



PAR

Participatory Action Research

2024

Reducing the impacts of floods and controlling erosion in Duhok

Prepared by:

1-Hiba Jaafar Abdullah
3-Marah Alaa Sabeeh

2-Lezan Jaafar Ahmed
4-Sidra Mardan Abdi

Supervised by:

Dr. Bahzad Muhammed Khaled

Abstract

This study assesses flood hazard zones in Duhok, focusing on areas vulnerable to flooding along the Hishkaro River. A multi-method approach was used, combining field visits(household), surveys, and secondary data collection.

Field visit (household) documented the impacts of recent floods on homes, with residents reporting extensive damage and displacement due to ineffective flood control measures. Surveys gathered insights from affected households, municipal officials, and university experts, shedding light on local flood risks and the role of climate change in exacerbating flooding events. GIS mapping revealed that a significant portion of the study area is at high flood risk, particularly near the river and in regions with impervious surfaces. Rainfall data highlighted increasing flash flood risks due to concentrated rainfall events. The study also examined the effectiveness of flood mitigation efforts, including government compensation and vegetation-based solutions, recommending a balanced approach combining natural and engineered flood management strategies. The findings underscore the urgent need for improved flood prevention and long-term resilience planning in flood-prone areas of Duhok.

Table of contents

SECTION ONE -INTRODUCTION.....	3
1.1 overview	4
1.2 Causes of Flooding	4
SECTION TWO-AIM.....	4
Objective and aim of this study:	5
SECTION THREE-METHODOLOGY	6
3.1 Introduction	5
3.2 Field Visits.....	6
3.2.1 Households Affected by Floods	6
3.2.2 Observations of the (Hishkaro) River	6
3.3 Survey Process	7
3.3.1 Surveys in Households	7
3.3.2 Survey in Municipality and Environment Department.....	8
3.3.3 Survey in GAVtv Studio.....	8
3.3.4 University Surveys	9
3.4 Data Collection	10
3.4.1 Compilation of Data and team collaboration	10
3.4.2 Field Observations	10
3.4.3 Rainfall Data.....	10
3.4.4 GIS Mapping and Flood Susceptibility	11
3.4.5 Flood Events and Vulnerable Areas.....	11
3.4.6 Municipality and Compensation Efforts.....	12
3.4.7 Vegetation in Flood Management	12

Table of figures

Fig. 1 Damaged interior of a house due to floodwaters.....	8
Fig. 2 Ineffective barriers used by residents to block floodwaters.....	8
Fig.3 Abandoned houses near the river, left due to flood damage and safety concerns.....	9
Fig. 4 Exterior damage to a house from the flood, left unrepaired and unaddressed.....	9
Fig. 5: The polluted (Hishkaro) river near flood-affected houses.....	10
Fig. 6: Team members conducting interviews with residents in flood-affected households to gather firsthand information about their experiences.....	11
Fig. 7 Discussion of flood data with officials and employees of the presidency of Duhok municipality, Environment and Climate Change Department.....	12
Fig. 8 Interviewing GAVtv Studio reporters who covered last year's floods live.....	13
Fig. 9 Collecting survey data from professors and students in the Soil and Water, Eco-Tourism, and Biology Departments at the University of Duhok.....	14
Fig. 10 Team members working together on data collection.....	15
Fig. 11 Consequence of the flood in Duhok city.....	17
Fig. 12 Map provided by the Presidency of Duhok Municipality, identifying areas affected by last year's flood, with corresponding compensation given to the affected households.....	18

SECTION ONE -INTRODUCTION

1.1 overview

Flood and erosion are an overflow of water onto land that is usually dry. It can occur due to various reasons, such as heavy rainfall, snowmelt, dam failure, or coastal storms, causing rivers, lakes, or oceans to exceed their normal levels.

Flood and erosion are the most common types of natural disasters, leading to changes in the land's shape and causing extensive damage to infrastructure.

Duhok, a province in the Kurdistan Region of Iraq, is exposed to environmental challenges such as heavy rainfall, which significantly impacts both the environment and the social fabric of the community. In recent years, flooding and soil erosion have become increasingly evident, as reported by local residents. These issues have raised serious concerns among the population, as people fear for their lives, their homes, and the loss of agricultural lands and vegetation.

This growing apprehension highlights the urgent need to adopt precautionary measures to address these challenges. To mitigate the risks, it is essential to implement strategic and dynamic approaches that balance community concerns with the objectives of flood management. Such strategies should aim to control flooding and protect the environment while fostering collaboration with local communities to ensure effective implementation and long-term success.

1.2 Causes of Flooding

Floods are often caused by extreme rainfall, snowmelt, and human activities such as reservoir storage and operations. Abrupt cloudbursts in semi-arid areas can result in flash floods. Factors influencing flooding include:

- Natural causes: Climate, rainfall intensity, snowmelt, and topographic features (e.g., slope, altitude, lithology).
- Human-induced causes: Urban expansion, land-use changes, and mismanagement of floodplains.

Recent catastrophic floods have been exacerbated by climate change, with studies showing increased global flood risks.

SECTION TWO-AIM

Objective and aim of this study:

1. **Assess Flood Risks:** To identify and analyze flood hazard zones in Duhok, focusing on areas most vulnerable to flooding, especially along the Hishkaro River.
2. **Document Community Impact:** To document the impact of flooding on local households, including property damage, displacement, and the effectiveness of flood protection measures.
3. **Gather Data for Decision-Making:** To collect and analyze data from field visits, surveys, rainfall statistics, and GIS mapping to inform flood management and mitigation strategies.
4. **-Evaluate Flood Mitigation Efforts:** To assess current flood control measures, including government compensation efforts and the role of vegetation in managing flood risks.
5. **-Recommend Sustainable Solutions:** To suggest effective, sustainable flood risk management strategies that combine natural and engineered solutions, promoting long-term resilience for vulnerable communities.

3.1 Introduction

The methodology employed in this study aims to assess flood hazard zones in Duhok by integrating multiple data collection methods. Field visits were conducted to document the (Hishkaro) river conditions and nearby homes, providing firsthand observations of flood impacts. Surveys were distributed to gather both qualitative and quantitative data from residents, officials, and university experts, contributing to a broader understanding of local flood risks. Secondary data, including rainfall statistics and a map from the Municipality and Environment Department, were utilized to support the analysis. This comprehensive approach, combined with the FHIS index, highlights key factors like distance from rivers and elevation in determining flood risk. By validating the modified FHIS index with past flood data, the methodology provides a robust foundation for effective flood mitigation strategies.

Literature review

M Amen et al., (2023) shown that the generated map indicates that 44.72 km² of the total land area of the study area in Duhok city has a very high susceptibility to flooding, and that these areas require significant attention from government authorities in order to reduce flood vulnerability.

3.2 Field Visits

3.2.1 Households Affected by Floods

We visited homes near the (Hishkaro) river that were severely affected by last year's floods. Families shared their experiences, describing how floodwaters entered their homes and caused extensive damage, Figure 1 shows the damaged interior of the houses from last year's flood. Despite efforts to use barriers to block the water, these measures were largely ineffective, Figure 2 illustrates the ineffective barriers used by residents to block the floodwaters. Some residents reported abandoning their homes due to repeated flooding and fear of future disasters, Figure 3 depicts the abandoned houses near the river that were left vacant due to safety concerns.

The extensive damage to the houses remained unaddressed, with the exterior still in poor condition, and repairs had not been made. The government had assessed the damage but had not yet cleaned or repaired the structures, leaving them in a state of disrepair. Figure 4 shows the exterior damage to a house from the flood, left unrepaired and unaddressed. Their accounts highlighted the urgency of finding effective flood prevention solutions to avoid further destruction and displacement.

3.2.2 Observations of the (Hishkaro) River

During the visits, we observed the river near the affected homes. The river was heavily polluted, filled with waste and debris that contributed to environmental and health hazards. Floodwaters carried this waste into homes, exacerbating unsanitary conditions. The smell from the river was overwhelming, reflecting its polluted state. Figure 5 shows the polluted river near the affected houses. This observation underscored the need for both flood control and environmental cleanup.

3.3 Survey Process

The survey employed a random sampling technique to ensure unbiased representation of the affected population. Participants were selected randomly from households near the (Hishkaro) river, and the surveys were conducted through face to-face interviews. These interviews took place both individually and in small groups, allowing us to gather diverse perspectives and ensure clarity in responses.

3.3.1 Surveys in Households

We surveyed 15 families near the (Hishkaro) river to learn about the flood's impact on their homes and lives. The questions focused on the damage caused by floods, the protective measures taken, residents' current concerns, and their knowledge about flooding and erosion. Additional questions were also included to gather more insights.



Fig. 6: Team members conducting interviews with residents in flood-affected households to gather firsthand information about their experiences.

3.3.2 Survey in Municipality and Environment Department

Our team visited the Presidency of Duhok Municipality, the Environment, and Climate Change Department to collect official data and insights about the floods. Officials and employees provided valuable information, including rainfall statistics and maps of flood-affected areas from previous years. Their expertise helped us understand the increasing flood risks and the role of climate change in exacerbating these events.



Fig. 7 Discussion of flood data with officials and employees of the presidency of Duhok municipality, Environment and Climate Change Department.

3.3.3 Survey in GAVtv Studio

We visited GAVtv Studio, where we interviewed reporters who had covered last year's floods live from the affected areas. These interviews provided firsthand accounts of the flood's immediate impact, the community's response, and the

challenges faced during and after the disaster. Their insights were crucial for understanding the flood's real-time effects and the media's role in documenting the event.



Fig. 8 Interviewing GAVtv Studio reporters who covered last year's floods live.

3.3.4 University Surveys

Our team conducted surveys across multiple universities to gather diverse academic perspectives on the causes of floods and potential mitigation strategies.

Each team member surveyed professors and students from different departments, including the Soil and Water Department, Eco-Tourism Department, and Biology Department of the University of Duhok (UOD). This approach ensured a broad range of insights, combining expertise in environmental sciences, tourism, and biological impacts to understand the multifaceted effects of flooding.

3.4 Data Collection

3.4.1 Compilation of Data and team collaboration

Data for this study was gathered through field observations, surveys, and secondary sources to assess the flood risk in Duhok. After gathering information, our team worked collaboratively to compile and organize the data. Survey responses were carefully entered into Excel spreadsheets to ensure accuracy and accessibility for future analysis. The entire team contributed to this process, reviewing findings together and discussing key observations to maintain consistency.

3.4.2 Field Observations

Field visits revealed that urban areas near the Hishkaro River are highly vulnerable to flooding due to inadequate drainage systems, impervious surfaces, and the proximity of homes to the river. The risk is compounded by the residents' reluctance to relocate, even with compensation offers, as their houses are only 15 meters away from the river. This limitation hinders effective flood mitigation strategies.

3.4.3 Rainfall Data

Rainfall data, sourced from the Ministry of Agriculture and Water Resources of the Kurdistan Regional Government, was collected from five meteorological stations (Semel, Malta Nasara, Duhok, Qarqarava, and Zawita). In the last few years, rainfall amounts have been significant:

- 2021: 3.7 ml of rain fell in 14 hours
- 2022: 10.2 ml of rain fell in 8 hours
- 2023: 150 ml of rain fell in 24 hours

These extreme rainfall events illustrate the shift in rainfall distribution, where more rainfall is now concentrated in shorter timeframes, increasing the risk of flash flooding in Duhok.

3.4.4 GIS Mapping and Flood Susceptibility

GIS mapping using the Inverse Distance Weighted (IDW) method to analyze rainfall distribution revealed that the average annual rainfall in the study area is 588 mm. The maps produced identified areas with varying flood susceptibilities, with 63.4% of the study area classified as having a high or very high flood risk. This was largely due to elevation, proximity to rivers, and inadequate infrastructure. These areas are most at risk during extreme rainfall events.

3.4.5 Flood Events and Vulnerable Areas

The flood susceptibility maps highlighted that high-risk areas are not limited to a specific location, but are distributed throughout the study area. Flash floods are especially likely in regions with dry, impervious terrains that prevent water absorption, increasing the flood risk. Past floods, such as the significant rainfall in March 2020, resulted in considerable damage in Duhok, with over 400 houses, 61 vehicles, and numerous shops damaged. In 2023, 800 houses were affected by flooding, including 150 homes near the Hishkaro River. These events underscore the urgent need for effective flood prevention strategies.



3.4.6 Municipality and Compensation Efforts

The Municipality has been providing compensation to households affected by flooding near the Hishkaro River. A map detailing the compensated areas in 2023 is available.

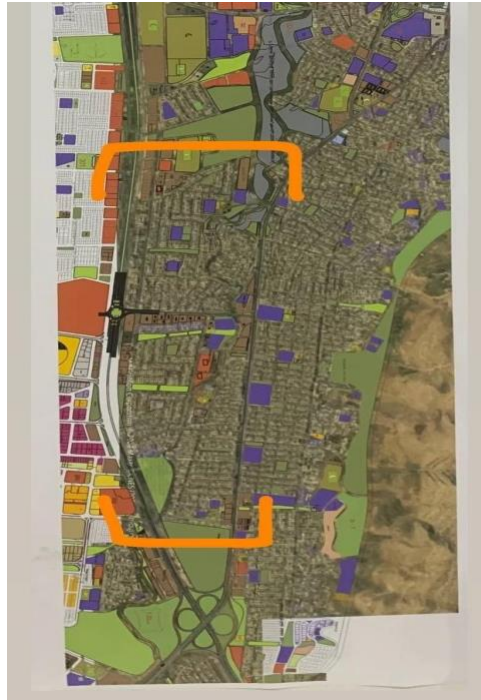


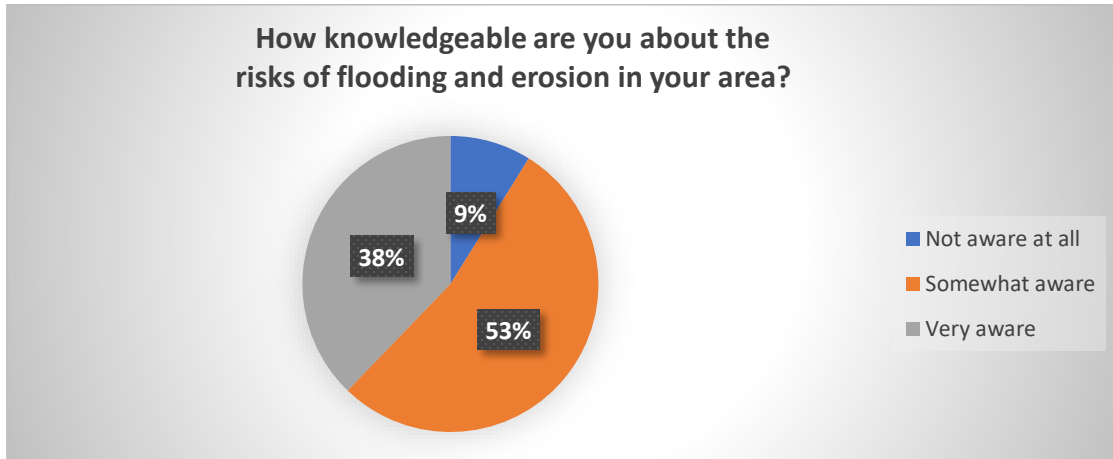
Fig. 12 A map provided by the Duhok Municipality, identifying the areas affected by last year's floods that were compensated.

3.4.7 Vegetation in Flood Management

Effective flood management requires a balanced approach that includes vegetation as a primary tool. Around 70% of flood management strategies should focus on vegetation planning along water bodies. This includes planting trees, shrubs, and grasses to stabilize the soil, reduce erosion, and enhance water absorption. The remaining 30% should incorporate engineered solutions such as constructing flood barriers, water harvesting systems, and retention ponds. These strategies, when combined, help manage flood risks while promoting sustainable solutions.

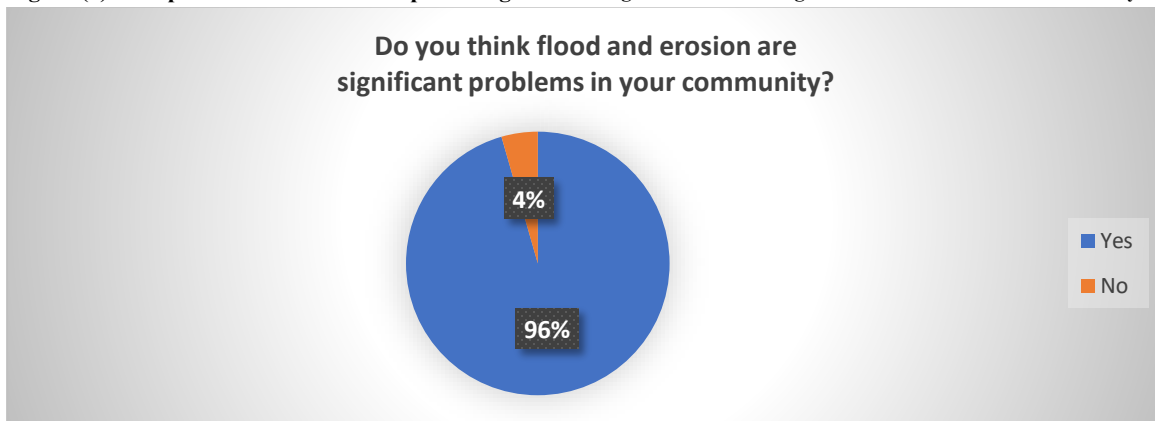
Result and Discussion

Figure (1): The pie chart illustrates the percentage of Awareness level of flooding and Erosion in the area.



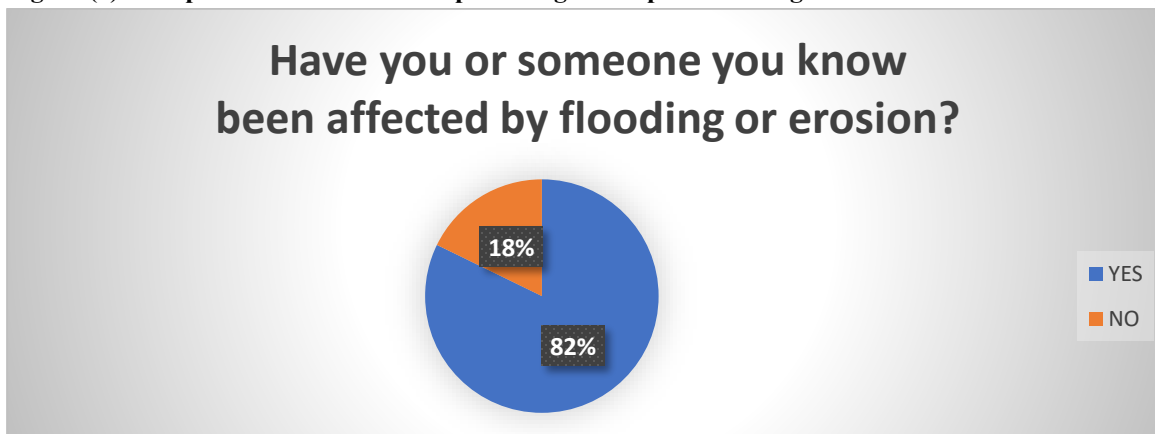
53% of respondents are somewhat aware of the risks of flooding and erosion, while 38% are very well aware. Only 9% reported being not aware at all. This suggests a relatively high level of awareness in the community.

Figure (2): The pie chart illustrates the percentage of Flooding and Erosion as Significant Problems in the Community.



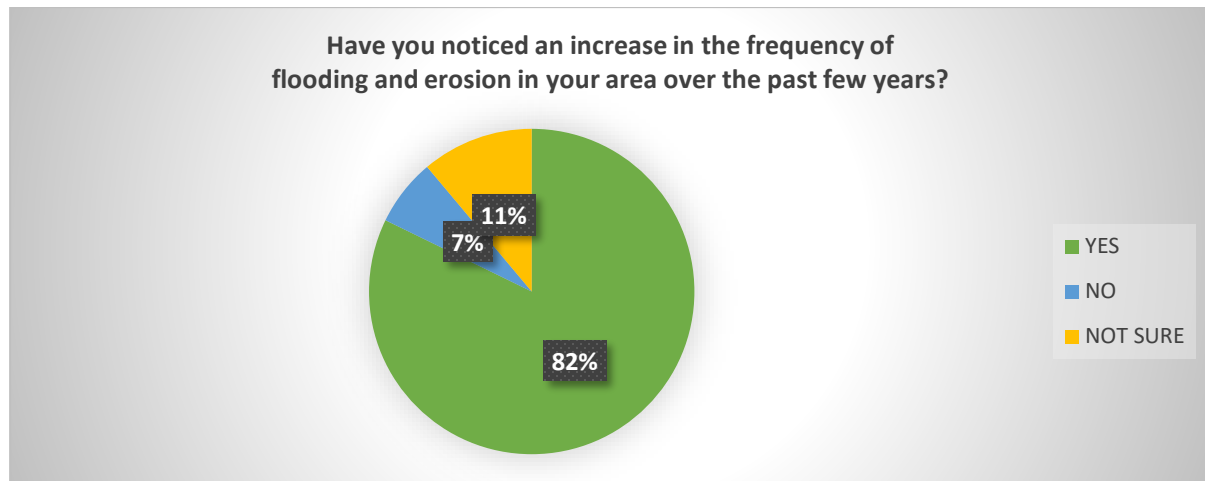
96% of respondents believe flooding and erosion are significant problems in their community, while only 4% disagree. This indicates that nearly all residents recognize these issues as critical concerns that may require attention and action.

Figure (3): The pie chart illustrates the percentage of Impact Flooding and Erosion on the Community.



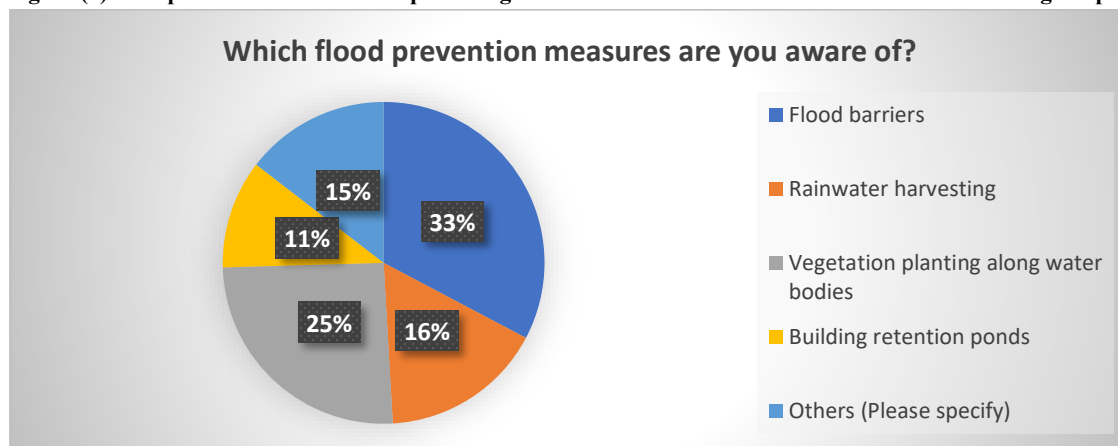
82% of respondents, or someone they know, have been affected by flooding or erosion, while 18% have not. This suggests that flooding and erosion have a widespread impact on the community.

Figure (4): The pie chart illustrates the percentage of Perceived Increase in Flooding and Erosion Frequency Over the Past Few Years.



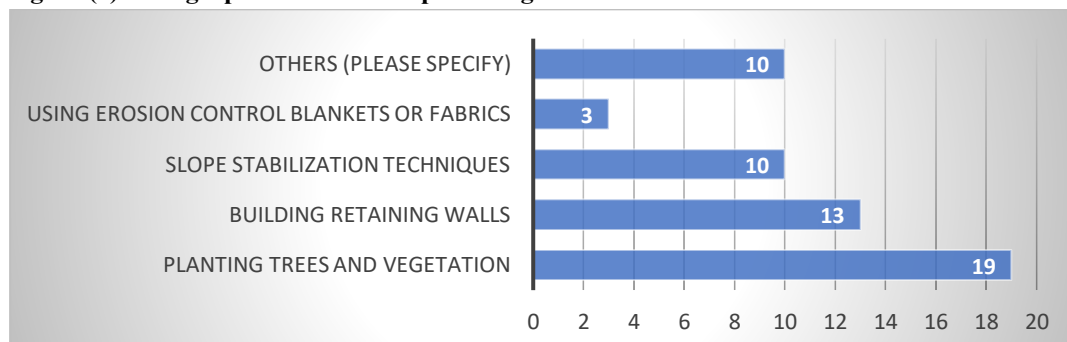
82% of respondents have noticed an increase in the frequency of flooding and erosion, while 7% have not, and 11% are unsure. This indicates that a significant majority of the community perceives a rising trend in these issues.

Figure (5): The pie chart illustrates the percentage of Awareness of Flood Prevention Measures Among Respondents.



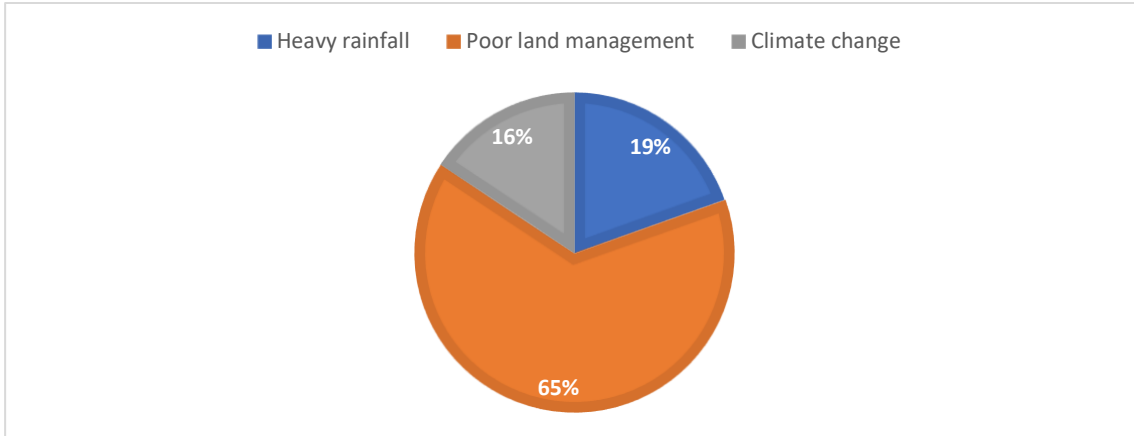
The most commonly known flood prevention measure is flood barriers (33%), followed by vegetation planting along water bodies (25%). Rainwater harvesting (16%), other measures (15%), and building retention ponds (11%) are less recognized. This suggests that while awareness of some measures is high, additional education could focus on promoting lesser-known strategies.

Figure (6): The graphs illustrate the percentage of the Perceived Effectiveness of Erosion Control Methods.



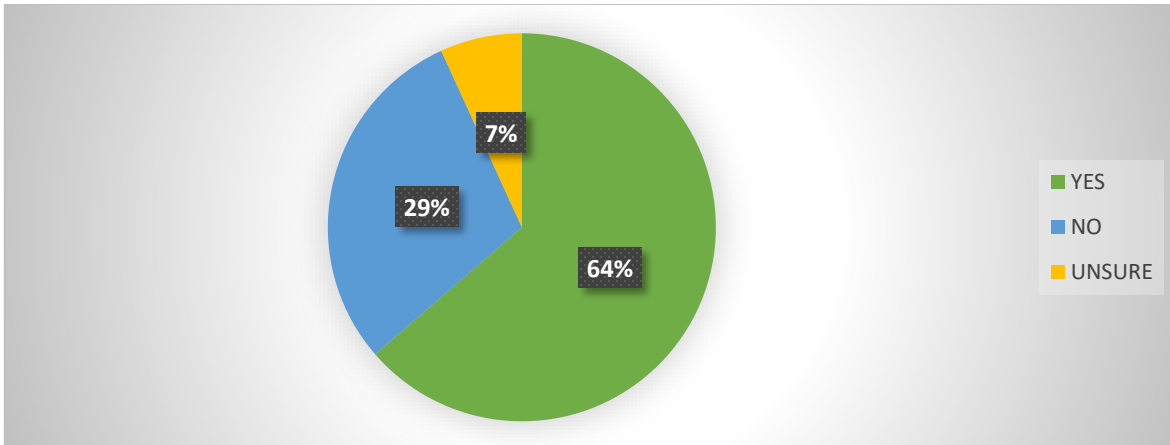
Planting trees and vegetation is considered the most effective erosion control method by respondents (19%), followed by building retaining walls (13%) and slope stabilization techniques (10%). Using erosion control blankets or fabrics (3%) and other methods (10%) are seen as less effective. This suggests that natural and structural solutions are preferred for erosion management.

Figure (7): The pie chart illustrate the percentage of Perceived Main Causes of Flooding in the Area.



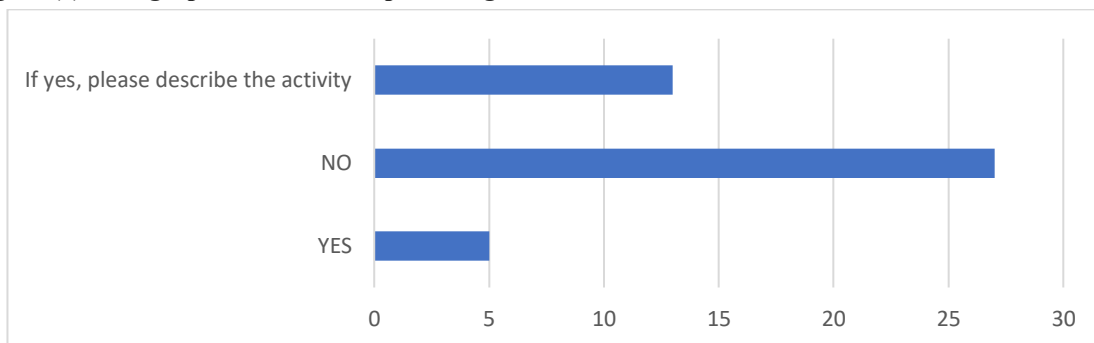
The majority of respondents (65%) believe that poor land management is the main cause of flooding in their area, followed by heavy rainfall (19%) and climate change (16%). This highlights the need to address land management practices to mitigate flooding risks.

Figure (8): The pie chart illustrates the percentage of Community Perception of Infrastructure Adequacy for Managing Flood Risk.



64% of respondents believe their community has adequate infrastructure to manage flood risks, while 29% disagree, and 7% are unsure. This suggests a general confidence in flood management infrastructure, but a significant portion of the population remains concerned or uncertain.

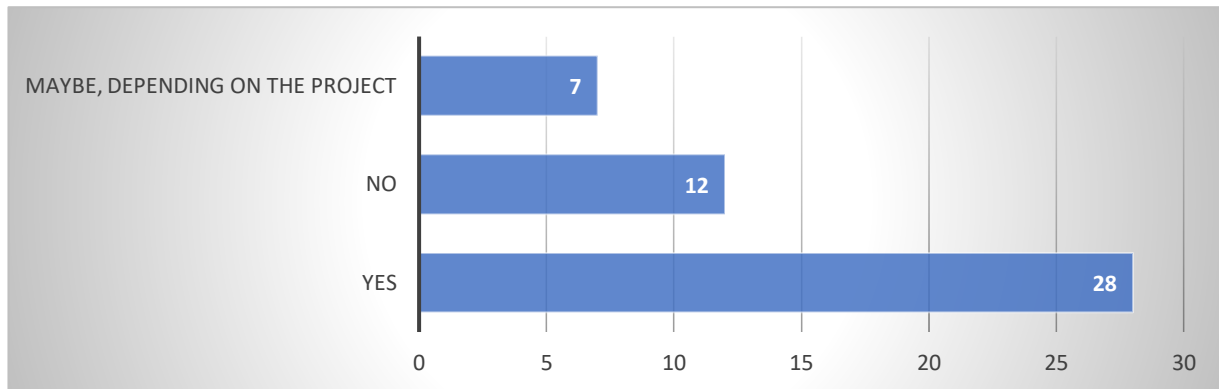
Figure (9): The graph illustrates the percentage of Perceived Effectiveness of Erosion Control Methods.



Planting trees and vegetation is considered the most effective erosion control method by respondents (19%), followed by building retaining walls (13%) and slope stabilization techniques (10%). Using erosion control blankets or fabrics (3%) and other methods (10%) are seen as less effective.

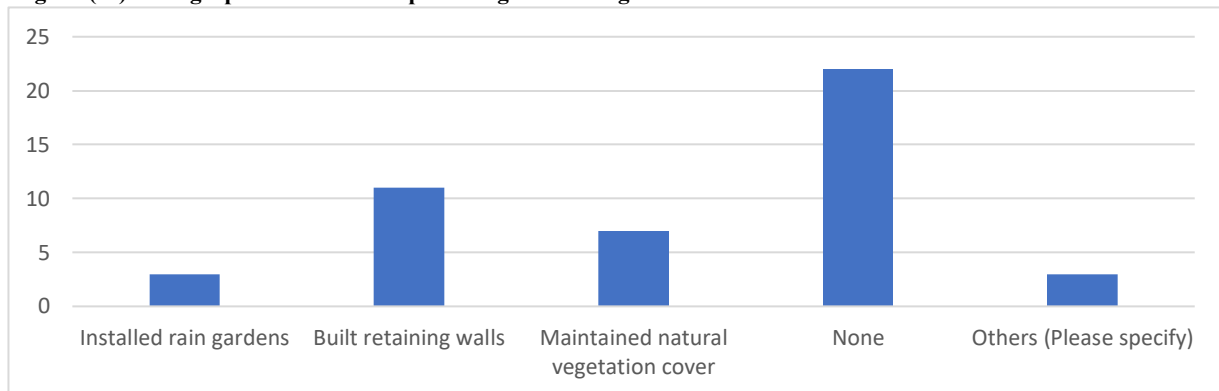
This suggests that natural and structural solutions are preferred for erosion management.

Figure (10): The graphs illustrate the percentage of Participation in Flood or Erosion Prevention Programs.



28% of respondents have participated in flood or erosion prevention programs, while 12% have not. Additionally, 7% indicated they might participate depending on the nature of the project. This suggests there is interest and willingness within the community to engage in such initiatives, with potential for increased participation if suitable projects are offered.

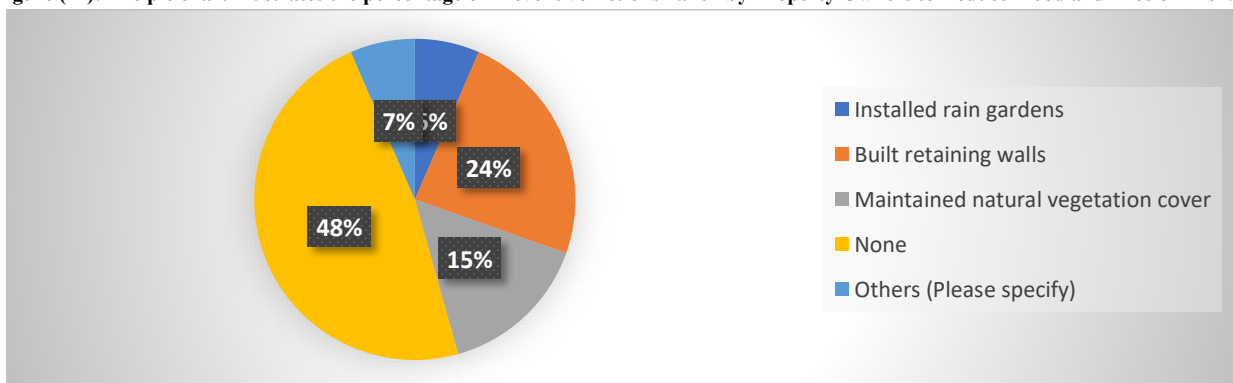
Figure (11): The graphs illustrate the percentage of Willingness to Contribute to Flood and Erosion Prevention Efforts.



When asked about contributing to flood and erosion prevention efforts, 23% indicated no willingness to contribute, while 11% reported having built retaining walls and 7% maintained natural vegetation. Installing rain gardens (3%) and other methods (3%) were less common.

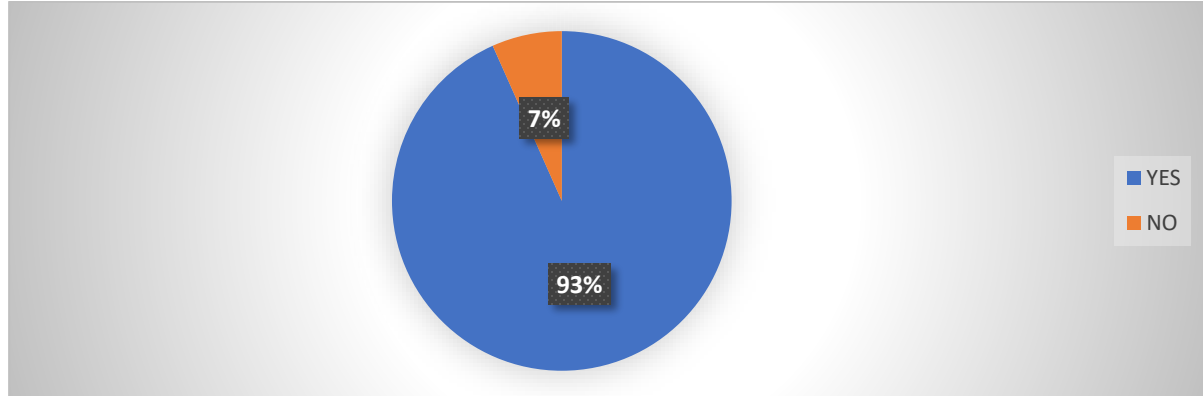
These results suggest varying levels of engagement in prevention efforts, highlighting potential areas to encourage greater participation through financial or volunteer contributions

Figure (12): The pie chart illustrates the percentage of Preventive Actions Taken by Property Owners to Reduce Flood and Erosion Risk.



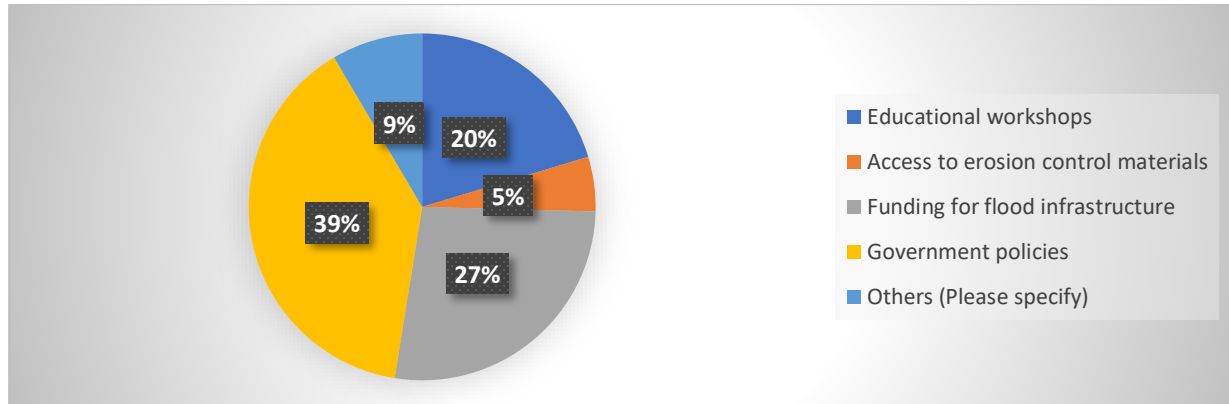
The most common preventive action taken by property owners is building retaining walls (24%), followed by maintaining natural vegetation cover (15%) and installing rain gardens (6%). However, 48% of respondents have taken no preventive action, and 7% have adopted other measures. This highlights the need for increased awareness and support to encourage proactive flood and erosion risk management.

Figure (13): The pie chart illustrates the percentage of Willingness to Participate in a Workshop on Flood and Erosion Management.



An overwhelming majority (93%) of respondents expressed willingness to participate in a workshop on flood and erosion management, while only 7% indicated they would not. This reflects a strong community interest in gaining knowledge and skills to address these issues.

Figure (15): The pie chart illustrates the percentage of Preferred Resources to Support Community Efforts in Flood and Erosion Control.



The most favored resource is government policies (39%), followed by funding for flood infrastructure (27%) and educational workshops (20%). Access to erosion control materials (5%) and other resources (9%) are considered less critical. This indicates that community members prioritize structural and policy-driven solutions to address flood and erosion risks effectively.

Conclusion

The survey highlights significant community awareness and concern about flooding and erosion risks, with 82% noticing an increase in frequency and 65% identifying poor land management as the main cause. While 64% feel the infrastructure is adequate, 29% believe more is needed. Preventive actions like building retaining walls (24%) and maintaining vegetation (15%) are common, but 48% have taken no action.

There is strong interest in workshops (93%) and support for government investment (72%) in flood control measures. Planting trees (19%) and retaining walls (13%) are seen as the most effective methods. These results underscore the need for targeted policies, infrastructure improvements, and community engagement to mitigate risks.

REFERENCESE

M Amen, A. R., Mustafa, A., Kareem, D. A., Hameed, H. M., Mirza, A. A., Szydlowski, M., & M. Saleem, B. K. (2023). Mapping of flood-prone areas utilizing GIS techniques and remote sensing: a case study of Duhok, Kurdistan Region of Iraq. *Remote Sensing*, 15(4), 1102.