (2016). *The National Resilience Plan: Breaking the cycle of food insecurity in Malawi*. Office of the Vice President Department of Disaster Management Affairs. https://massp.ifpri.info/files/2017/10/NATIONAL-RESILIENCE-PLAN-MASTER-2016.pdf

Haasnoot, M., Kwadijk, J., Van Alphen, J., Le Bars, D., Van Den Hurk, B., Diermanse, F., Van Der Spek, A., Oude Essink, G., Delsman, J., & Mens, M. (2020). Adaptation to uncertain sea-level rise; how uncertainty in Antarctic mass-loss impacts the coastal adaptation strategy of the Netherlands. *Environmental Research Letters*, *15*(3), 34007. https://doi.org/10.1088/1748-9326/ab666c

Heer, J. de, Nijwening, S., Vuyst, S. De, Rijswick, M. van, Smit, T., & Groenendijk, J. (2004). *Towards Integrated Water Legislation in The Netherlands: Lessons from Other Countries.* 1–73. https://www.uu.nl/sites/default/files/rebo-ucwosl-2004-appendixtofinalreport.pdf

Hollis, S. (2015). Regional Disaster Risk Management. *The Role of Regional Organizations in Disaster Risk Management*, 13–46. https://doi.org/10.1057/9781137439307_2

Humanitarian Situation Report. (2015). https://reliefweb.int/organization/ocha (2015)

Katsman, C. A., Sterl, A., Beersma, J. J., Van den Brink, H. W., Church, J. A., Hazeleger, W., ... & Weisse, R. (2011). Exploring high-end scenarios for local sea level rise to develop flood protection strategies for a low-lying delta-the Netherlands as an example. *Climatic Change*, *109*(3–4), 617–645. https://doi.org/10.1007/s10584-011-0037-5

Klijn, F., De Bruijn, K. M., Knoop, J., & Kwadijk, J. (2012). Assessment of the Netherlands' flood risk management policy under global change. *Ambio*, *41*(2), 180–192. https://doi.org/10.1007/s13280-011-0193-x

Klijn, F., Kreibich, H., de Moel, H., & Penning-Rowsell, E. (2015). Adaptive flood risk management planning based on a comprehensive flood risk conceptualisation. *Mitigation and Adaptation Strategies for Global Change*, *20*(6), 845–864. https://doi.org/10.1007/s11027-015-9638-z

Lambrechts, H. A., Paparrizos, S., Brongersma, R., Kroeze, C., Ludwig, F., & Stoof, C. R. (2023). Governing wildfire in a global change context: lessons from water management in the Netherlands. *Fire Ecology*, *19*(1). https://doi.org/10.1186/s42408-023-00166-7

Lee, H. J., & Whang, H. (2020). The Netherlands Spatial Development for Port Area in City-Region Focusing on the Case of Kop van Zuid in Rotterdam. *Architectural Research*, *22*(4), 135–143. https://doi.org/10.5659/AIKAR.2020.22.4.135

Lukić, T., Basarin, B., Micić, T., Bjelajac, D., Maris, T., Marković, S. B., Pavić, D., Gavrilov, M. B., & Mesaroš, M. (2018). Rainfall erosivity and extreme precipitation in the Netherlands. *Idojaras*, *122*(4), 409–432. https://doi.org/10.28974/idojaras.2018.4.4

Mailosi, A., Mwalwanda, S., Hassan, C., Zinkanda, S., Matanje, B., Munyaneza, F., Aron, M. B., Dally, E., Mulwafu, M., & Kachimanga, C. (2022). Experiences from Cyclone Anna and Cyclone Dumako: A short report. *African Journal of Primary Health Care and Family Medicine*, *14*(1), 1–4. https://doi.org/10.4102/PHCFM.V14I1.3761

Mann, D. E. (2022). Research at The University of Arizona. *The Politics of Water in Arizona*, *0583*, 213–228. https://doi.org/10.2307/j.ctv2nrzgkb.19

Mengist, W., Soromessa, T., & Legese, G. (2020). Method for conducting systematic literature review and meta-analysis for environmental science research. *MethodsX*, *7*, 100777. https://doi.org/10.1016/j.mex.2019.100777

Ministry of Infrastructure and the Environment & Ministry of Economic Affairs. (2015). National Water Plan 2016-2021. *Government of the Netherlands*. https://www.government.nl/documents/policy-notes/2015/12/14/national-water-plan-2016-2021

Molenveld, A., & van Buuren, A. (2019). Flood risk and resilience in the Netherlands: In search of an adaptive governance approach. *Water (Switzerland)*, *11*(12), 1–20. https://doi.org/10.3390/w11122563

Musa, F. B., Katundu, M. C., Lewis, L. A., & Munthali, A. (2024). Gender and livelihood assets: Assessing climate change resilience in Phalombe district – Malawi. *Environmental and Sustainability Indicators*, *22*(January), 100347. https://doi.org/10.1016/j.indic.2024.100347

Mwase, W., Mtethiwa, A. T., & Makonombera, M. (2014). Climate change adaptation practices for two communities in Southern Malawi. *Journal of Environment and Earth Science*, *4*(2), 87–93. iiste.org/Journals/index.php/JEES/article/view/10592

National Council for Law Reporting Library. (2023). *The National Disaster Risk Management Bill, 2023. Kenya Gazette Supplement No. 80 (National Assembly Bills No. 24)*. https://kenyalaw.org/kl/fileadmin/pdfdownloads/bills/2023/TheNationalDisasterRiskManagementBill_2023.pdf

Okoli, C., & Schabram, K. (2012). A Guide to Conducting a Systematic Literature Review of Information Systems Research. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.1954824

Osti, R. P. (2019). *Institutional and Governance Dimensions of Flood Risk Management: A Flood Footprint and Accountability Mechanism.* Asian Development Bank.

Oukes, C., Leendertse, W., & Arts, J. (2022). Enhancing the Use of Flood Resilient Spatial Planning in Dutch Water Management. A Study of Barriers and Opportunities in Practice. *Planning Theory and Practice*, *23*(2), 212–232. https://doi.org/10.1080/14649357.2022.2034921

Pangapanga-Phiri, I., Mungatana, E. D., Pangapanga, L., & Nkoka, F. S. (2022). Understanding the impact of sustainable land-scape management practices on farm productivity under intensifying tropical cyclones: Evidence from Southern Malawi. *Tropical Cyclone Research and Review*, *11*(4), 265–276. https://doi.org/10.1016/j.tcrr.2023.02.002

Rentschler, J., Salhab, M., & Jafino, B. A. (2022). Flood exposure and poverty in 188 countries. *Nature Communications*, *13*(1), 1–11. https://doi.org/10.1038/s41467-022-30727-4

Šakić Trogrlić, R., Duncan, M., Wright, G., van den Homberg, M., Adeloye, A., & Mwale, F. (2022). Why does community-based disaster risk reduction fail to learn from local knowledge? Experiences from Malawi. *International Journal of Disaster Risk Reduction*, *83*(July), 1–14. https://doi.org/10.1016/j.ijdrr.2022.103405

Šakić Trogrlić, R., Wright, G. B., Adeloye, A. J., Duncan, M. J., & Mwale, F. (2018). Taking stock of community-based flood risk management in Malawi: different stakeholders, different perspectives. *Environmental Hazards*, *17*(2), 107–127. https://doi.org/10.1080/17477891.2017.1381582

Sandelowski, M. (2010). What's in a name? Qualitative description revisited. *Research in Nursing and Health*, *33*(1), 77–84. https://doi.org/10.1002/nur.20362

The Government of Malawi. (2018). *National Resilience Strategy*. http://hdr.undp.org/sites/default/files/2016_human_development_report.pdf2http://ghi.ifpri.org/3http://www1.wfp.org/countries/malawi7http://www1.wfp.org/countries/malawi

Trogrlić, R. Š., Wright, G. B., Duncan, M. J., van den Homberg, M. J. C., Adeloye, A. J., Mwale, F. D., & Mwafulirwa, J. (2019). Characterising local knowledge across the flood risk management cycle: A case study of Southern Malawi. *Sustainability (Switzerland)*, *11*(6). https://doi.org/10.3390/su11061681

Van Alphen, J. (2016). The Delta Programme and updated flood risk management policies in the Netherlands. *Journal of Flood Risk Management*, *9*(4), 310–319. https://doi.org/10.1111/jfr3.12183

van Doorn-Hoekveld, W. J., Gilissen, H. K., Groothuijse, F. A. G., & van Rijswick, H. F. M. W. (2022). Adaptation to Climate Change in Dutch Flood Risk Management: Innovative Approaches and Related Challenges. *Utrecht Law Review*, *18*(2), 51–69. https://doi.org/10.36633/ulr.860

Venäläinen, A., Pilli-Sihvola, K., Tuomenvirta, H., Ruuhela, R., Kululanga, E., Mtilatila, L.,

Kanyanga, J., & Nkomoki, J. (2016). Analysis of the meteorological capacity for early warnings in Malawi and Zambia. *Climate and Development*, *8*(2), 190–196. https://doi.org/10.1080/17565529.2015.1034229

Vincent, K., Dougill, A. J., Mkwambisi, D. D., Cull, T., Stringer, L. C., & Chanika, D. (2014). *Analysis of the existing weather and climate information for Malawi.* University of Leads.

Wang, L., Gu, X., & Beck, H. E. (2021). Cyclones and global floods from an observation-simulation evaluation: Contributions and long-term changes. *Water (Switzerland)*, *13*(21), 1–20. https://doi.org/10.3390/w13212965

Wiering, M., & Winnubst, M. (2017). The conception of public interest in Dutch flood risk management: Untouchable or transforming? *Environmental Science and Policy*, *73*, 12–19. https://doi.org/10.1016/j.envsci.2017.03.002

Wouw, R. van de. (n.d.). *How spatial planning measures and tools are used to reduce the risks of a flood*. https://edepot.wur.nl/401369

Wuijts, S., Van Rijswick, H. F., Driessen, P. P., & Runhaar, H. A. (2023). Moving forward to achieve the ambitions of the European Water Framework Directive: Lessons learned from the Netherlands. *Journal of Environmental Management*, *333*(January), 117424. https://doi.org/10.1016/j.jenvman.2023.117424

Zeilsta, P. S. (2009). The Water Act in brief The Water Act. *Public Works and Water Ministry of Transport*, *March 2009*, 70.

Zuzani, P. N., Ngongondo, C. S., Mwale, F. D., & Willems, P. (2019). Examining trends of hydro-meteorological extremes in the Shire River Basin in Malawi. *Physics and Chemistry of the Earth*, *112*(August 2018), 91–102. https://doi.org/10.1016/j.pce.2019.02.007

Biographies of Authors

Precious Douglas Maulana, a graduate student at the University of Indonesia, in the School of Environmental Sciences. He obtained a bachelor's degree in Meteorology and Climate Science and the Malawi University of Science and Technology in Malawi.

- Email: premaulana@gmail.com
- ORCID: N/A
- Web of Science ResearcherID: N/A
- Scopus Author ID: N/A
- Homepage: N/A

Raldi Hendrotoro Seputro Koestoer, a professor in the field of heat transfer at the Department of Mechanical Engineering, Faculty of Engineering, University of Indonesia. He is known for initiating the movement for free premature baby incubators in Indonesia. He has a rich background in environmental science and planning, with degrees from the University of Indonesia and universities in Australia. He is also a researcher and lecturer at the School of Environmental Science. He has a Ph.D. in Environmental Science-Planning and has been involved in various research and teaching roles internationally.

- Email: ralkoest@gmail.com
- ORCID: 0000-0003-1701-0419
- Web of Science ResearcherID: N/A
- Scopus Author ID: 57418579200
- Homepage: N/A

Mahawan Karuniasa, affiliated with Universitas Indonesia, is a researcher and a lecturer at the School of Environmental Sciences and focuses his research on climate change, systems thinking, and environmental science. He addresses global climate impacts and strategies, employs a holistic approach to problem-solving by viewing issues as parts of interconnected systems, and explores the interplay between human activities and natural systems.

- Email: mahawancac@yahoo.com
- ORCID: 0000-0001-6444-6560
- Web of Science ResearcherID: N/A
- Scopus Author ID: 57205022900
- Homepage: N/A