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Presented by

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**Evaluating the impact of armed conflict on the water
education-gender nexus in Adar village, West Darfur,
Sudan**

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EVALUATING THE IMPACT OF ARMED CONFLICT ON THE WATER-
EDUCATION-GENDER NEXUS IN ADAR VILLAGE, WEST DARFUR, SUDAN

BY

MOHAMMED ABAKAR HASAN

MARCH 2025
TLEMEN, ALGERIA

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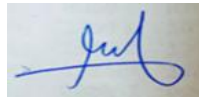
A MASTER THESIS SUBMITTED TO THE WATER PROGRAM FOR THE
PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF SCIENCE IN WATER POLICY

MARCH 2025
TLEMEN, ALGER

DECLARATION

I, Mohammed Abakar, Hasan declare that this M.Sc. Thesis titled “Evaluating the impact of armed conflict on the water-education-gender nexus in Adar village, West Darfur, Sudan” is my original work and has not been presented to acquire a degree in any other University. Where other sources of information have been used for this Thesis, they have been duly acknowledged and properly cited. To the best of my knowledge and belief, I declare that I have not committed or induced an act of plagiarism in the writing of this thesis.

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Date _____ 25 MARCH 2025 _____

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This is to certify that the thesis entitled “**Evaluating the impact of armed conflict on the water-education-gender nexus in Adar village, west Darfur, Sudan**” submitted in partial fulfillment of the requirements for the degree of **Master of Science in Water Policy**, the Graduate Program of the Pan Africa **Institute for Water and Energy Sciences (incl. Climate Change)**, and has been carried out by **Mohammed Abakar Hasan**. Id. No **PAUWES/2023/MWP05**, under my supervision. Therefore, I recommend that the student has fulfilled the requirements and hence hereby can submit the thesis to the Water Program for defense.



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We, the undersigned, members of the board of Examiners of the final open defense by Mohammed Abakar Hasan have read, evaluated, and reviewed his thesis work entitled “Evaluating the impact of armed conflict on the water-education-gender nexus in Adar village, west Darfur, Sudan” and examined the candidate’s oral presentation. This is, therefore, to certify that the thesis has been accepted in partial fulfillment of the requirements for the Master of Science Degree with specialization in Water Policy.

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TABLE OF CONTENTS

DECLARATION.....	i
ADVISOR APPROVAL SHEET	ii
EXAMINERS' APPROVAL SHEET.....	iii
ACKNOWLEDGMENTS	iv
TABLE OF CONTENTS	v
LIST OF TABLES	vii
LIST OF FIGURES	viii
ACRONYMS.....	ix
ABSTRACT.....	x
CHAPTER ONE: INTRODUCTION.....	1
1.1. Background of the study	1
1.2. Statement of the problem	3
1.3. Research questions.....	4
1.4. Objectives of the study.....	4
1.4.1. General objective	4
1.4.2. Specific objectives	5
CHAPTER TWO: LITERATURE REVIEW.....	6
2.1. Water-education-gender nexus related sustainable development goals	6
2.2. The water crisis at different perspectives.....	12
2.2.1. Water crisis in Darfur itis impacts on education and gender.....	13
2.2.2. Water policies and governance.....	16
2.3. Education	17
2.3.1. Education challenges in Darfur.....	17
2.4. Gender.....	19
2.4.1. Empowerment and equality	19
2.4.2. Gender and access to education	21
2.4.3. Cultural norms and gender roles in water collection and education	22
2.5. Armed conflict and its impact on education and water	23
2.6. Challenges to achieving Water Education Gender goals.....	26
CHAPTER THREE: RESEARCH METHODOLOGY.....	28

3.1. Description of the study area	28
3.2. Research design	29
3.3. Sampling technique.....	30
3.4. Data collection methods.....	31
3.5. Data analysis	32
3.6. Ethical considerations	32
CHAPTER FOUR: RESULTS AND DISCUSSION.....	33
4.1. Socio-economic characteristics of the respondents.....	33
4.2. Water supply, accessibility, acceptably, affordability and consumption patterns in Adar	34
4.2.1. Water quality, primary uses, affordability and cost implications	37
4.2.2. Climate change and water supply	40
4.3. Water scarcity, school attendance, and its impact on girls' education	42
4.3.1. Gendered division of labor in water collection	44
4.4. Community participation, governance, and effectiveness in water management	44
4.5. Impact of armed conflict on WEG nexus.....	49
4.5.1. Water scarcity, conflict, and their impact on gender, education, and infrastructure.....	49
4.5.2. The multiple linear regression model impact of armed conflict (WEG) nexus	51
4.6. The gender dynamics and school attendance model	52
4.7. Factors affecting the WEG nexus study.....	54
4.7.1. Factors impacting water accessibility in Adar village.....	54
4.7.2. Factors affecting girls' education in Adar village	55
CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS.....	57
5.1. Conclusions.....	57
5.2. Recommendations.....	58
REFERENCES	58
APPENDICES	65
APPENDIX 1: QUESTIONNAIRE FOR THE GENERAL PUBLIC	65
APPENDIX 2: QUESTIONNAIRE FOR THE OFFICIALS.....	70
APPENDIX 3: LIST OF IMAGES DURING DATA COLLECTION	75

LIST OF TABLES

Table 2.1. Nile basin countries: population, gross domestic product and water uses	13
Table 4.1. Socio-economic characteristics of the respondents	34
Table 4.2. Water accessibility and consumption patterns in Adar village	36
Table 4.3. Reasons of poor water quality in Adar village	38
Table 4.4. Water supply and climate change in Adar	41
Table 4.5. Impact of water collection on girls' education.....	43
Table 4.6. Community engagement in water management.....	46
Table 4.7. Key findings from officials' survey in Adar village	48
Table 4.8. Impact of armed conflict on WEG nexus	51
Table 4.9. Multiple linear regression model for impact of armed conflict on WEG nexus.....	52
Table 4.10. Gender dynamics and school attendance model	52
Table 4.11. Factors influencing water accessibility in Adar village.....	54
Table 4.12. Factors affecting girls' education in Adar village.....	55

LIST OF FIGURES

Figure 2.1. Primary school completion rate in sub-Saharan Africa, by sex, 1975-2020.....	7
Figure 2.2. Global legal frameworks related to gender equality in 2022.....	8
Figure 2.3. The gendered burden of water collection in Sub-Saharan Africa.....	9
Figure 2.4. Change in documented conflict-related deaths of civilians, 2015–2022.....	11
Figure 2.5. The water-education-gender and armed conflict nexus in Adar village.....	11
Figure 2.6. Global water withdrawal and population growth.....	12
Figure 2.7. Educational infrastructure in Adar village - Adar dual primary school.....	18
Figure 3.1. Location map of Adar village.....	29
Figure 3.2. Research design of this study.....	30
Figure 4.1. Water quality, primary uses, affordability and cost implications.....	39
Figure 4.2. Distribution of fetching water within households in Adar.....	44
Figure 4.3. Measures to resolve water related conflicts in Adar village.....	51

ACRONYMS

FAO	Food and Agriculture Organization
NGOs	Non-Governmental Organizations
SDG	Sustainable Development Goal
SLA	Sudan Liberation Army
SPSS	Statistical Package for the Social Sciences
UN	United Nations
UNICEF	United Nations International Children's Emergency Fund
WASH	Water, Sanitation, and Hygiene
WEG	Water-Education-Gender
WHO	World Health Organization

ABSTRACT

Adar village in West Darfur, Sudan, faces severe challenges due to armed conflict, water scarcity, and gender disparities, which intersect to impact education and community well-being. This study evaluates the impact of armed conflict on the water-education-gender (WEG) nexus, employing a mixed-methods approach with data collected from 367 households and 12 community leaders through structured questionnaires and interviews. Data were analyzed using SPSS version 27 and OriginPro 8.5, employing descriptive statistics, multiple linear regression, and thematic coding. The findings reveal that armed conflict has severely disrupted water infrastructure, with 49.3% of respondents reporting unsafe water access and 45.4% noting depleted resources. Water quality issues were widespread, with 68.1% of respondents citing pollution as the primary problem, and 56.7% rating the physical quality (taste, color, and odor) of water as poor. Gender disparities in education were evident, as 81.2% of households had school-aged girls, but only 28.1% attended school regularly, compared to 36.6% of boys, with 49% of girls miss school due to household chores, including water collection. Water scarcity exacerbated gender roles, as 75% of water collection tasks were performed by women and girls, leading to increased household stress and reduced educational opportunities by 22.5%, 64.2% of the respondent said that conflicts make women taking additional responsibilities, while 35% said, mean migrating for work in the urban centers. Existing water management policies were largely ineffective, with 69.8% of respondents reporting no policies or programs, and only 10.6% considering them highly effective. Community-driven initiatives, supported by NGOs 20.4%, were more prevalent than government involvement (0.8%). 47% of the respondent said their alternative education arrangements response to conflicts. 80% of respondents state water scarcity contribution to conflict and the majority 79.5% of respondents regarded dialogue as the main method for conflict resolution. The study concludes that addressing water scarcity, improving infrastructure, and implementing gender-sensitive policies are crucial for enhancing education and gender equity in conflict-affected regions.

Keywords: Adar village, Armed conflict, Darfur region, Gender equality, Nexus, Water -education – gender

CHAPTER ONE: INTRODUCTION

1.1. Background of the study

Adar village is in West Darfur, Sudan, around 22,500 people live in it, and has 4,400 household. With only 59% of rural populations having access to at least basic drinking water services, compared to 74% in urban centers like Khartoum, access to water in Sudan demonstrates a notable rural-urban inequality (World Bank, 2022). In Sudan, the impact of ongoing violence are gender norms, and social dynamics are all strongly related to the urgent problem of water scarcity. Considering these challenges, the UN underscores the vital importance of water management in advancing gender equality and addressing social justice (UN, 2019).

Limited access to water and gender roles strongly influences household responsibilities. Study by Sorenson et al. (2011), revealed that women in 44 countries globally are primarily responsible for fetching water, with 58.6% of water fetchers being women, 30.4% men, and 9.1% children. Females frequently face gender inequality in household duties, for instance fetching water, because of social norms believing unemployed women have more time for these responsibilities (Chauhan, 2021). In developing countries, social norms assign water-fetching responsibilities primarily to women and girls, often due to beliefs that they have more time for these roles. The burden of water fetching is especially heavy in households without reliable water sources, limiting women's and girls' opportunities for education, income generation, and overall well-being (Chauhan, 2021).

According to Sultana (2014), climate change made the challenges more complex, worsening water shortages, increasing the time and cost of water collection, and disproportionately impacting women who bear the financial and physical burdens of these tasks. Poor water management and climate pressures have intensified vulnerabilities, violence, migration, and loss of livelihoods, particularly in female-led households. These experiences highlight the serious need for sustainable water management that integrates social, environmental, and gender-sensitive approaches.

Gender mainstreaming, proposed as a universal development priority in the 1995 Beijing platform for action, provides a critical framework for addressing gender inequalities in access to resources and opportunities (Ampaire et al., 2020). This approach encourages governments to embed gender considerations in policymaking to promote equity in areas like health, and resource distribution

(Ampaire et al.,2020). Despite these efforts, gender policies in water ministries remain few worldwide, and awareness of gender issues in water interventions is frequently restricted, impacting service delivery in local communities (FAO, 2022). For instance, Anderson et al. (2021), revealed that men and women often adopt distinct approaches to influence water management practices. Women, operating in traditionally male-dominated sectors, frequently leverage social networks to drive change. However, they still encounter challenges such as wage disparities, restricted access to training, and enduring cultural biases (Anderson et al. 2021).

Water and sanitation are fundamental human rights recognized by the United Nations (Langford, 2005). The study conducted by Neto and Camkin (2020), state that governments, as duty-bearers, must provide equitable access to water and sanitation, ensuring affordability and quality. This requires addressing water tariffs not as technical issues but as matters of social and political justice. The study emphasizes re-politicizing water governance to clarify state responsibilities in upholding human rights without compromising the financial viability of water systems. Similarly, the study conducted by Cornejo et al. (2019), emphasizes the significance of sustainability metrics-covering environmental, economic, technical, and social aspects-in assessing innovative water resource recovery facilities. These metrics, alongside a global network for testing advanced technologies, enable improved water recovery processes that address sustainability challenges.

The civil administration in Adar village reports that the water system consists of only two solar-powered wells, which were built in 2020 through collaborations with non-governmental organizations (NGOs). Managed by the civil administration, these wells provide inadequate water for the village's 22,000 residents (Adar civil administration, 2024).

The absence of water tariffs prevents sustainable cost recovery, jeopardizing maintenance and expansion efforts. While the solar-powered system is a step toward sustainability, greater investment in innovative technologies, equitable resource allocation, and infrastructure is essential to ensure a resilient, rights-based water supply (Adar civil administration, 2024).

Community involvement has been identified as a key factor in ensuring the sustainability of water supply systems. Study by Marks et al. (2014), emphasize that active participation by local communities is essential for the successful implementation and sustainability of water projects. Such involvement addresses issues related to willingness and ability to pay user fees and ensures proper maintenance of water infrastructure (Marks et al., 2014). In the context of Adar village,

fostering community engagement in water resource management could alleviate current challenges by encouraging shared responsibility for the operation and upkeep of water systems. The study Kusters et al. (2020), highlights that technical, financial, and governance challenges frequently hinder progress. In the case of Adar village, these obstacles are exacerbated by environmental degradation, socio-political instability, and a history of armed conflict, which intensify the difficulties in managing water access and resources.

Sivakumar (2011), asserts that the availability of freshwater per person is declining due to factors such as water pollution, rapid global population growth, and inadequate water management. This trend increases the likelihood of conflicts and water scarcity, especially in developing nations where supplies are limited, and demand is growing. Innovative approaches of water planning and management are needed to resolve these issues to effectively estimate future water availability and fulfill demand (Sivakumar, 2011). Local conflicts in West Darfur are worsened by the above trend, the conflicts are mostly between farmers and pastoralists who rely on limited water resources for cattle and agriculture. These conflicts emphasize the value of sustainable water management to meet the demands of several community groups and prevent future conflicts.

The context of armed conflict in West Darfur further complicates the water-education-gender (WEG) nexus in areas like Adar. Water scarcity, entrenched poverty, low education levels, and conservative gender norms intersect, amplifying the vulnerabilities faced by women and girls. Understanding this nexus is crucial for designing interventions that improve water access and education while promoting gender equity.

1.2. Statement of the problem

Adar village in West Darfur faces a serious water crisis due to limited sources, with only two available wells to supply water to around 22,500 people within 4,400 household. According to the civil administration in Adar village (2024), during the rainy season, these wells become inaccessible as they are surrounded by floodwater, forcing villagers to rely on unsafe, stagnant ponds formed by rain or unsafe hand-dug well. Families are compelled to travel long distances, spending hours daily fetching water. This burden falls disproportionately on female, who are obligated to allocate substantial time and effort to collect water, delaying their access to education and risking physical strain from carrying heavy containers. This gender-based disparity not only

limits female educational opportunities but also perpetuates social inequalities, hindering both their empowerment and the development of the community (Chant, 2016). Furthermore, girls and women face heightened risks of sexual abuse when fetching water or gathering fuelwood for cooking, as reported by the village's civil administration.

The Sustainable development goals (SDGs), specifically SDG-6, emphasize the need for universal access to water and sanitation by 2030, with a focus on gender equality and support for communities in conflict-affected areas. However, in regions like Adar, poor sectoral coordination and fragmented regulation pose significant challenges to achieving these targets (Dhital et al., 2022). The longstanding conflict in Darfur, described by the United Nations as one of the world's worst humanitarian crises, has worsened the water crisis, intensifying the strain on limited water resources and exacerbating the burden on girls and women who must navigate both water scarcity and conflict-related risks (Parks, 2009).

1.3. Research questions

The following research questions guide the evaluation of the impact of armed conflict on the water, education, and gender nexus in Adar village:

- i) How armed conflict disrupted water access and infrastructure in Adar village and affect gender and education?
- ii) What gendered differences exist in school attendance and dropout rates during conflict, and how these linked to water-related responsibilities?
- iii) How do water scarcity and conflict-driven displacement interact to exacerbate gender inequalities in access to education and economic opportunities?
- iv) What strategies have been employed by the government and the external actors to address the interconnected challenges of water access, education, and gender equity during and after the conflict?

1.4. Objectives of the study

1.4.1. General objective

The main objective of this study is to evaluate the impact of armed conflict on the water, education, and gender (WEG) nexus in Adar village, West Darfur, Sudan.

1.4.2. Specific objectives

The specific objectives of this study are:

- To assess the impact of armed conflict on water infrastructure, access, and affordability
- To identify gender disparities in school attendance and dropout rates
- To evaluate the compounding effects of water scarcity and conflict on gender roles
- To analyze the effectiveness of existing water management policies, community initiatives, and NGO programs in addressing the interconnected challenges of WEG during conflict

CHAPTER TWO: LITERATURE REVIEW

2.1. Water-education-gender nexus related sustainable development goals

The sustainable development goals (SDGs) were established by the United Nations general assembly in 2015 to address global challenges and promote sustainable development. These 17 goals serve as a comprehensive framework aimed at improving human welfare and addressing environmental issues through international collaboration (Gulseven et al., 2020). The success of the SDGs relies on active partnerships among all member states, with the goals intended to guide development policies and actions worldwide (Gulseven et al., 2020). In this section, quality education (SDG-4), gender equality (SDG-5), clean water (SDG-6), and promoting peace (SDG-16) were given emphasizes.

The SDG-4 emphasizes ensuring inclusive and equitable quality education for all, promoting lifelong learning opportunities that benefit personal and professional development. This goal acknowledges education as a fundamental human right, aiming to remove barriers that prevent access to educational resources, especially for marginalized groups (Gulseven et al., 2020). Global progress for universal primary education is about 89%, but Sub-Saharan Africa is at only 67%, additionally, the COVID-19 pandemic worsened educational inequalities, affecting 1.6 billion students challenges in improving learning outcomes and lowering dropout rates persist, especially in low-income countries (UNESCO, 2020). In the context of the WEG nexus, SDG-4 is particularly relevant, as it highlights the importance of addressing issues that prevent girls from attending school, including those related to water scarcity and the burden of water collection that disproportionately affects women and girls.

Figure 2.1, illustrates the primary completion rate in sub-Saharan Africa from 1975 to 2020, categorized by sex. The data reveals that, despite advancements over the years, notable inequalities persist between girls and boys regarding educational access and success (World Bank & UNESCO, 2022). Additionally, the (Figure2.1), highlights the ongoing challenges that girls encounter in attaining and completing primary education in sub-Saharan Africa. A major obstacle emphasized by the WEG nexus is the unequal responsibility of water collection placed on women and girls, which often results in decreased school attendance and elevated dropout rates.

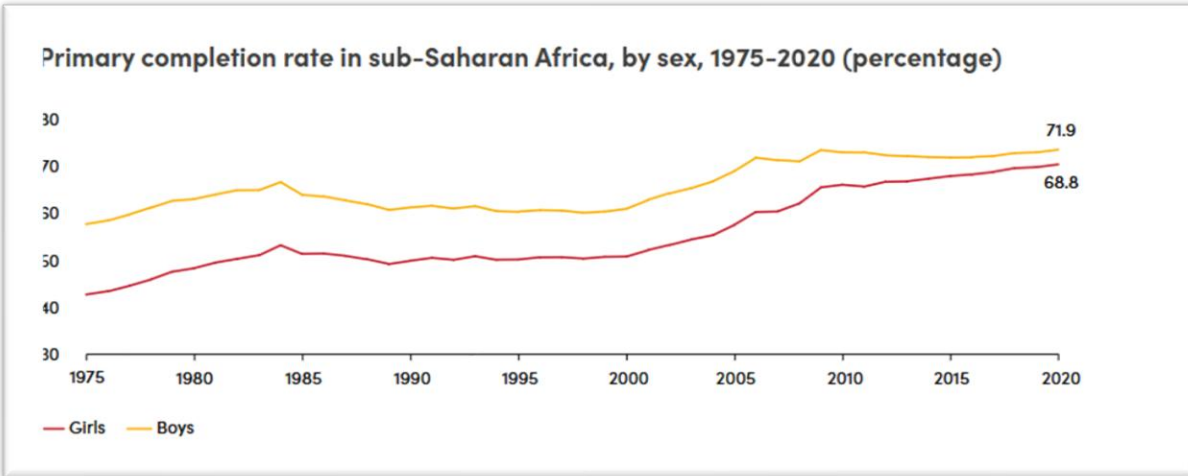


Figure 2.1. Primary school completion rate in sub-Saharan Africa, by sex, 1975-2020

Study by Rosati and Faria (2019), state that SDG-5 seeks to achieve gender equality and empower all women and girls by challenging social, economic, and institutional norms that perpetuate gender-based discrimination. It is fundamental to creating a more inclusive and representative democracy by addressing systemic gender inequalities within both public and private sectors (Rosati & Faria, 2019). The World economic forum (2023), indicates that the worldwide gender gap has diminished by 68.1%, showcasing advancements in educational achievements and political representation. Nevertheless, economic participation and opportunities remain problematic, with merely 58% of the gender gap resolved in this sector. In developing nations, societal norms and restricted access to resources perpetuate the stagnation of progress. For example, in South Asia, the labor force participation rate for women stands at only 62%, in contrast to 92% for men (UNDP, 2022). This goal aligns directly with the objectives of this study, which aims to explore how the burden of water collection restricts educational opportunities for girls, reinforcing gender inequalities and limiting their overall empowerment.

Figure 2.2 presents a global view of legal frameworks related to gender equality in 2022, showing that stronger laws lead to better representation. This information, from UN Women (2022), compares countries' progress in creating and enforcing gender equality laws linked to SDG-5. There are significant differences worldwide in the strength of such laws, with some countries having strong legislation and others lacking. The figure highlights the need for legal reforms in women's rights, workplace equality, violence protection, and access to education and healthcare. It also points out Sudan's insufficient legal measures, rating it at 50% with some improvements

but still showing major issues. This rating helps assess its position against regional countries like South Sudan and Ethiopia.

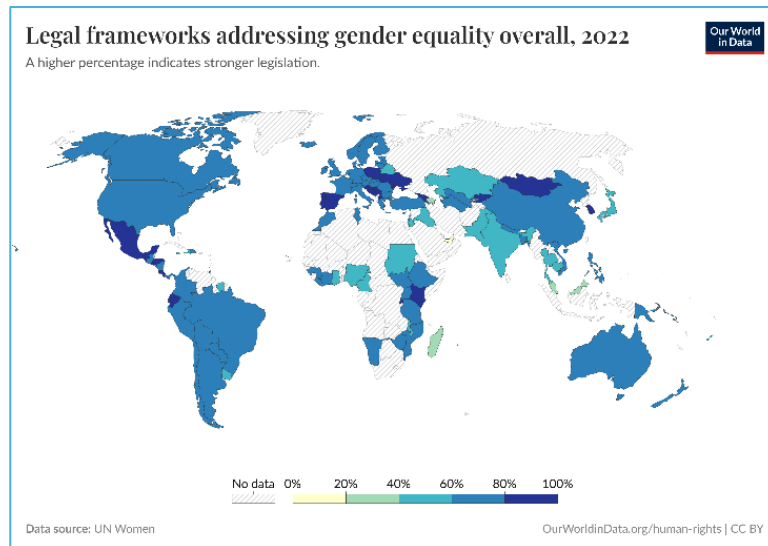


Figure 2.2. Global legal frameworks related to gender equality in 2022

The SDG-6 focuses on ensuring access to clean water and sanitation for all, recognizing that water security is essential for health, economic growth, and social justice. Gulseven et al. (2020), revealed that improved water and sanitation contribute to sustainable urban development, job creation, and enhanced public health. The WHO/UNICEF joint monitoring Programme (2021), reports that 74% of the global populace currently enjoys access to safely managed drinking water services. Nonetheless, considerable disparities remain in rural regions, where merely 54% of individuals have access to potable water, in contrast to 86% in urban environments. Furthermore, water stress impacts more than 2 billion individuals globally, with Sub-Saharan Africa and Central Asia being the regions most severely affected (UN Water, 2023). In Adar, the water crisis has had far-reaching impacts on daily life, exacerbated by conflict and limited infrastructure. Addressing SDG-6 is critical to the WEG nexus, as the availability of water directly affects education and gender roles.

Access to safe water is essential for health and well-being, specifically in areas like Adar village. According to Crider and Ray (2022), diarrhea disease is a major health issue related to water, leading to high economic costs due to unsafe water access. It was a significant cause of death in 1990 and 2010, especially affecting children under 5 years. The (Bradley Classification), in place since 1972, categorizes water-related diseases into four groups; waterborne, water-washed, water-based, and water-related with an insect vector. While much of the existing literature on health impacts focuses on environmental toxicology and microbiology, studies have started to explore the

broader influence of (blue space) which mean natural water environments -on mental and physical health (Volker & Kistemann, 2011).

Figure 2.3, shows that fetching water is a challenging task, particularly in Sub-Saharan Africa, where individuals often spend over 30 minutes collecting water in a single trip. This responsibility primarily falls on women and girls, who account for nearly 80% of households without direct water access. In certain African countries, the proportion of women tasked with water collection significantly surpasses that of men, with some regions reporting figures over 80%, revealing a significant inequality in domestic labor distribution. The time dedicated to water collection is substantial, with many people reporting trips that take between 30 minutes to over an hour, as depicted by the yellow and orange segments in the chart below (World bank, 2024).

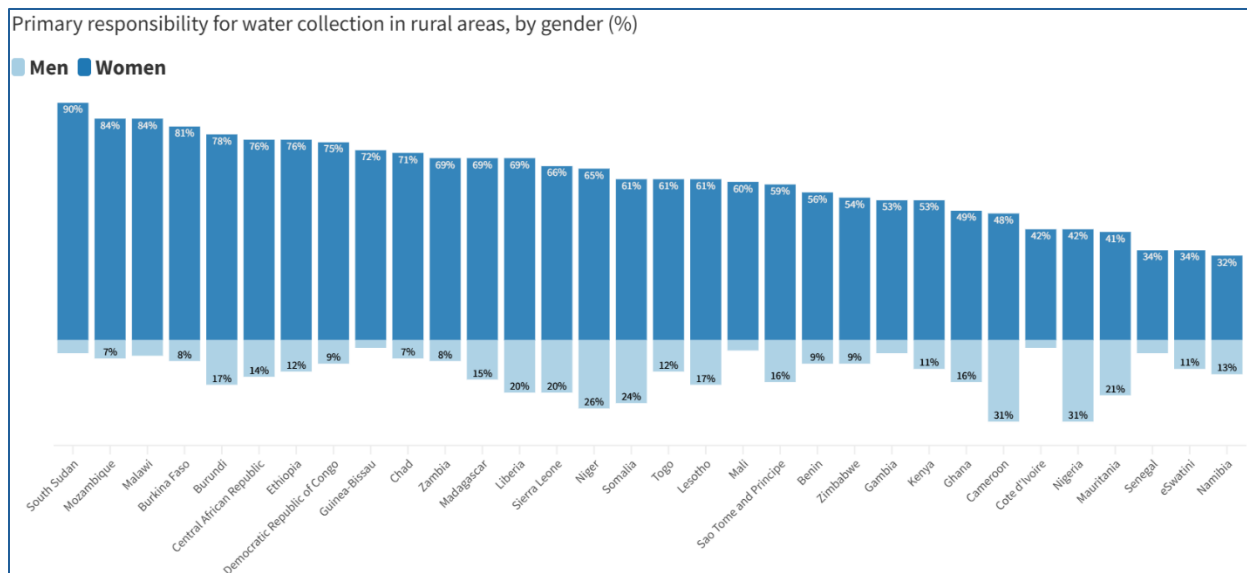


Figure 2.3. The gendered burden of water collection in Sub-Saharan Africa

The study Volker and Kistemann (2011), identified benefits of blue space, including stress reduction, emotional restoration, and recreational enjoyment, all of which contribute positively to mental health. These insights underscore the restorative value of accessible water environments on overall well-being. Moreover, the study Guardiola et al. (2013), revealed a significant relationship between water access and subjective well-being, highlighting the importance of clean water in overall life satisfaction and happiness. This finding supports the argument that water access should be considered a fundamental asset for well-being and highlights the need for water access indicators in well-being studies. In Adar village, where women and girls must travel long distances

for water, easy access to water is crucial for improving health and well-being, as well as promoting gender equality by reducing the burden of water collection on female.

According to Gulseven et al. (2020), SDG-16 aims to promote peaceful and inclusive societies for sustainable development, provide access to justice for all, and build effective, accountable, and inclusive institutions at all levels. While SDG-16's focus on reducing violence, upholding the rule of law, and improving governance is universally relevant, achieving this goal is particularly challenging for fragile and conflict-affected countries. These regions face unique obstacles to stability and peace, which complicate their progress towards SDG-16. The study by Milton (2021), explores the role of higher education in advancing-or potentially hindering-the objectives of SDG-16, emphasizing that universities in conflict-affected contexts can influence peacebuilding through teaching, research, and governance. According to the Global Peace, Index, (2023) global peacefulness has improved by 0.42% over the past year, with Europe remaining the most peaceful region. However, conflicts in regions such as the Middle East and Sub-Saharan Africa have hindered progress. The UNDP (2022), reports that 1 in 4 people worldwide still lack access to justice systems, highlighting the need for institutional reforms and conflict resolution mechanisms.

In the context of Adar village, West Darfur, where ongoing conflict impacts water accessibility, education, and gender dynamics, SDG-16 is directly linked to this study's objectives. Addressing peace and stability in fragile regions is essential for advancing the (WEG) nexus, as sustainable development is not achievable without a foundation of peace. This study's exploration of the WEG nexus in a conflict-affected area adds to the understanding of how SDG-16, in conjunction with other goals, can contribute to sustainable, peaceful development in vulnerable communities.

The figure 2.4 shows Civilian deaths linked to 12 of the world's deadliest conflicts rose by 53% from 2021 to 2022, marking the first increase since 2015, moreover, at least 16,988 civilians were killed, with one in five being women. The use of heavy weapons and explosive attacks grew significantly. Sub-Saharan Africa and Europe made up 90% of the deaths, with 40% occurring in Ukraine (UNDP, 2022). There was a call for a stronger global commitment to peace and adherence to humanitarian laws to protect civilians.

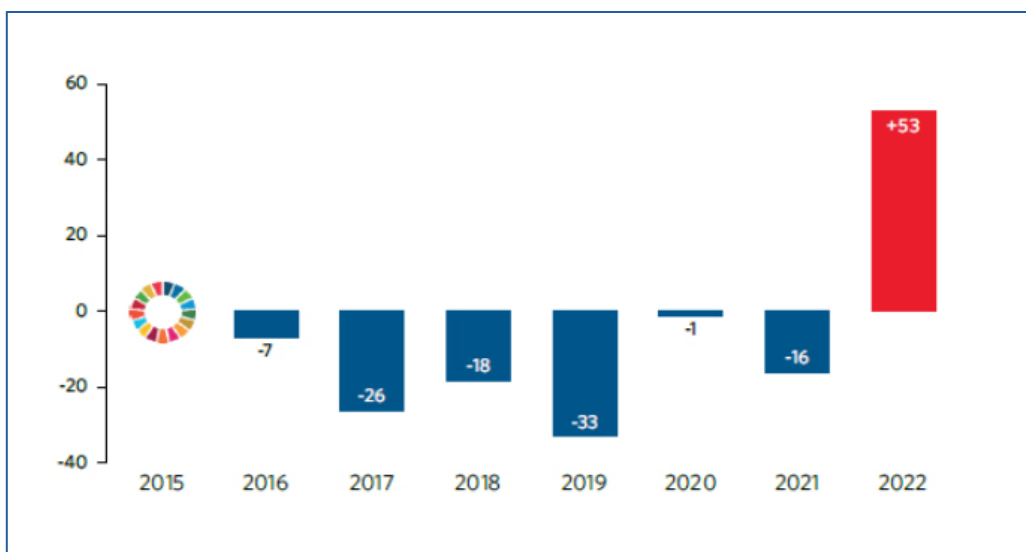


Figure 2.4. Change in documented conflict-related deaths of civilians, 2015–2022

Figure 2.5 shows the interlinked challenges in Adar involving water, education, gender, and conflict. Clean water access (SDG-6) is a major issue, especially affecting women and girls due to their roles in water collection, which limits their education and job opportunities. Armed conflict worsens water scarcity, damages infrastructure, and raises health risks. Education (SDG-4) suffers as girls miss school due to water collection and unsafe schools. Gender roles (SDG-5) support inequalities, conflict (SDG-16) leads to community displacement and violence. A holistic approach is needed to improve water access, promote gender equality, ensure education, and foster peace.

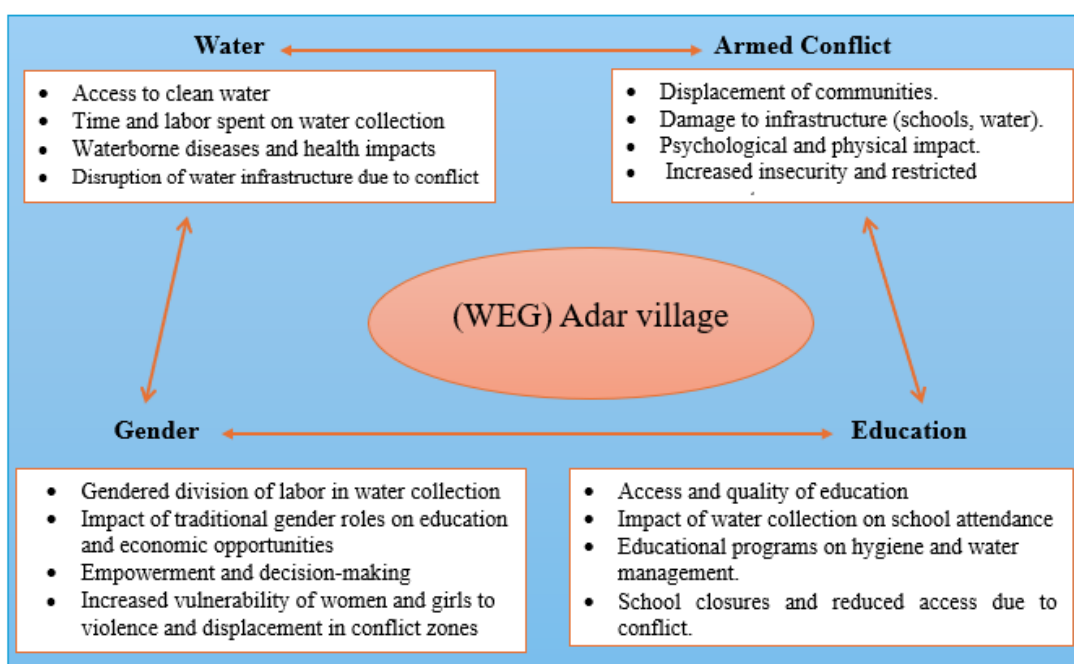


Figure 2.5. The water-education-gender and armed conflict nexus in Adar village

2.2. The water crisis at different perspectives

According to Sivakumar (2011), the global water crisis is a significant problem involving freshwater scarcity and poor water quality. It is caused by natural and human factors like population growth, economic development, and climate change. The main reason for the water crisis is the rising demand for freshwater due to more people and development (Sivakumar, 2011). As the world's population grows, the need for water for drinking, farming, and industry increases. Figure 2.6 presents the global water withdrawal, the Gross Domestic Product (GDP) per capita, and the world population from the year 1900, as well as the population trends in select countries of Asia and Africa since 1950, additionally, the figure depicts the graphical representation of water scarcity, which arises from a demand that increases at a rate exceeding linear proportions, alongside a comparable reduction in the availability of clean water, it is evident that the rising demand and diminishing availability will eventually intersect, occurring locally before manifesting on a global scale (Boretti & Rosa, 2019).

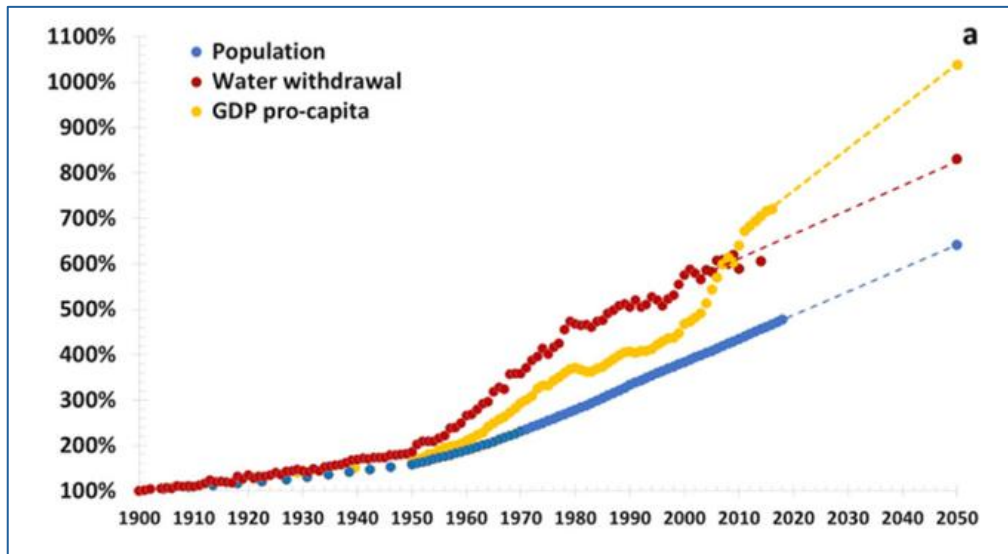


Figure2. 6. Global water withdrawal and population growth

Climate change worsens the water situation by changing rainfall patterns and causing more extreme weather. The study conducted by Vorosmarty et al. (2000), states that climate change and population growth create water vulnerability, increasing water stress in many areas. Integrated water resource management is essential to address climate impacts on water.

In Africa, the water crisis is severe due to factors like rapid population growth, inadequate infrastructure, and climate issues. Sudan, confronted with considerable water difficulties stemming

from its arid climate, political issues, and inadequate management practices, depends on the Nile River, which is experiencing strain due to upstream endeavors and climate change (Muller, 2021). Table 2.1, shows that the magnitude of the challenge and the economic resources available to address it differ significantly across countries moreover, Egypt and Ethiopia possess comparable, substantial populations, whereas per capita water availability in Egypt is more akin to that of Kenya, Egypt, Sudan, and Kenya exhibit greater wealth compared to the other Nile basin nations, while the East African countries and Ethiopia are experiencing a rise in rural population (Muller, 2021). The crisis impacts health and economic growth, leading to competition for water resources. Water scarcity is especially harmful in Africa, affecting food security and wellness. In Sudan, dependence on the Nile for water makes it vulnerable to conflicts over its use, especially with neighboring countries concerning the Grand Ethiopian Renaissance Dam (Elsayed et al., 2020). Degraded water quality also poses health hazards. A study by Yuan et al. (2016), noted that pollution significantly lowers water quality. Effective pollution controls and restoration efforts are needed to safeguard water resources. In Sudan, poor sanitation and industrial waste contribute to water contamination, creating serious health risks (Angelakis & Durham, 2008).

Table 2.1. Nile basin countries: population, gross domestic product and water use

Country	Population in 2017 ¹	Water availability in 2017: m ³ /capita ²	Gross domestic product in 2019 based on purchasing power parity: US\$/capita ³	Water use, consumption of total in (year): % ²	Rural population growth projected for 2018–2050 ¹
Tanzania	58 005 000	1680	2771	No data	22 407
Kenya	52 574 000	618	4509	13 (2017)	14 103
Uganda	44 270 000	1402	2272	1 (2008)	25 289
South Sudan	11 062 000	3936	1495 (2014)	1 (2011)	5850
Ethiopia	112 079 000	1162	2312	9 (2016)	31 126
Sudan	42 813 000	932	4123	71 (2011)	10 993
Egypt	100 388 000	589	12 251	112 (2017)	11 175

2.2.1. Water crisis in Darfur its impacts on education and gender

The water crisis in Darfur is closely linked to the region's resource scarcity and ongoing conflicts, which have exacerbated competition over limited natural resources. According to Abdo (2011), water shortages in Darfur contribute significantly to rising tensions, as the available water supply only meets about 14% of the domestic and livestock demand. Based on Hutchinson and Herrmann (2008), Darfur's water infrastructure includes 426 boreholes, 174 hafirs and small dams, 4,287 hand pumps, and large-diameter wells, which collectively provide approximately 30 million cubic

meters of water per year. Water demand calculations, based on 80 liters per person daily for urban areas and 40 liters for rural areas, highlight the substantial shortfall in meeting local needs (Hutchinson & Herrmann, 2008). The WHO recommends a minimum of 20-50 liters of water per person per day to meet basic needs for drinking, cooking, and hygiene, this amount ensures adequate health and well-being (Howard et al., 2020).

Abdo (2011), states that water scarcity in Darfur is not solely due to inadequate resources; rather, it stems from a lack of technical and financial support to effectively harness available water supplies. Rainfall varies dramatically across the region, from less than 50 mm in the north to up to 1,000 mm in the south, with surface and groundwater renewables estimated at around 3,425 million cubic meters annually. This variability in water underscores the need for robust resource management and investment to optimize existing water supplies.

The water sector in Darfur faces additional, multifaceted challenges. Additionally, Abdo (2011), points to an absence of systematic monitoring, insufficient data on water resources, and a lack of cohesive policy frameworks as major obstacles to sustainable water management. The sector suffers from weak governance, inadequate legislative support, and limited capacity among water management personnel, all of which hinder effective resource utilization. Addressing these issues requires a coordinated strategy that incorporates policy guidance, improved infrastructure, and cross-sectoral collaboration to meet the region's water needs comprehensively.

Adar village shares the same challenges as the broader Darfur region. The crisis in Adar is worsened by a lack of infrastructure, with only two wells serving 22,500 people across 4,400 households (Adar civil administration, 2024). This highlights an urgent need for additional water sources to meet the community's demands. Moreover, sustainable water management necessitates active involvement from the local community to ensure the efficient use, maintenance, and equitable distribution of resources.

The water crisis in Adar village, like in many parts of the world, has a profound impact on education, particularly for girls, as they often bear the responsibility of water collection (Adar civil administration, 2024). Studies demonstrate that time spent on water collection significantly reduces school attendance and academic performance among children. Volker and Kistemann (2011), in their survey of 10,698 households in Malawi, revealed that the probability of school

attendance decreased for children aged 6-14 who were engaged in water and fuelwood collection. They observed that children in areas with severe resource deficits spent considerable time on these tasks, which led to lower school attendance rates. Although their study focused on fuelwood, the findings underscore how resource collection duties interfere with education, particularly in households with fewer women or members beyond school age to share the burden.

In a similar study in Ghana conducted by Nauges and Strand (2017), examined the impact of water-fetching responsibilities on girls' schooling, analyzing data from four rounds of the demographic and health surveys. Using GPS data to identify proximity clusters, they found a significant negative relationship between girls' school attendance and time spent on water collection. Their results indicated that reducing water-fetching time by half increased girls' school attendance by an average of 2.4% points, with stronger effects in rural. This finding provides definitive evidence of the detrimental effects of water collection on girls' educational opportunities in Africa, highlighting the population-wide benefits of improved water access.

These studies demonstrate the critical link between water accessibility and education within the WEG nexus, emphasizing that the time-intensive burden of water collection perpetuates educational and gender disparities. In Adar, the water crisis not only strains girls' access to schooling but also hinders their overall empowerment and opportunities.

The water crisis has profound gender-specific impacts, particularly in communities where women are primarily responsible for fetching water. Whitbread et al. (2020), examined a watershed project in the drought-prone Bundelkhand region of India, demonstrating that improved water access significantly reduced the burdens on women. For instance, the construction of check dams reduced women's daily water-fetching time by about 29% and decreased the physical effort required to draw water. Furthermore, Whitbread et al. (2020), said this time reduction allowed women more flexibility for other activities, including education and income-generating work, underscoring the transformative impact of accessible water on women's lives.

However, Whitbread et al.(2020), emphasized that strict patriarchal norm limited women's involvement in water management, restricting their mobility and visibility within the community. This reflects the need for gender-sensitive approaches to water projects to ensure that women not only benefit from improved access but also have a voice in decision-making. Addressing these

gender disparities is essential in the WEG nexus, as equitable water access is crucial for advancing gender equality and supporting women's empowerment.

2.2.2. Water policies and governance

Water governance and legal frameworks are key for sustainable water management, especially in areas with complex challenges. Water laws and governance differ worldwide, influenced by culture and politics. A common issue is the conflict between centralized and decentralized systems, affecting equitable water distribution and management.

Breidlid (2010), state that Sudan's complex governance issues, rooted in religious, ethnic, and political divides. In Darfur, the absence of localized water policies forces water ministers to follow national guidelines, resulting in a centralized system that fails to address local needs (Mulder & van Steenbergen, 2021). This centralization hinders equitable water access and sustainable management, both essential for improving the WEG nexus in the region.

According to Mulder and van Steenbergen (2021), Sudan's water policies, such as the 1995 water law and the draft 2007 water policy, lack a comprehensive framework for integrated water resource management, particularly at the regional and local levels. The absence of clear guidelines on federal versus state responsibilities often leads to gaps and overlapping roles in water management, complicating efforts to address water scarcity in Darfur.

In conflict-affected and water-scarce regions like Darfur, these governance issues exacerbate the challenges faced by communities, particularly for women and girls who are primarily responsible for water collection. Based on Mulder and van Steenbergen (2021), the absence of a national water resources allocation plan further limits the establishment of priorities and strategic investments necessary to ensure water security in underserved areas, impacting daily life and hindering educational opportunities for girls who lose time to water-fetching duties.

The strategy water for new Sudan -transforming livelihoods (2021-2031) seeks to address these issues by enhancing institutional frameworks and empowering local water councils to engage communities in water management decisions. These councils aim to incorporate local voices, particularly those of women, in governance processes to ensure that water resources are managed sustainably and equitably (Mulder & van Steenbergen, 2021). Effective water governance that

prioritizes community involvement and addresses the needs of women and girls is essential for achieving the WEG nexus, as improved access to water can support educational access and promote gender equality in Darfur's challenging context.

2.3. Education

Achieving the right to education in conflict-affected areas like Sudan is highly challenging. The study Bakhshi et al. (2018), states that SDG-4 aims to provide inclusive, equitable, and quality education, yet prolonged conflict has severely disrupted educational access, leaving millions of children out of school. In West Darfur, United Nations International Children's Emergency Fund (UNICEF) and NGOs have been working to rebuild schools and restore education since the conflict began in 2003, addressing educational disparities exacerbated by the crisis.

Sommers (2005), highlights the major problems in Southern Sudan's education system, worsened by government attacks, forced child soldier recruitment, and inconsistent international support. These issues have restricted educational access for most children. Efforts to enhance education are limited by poor funding and uncoordinated curricula. The study conducted by Breidlid (2010), notes that outdated policies also create inefficiencies. There is an urgent need for coordinated strategies that ensure safe, relevant, and inclusive education to support stability and development in conflict areas. These strategies should tackle immediate security and funding challenges as well as long-term issues like curriculum and teacher training.

2.3.1. Education challenges in Darfur

According to the officers in Adar village (2024), the Adar village has only one primary school, (Adar dual primary school), which serves both boys and girls. According to the civil administration in Adar village, (2024), the lack of secondary schools within Adar village further exacerbates educational inequalities, particularly for girls. Many students seeking secondary education must travel to Algenana city or neighboring villages, which introduces additional barriers, such as long travel distances, safety risks, and increased costs. These factors disproportionately affect girls, who are more likely to drop out due to the cumulative burden of travel and socio-cultural constraints on mobility.



Figure 2.7. Educational infrastructure in Adar village - Adar dual primary school

The study Bartl (2022), investigated the role of indicators in managing regional disparities in school infrastructure in Germany, highlighting that indicators serve for both data gathering and resource allocation. Although indicators were introduced as early as the 19th century, their practical impact on school infrastructure was limited until the 1970s due to policy conservatism and conceptual issues. With demographic and administrative indicators institutionalized, they effectively supported resource distribution during educational expansion. Despite the destruction and setbacks following World War II, Germany successfully rebuilt its education system, incorporating robust planning mechanisms that helped mitigate spatial inequalities.

According to Bakhshi et al. (2018), in conflict-affected regions like Darfur, the promotion of education requires substantial external support to ensure that all children, including those with disabilities, have access to quality education and can achieve positive learning outcomes. Additionally, Bakhshi et al. (2018), revealed that significant challenges in the educational sector, particularly the low cognitive learning outcomes for children in the region. The survey of the study which involved 1,436 children, found that only 23.3% of children had access to schools. Among those, a mere 45.2% demonstrated basic literacy skills, such as the ability to read and write. This underscores the severe limitations in both access to education and the quality of learning in Darfur, where instability and displacement continue to disrupt educational infrastructure.

In addition, research by conducted by Dhital et al. (2022), highlights the broader socio-economic and environmental challenges affecting education, particularly for girls in remote areas. Their study on the water-gender-education nexus in Nepal reveals a significant negative relationship between the time spent fetching water and the likelihood of girls completing primary school. This finding illustrates the detrimental effect of limited water accessibility on educational outcomes, particularly for girls who are often tasked with water collection duties. The study emphasizes how the lack of reliable water sources exacerbates gender disparities in education, further hindering the educational prospects of girls in marginalized communities.

These studies together underscore the interconnectedness of water access, gender, and education. In the context of Darfur, similar challenges may exist, where the combination of ongoing conflict, water scarcity, and gender inequality exacerbates the already fragile educational system, particularly for girls and children.

2.4. Gender

Gender roles, as socially constructed norms, significantly impact individuals' opportunities and responsibilities. In Adar village, these roles place the burden of water collection on girls, which often interferes with their education. The time and energy spent on this task limits their school attendance and academic performance, thereby perpetuating gender inequalities and restricting their empowerment within the community.

Gender equality, as defined by Ramsak (2017), involves equal access to rights, resources, and opportunities for both sexes. Achieving this often requires gender equity-fair treatment that compensates for historical disadvantages. According to Lorber (2010), feminism are endeavors for equality between men and women across legal, social, and cultural spheres, though it acknowledges that gender inequality, while typically disadvantaging women, can also impact men for instance military conscription the study Garcia (2019), state that 80% of households without on-premises water access rely on women and girls for water collection, which reduces girls' school attendance and limits women's economic activities, reinforcing traditional gender roles.

2.4.1. Empowerment and equality

The concept of the feminization of poverty, which has garnered attention in the last twenty years, underscores the gender-specific disadvantages encountered by women. Nevertheless, the effects

of associated policies on authentic empowerment remain debate topic (Griffin, 2015). Interventions such as microfinance schemes, conditional cash transfer programs, and initiatives like the Nike foundation's (girl effect) often assume traditional gender roles, placing greater burdens on women and girls without fundamentally addressing underlying inequalities (Chant, 2016).

The study Vallas (2006), critiques these methodologies, indicating that they may inadvertently solidify established roles rather than offering authentic empowerment. In Adar village, where girls are responsible for time-consuming water collection tasks, policies that overlook these gendered labor expectations could inadvertently perpetuate the very disparities they aim to address. Girls in Adar are limited in their educational pursuits because of water collection responsibilities, reinforcing their roles within the household and limiting their opportunities for empowerment.

The study conducted by Azmanova et al. (2016), expands on this critique, arguing that while women have gained rights and access to labor markets, this empowerment often comes at the cost of conforming to neoliberal, profit-driven expectations, the pursuit of gender equality in capitalist democracies has focused on access and inclusion within existing structures, rather than challenging the foundational systems that drive competitive profit-making and exploitative labor practices. In Adar village, the emphasis on gender equity should not only aim for inclusion within current socio-economic roles but should also challenge traditional expectations, enabling both women and men to pursue empowerment beyond the confines of productivity and market values.

According to Crider and Ray (2022), the Dublin Principles 1992 emphasize the critical role women play in water management and the need for participatory approaches involving all stakeholders, this perspective aligns with the recognition of safe water as a human right in early 2000, as articulated by the UN in general comment 15, which underscores the necessity of ensuring safe, accessible, and affordable water for all.

While frameworks like UN SDG 5 aim to address gender inequality in resources, time, and power, the lack of political will to challenge entrenched gender norms and economic imperatives can hinder meaningful progress. The studies Chant (2016), and Azmanova et al. (2016), both argue that anti-poverty initiatives often result in the "over-utilization" of women rather than true empowerment, by adding to their responsibilities without providing them with meaningful choices. This may be relevant in Adar, where increasing educational and economic opportunities for girls would require policies that challenge these gendered expectations, rather than reinforcing them.

Furthermore, chant (2016), advocates for transformative, context-sensitive policies that incorporate the perspectives of local women and girls, allowing them to participate meaningfully in shaping gender equality initiatives. In line with UN Women's (Planet 50:50 by 2030) vision, true empowerment in Adar would mean granting women and girls the freedom to make choices beyond their traditional roles, supporting both gender equality and community development.

2.4.2. Gender and access to education

Education is central to addressing gender disparities and poverty, yet its impact is shaped by complex interactions between these factors. The study Chege and Arnot (2012), highlight the gender-education-poverty nexus, where educational outcomes influence and are influenced by gender roles and poverty. Their study in Kenya revealed that while education is seen as a means of escaping poverty, its effectiveness in challenging entrenched gender norms varies. Young women expressed aspirations for independence, while young men sought respect and leadership within their communities. However, limited access to education left both genders facing vulnerabilities, such as exploitation for women and unmet societal expectations for men.

The burden of unpaid labor, particularly water and fuel collection, further limits educational opportunities for children, especially girls. The research conducted by Choudhuri and Desai (2021), revealed that in rural India, children from households reliant on free water and fuel collection had lower educational outcomes, with girls' school attendance and academic performance disproportionately affected. Boys also experienced negative impacts, such as lower educational expenditures and grade repetition, due to overall household resource strains.

Dhital et al.(2022), demonstrated similar trends in Nepal's mountainous regions, where household water accessibility significantly impacted children's education, one-hour increase in water-fetching time reduced the likelihood of girls completing primary school by 17% points for those aged 14-16. Boys were less affected in school completion but showed higher rates of grade repetition due to increased household duties. In Adar village, where girls bear the primary responsibility for water collection, these findings emphasize the importance of addressing unpaid labor burdens to improve educational access. Investments in water infrastructure, such as piped systems, could reduce the time spent on water collection, allowing girls to focus on their education. While formal schooling is essential, it must be complemented by policies that address gender norms and systemic barriers to ensure equitable opportunities for both boys and girls. Reducing

rigid gender roles through education, as noted by Chege and Arnot(2012), offers a pathway for transformative change. Achieving this requires investments in infrastructure and fostering gender-sensitive education systems to enable self-reliance and dignity for all youth.

2.4.3. Cultural norms and gender roles in water collection and education

According to Adams et al. (2018), socio-cultural norms and gender roles continue to shape water collection practices and educational opportunities, particularly in rural and resource-constrained settings. These norms often place disproportionate burdens on women and girls, as they are traditionally responsible for household chores, including water collection. In Adar village, this dynamic reflects broader global trends where such gendered responsibilities hinder educational progress and perpetuate inequalities. For instance, Dhital et al. (2022), examined how water-fetching duties in remote Nepali villages adversely affect children's education, particularly that of girls. The study found that limited household access to water disproportionately burdens girls, forcing them to miss or drop out of school. While boys might also face educational setbacks due to water collection, they are more likely to complete primary and lower-secondary education, unlike girls who increasingly take on domestic roles as they age. The findings highlight that inadequate access to water exacerbates gendered educational disparities.

Socio-cultural norms greatly impact natural resource management and governance in developing regions. These customs can restrict women from participating in decision-making processes, as seen in Tanzania where women faced barriers due to traditional roles (Adams et al., 2018).According to the civil administration in Adar (2024), this situation parallels the challenges faced in Adar village, where socio-cultural norms similarly dictate that girls prioritize water collection and household duties over their education. The introduction of sustainable water supply systems, such as solar-powered facilities, can alleviate these burdens. Additionally, addressing these barriers in Adar village would not only promote gender equality but also contribute to achieving SDGs, particularly those related to universal education and gender equality (SDG-5). The insights from Dhital et al. (2022), study underscore the urgent need for targeted interventions that combine water accessibility improvements with strategies for shifting cultural norms to support educational and gender equity in rural contexts.

2.5. Armed conflict and its impact on education and water

Armed conflict, as defined by Eriksson et al. (2003), is a contested incompatibility concerning government, territory, or both, where the use of armed force between two party's results in at least 25 battle-related deaths. At least one party in such a conflict is the government of a state. This definition is highly relevant to the ongoing conflict in Darfur, located in Western Sudan, a region home to approximately 9.2 million people predominantly of Muslim faith, distributed across five states: Darfur (North -South -West -East and Central) (Darfur Population Census ,2017).

According to Robyn (2017), Darfur conflict, which began in 2003, has deeply impacted on all aspects of life, including education, water infrastructure, and peacebuilding efforts (SDG-16). Ethnic tensions, competition over scarce resources like water and grazing land, and poor governance have created a toxic environment leading to violence. The study by Fabrice (2014), also described Darfur demographic and ethnic composition, noting that the western area is predominantly non-Arab, while Arab-affiliated nomads inhabit the southern and northern regions. Initial clashes over resources escalated into full-blown conflict in February 2003 when the Sudan Liberation Army launched an attack on Gulu town in west Darfur, resulting in heavy casualties. By 2008, at least 200,000 people had been killed, over 2.4 million displaced, and 3.5 million left reliant on international aid for survival (Alex & Elizabeth, 2008). By the middle of March 2024, the ongoing conflict in Sudan has led to approximately 15,000 fatalities and more than 27,700 injuries. Additionally, over 8.5 million individuals have been displaced, with 6.5 million residing within Sudan's borders. The majority of those displaced originate from Khartoum and Darfur, primarily fleeing to Darfur and the banks of the River Nile, additionally, women constitute 69% of the displaced population and encounter significant hardships (Kirui et al., 2024).

The harmful impacts of violence in Darfur were also highlighted in epidemiological studies. Mortality rates in Murnei and Niertiti which are in west Darfur were as high as 9.5 and 7.3 deaths per 10,000 people per day, mainly caused by violence (Alex & Elizabeth, 2008). Most deaths were among adult men, but women and children were also affected. Displacement from direct attacks led to high mortality rates in camps, including in El Geneina. The violence also resulted in a significant shortage of adult men in the population (Depoortere et al., 2004).

The consequences of the conflict extend beyond human displacement and loss of life due to water infrastructure have been profoundly affected and become a scare resource. The investigation by

Alex and Elizabeth (2008), observed that displaced populations live in camps in Sudan and refugee camps in Chad, relying heavily on external aid for basic survival. For women and girls, who bear primary responsibility for water collection, the insecurity created by the conflict has exacerbated their vulnerability. The task of fetching water has become increasingly hazardous, limiting their educational opportunities and further entrenching gender inequality.

In Adar village, these dynamics are deeply experienced. The conflict has compounded existing water scarcity issues, making it even more difficult for communities to access clean and reliable water sources. This disproportionately affects women and girls, who already face the brunt of water collection responsibilities. The study by Robyn (2017), has revealed that the interplay of ethnic tensions, water scarcity, and poor governance in Darfur has created a normatively multifaceted scenario that demands alternate, green-oriented solutions to promote sustainable peace.

The impact of the Darfur conflict on the WEG nexus in Adar village underscores the urgent need for conflict resolution strategies that address both the immediate needs of water infrastructure rehabilitation and the long-term goals of gender equality and education. By improving water access and security, the region can begin to alleviate the burdens placed on women and girls and create pathways for sustainable development.

The armed conflict in Sudan, especially in Darfur, has severely impacted education by disrupting infrastructure and displacing populations. A study conducted by Khattak et al.(2015), highlighted how conflict affected the managerial behavior of school principals in Darfur. Insecurity and fear hindered their ability to perform administrative duties effectively. Communication gaps between principals, teachers, and parents worsened the situation. Principals also lacked proper budget management skills, further straining educational institutions. The study recommended administrative training for school principals to navigate crises.

According to IFPRI & UNDP (2024),the armed conflict that erupted in Sudan on April 2023, between the Sudanese Armed Forces and the Rapid Support Forces has caused significant disruption to education generally. Initially the conflicts were centered in Khartoum, but its rapidly spread to regions like Darfur and Kordofan, creating a nationwide crisis that devastated social and economic structures. By mid-March 2024, almost 15,000 people had been killed, over 27,700 injured, and more than 8.5 million displaced. Women, who constitute 69% of internally displaced persons are disproportionately affected, facing displacement, gender-based violence, and the loss

of livelihoods. Children, nearly half of those in dire need of humanitarian assistance, face severe challenges in accessing education, with nine out of ten displaced households reporting that educational services are no longer available in their areas (IFPRI & UNDP, 2024).

According to Dsouza and Jolliffe (2013), the disruption of education has far-reaching consequences. The destruction of infrastructure, including schools, and the lack of essential services such as electricity and healthcare have left entire communities unable to provide stable educational environments. This mirrors global findings on conflict's impact on education, as seen in Afghanistan, furthermore, D'Souza and Jolliffe (2013), revealed that conflict exacerbates economic shocks, limiting households' ability to cope and reducing access to education. Similarly, Goodhand (2001), noted that conflict leads to chronic poverty by destroying livelihoods and limiting access to essential services, including education.

The effects of conflict on education are multifaceted, extending beyond physical destruction. In Rwanda, the study by Justino Verwimp (2008), revealed that the genocide of the 1990s reshaped poverty and access to education, as households lost assets and land, making it harder for families to send children to school. The study by Tollefsen (2020), highlighted the cyclical relationship between poverty and conflict, where poorer households were more likely to participate in or support armed groups, further destabilizing communities and limiting educational opportunities.

In Adar village, the impact of the Sudanese conflict on education reflects these broader patterns. The loss of schools, displacement of families, and insecurity have severely hindered children's ability to attend school, with girls being disproportionately affected due to their dual burden of water collection and educational barriers.

Armed conflicts, like in Darfur, have severe implications for water infrastructure and management, exacerbating water access challenges and threatening public health. According to Ameen (2023), conflict in Sudan has severely disrupted water supply and sanitation systems, with 65% of urban water treatment plants across the country non-functional. Many rural areas, including Darfur, rely heavily on boreholes and shallow wells, which are vulnerable to contamination and overuse during conflict due to displacement and increased demand (Detges, 2016).

Conflicts also exacerbate environmental vulnerabilities by damaging infrastructure. The study conducted by Shumilova et al. (2023), has discussed the global implications of targeting water

systems during armed conflicts, noting that direct attacks, collateral damage, and operational disruptions severely limit access to clean water. In the context of Sudan, the conflict-induced damage to water supply systems has led to increased reliance on unsafe water sources, raising the risk of waterborne diseases and undermining long-term water security. Similar trends have been observed in other conflict zones, such as Ukraine, where targeted destruction of water facilities has disrupted agricultural and industrial water use.

Furthermore, drought-related conflicts in Sub-Saharan Africa highlight the vulnerability of water infrastructure during periods of environmental stress. Detges (2016), argued that poorly developed water infrastructure, such as limited access to deep wells or piped water, exacerbates resource competition during droughts, fueling communal violence. This dynamic is particularly relevant in Darfur, where conflict and environmental stress interact to compound water access issues, leading to displacement, resource depletion, and increased tensions among communities.

To address these challenges, there is an urgent need for investment in resilient water infrastructure capable of withstanding the dual pressures of conflict and climate change. Establishing protected and well-maintained water supply systems, supported by international aid and SDGs programs, is essential for mitigating the impacts of armed conflict on water access in Darfur and similar regions.

2.6. Challenges to achieving Water Education Gender goals

Achieving the WEG nexus in Adar village faces significant challenges rooted in structural, social, economic, and environmental factors. These barriers hinder progress in ensuring sustainable water access (SDG-6), improving educational outcomes (SDG-4), and addressing gender inequalities (SDG-5). Adar village relies on just two wells to serve its population of around 22,500 people (Civil administration Adar village,2024). During the rainy season, these wells become inaccessible as they are surrounded by floodwater, forcing villagers to rely on unsafe, stagnant ponds formed by rain. This severe scarcity of water infrastructure forces families-particularly women and girls-to spend hours in collecting water daily, limiting their time for education and economic activities. The lack of adequate water infrastructure is a critical barrier to achieving the WEG nexus.

The study by Koolwal and Walle (2013), argue that poor infrastructure significantly constrains women's economic opportunities, as time-intensive domestic tasks, such as water collection, leave little room for engaging in productive or market-based activities. Moreover, the burden on

children, particularly girls-is considerable, as they are often involved in these tasks. Improved infrastructure can increase the productivity of domestic labor and free up time for education, thereby addressing gender-based disparities and enhancing community well-being.

Meaningful community participation is essential for addressing the WEG nexus; however, communities like Adar village often lack platforms for engagement, especially for women and girls. Restricted involvement in decision-making processes reduces the effectiveness and sustainability of water projects.

According to Candido et al.(2022), only 55% of water projects remain efficient after implementation, largely due to insufficient community involvement in decision-making and resource allocation. Poor sanitation and the prevalence of waterborne diseases are direct consequences of this lack of engagement. The study emphasizes the importance of empowering communities, ensuring active participation of various stakeholders, and delineating roles to improve the sustainability of water supply projects.

The ongoing armed conflict in the Darfur region has intensified the water crisis, with infrastructure destruction, population displacement, and persistent insecurity creating hazardous conditions for water collection. Women and girls face heightened risks while traveling to collect water, and the instability disrupts educational systems, compounding gender-based disparities.

The research carried out by Bakhshi et al.(2018), highlights that in contexts of emergencies, conflicts, and disasters, national education systems are often dismantled, and infrastructure is destroyed. For instance, in 2015, an estimated 75 million children globally in conflict-affected areas were denied access to education. The destabilization caused by conflict undermines efforts to improve water access, perpetuating cycles of poverty and inequality.

Adar is situated in a poor, rural region where poverty exacerbates existing challenges. Limited financial and resources constrain investments in water infrastructure and educational initiatives, further delaying progress in achieving the WEG nexus. The study by Kwame (2015), described poverty as the denial of opportunities for social, economic, and human development. The lack of resources in Adar hampers the community's ability to implement sustainable solutions for water access and education, perpetuating inequalities and reducing overall quality of life.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1. Description of the study area

This research was conducted in Adar village, located in the El Geneina locality of the West Darfur region, in the western part of Sudan (Figure 3.1). The geographical coordinates of Adar village are 13.33°N and 22.250°E, and it is situated approximately 30 to 35 kilometers from El Geneina city. Adar village has a population of 22,500 people distributed across 4,400 households, as reported by the local community leader in 2024.

Darfur lies within the Sahel region, characterized by semi-arid to semi-humid grasslands and wooded savannas close to the Sahara Desert (Khalid et al., 2012). The region experiences a rainy season from June to October, with annual precipitation ranging from 152 mm in the northern parts to 540 mm in the southern parts. Temperatures in the region vary significantly, (average=24.5°C) with recorded highs of 42°C and lows of 11°C during the year (Altoom et al., 2023).

The economic activities in Darfur primarily revolve around agriculture and animal husbandry. Agriculture involves cultivating crops such as millet, corn, and sesame, while animal husbandry includes raising cattle, goats, and sheep. Many households engage in both practices, utilizing specific land areas for each. Additionally, cross-border trade with neighboring countries like Chad, the Central African Republic, and Libya supports local livelihoods through the exchange of crops, livestock, and consumer goods (Satti & Castro, 2012).

According to Satti and Castro (2012), ethnically and economically, Darfur's population consists of Arab tribes, predominantly pastoralists, and non-Arab tribes, mainly farmers. Historically, these groups maintained cooperative relationships through intermarriage and shared socio-economic activities. Common Islamic values fostered harmony, while local agreements enabled resource-sharing practices, such as pastoralists utilizing crop residues after harvest and grazing rights during the dry season. These arrangements also benefited farmers through soil enrichment from manure.

Since 2003, the region has been severely affected by conflicts driven by scarcity, ethnic tensions, political marginalization, and ineffective governance. The preferential treatment of Arab communities by the Khartoum administration, particularly regarding access to clean water, exacerbated tensions and fueled resentment among non-Arab populations. The Janjaweed militia's

attacks alone resulted in the deaths of 800,000 African Darfuri people and the displacement of over 200,000 refugees to neighboring countries, while recent agreements have lessened the intensity of conflict, disputes over water resources remain unresolved. Rapid environmental degradation and inequitable water allocation continue to pose a significant risk of renewed violence (Robyn, 2017).

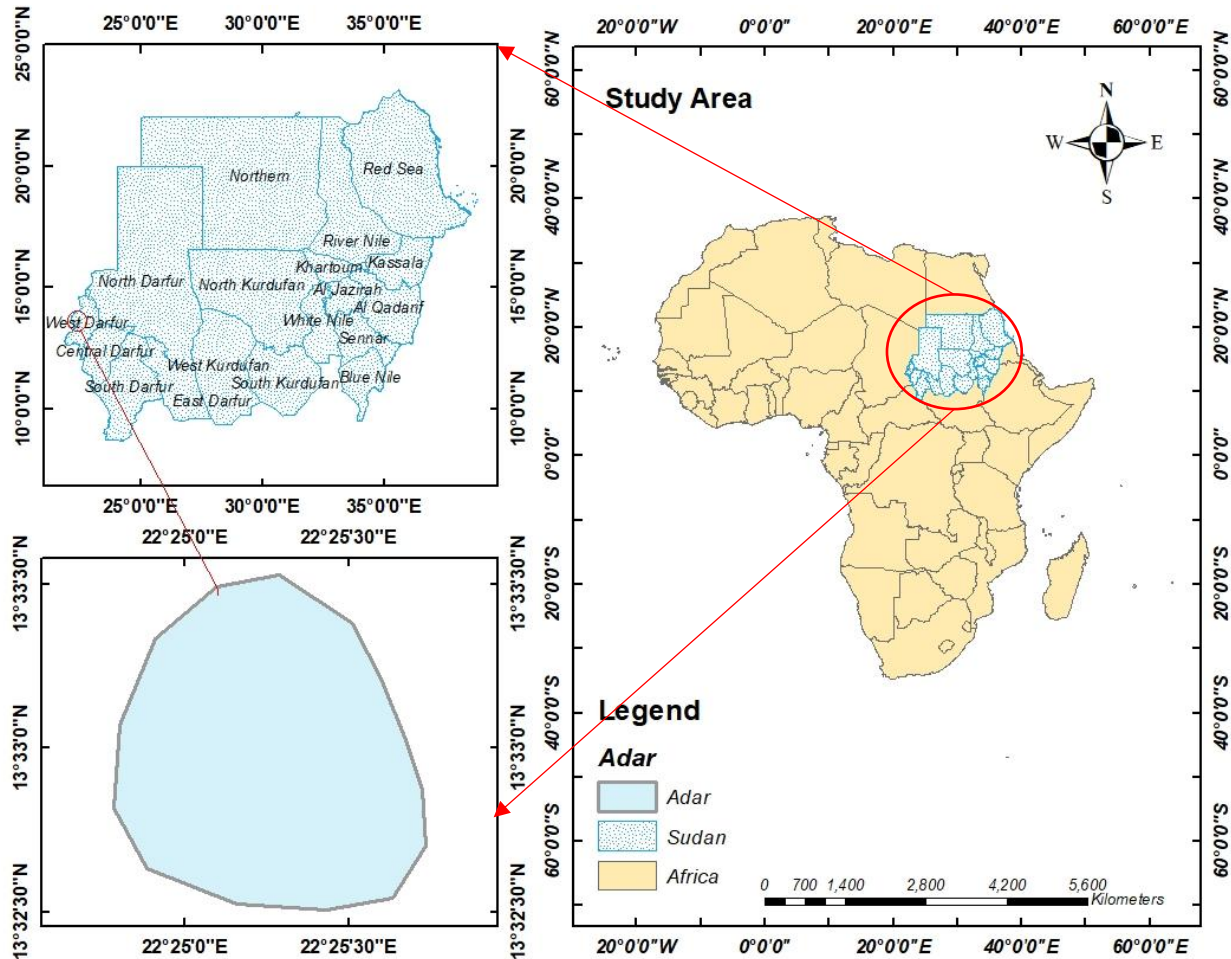


Figure 3.1. Location map of Adar village

3.2. Research design

This research adopted a mixed-methods approach to examine the WEG nexus in Adar village, utilizing both qualitative and quantitative methodologies to ensure a comprehensive understanding of the issues at hand (Figure 3.2) The study was conducted in compliance with ethical standards, including obtaining permissions and informed consent from participants before data collection commenced. The research process began with interviews involving key community stakeholders to capture diverse perspectives on the WEG nexus and the impact of armed conflict. About 36

structured questions were presented to 12 community leaders and officers in Adar, providing insights into the challenges faced by the village.

To complement the qualitative data, a detailed household survey questionnaire was developed, consisting of 62 questions designed to collect quantitative data on water accessibility, educational challenges, and gender dynamics. Given Adar village's population of 22,500 people across 4,400 households, a random sampling method was employed to select a representative sample size of 367 households. This sample size was calculated to ensure statistical reliability and accuracy in reflecting the village's overall conditions.

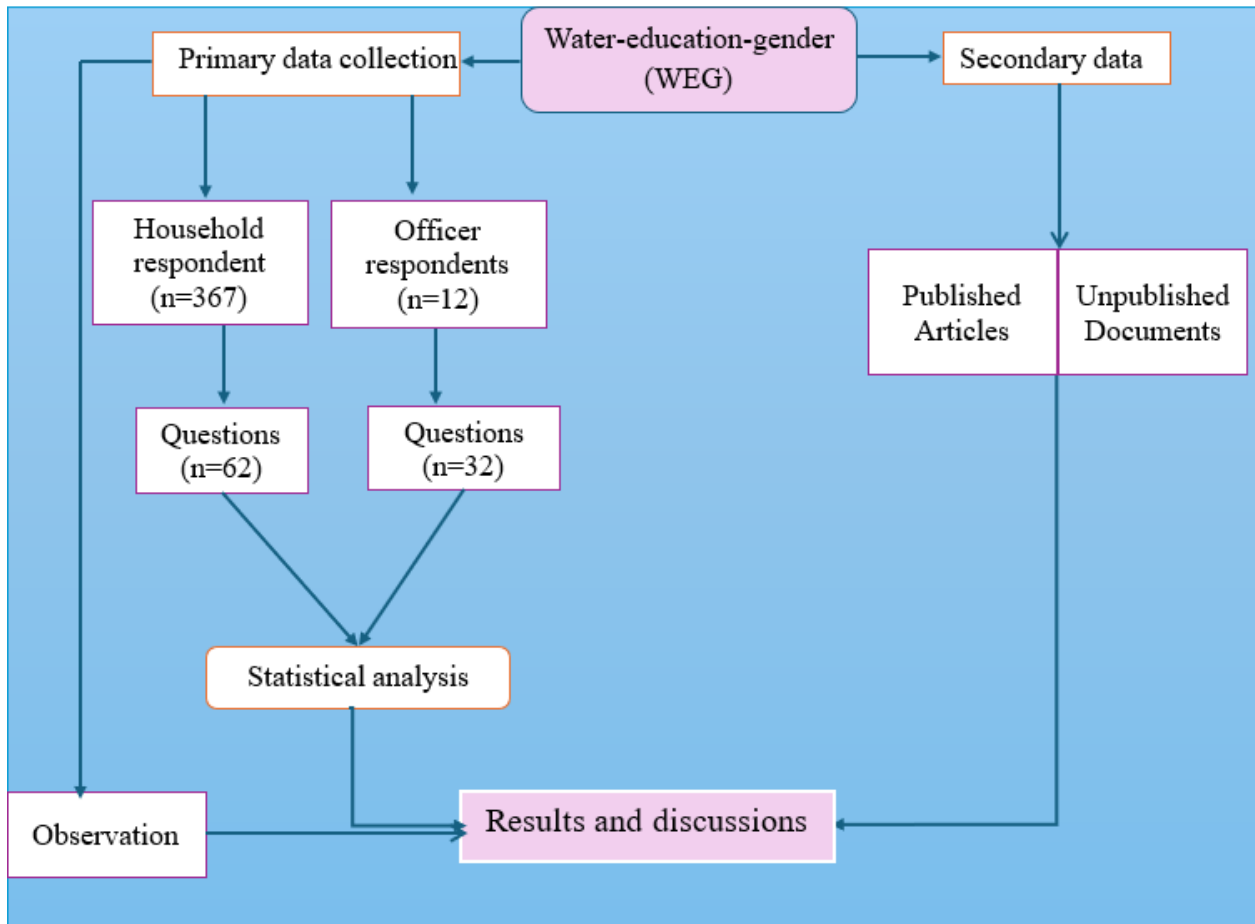


Figure 3.2. Research design of this study

3.3. Sampling technique

This study employs a combination of purposive sampling and simple random sampling to ensure a comprehensive and representative data collection process. Purposive sampling was used to select key informants for qualitative interviews. This method is appropriate for identifying individuals

with specialized knowledge or insights into the study's focus. Seven community leaders from Adar are chosen based on their leadership roles, direct involvement in community and education affairs, and their understanding of the interplay between water, education, and gender in the study area. For quantitative data collection from households, simple random sampling is employed to select 367 from the total 4,400 households in Adar village. This technique ensures that every household has an equal probability of being selected, thus eliminating selection bias and enhancing the representativeness of the sample. The sample size was calculated using the revised Slovin's formula (Eq. 1) as outlined by Tejada et al. (2012), which adjusts for the desired level of precision and the population size. This formula is particularly suitable for ensuring an adequate sample size to draw meaningful statistical inferences about the larger population.

$$n = \frac{N}{1+Ne^2} \quad (1)$$

Where (n) is sample size, (N) is the population size, and (e) is margin of error and e = (5%)

3.4. Data collection methods

This research adopts a mixed-methods approach to collect both quantitative and qualitative data using primary and secondary sources.

Primary data was collected through structured questionnaires, interview guides, tailored to the target participants. A structured questionnaire comprising 62 questions was used to collect data from a sample of 367 households, determined using Slovin's formula (Eq.1). The survey focused on critical variables, including the time spent fetching water, the number of daily trips, distances covered, gender roles in water collection, and the impact of these factors on girls' education. The questions also consider wider topics associated with water accessibility, gender dynamics, educational factors, conflict, and governance. They analyzed domestic water consumption patterns, the decision-making processes involved in the management of water resources, and the involvement of women and girls in water-collecting the survey further explores the ramifications of armed conflict on water infrastructure, access, and the resilience of communities. Moreover, it examines how water shortages and prolonged collection durations influence school attendance, academic achievement, and dropout rates among female students. Furthermore, the survey evaluates local water governance frameworks, policy measures, and community participation in the sustainable management of water resources.

Guided interviews were also used to conduct interviews with 12 community leaders. Each interview consisted of 36 questions designed to explore their perspectives on water issues and education challenges, and gender roles in the community.

Secondary data was obtained from reputable sources, including government reports, NGOs reports, publications, academic articles, and reliable online resources. These sources provided additional context on water access, the impact of armed conflict in Darfur, education status, and gender dynamics in the region.

3.5. Data analysis

The research data was analyzed using a combination of qualitative and quantitative techniques. Survey data was entered into and analyzed using the Statistical Package for Social Sciences version 27. Descriptive statistics, including measures of central tendency (mean, median) and dispersion (standard deviation), were used to summarize the data. A multiple linear regression model was applied to examine the relationships between independent variables and dependent variables. Frequency analysis was conducted to assess the distribution of categorical data. OriginPro 8.5 were also employed and used in this study to visualize data in the form of Figure.

Data from interviews with community leaders and teachers were thematically coded to identify patterns, insights, and perspectives related to the water-education-gender (WEG) nexus. The integration of qualitative and quantitative findings through triangulation allowed for a comprehensive understanding of the research questions.

3.6. Ethical considerations

Ethical principles were upheld throughout the research process:

Ethical clearance: Approval for the research was obtained from the Pan African university institute of water and energy sciences (PAUWES) and relevant local offices in Sudan.

Informed consent: Participants were fully informed about the study's objectives, methods, and their rights. Verbal consent was obtained from all participants.

Confidentiality and anonymity: The identities of respondents were kept anonymous, and their data was treated with strict confidentiality. Specific protocols were implemented to ensure data security, including encryption and restricted access.

Community engagement: Preliminary discussions were held with community leaders to gain their approval and support for conducting the research.

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1. Socio-economic characteristics of the respondents

Table 4.1 presents the demographic details of (n=367) respondents from Adar village, gathered through interviews. Understanding the respondents' socio-economic characteristics-such as gender, age, education level, occupation, household size, and marital status, is essential insights into the community's demographic makeup. These factors are key to assessing the community's capacity, participation, and attitudes toward WEG nexus and its related development initiatives.

Slightly higher representation of females (53.4%) compared to males (46.6%) were included in the study. This gender balance is significant for the study, considering that women and girls are disproportionately affected by water collection responsibilities. Females' higher representation ensures that their experiences and challenges, especially regarding water access and education, are well captured in the WEG nexus analysis (Table 4.1).

Most respondents fall within the 26-35 age group (48.0%), followed by the 18-25 group 29.2% (Table 4.1). This young (18-35 years which accounts 77.2%) demographic age group indicates a population in its productive years, potentially engaged in farming and caregiving roles. The presence of 15.3% respondents under 18 years suggests a considerable number of school-aged children, emphasizing the importance of examining how water collection affects girls' school attendance and academic performance.

Among respondents, 31.6% have no formal education, while 26.7% and 28.6% have primary and secondary education, respectively. Only 13.1% respondents have attended college or university education. This shows low literacy levels in the community, which may affect awareness and the use of better water management practices. These findings highlight the need to tackle education barriers, especially for girls responsible for water collection, which is a key concern of this study.

Table 4.1 shows that farming is the main 70.6% livelihood of the household, suggesting that the community's reliance on agriculture, which is affected by water scarcity and climate change. There are very few government employees 0.3%, showing limited job opportunities, while the presence of self-employed individuals 13.4% and students 11.2% indicates possibilities for community solutions and youth involvement in water resource management.

Table 4.1 also shows that higher 40.3% portion of households has 3-5 members, while 33.0% have 6-10 members and 19.3% have less than 3 family. Larger number of households may increase water demand, intensifying the burden on women and girls to secure enough water. This directly impacts their time and ability to pursue education and other developmental opportunities, which is central to the WEG nexus. Most 66.8% respondents are married, showing that traditional family roles with women mainly handling household chores, like water collection. The 24.8% single group, likely younger, suggests possibilities for education and changing gender roles among them.

Table 4.1. Socio-economic characteristics of the respondents

Variables	Alternatives	Responded	
		Frequency	%
Gender	Male	171	46.6
	Female	196	53.4
Age (year)	<18	56	15.3
	18-25	107	29.2
	26-35	176	48.0
	>35	28	7.6
Education level	None	116	31.6
	Primary	98	26.7
	Secondary	105	28.6
	College	12	3.3
	University	36	9.8
Occupation status	Farming	259	70.6
	Government employee	1	0.3
	Self employee	49	13.4
	Unemployed	17	4.6
	Student	41	11.2
Household size (number)	<3	70	19.1
	3-5	148	40.3
	6-10	121	33.0
	≥10	28	7.6
Marital status	Single	91	24.8
	Married	245	66.8
	Divorced	31	8.4

4.2. Water supply, accessibility, acceptably, affordability and consumption patterns in Adar

The findings of this section revealed significant challenges in water supply, accessibility, affordability, and consumption in Adar village due to conflict and climate change. Table 4.2 indicates that most (52.9%) households depend on water sources they have utilized for over five years, reflecting a long-term reliance.

The primary (46.5%) water sources are from wells [protected (25.3%), unprotected (21.0%), and pump (11.2%)] followed by surface water (24.5%), and public tap (10.9%). Rainwater harvesting remains low (7.1%) source of water in the study area, despite its ability to help ease water shortages. The dependence on unprotected sources points up the risks of contamination (Table 4.2).

According to the World Health Organization (WHO), adequate access to water is defined by having a reliable water source situated within a 30-minute walk, supplying at least 20 liters per person per day (WHO, 2020). Although 62.9% of respondents indicate that they travel for less than 30 minutes to obtain water, 32.2% require between 30 and 60 minutes, which suggests large proportion of household is out of the WHO recommendation distance (Table 4.2). This situation is further complicated by the waiting durations after they arrived to the water source. Most respondents said that they wait 75.5% for about or less than 60 minutes while 24.0% respondents said they wait up to 3 hours at the source of water. The significant (65.5%) frequency of daily trips are three (49.0%) and more (16.5%) times per day, reflects that a considerable amount of time is devoted to water collection, consequently influencing other socioeconomic activities.

Individual water usage is minimal, as 26.4% of the population utilizes fewer than 20 liters each day, while merely 21.3% surpass the 50-liter mark (Table 4.2). Analysis of household consumption indicates that over half (54.8%) of the households consume between 101-500 liters daily, a figure that potentially falls short of the sphere standards applicable in humanitarian settings.

Table 4.2 reveals significant challenges in water access, affordability, and irrigation practices in Adar. Most households 85.6% rely on free, but unsafe, water sources, raising quality and accessibility concerns. The WHO (2020) states that water costs should not exceed 3% of household income for affordability, and adopting water-efficient irrigation is crucial for food security. Addressing these issues through infrastructure investment, education, and subsidies can help align water management in Adar with global standards. The lack of water tariffs leads to overuse, making sustainable management difficult. The World Bank (2019), emphasises implementing tariffs for efficient use and financial viability. A fair tariff system could promote conservation and improve sustainability. A fair tariff system, following WHO standards, (water costs not exceeding 3% of household income), could promote conservation and improve sustainability.

Table 4.2. Water accessibility and consumption patterns in Adar village

Variables	Alternatives	Frequency	%
Years depended on water source	<2	39	10.6
	2-5	134	36.5
	>5	194	52.9
Main water sources	Public tap	40	10.9
	Pump well	41	11.2
	Protected well	93	25.3
	Unprotected well	77	21.0
	Surface water	90	24.5
	Rainwater harvesting	26	7.1
Distance from water source (minutes)	<30	231	62.9
	30-60	118	32.2
	61-120	16	4.4
	>120	2	0.5
Waiting time at the water source (minutes)	<60	277	75.5
	60-180	88	24.0
	>180	2	0.5
	Once	12	3.3
	Twice	114	31.1
	Three times	180	49.0
	More than three times	60	16.3
Water consumed daily per person (litters)	<20	97	26.4
	20-50	158	43.1
	51-100	78	21.3
	>100	34	9.3
Water consumed daily per household (litters)	<50	6	1.6
	50-100	91	24.8
	101-500	201	54.8
	>500	69	18.8
Water cost & proportion from monthly income	No, I do not have pay	314	85.6
	< 1% of my income	48	13.1
	1-3% of my income	5	1.4
Irrigation practice on farms in Adar	Yes	292	79.6
	No	75	20.4
Kind and methods of irrigation practice	Drip irrigation	2	0.5
	Sprinkler irrigation	23	5.7
	Flood irrigation	52	12.9
	Furrow irrigation	165	40.9
	Manual irrigation	161	40.0
Irrigation affordability in Adar	Very affordable	51	13.9
	Somewhat affordable	75	20.4
	Affordable	110	30.0
	Too expensive for most	69	18.8
	I don't know/No opinion	62	16.9

A majority of farmers 79.6% practice irrigation in their farms in the study area, primarily using traditional methods like furrow 40.9% and manual irrigation 40.0%, with minimal adoption of efficient techniques such as drip irrigation 0.5% (Table 4.2). Affordability is a barrier for 18.8% of respondents, who find irrigation too expensive, potentially limiting access to modern technologies. These findings highlight the need for improved water quality, efficient irrigation methods, and financial support to ensure sustainable water use and agricultural productivity. In similar study by Baruah et al.(2023), state that sustainable practices for water conservation benefit farming and the environment. They improve water use, reduce waste, and save water for future generations. Techniques like drip irrigation enhance productivity while using less water. Good water management supports crop yields, and helps farmers adapt to climate changes.

4.2.1. Water quality, primary uses, affordability and cost implications

Challenges related to water quality are widespread. Figure 4.1a illustrates that 68.1% of participants recognize pollution as the predominant issue, whereas microbial and chemical contamination are reported by 12.8% and 4.1%, respectively. The majority 56.7% of households said that overall physical (taste, colour, and odor) water quality is poor (Figure 4.1b), which further diminishes acceptability for human consumption.

Figure 4.1c illustrates that, although 64.6% of participants indicate the absence of barriers, social 22.62% and financial 12.0% obstacles inhibit access for certain individuals. Legal impediments are minimal 0.82%, indicating the informal characteristics of water accessibility.

Figure 4.1d shows the distribution of household water usage-drinking (21.1%), cooking (19.3%), washing (19.3%), hygiene (17.1%), livestock (10.7%), and agriculture (2%)-reveals critical insights for water conservation strategies. Hygiene and washing dominate water consumption, highlighting the potential for significant savings through water-efficient appliances and behavioural changes, such as shorter showers and full laundry loads. Livestock and agriculture, while smaller in percentage, are vital for household's dependent on these activities, necessitating sustainable practices like drip irrigation and automated watering systems. Addressing these high-impact areas through targeted interventions can optimize water use, ensuring sustainability and resource availability for future generations. Future research should focus on empirical data collection and evaluating the effectiveness of conservation technologies and practices to refine these strategies further.

Table 4.3 indicates that the inferior quality is largely attributed to insufficient infrastructure maintenance, lack of treatment, and contamination from nearby waste. The leading reason identified is the insufficient maintenance of water supply infrastructure, which accounts for 21.9% of the responses. This reveals notable deficiencies in maintenance practices and underscores the necessity for systematic maintenance initiatives and infrastructural enhancements to assure safe water supply. The second most commonly cited reason is the absence of adequate treatment or filtration, represented by 19.7% of responses, highlighting the immediate need to establish cost-effective and accessible water treatment facilities.

Contamination stemming from adjacent waste disposal sites, which constitutes 16.9% of responses, indicates deficiencies in waste management systems and emphasizes the necessity for improved waste collection and disposal methods to avert contamination of water sources. Environmental elements, such as turbid or muddy water, were reported by 18.6% of respondents, signifying the effects of ecological conditions, particularly during the rainy season, on water quality. Elevated (15.4%) concentrations of minerals or salts point to the prevalence of naturally occurring contaminants that compromise both taste and potability. While the reference to chemicals or pollutants was less (7.6%) frequent, it remains an important concern, especially given the potential health risks associated with chemical exposure. It should be noted that no specific measures exist for water quality testing in Adar, as indicated by the 12 officials (which will be discussed later in detail) in the village their consensus (100%) confirmed a lack of established protocols for water quality assessment in Adar. These findings indicate that enhancing water quality in Adar necessitates a comprehensive strategy: upgrading and maintaining infrastructure, implementing affordable water treatment solutions, fortifying waste management systems, and promoting community awareness regarding the protection of water sources.

Table 4.3. Reasons of poor water quality in Adar village

Reasons of poor water quality in Adar	Responses	
	Frequency	%
Contamination from nearby waste disposal	91	16.9
Poor maintenance of water supply infrastructure	118	21.9
High levels of minerals or salts	83	15.4
Presence of chemicals or pollutants	41	7.6
Lack of proper treatment or filtration	106	19.7
Natural factors (e.g., muddy or turbid water sources)	100	18.6

Water affordability is a concern, as 85.6% of respondents incur no costs, indicating dependence on communal or informal sources (Table 4.2). As stated by the 12 officials in Adar, their agreement (100%) indicates that water is provided at no cost in Adar. Nevertheless, 13.1% of individuals spend less than 1% of their income on water. Perceptions of affordability vary 34.3% view irrigation costs as somewhat affordable or affordable, while 20.4% find them too expensive.

The household water consumption focuses on drinking (21.1%), cooking (19.3%), and washing (19.3%) (Figure 4.10). livestock and agricultural applications are allocated a smaller proportion (10.7% and 2%), highlighting the constraints on water availability for productive purposes.

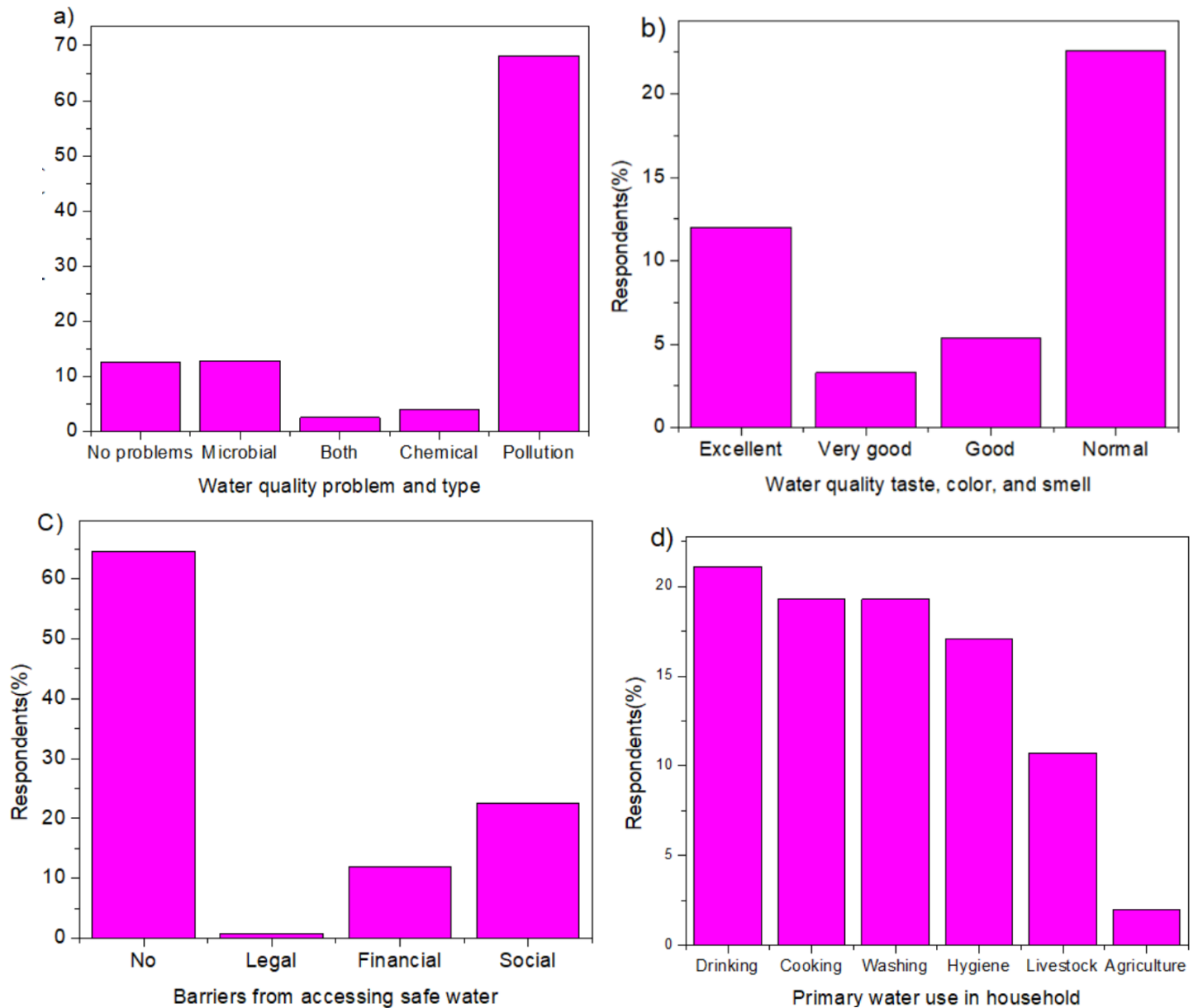


Figure 4.1. Water quality, primary uses, affordability and cost implications

4.2.2. Climate change and water supply

Table 4.4 highlights various aspects of water supply and climate change in the study area. Majority of respondents 88.3% noticed changes in water supply, with 75.6% attributing these changes to climate change, while 8.1% cited population increases and 16.3% mentioned pollution during autumn. Climate change has impacted water availability, with 55.7% noting changes in rain patterns, 44% reporting frequent floods, and only 0.3% mentioning increased drought. In a similar study conducted in Sub-Saharan Africa, researchers found that climate change significantly impacts water availability, with shifts in rainfall patterns and increased frequency of floods being major contributors to water scarcity (Ofori et al., 2021).

Additionally, Table 4.4, shows challenges in accessing water due to climate change include poorer water quality (47%), reduced availability (25.3%), increased distance to water sources (25%), and higher prices (2.7%). To adapt, 46.3% of respondents have adopted rainwater harvesting, 41.7% sought alternative sources, and 12% considered migration. Moreover, the issue of poor water quality due to climate change, particularly the increase in waterborne diseases, has been documented in a study conducted by Ashrafuzzaman et al. (2023), revealed over 70 % of respondents reported similar health-related challenges due to deteriorating water quality. This mirrors the study area findings with 39.5% reporting waterborne diseases, 31.4% noting taste changes, and 29.3% observing increased salinity. Water supply challenges are most prevalent during the dry season (46.2%), followed by during rains (19.9%), at any time (11.5%), rarely (14.9%), and never 7.5% (Table 4.4). According to the African Development Bank (2020), only 54% of the African population has access to a safely managed drinking water service, during the dry season, this access drops by 15-20% in arid and semi-arid areas as a result of the depletion of wells, boreholes, and other sources of water. Sewage disposal methods include pit latrines (60.7%), septic tanks (8%), public networks (3.8%), open defecation (2.5%), and direct disposal into streams (2.5%). Challenges related to water supply include insufficient water quantity (29%), poor water quality (23.3%), high costs (5.5%), lack of accessibility (13.3%), seasonal variability (9.6%), and infrastructure issues (18.9%). The study by Malima et al. (2022), revealed challenges related to water supply, such as water cost, quality, system failures, lack of funding, and poor maintenance. It recommends that communities get involved in water projects and pay for services. Active participation in water committees is also advised, aiming for better rural water supply through collaboration with stakeholders.

Table 4.4. Water supply and climate change in Adar

Variables	Alternatives	Respondent	
		Frequency	%
Do you notice change in water supply	Yes	324	88.3
	No	43	11.7
Changes in water supply throughout year	Climate change	307	75.6
	Population increases	33	8.1
	Pollution during autumn	66	16.3
How climate affected water availability	Increased drought	1	0.3
	Frequent floods	158	44
	Rain pattern change	200	55.7
Challenge accessing water due climate cha	Increased distance	168	25
	Higher prices	18	2.7
	Reduced availability	170	25.3
	Poorer water quality	315	47
Measures taken to adapt to climate change	Rainwater harvesting	170	46.3
	Alternative sources	153	41.7
	Migration	44	12
Challenge accessing water due climate change	Frequent floods	158	44
	Rain pattern change	200	55.7
	Increased distance	168	25
	Higher prices	18	2.7
	Reduced availability	170	25.3
	Poorer water quality	316	47
How climate change impacted water quality	Increased salinity	125	29.3
	Taste changes	134	31.4
	Waterborne diseases	168	39.3
When water supply is a challenge	Lack water in dray season	204	46.2
	Lack water during rains	88	19.9
	Lack water at any time	51	11.5
	Rarely lack water	66	14.9
	Never lacks water	33	7.5
Destination of the sewer of houses	Public network	14	3.8
	Septic tank	29	8
	Pit latrine	221	60.7
	Directly in the stream	9	2.5
	Open defecation	91	25
Challenges faced related to water supply	Insufficient water quantity	207	29.4
	Poor water quality	164	23.3
	High cost of water	39	5.5
	Lack accessibility to source	94	13.3
	Seasonal variability in supply	68	9.6
	Infrastructure issues	133	18.9

4.3. Water scarcity, school attendance, and its impact on girls' education

Table 4.5 shows that 81.2% of the households examined have female students of school age; however, their school participation is irregular. Merely 28.1% of these girls are enrolled in school consistently, whereas a minority (7.6%) attends frequently, occasionally (18.8%), infrequently (20.4%), or not at all (25.0%). In contrast, the attendance rate among boys is notably higher, with regular attendance at 36.6%, while lesser percentage experiences total exclusion from educational institutions (21%). The gap in educational attendance can be primarily ascribed to domestic duties, such as the collection of water, which requires considerable time and effort. The study by Nauges & Strand (2017), shows significant negative link between girls' school attendance and water fetching, halving water fetching time raises girls' school attendance by 2.4%, in rural areas.

Domestic duties are significant factor contributing to the irregular school attendance of girls. As shown in Table 4.5, 49% of girls miss school due to household chores, including water collection. Additional factors influencing girls' school attendance include financial constraints 12.1%, distance to educational facilities 6.3%, cultural influences 11.0%, and inadequate education quality 21.7%. Similar factors impact boys' attendance; however, the percentage of boys missing school due to chores is notably lower 9.4%, emphasizing the heavier responsibilities by girls (Table 4.5).

Water scarcity is a crucial element exacerbating educational inequalities. Data presented in Table 4.5 indicates that 58.5% of respondents concur that water scarcity adversely affects girls' educational opportunities, with substandard facilities (22.8%) and health issues (18.7%) contributing to absenteeism. Among the challenges posed by water scarcity for females, the most critical factors include the increased time required for water collection (24.1%), physical exhaustion (15.7%), diminished time available for educational and income-generating activities (21.8%), and elevated household stress (15%). Moreover, limited access to water during menstruation period (3.6%) further limit girls' school participation.

In response to these challenges, certain households have implemented strategies to bolster girls' education. Table 4.5 reveals that 54.1% of respondents identified proximate water sources as a crucial facilitator for enhancing school attendance. Improved facilities (19.7%) and heightened awareness (26.2%) were also the most likely highlighted as vital interventions. However, obstacles such as safety concerns (82.6%), lack of transportation (24.6%), and economic difficulties (13%) persist, continuing to constrain educational access, particularly for girls.

Table 4.5. Impact of water collection on girls' education

Variables	Alternatives	Respondents	
		Frequency	%
School-aged girls in household	Yes	298	81.2
	No	69	18.8
School attendance school-aged girls	Always/regular	103	28.1
	Often	28	7.6
	Sometimes	68	18.5
	Rarely	75	20.4
	Never	93	25.3
School-aged boys in household	Yes	304	82.8
	No	63	17.2
School attendance school-aged boys	Always/regular	135	36.8
	Often	86	23.4
	Sometimes	48	13.1
	Rarely	21	5.7
	Never	77	21.0
Girl's school attending not regular	Chores	201	49.0
	Cost	49	12.1
	Distance to school	26	6.3
	Cultural reasons	45	11.0
	Poor quality	89	21.7
Boys school attending not regular	Chores	30	9.4
	Cost	100	31.4
	Distance to school	44	13.8
	Cultural reasons	9	2.8
water scarcity affects girls' education	Girls miss school	298	58.5
	Poor facilities	116	22.8
	Illness	95	18.7
Water scarcity challenges affecting females	Increased time spent collecting water	181	24.1
	Physical strain	118	15.7
	Reduced activities time for education or income	164	21.8
	Increased household stress and workload	113	15.0
	Greater risk of health	87	11.6
	Emotional-mental stress	42	5.6
	Limited access to water during menstruation	46	6.1
Actions to support girls' education	Nearby water	272	54.1
	Better facilities	99	19.7
	Awareness	132	26.2
Barriers preventing children attending school	Safety concerns	304	62.3
	Lack of transportation	120	24.6
	Economic hardship	64	13.0

4.3.1. Gendered division of labor in water collection

The gender dynamics in Adar reveals notable inequities in domestic responsibilities, particularly in relation to water collection, which in turn influences school attendance. As shown in Figure the responsibility of fetching water predominantly falls on females (~75.0%), with 47.0% of women and 28.0% of girls undertaking this duty. Conversely, only ~10.0% of men and 5.0% of boys participate in water collection, while 11.0% of families distribute this responsibility equally. Consistent to this study, Graham et al. (2016), state that households where water collection took over 30 minutes, adult women were the main collectors in all 24 countries, from 46% in Liberia to 90% in Cote d'Ivoire. Additionally, female children were more frequently involved in water collection than male children, with girls responsible for 62% of the task compared to 38% for boys.

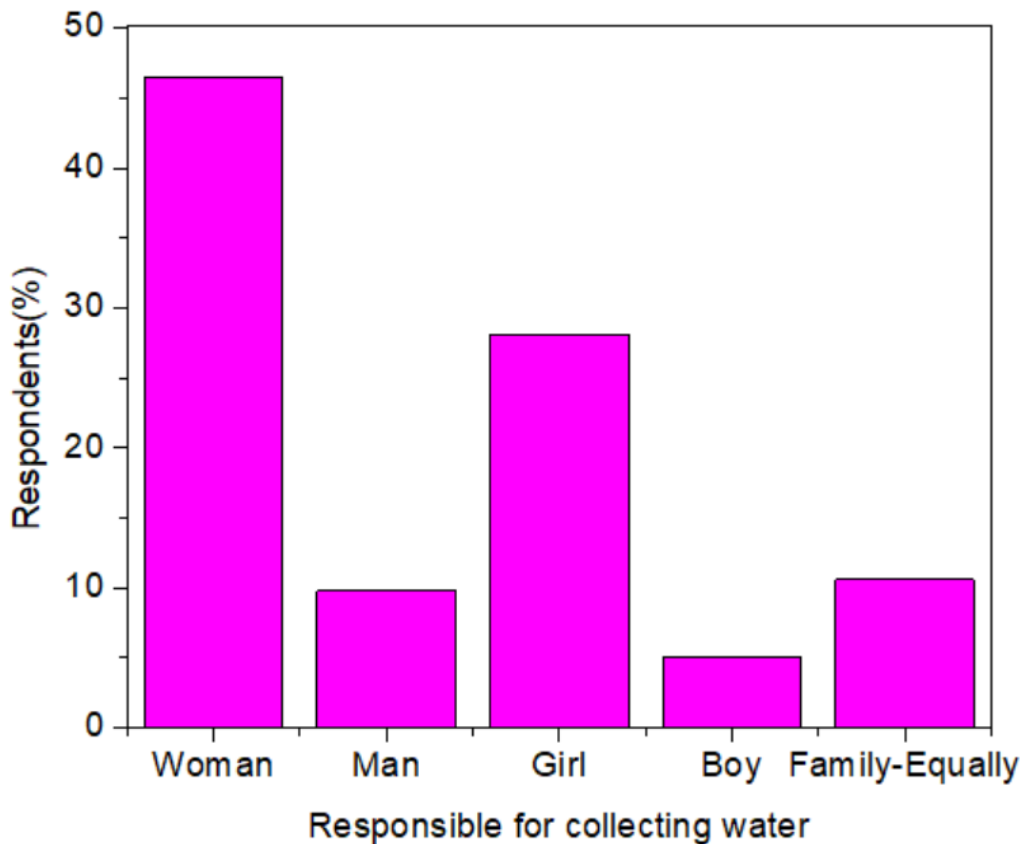


Figure 4.2. Distribution of fetching water within households in Adar

4.4. Community participation, governance, and effectiveness in water management

Community-driven efforts are vital for the management of water resources in Adar village. A significant (54.5%) portion of the water management duties is undertaken by community committees, while NGOs (20.4%) and individual households (15.7%) also contribute. In contrast,

the participation of local government (0.8%) and the private sector (8.5%) is notably very low (Table 4.6). This situation reveals a governance deficiency, whereby communities are compelled to assume responsibility in the absence of robust institutional backing, a condition likely intensified by the prevailing conflicts. Dewan et al. (2014) highlight the vital role of community-based organizations in water management in coastal Bangladesh, where Water Management Organizations handle most responsibilities. However, these groups, often supported by NGOs and donors, receive little formal recognition or support from local governments, undermining sustainability and equity. This mirrors Adar village, where weak institutional backing forces communities to manage water resources independently. Similarly, Adams and Zulu (2015) examine Water User Associations in Malawi's peri-urban areas, which manage communal water kiosks with NGOs and donor support. However, minimal government and private sector participation hinder their effectiveness. This is comparable to Adar village, where NGOs contribute significantly (20.4%) to water management, but local government involvement is nearly absent (0.8%). In both cases, NGOs play a crucial role-organizations like Nijera Kori in Bangladesh and WaterAid in Malawi provide funding, technical expertise, and capacity building, compensating for weak government engagement. The studies also highlight a governance gap: local governments are marginalized, leading to inefficiencies, while the private sector remains largely uninvolved due to financial constraints. This aligns with Adar village's challenges, where local government participation is minimal, and the private sector's contribution is only 8.5%

The existence of policies aimed at enhancing water accessibility is notably sparse, as indicated by 69.8% of respondents reporting that the absence of any policies or programs, while 30.2% acknowledged the existence of such policies (Table 4.6). Nonetheless, the efficacy of these policies remains uncertain, with 75.2% of participants expressing unawareness regarding their impact. Of those who provided an evaluation, only 10.6% deemed the policies to be highly effective, an equal percentage classified them as minimally effective, and 3.5% categorized them as moderately effective. This disparity highlights a substantial disconnect between the creation of policies and their actual execution, likely attributable to inadequate enforcement mechanisms and the destabilizing consequences of conflict.

The function of civil administration in water governance exhibits variability. While 50.4% of participants indicated that the administration plays a primary role, 20.7% regarded it as

supplementary, and 23.4% asserted that it has no role whatsoever (Table 4.6). This fragmented governance dynamic mirrors the broader instability induced by conflict, with local institutions encountering difficulties in sustaining authority and delivering essential services.

Table 4.6. Community engagement in water management

Variables	Alternatives	Respondents	
		Frequency	%
How water managed in Adar	By community committee	198	54.5
	By the local government	3	0.8
	Private sector	31	8.5
	NGOs	74	20.4
	Household management	57	15.7
Policies to improve water access	No, polices or programs	256	69.8
	Yes, theirs polices	111	30.2
Effectiveness of the polices	Highly effective	39	10.6
	Moderately effective	13	3.5
	Minimally effective	39	10.6
	Effectiveness is unknown	276	75.2
Civil administ role in managing water	Primary	185	50.4
	Supplementary	76	20.7
	Replaced	20	5.4
	They have no role	86	23.4
level of community participation	Very high	19	5.2
	High	58	15.8
	Moderate	180	49.0
	Low	61	16.6
	Very low	49	13.4
Satisfaction with community engage	Very satisfied	54	14.7
	Satisfied	142	38.7
	Neutral	114	31.1
	Dissatisfied	22	6.0
	Very dissatisfied	35	9.5
Performance of water management system	Excellent	28	7.7
	Good	49	13.4
	Average	163	44.5
	Poor	99	27.0
	Very poor	27	7.4
Who are projects resources responsible	Donor	66	18.0
	Community	210	57.2
	Village government	91	24.8
Governments &NGO involve communities in projects	Yes	215	58.6
	No	88	24.0
	Unsure	64	17.4

Community involvement in water management is rated as moderate, with 49.0% of respondents categorizing their level of engagement as such, whereas only 5.2% described it as very high. Conversely, 16.6% indicated low participation, and 13.4% reported very low levels (Table 4.6). These results imply that despite the role of communities, obstacles such as resource constraints, displacement, and disruptions related to conflict impede more profound engagement. Considering these challenges, levels of community satisfaction vary. While 38.7% of respondents expressed satisfaction, and 14.7% reported being very satisfied, a substantial portion remained neutral 31.1%, and dissatisfied 15.5% (Table 4.6). This demonstrates that while local initiatives are acknowledged, structural limitations undermine total confidence in community-led water management.

The assessment of water management systems in Adar is predominantly characterized as average 44.5%, with merely 7.7% deeming it excellent and 13.4% labeling it good. A notable segment of respondents categorized it as poor 27.0% or very poor 7.4% (Table 4.6). These observations suggest that although community-driven efforts are essential, they are deficient in the requisite technical and financial resources to secure a sustainable water supply. The ongoing conflict has likely exacerbated this issue by damaging infrastructure and diminishing external support.

The survey conducted among officials indicates that the availability of water in Adar is inconsistent, with 50.0% indicating that supply is inadequate during the dry seasons (Table 4.7). Furthermore, there are no established measures for water quality testing, nor are there any initiatives aimed at increasing the water supply (Table 4.7). These results underscore the significant governance and infrastructure issues intensified by the ongoing conflict.

Water scarcity and poor sanitation significantly affect education, especially for female students. The prevalence of shared sanitation facilities in educational institutions is notable, with 91.7% of officials reporting the absence of separate facilities and 8.3% indicating that privacy is lacking (Table 4.7). This deficiency in adequate sanitation may deter school attendance, mainly for girls.

Moreover, female students encounter considerable obstacles in their education, as 33.3% discontinue their studies due to household obligations, while another 33.3% suffer from exhaustion linked to water collection efforts (Table 4.7). Additional hindrances include lengthy distances to water sources (16.7%) and societal expectations (8.3%). These results illustrate the interconnectedness of water access, education, and gender, highlighting how insufficient water

availability disproportionately influences the educational prospects of girls. In a similar study conducted by Nauges and Strand (2017), it is demonstrated that there exists a notable negative correlation between the school attendance of girls and the activity of water collection. Specifically, a reduction in water-fetching time by half correlates with an average increase of 2.4 % points in the school attendance of girls, with more pronounced effects observed in rural areas.

Table 4.7. Key findings from officials' survey in Adar village

Variable	Response options	Respondent	
		Frequency	(%)
Current water situation	Sufficient but unreliable at times	6	50
	Insufficient during dry seasons	6	50
	Sufficient reliable year-round	0	0
	Insufficient unreliable year-round	0	0
	Severe water scarcity	0	0
Water quality testing	No specific measures in place	12	100
Plans to increase water supply	No plans currently in place	12	100
Separate sanitation at school	Yes, but privacy insufficient	1	8.3
	No, only shared facilities	11	91.7
Existence of adaptive measures	Yes	6	50
	No	6	50
Current state of education	Limited access; frequent conflict disruptions	7	58.3
	Limited access; insufficient resources	3	25
	Severe lack of facilities and resources	1	8.3
	Limited access; sufficient resources	1	8.3
Girls' challenges in education	Fatigue from water collection	4	33.3
	Increased dropout due to household roles	4	33.3
	Long distance to water sources	2	16.7
	Lack of time for homework	1	8.3
	Social/cultural expectations	1	8.3
Cost of accessing water	No, water is free	12	100
Water management systems	Community-based management	12	100
Primarily responsible water collects	Women	5	38.5
	Girls	4	30.8
	All family	4	30.8
	Men	0	0
	Boys	0	0
Conflicts impact on water infrastructure	Destruction water infrastructure	2	14.3
	Reduced water facilities maintenance	7	50
	Increased water competition	1	7.1
	Restricted access to water sources	3	21.4
	Displacement of communities	1	7.1

Armed conflict has had a direct impact on water infrastructure in Adar, with destruction cited as the most commonly reported concern (Table 4.7). Other contributing factors include diminished maintenance efforts (50.0%), heightened competition for water resources (71.4%), restricted access (21.4%), and contamination of water sources (14.3%), which collectively exacerbate the crisis. Additionally, community displacement (21.4%) and the loss of qualified personnel impede the restoration of services. These challenges manifest the extensive repercussions of conflict on water governance and accessibility. In similar study conducted by Schillinger and Ozerol (2024), revealed that armed conflicts often damage infrastructure, reduce operational capacity, and make it hard to maintain water services. This is worsened by destroyed facilities, poor maintenance, and limited access to resources. For example, in Aleppo, Syria, conflict led to destruction of the water network due to electricity shortages. In Mosul, Iraq, ISIS's capture of the city caused public water services to fail, forcing residents to use unsafe water sources. Similar issues are seen in Adar, where infrastructure destruction has affected water access. The study also notes that conflicts can weaponize water resources, as seen in Ramadi, Iraq, where ISIS controlled dams. This is similar to the competition for water resources in Adar. Community displacement and loss of skilled workers are common in conflict areas, complicating efforts to restore water services. In summary, the evidence shows that armed conflict disrupts water systems, leading to greater vulnerability and reduced resilience. The cases in the Middle East echo the serious effects of conflict on water management in Adar.

4.5. Impact of armed conflict on WEG nexus

4.5.1. Water scarcity, conflict, and their impact on gender, education, and infrastructure

Water scarcity is a critical factor in exacerbating conflict, with 80.4% of participants recognizing its impact on conflict situations (Table 4.8). The main mechanisms through which water scarcity has incited conflict encompass competition for resources (44.1%), displacement of populations (25.7%), and acts of violence (30.2%). These results imply that inadequate water resources intensify tensions within communities, resulting in involuntary migration and aggressive disputes. With 73.3% of respondents recognizing their engagement, women's involvement in peace-building initiatives is noteworthy (Table 4.8). About 46.6% of participants said that gender-based violence is still a common problem, as are women's increased obligations (39.8%) and restricted mobility (13.6%). Gender roles have also changed because of the conflict. About 64.2% of respondents said that women now shoulder more responsibilities, and 35.8% said that men have moved abroad in

search of employment. These results demonstrate the disproportionate burden that women bear because of displacement brought on by conflict and the dissolution of conventional social systems. The ongoing conflict has profoundly impacted educational accessibility, primarily through interruptions in the water supply to both households and educational institutions. Significant issues comprise an increase in the time required to gather water (20.0%), a decline in the availability of safe water (17.9%), and a rise in school dropout rates (19.5%) (Table 4.8). Furthermore, 22.5% of survey participants indicated that the conflict has resulted in heightened attendance at informal water-fetching locations, which consequently diverts children, especially girls, from participating in formal education. These disruptions underscore the intricate relationship between water scarcity and education, with insufficient water infrastructure intensifying the difficulties encountered by students in areas affected by conflict. The conflict has resulted in the degradation of water infrastructure, with 49.3% of participants indicating that access to water has become unsafe and 45.4% noting that water resources have been exhausted (Table 4.8). This worsens the water crisis, complicating efforts for communities to maintain their livelihoods and hygiene practices.

To address these challenges, several measures have been implemented for resolving water-related conflicts. The majority (79.5%) of respondents regarded dialogue as the main method for conflict resolution, whereas government intervention was identified by 19.4%, and formal agreements had minimal presence at only 1.0% (Figure 4.3). These findings indicate that community-driven dialogue is the most effective approach for alleviating water-related conflicts, as formal agreements and governmental interventions are limited in resolving localized disputes.

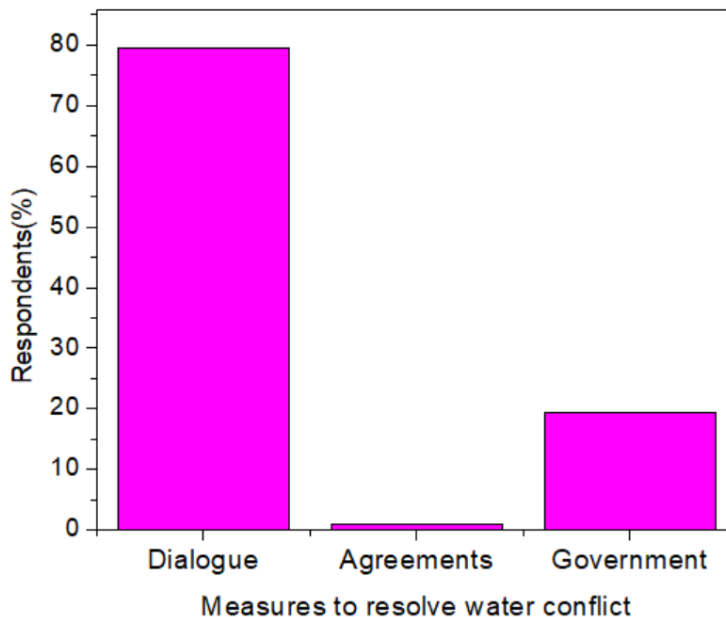


Figure 4.3. Measures to resolve water related conflicts in Adar village

Table 4.8. Impact of armed conflict on WEG nexus

Variables	Alternatives	Response	
		Frequency	%
Water scarcity contribution to conflict	Yes	295	80.4
	No	44	12.0
	Unsure	28	7.6
How water scarcity contributed to conflict	Resource competition	206	44.1
	Displacement	120	25.7
	Violence	141	30.2
Women involvement in peace-building	Yes	269	73.3
	No	45	12.3
	Unsure	53	14.4
Conflicts change women men role	Increased responsibilities	146	39.8
	Gender-based violence	171	46.6
	Limited mobility	50	13.6
	Men migrating for work	157	35.8
	Women taking additional responsibilities	281	64.2
Conflict houses access water educating	Disrupted access to water sources	168	17.7
	Increased time to fetch water	190	20.0
	Reduced availability of safe water	170	17.9
	Increased school dropouts	185	19.5
	Reduced attendance to fetcewater	214	22.5
	Increased water cost & education	23	2.4
Conflicts effect on water infrastructure	Water access unsafe	232	49.3
	Depleted resources	214	45.4
	Remain unaffected	25	5.3
Alternative education arrangements response to conflicts	Yes	173	47.1
	No	149	40.6
	Unsure	45	12.3

4.5.2. The multiple linear regression model impact of armed conflict (WEG) nexus

Table 4.9 presents the results of a multiple linear regression model assessing the impact of armed conflict on the nexus, with the dependent variable being the heightened time and distance required to procure water. The independent variables include disrupted access to water sources, safety concerns preventing school attendance, increased school dropouts due to safety concerns, and women taking on additional responsibilities. Disrupted access to water sources shows a non-significant negative effect ($B = -0.092, p = 0.078$), contributing 23.65% to the model, suggesting that emergency water sources established during conflict may reduce the time and distance needed.

Safety concerns preventing school attendance have a significant negative impact ($B = -0.140$, $p = 0.045$), contributing 27.25%, implying that families may opt for closer, lower-quality water sources during periods of insecurity. Increased school dropouts due to safety concerns are not statistically significant ($B = -0.061$, $p = 0.249$), contributing 15.68%. Women taking on additional responsibilities show a significant positive effect ($B = 0.154$, $p = 0.015$), contributing 33.42%, indicating that as women assume more duties during conflict, the time and distance for water collection increase. The model summary (2 Log Likelihood = 170.567, Cox and Snell $R^2 = 0.045$, Nagelkerke $R^2 = 0.060$) highlights the gender-specific burdens of conflict, with safety concerns and women's increased responsibilities being key predictors of changes in water procurement dynamics. In a similar study conducted by Mayai (2022), the research reveals that educational institutions situated in the conflict areas of South Sudan experience an annual loss of approximately 85 students, which corresponds to 18.5 % of the overall enrolment figures. These results carry considerable ramifications for educational policies and the labor market.

Table 4.9. Multiple linear regression model for impact of armed conflict on WEG nexus

Variable	(B)	Std.	Beta	t-value	Sig.
Constant	1.689	0.142	0	11.869	< 0.001
Disrupted access to water sources	-0.092	0.052	-0.092	-1.770	0.078
Safety concerns prevent school attendance	-0.140	0.070	-0.106	-2.008	0.045
Increased school dropouts' due safety concerns	-0.061	0.053	-0.061	-1.153	0.249
Women taking on additional responsibilities	0.154	0.063	0.130	2.451	0.015

Modal summary		
2 Log Likelihood	Cox and Snell R square	Nagelkerke R square
170.567	0.45	0.060

4.6. The gender dynamics and school attendance model

Table 4.10 presents the results of a nominal logistic regression model examining the influence of household water collection duties on gender dynamics and the school attendance of girls in Adar village. The dependent variable is the frequency of school attendance among girls, with independent variables including roles in water collection (e.g., assigned to girls, boys, women, or men), time and effort related to water collection (e.g., waiting time, distance, number of trips), and socio-economic and cultural factors (e.g., family size, education, cultural norms). Chores, particularly fetching water, contribute 27.49% to the model, significantly reducing the likelihood of regular school attendance for girls ($p = 0.000$).

Table 4.10. Gender dynamics and school attendance model

Effect	-2 Log	Chi-²	df	Sig.
Gender	546.719	4.377	4	0.357
Woman is responsible for collecting water	549.212	6.870	4	0.143
Man is responsible for collecting water	542.815	0.473	4	0.976
Girl is responsible for collecting water	562.242	19.900	4	0.001
Boy is responsible for collecting water	553.217	10.875	4	0.028
All family members contribute equally	559.689	17.348	4	0.002
Cultural reasons	572.130	29.789	4	0.000
Cultural reasons	549.576	7.234	4	0.124
Chores	554.907	12.566	4	0.014
Chores (e.g., fetching water)	691.433	149.091	4	0.000
Age (year)	548.819	6.478	4	0.166
Family members	550.979	8.638	4	0.071
Water used for drinking	549.802	7.461	4	0.113
Water used for cooking	553.100	10.759	4	0.029
Water used for washing	551.517	9.176	4	0.057
Water used for hygiene	546.833	4.491	4	0.344
Water used for livestock	545.078	2.737	4	0.603
Water used for agriculture	554.003	11.661	4	.020
Involvement of women in peace-building efforts	550.701	8.359	4	0.079
Women taking on additional responsibilities	545.500	3.159	4	0.532
Frequency of school attendance for school-aged boys	615.919	73.577	16	0.000
Marital status	550.412	8.071	8	0.427
Level of education	570.865	28.524	16	0.027
Occupational status	569.493	27.151	12	0.007
Main water sources	560.166	17.824	20	0.599
Water is consumed daily per person (litter)	562.513	20.171	12	0.064
Water consumed daily per household (litters)	560.265	17.923	12	0.118
Water cost and proportion from total monthly income	560.210	17.868	8	0.022
Water quality problem and type	568.564	26.223	16	0.051
Waiting time at the water source (in minutes)	565.196	22.854	8	0.004
Number of trips made daily to the water source	571.327	28.985	12	0.004
Distance from water source in kilometers	586.273	43.931	16	0.000

Model summary

2 Log Likelihood	Cox and Snell R square	Nagelkerke R square
542.341	0.797	0.835

When girls are responsible for water collection, their school attendance is significantly lower ($p = 0.001$, $\text{Exp}(B) = 0.308$), contributing 3.67% to the model. Conversely, when boys are tasked with water collection, girls' school attendance improves ($p = 0.028$), contributing 2.01%. Shared responsibility among all family members correlates with higher attendance ($p = 0.002$, $\text{Exp}(B) = 15.797$), contributing 3.20%, suggesting that reducing girls' workload enhances educational access. Cultural reasons contribute 5.49% ($p = 0.000$, $\text{Exp}(B) = 0.044$), reinforcing traditional

gender roles that restrict girls' schooling. Water accessibility issues, such as longer waiting times ($p = 0.004$), contributing 5.32%, and greater distances to water sources ($p = 0.000$), contributing 8.10%, significantly reduce school attendance, underscoring the need for improved infrastructure.

In a related study by Aikowe and Mazancova (2021), the factors influencing water access encompass demographic, cultural, and social elements. Traditional beliefs and gender roles impact the selection of water sources. 79% collect water twice daily. Of those using boreholes, 35.6% walk less than 15 minutes, while 18.6% who use streams walk more than 15 minutes. Only 4% travel over 30 minutes to obtain water.

4.7. Factors affecting the WEG nexus study

4.7.1. Factors impacting water accessibility in Adar village

Table 4.11 presents the results of a nominal logistic regression model examining factors influencing water accessibility in Adar village, with the dependent variable being the distance from the water source (categorized into less than 1 km, 1-5 km, 6-10 km, 11-20 km, over 20 km, and no idea). The independent variables include household demographics, water consumption behaviors, social barriers, and climate-related factors. Occupational status is the most significant predictor, contributing 71.47% to the model ($p = 0.000$), with government-employed households having better water access compared to agricultural households. Water quality (taste, color, smell) is the second most influential factor, contributing 13.10% ($p = 0.018$, $\text{Exp}(B) = 3.380$), with negative perceptions of water quality associated with greater distances to water sources. Social barriers contribute 5.43% ($p = 0.012$, $\text{Exp}(B) = 0.328$), decreasing the likelihood of nearby water sources. Greater reliance on water for cooking contributes 4.46% ($p = 0.034$), reducing accessibility, likely due to increased demand. Seasonal variability shows borderline significance, contributing 3.88% ($p = 0.062$), indicating less reliable access for affected households. Households making twice-daily trips contribute approximately 1.65% ($p = 0.034$, $\text{Exp}(B) = 0.236$) and are 76% less likely to travel beyond 5 km, suggesting better accessibility. In a comparable study conducted by Graham et al. (2016), the researchers examined water accessibility in rural Uganda, emphasizing the impact of socio-economic and environmental determinants. Their findings indicated that household income, employment, and seasonal fluctuations had a significant effect on water access ($p < 0.05$), with more affluent households enjoying superior access. Additionally, social obstacles and negative perceptions of water quality were associated with greater distances to water sources ($p = 0.03$).

Table 4.11. Factors influencing water accessibility in Adar village

Predictor variable	Chi- ²	df	Sig.	Exp(B)	Interpretation
Occupational status	193.488	20	0.000	-	Significant predictor; employment improves access.
Water used for cooking	12.079	5	0.034	0.512	Higher cooking water usage decreases accessibility.
Social barriers to water access	14.710	5	0.012	0.328	Social barriers reduce likelihood of closer sources.
Water quality (taste, color, Smell)	35.473	20	0.018	3.380	Normal quality perceptions improve water access.
Seasonal variability in supply	10.509	5	0.062	0.418	Borderline significant; seasonal changes hinder access.
Number of daily trips (Twice)	4.479	1	0.034	0.236	Twice-daily trips associated with better accessibility.

Model summary

2 Log Likelihood	Cox and Snell R square	Nagelkerke R square
565.198	00.479	0.538

4.7.2. Factors affecting girls' education in Adar village

Table 4.12 revealed the outcomes of a nominal logistic regression analysis investigating the determinants of girls' educational engagement in Adar village, where the dependent variable is defined as the frequency of school attendance, categorized into always/regular, often, sometimes, rarely, and never. The independent variables encompass household characteristics, variables pertaining to water access, and individual demographics. The tasks associated with household responsibilities, particularly the need to collect water, substantially diminish the probability of consistent school attendance ($p = 0.000$), accounting for 48.96% of the explanatory power of the model. This reflects a robust negative correlation, evidenced by an odds ratio (Exp(B)) of 0.044 for the "often" category. Furthermore, the distance to the water source ($p = 0.023$) and the waiting duration at this source ($p = 0.028$) are notable predictors, contributing 8.67% and 5.12% to the model, respectively. Increased distances and extended waiting times are linked to reduced attendance rates. Additionally, occupational status ($p = 0.033$) accounts for about 6.66% of the model's explanatory capacity, indicating that households engaged in agricultural activities tend to experience lower attendance rates compared to those employed in government positions. The educational attainment of the household head contributes roughly 7.01% to decreased attendance in families where education levels are lower, despite not reaching statistical significance. Family size, which contributes around 3.84%, similarly suggests a trend toward decreased attendance rates in larger households, though this finding is also not statistically significant. Other factors, including age (1.21% contribution), gender (1.34%), marital status (around 2.10%), the primary sources of

water (5.02%), the proportion of water costs (3.56%), and the frequency of trips to the water source daily (6.23%), exhibit relatively minor contributions to the model. A comparable study conducted by Koolwal and van de Walle (2013), revealed how water access and household duties impact children's education. The findings indicate that the activities of fetching water adversely affect school attendance, particularly among females, corroborating the results of the Adar study regarding this concern ($p = 0.000$). Increased distances to water sources and prolonged waiting periods correlate with diminished attendance rates ($p = 0.023$, $p = 0.028$). The research further emphasizes that economic activities and larger family sizes influence the time allocated for education. Additionally, it subtly examines familial structures, suggesting that those with more members may dedicate increased time to household chores, such as water collection, thereby potentially lowering school attendance, which aligns with your observation that family size impacts attendance rates.

Table 4.12. Factors affecting girls' education in Adar village

Effect	Chi-Square	df	Sig.
Chores (e.g., fetching water)	164.880	4	0.000
Age (year)	4.078	4	0.396
Gender	4.514	4	0.341
Marital status	7.077	8	0.528
Family size	12.929	12	0.374
Level of education	23.602	16	0.099
Occupational status	22.428	12	0.033
Main water sources	16.890	20	0.660
Water cost proportion	11.975	8	0.152
Distance from water source (km)	29.202	16	0.023
Waiting time at water source (minutes)	17.227	8	0.028
Number of trips to water source daily	20.964	12	0.051

Modal summary

2 Log Likelihood	Cox and Snell R square	Nagelkerke R square
787.261	0.577	0.605

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusions

his study underscores the critical challenges faced by Adar village, West Darfur, Sudan, in addressing the interconnected issues of water access, education, and gender equity amidst armed conflict. The findings reveal significant disruptions to water infrastructure, widespread water quality issues, and pronounced gender disparities in education, particularly affecting girls who bear the primary burden of water collection. Existing water management policies and community initiatives, while present, are insufficient to address these multifaceted challenges. To achieve sustainable development, it is imperative to strengthen water infrastructure, implement gender-sensitive policies, and enhance community participation in water governance. By addressing water scarcity, improving educational access, and promoting gender equity, Adar village can build resilience and foster long-term development in the face of ongoing conflict. Furthermore, deficiencies in governance and policy have obstructed the efficient management of water resources. The lack of sustainable water tariffs, inadequate institutional frameworks, and ineffective community engagement strategies have contributed to the inefficiency of water supply systems, posing substantial challenges to sustainable development in Adar village. Addressing these structural shortcomings is essential for improving water access, enhancing educational opportunities, and fostering gender equity in the area.

5.2. Recommendations

Considering the study's findings, the following recommendations are presented to improve water availability, advance gender equity, and enhance educational opportunities in Adar village:

- Invest in the rehabilitation and expansion of water infrastructure, such as solar-powered wells, piped systems, and rainwater harvesting facilities, to ensure reliable and safe water access. Implement water treatment solutions to address pollution and contamination, as 68.1% of respondents identified pollution as a major issue, and 56.7% rated water quality as poor.
- Develop and enforce policies that reduce the burden of water collection on women and girls, who perform 75% of this task. Introduce community-based initiatives, such as shared water collection responsibilities and gender-sensitive education programs, to improve girls' school attendance, which currently stands at only 28.1% compared to 36.8% for boys.
- Strengthen community-driven water management systems by increasing local involvement in decision-making processes. Currently, 54.5% of water management is community-led, but greater collaboration with NGOs (20.4%) and government (0.8%) is needed to ensure sustainable and equitable water distribution.
- Implement adaptive measures, such as rainwater harvesting and flood control systems, to mitigate the impacts of climate change on water availability. With 75.6% of respondents attributing water supply changes to climate change, these measures are essential to ensure long-term water security and reduce the strain on women and girls.

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MOHAMMED ABAKAR HASAN ABDALRAHMAN

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PROFESSIONAL OBJECTIVE

Experienced Agricultural Engineer and Water Policy Master's Candidate specializing in sustainable water resource management and food security. Proven expertise in agricultural machinery, smart irrigation systems, and policy analysis. Seeking to leverage skills and experience to drive impactful solutions in water resource governance and development.

PERSONAL INFORMATION

- **NAME:** Mohammed Abakar Hasan Abdalrahman.
- **NATIONALITY:** Sudanese.
- **DATE OF BIRTH:** 1. Jan.1997
- **HOMELAND:** West Darfur State, Al-Geneina

EDUCATION

- **Master of Science in Water Policy**
Pan African University Institute for Water and Energy Sciences (PAUWES), Algeria
May 2023 – Expected May 2025
- **Bachelor of Science (Honors) in Agricultural Engineering**
Bahri University, Sudan 2015 – 2021

PROFESSIONAL EXPERIENCE

Reporter & Board Member

Hajar Satellite Channel

Jan 2022 – Present

- Co-founded Hajar satellite channel and serve on the board of directors.
- Produce reports on issues in Sudan, including human rights and social challenges.

Essay Writer

Intelligent World Newspaper

Jan 2021 – Present

- Wrote analytical articles focused on Sudanese and African socio-political topics, emphasizing water policy and regional development.

CORE SKILLS

- Data analysis: Excel, RStudio, SPSS, OriginPro.
- Technical tools: COWPAT 8.0, ArcMap, QIS, HEC-HMS, Powersim.
- Effective communication and time management
- Complex problem-solving and critical thinking
- Leadership and team collaboration

CERTIFICATIONS

- Conflict Sensitivity and Peacebuilding, UNDP | Feb 2023
- SDG Indicator 6.4.2 (Water Stress Level), FAO | July 2024

Mohammed Abakar CV

APPENDICES

APPENDIX 1: QUESTIONNAIRE FOR THE GENERAL PUBLIC

The purpose of this questionnaire is to collect data that are imperative to “evaluating the impact of armed conflict on the water-education-gender-nexus in Adar village, West Darfur, Sudan.” The data will be applied for direct academic research fulfillment of the Master of Science degree (M. Sc) in Pan African University Institute for Water and Energy Science (incl. Climate Change). The information you provide in these questions will be utilized only for study purposes. Your genuine response is highly valuable for the achievement of the objectives of the research. Confidentiality is guaranteed. Hope, you will consider this questionnaire important for collecting relevant information and participate in answering out it openly and honestly.

I thank you in advance for your cooperation!

With regards,

Mohammed Abakar Hasan M.Sc. Student at PAUWES
muhmmmedabkare@gmail.com Tell: +249110088465

Section I- Personal information

1) What is your gender?

Male Female

2) What is your marital status?

Single Married Divorced Separated Widowed

3) What is your age (year)?

<18 18-25 26-35 >35

4) How many family members are in your household?

<3 3-5 6-10 ≥10

5) What is the highest level of education you have completed?

None Primary Secondary College University

6) What is your occupational status?

Farming Government employee Self employee Unemployed Student

Other (specify) _____

Section II-General water related information

7) What are your main water sources?

Public tap Pump well Protected well Unprotected well Surface water

Rainwater harvesting Other (specify) _____

8) How many years have you depended on this water source?

< 2 2- 5 >5

9) How much water is consumed daily per person (litter)?

< 20 20-50 51-100 >100

10) How much water is consumed daily per household (liters)?

< 50 50–100 101–500 > 500

11) Do you have to pay for water? If yes, what proportion of your total monthly income do you spend on it?

- No, I do not have to pay Yes, less than 1% of my income Yes, 1–3% of my income
 Yes, more than 3% of my income

12) Have you ever experienced water quality problem? If yes, what type of problem was it? (Select all that apply)

- No, I have not experienced any problems Yes, chemical contamination Yes, microbial contamination Yes, physical contamination Yes, microbial and chemical contamination
 Yes, other (please specify): _____

13) How would you rate the quality of the water currently you use in terms of taste, color and smell? Excellent Very good Good Normal Poor

14) If your answer for Q13 is poor, what is the reason of poor quality? (Select all that apply)

- Contamination from nearby waste disposal Poor maintenance of water supply infrastructure
 High levels of minerals or salts (e.g., hardness) Presence of chemicals or pollutants Lack of proper treatment or filtration Natural factors (e.g., muddy or turbid water sources) Other (please specify): _____

15) What is the primary use of water in your household? (Select all that apply)

- Drinking Cooking Washing Hygiene Livestock Agriculture Other (specify) _____

16) Distance from the source of water (minutes): <30 30-60 61-120 >120

17) How far, in kilometers, is the water source from your household?

- Less than 1 1-5 6-10 11-20 More than 20 No idea

18) How long do you wait at the source (minutes)? <60 60-180 >180

19) How many trips do you make daily?

- Once Twice Three times More than three times

20) Are there any barriers preventing you from accessing safe water sources? Select all that apply

- No barriers Legal barriers Financial barriers Social barriers Other (please specify): _____

21) Do you notice changes in the water supply throughout the year? If yes, what do you think is the reason? (Select all that apply)

- No, I do not notice changes Yes, due to climate change Yes, due to population increase
 Yes, due to pollution during the rainy season Yes, other (please specify): _____

22) If your answer above is climate change, how has climate change affected water availability? (Select all that apply) Increased drought Frequent floods Rain pattern changes Other (specify) _____

23) What are the main challenges you face in accessing safe drinking water due to climate change? Increased distance Higher prices Reduced availability or reliability of water sources Poorer water quality Other (please specify): _____

24) What measures have you taken to adapt climate change? (select all that apply)

Rainwater harvesting Alternative sources Migration Other _____

25) How has climate change impacted water quality? (select all that apply) Salinity Taste changes Waterborne diseases Other (specify) _____

26) When do you think water supply is a challenge? (select all that apply)

Lack of water mainly during the dry season Lack of water mainly when it rains too much

Lack of water at any time of the year Rarely lacks water Never lacks water

27) What is the destination of the sewer of your house? Select all that apply

Public network Septic tank connected to the net Pit latrine Directly in the stream

Open defecation Other (specify) _____

28) What challenges do you face related to water supply? (Select all that apply)

Insufficient quantity of water Poor water quality High cost of water Lack of accessibility to water sources Seasonal variability in supply Infrastructure issues (e.g., broken pipes, lack of storage) Other (please specify): _____

Section III-Water-gender-education

29) Who is the most responsible in your household that collect water for the family? (Select all that apply) Woman Man Girl Boy All family contribute equally Other (specify) _____

30) If your answer is "including female," how do water scarcity challenges affect female in the household? (Select all that apply)

Increased time spent collecting water Physical strain from carrying water Reduced time for education or income-generating activities Increased household stress and workload Greater risk of health problems due to poor water quality Emotional and mental stress Limited access to clean water during menstruation Other (please specify): _____

31) Do you have school-aged girls in the household? Yes No

32) If your answer above is yes, how often do they attend school?

Always/regular Often Sometimes Rarely Never

33) If not regular, what are the reasons? (Select all that apply)

Chores (e.g., fetching water) Cost Distance Cultural reasons Poor quality

Other (please specify): _____

34) Do you have school-aged boys in the household? Yes No

35) If yes, how often do they attend school?

Always/regularly Often Sometimes Rarely Never

36) If not regular, what are the reasons? (Select all that apply)

- Chores Cost Distance Cultural reasons Poor quality
 Other (specify) _____

37) How does water scarcity affect girls' education? (Select all that apply) Miss school Poor facilities Illness Other (specify) _____

38) What actions can support girls' education? (Select all that apply)

- Nearby water sources Better facilities Awareness Other (specify)

Section IV-Water management information

39) How is water managed in your community?

- By a community committee Managed by the local government Private sector involvement
 NGOs or international organizations Individual household management Other (specify):

40) Are there policies or programs to improve water access in Adar? If yes, how effective are they? No, there are no policies or programs Yes, they are highly effective Yes, they are moderately effective Yes, but they are minimally effective Yes, but their effectiveness is unknown Other (please specify): _____

41) What is the role of the civil administration in managing water in Adar?

- Primary (They are primarily responsible for managing water in Adar) Supplementary (They support other entities in managing water in Adar) Replaced (Their role in managing water in Adar has been taken over by others) None (They have no role in managing water in Adar)

42) How would you rate the level of community participation in water management initiatives in Adar village? Very high High Moderate Low Very low

43) How satisfied are you with the level of community engagement and involvement in decision-making processes related to water supply in Adar village?

- Very satisfied Satisfied Neutral Dissatisfied Very dissatisfied

44) How would you rate the overall performance of the water management system in Adar village? Excellent Good Average Poor Very poor

45) Who is responsible for handling project resources (money, tapes, channels, dams, etc.)?

- Donor Community Village government and community committee leader

46) Do governments or NGO involve communities in projects? Yes No Unsure

47) What support is provided by governments or NGOs? (Select all that apply)

- Financial Training Awareness Other _____

48) Do you practice irrigation in your farms? Yes No

49) If your answer to the above question is yes, what kind of irrigation methods do you practice? (Select all that apply)

- Drip irrigation Sprinkler irrigation Flood irrigation Furrow irrigation Manual irrigation (e.g., using buckets or watering cans) Other (please specify): _____

50) How affordable is the irrigation system?

Very affordable Somewhat affordable Affordable Too expensive for most people I don't know/No opinion

51) Has water scarcity contributed to conflicts? Yes No Unsure

52) If yes, how has water scarcity contributed to conflicts? (Select all that apply) Resource competition Displacement Violence Other (specify) _____

53) How can water management support economic development? (Select all that apply)

Rainwater harvesting and storage Adoption of low-cost, water-efficient farming techniques
 Improved access to clean water and sanitation

54) What are the effects of conflict on water infrastructure? (Select all that apply)

Unsafe access Resource depletion Unaffected Others (specify)

55) How has the ongoing conflict impacted your household's access to water and education? (Select all that apply)

Disrupted access to water sources Increased time and distance required to fetch water
 Reduced availability of clean or safe water Increased school dropouts due to safety concerns
 Reduced attendance due to water collection duties Increased cost of water and education-related expenses
 Other (please specify): _____

56) What measures have been taken to resolve water-related conflicts? (Select all that apply) Dialogue Agreements Government intervention Other (specify) _____

Section V- Conflict-education- gender

57) Are there alternative education arrangements (e.g., temporary learning spaces) in response to conflict? Yes No Not sure

58) What barriers prevent children from attending school during conflict situations? (Select all that apply) Safety concerns Lack of transportation Economic hardship Other (specify): _____

59) How do the effects of conflict on education differ between boys and girls?

Girls more affected Boys more affected Both equally affected Not sure

60) What challenges do women face in accessing resources (e.g., water, education) during conflict? Increased responsibilities Gender-based violence Limited mobility Other (specify): _____

61) Have women been involved in peace-building or conflict resolution efforts?

Yes No Not sure

62) How has conflict changed the traditional roles of women and men in your community select all that apply?

Women taking on additional responsibilities Men migrating for work Other (specify): _____

APPENDIX 2: QUESTIONNAIRE FOR THE OFFICIALS

Questionnaire for the official

The purpose of this questionnaire is to collect data that are imperative to “evaluating the impact of armed conflict on the water-education-gender-nexus in Adar village, West Darfur, Sudan.” The data will be applied for direct academic research fulfillment of the Master of Science degree (M. Sc) in Pan African University Institute for Water and Energy Science (incl. Climate Change). The information you provide in these questions will be utilized only for study purposes. Your genuine response is highly valuable for the achievement of the objectives of the research. Confidentiality is guaranteed. Hope, you will consider this questionnaire important for collecting relevant information and participate in answering out it openly and honestly.

I thank you in advance for your cooperation!

With regards,

Mohammed Abakar Hasan M.Sc. Student at PAUWES

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(Water-Related Offices)

Section I: Personal information

1) What is your highest education level?

None Primary Secondary Technical education Diploma University Other, please specify _____

2) what is your Occupation? _____

Position _____

Mobile phone number _____ Email address _____

Section II-General water related information

3) How would you describe the current water situation in Adar village?

Sufficient and reliable year-round Sufficient but unreliable at times Insufficient during dry seasons Insufficient and unreliable year-round Severe water scarcity Other (specify): _____

4) What are the main challenges and issues faced by the community regarding water access?

(Select all that apply)

Poor water quality Insufficient water supply High cost of water Long distances to water sources Limited availability of infrastructure (e.g., wells, pipelines) Seasonal water shortages Conflicts over water resources Lack of maintenance of water facilities Pollution of water sources Government or institutional inefficiencies Lack of awareness about water conservation Other (please specify): _____

5) Are there any costs associated with accessing water from the wells in Adar village, and if yes, how is affordability ensured for low-income households?

No, water is free Yes, and affordability is ensured through subsidies Yes, and

affordability is ensured through tiered pricing based on income Yes, but there are no specific measures to ensure affordability Other (specify): _____

6) What measures are in place to address complaints related to water acceptability? (Select all that apply)

Regularly testing and improving water quality Providing alternative water sources during disputes or issues Conducting community consultations to understand concerns Monitoring and resolving complaints within a set time limit Collaborating with stakeholders to address systemic issues No specific measures in place Other (please specify): _____

7) Is the current water supply sufficient to meet the daily needs of Adar's population, and if not, what plans are in place to increase water availability?

Yes, the water supply is sufficient No, and there are no plans currently in place No, and there are plans to increase water availability (please specify): _____

8) Does Adar school have access to sanitation facilities (e.g., toilets or latrines)?

Yes, for both students and teachers Yes, but only for teachers Yes, but they are not functional No, there are no sanitation facilities

9) If your above answer is no, what is the reason? _____

10) Does Adar school have separate?

Yes, with adequate privacy Yes, but privacy is insufficient No, only shared facilities No facilities are available

11) Where is drinking water for students and staff in Adar school sourced from?

A piped water supply A nearby well or borehole Delivered water or bottled water No access to drinking water Other please specify _____

12) How does the lack of sanitation facilities affect girls' attendance at school?

Girls attend school regularly despite the lack of facilities Girls miss school occasionally due to poor sanitation conditions Girls frequently miss school, especially during menstruation Girls drop out of school entirely

Section III-Water management information

13) How does the administration plan for future water demands, considering population growth and climate change? (Select all that apply)

Developing new water infrastructure (e.g., dams, reservoirs, pipelines) Promoting water conservation and efficiency programs Implementing rainwater harvesting systems Upgrading and maintaining existing water supply systems Enforcing policies for sustainable water use Collaborating with private sector and stakeholders No specific plans in place Other (please specify): _____

14) What kind of support have you received from government or NGOs for water management in your community? _____

15) What water management systems are currently in Adar village?

Community-based management committees Local government oversight Private sector involvement NGO or international organization support Individual household management Traditional or informal management systems Other (specify): _____

16) What role do NGOs and private sector partners play in water management in Adar village? (Select all that apply) Providing financial support Building and maintaining water infrastructure Offering training and capacity building Conducting awareness campaigns Supplying water directly to communities Supporting policy development and advocacy Other (specify): _____

17) How are local communities typically involved during the planning phase of water projects? (Select all that apply)

Through public consultations and feedback sessions By selecting the construction materials for the project By forming committees to represent their interests They are not involved

18) What is the most common method used to gather community input for planning water projects? (Select all that apply)

Surveys and interviews Random selection of community members Government-mandated policies without consultation Direct votes on the project plan

19) Is there a bank account for the water projects management in Adar village? Yes No

20) Is there any capacity-building or training given to the community or project leaders to enable them to sustain project interventions? Yes No

21) Are there mechanisms for feedback from the community? Yes No

22) How effective are these mechanisms?

Very effective - They meet current and future needs efficiently Moderately effective - Some needs are met, but improvements are needed Slightly effective - Limited impact on addressing water demands Ineffective - They fail to meet water demands adequately Unsure - Lack of information or clarity on their effectiveness

23) How does the administration address the impacts of climate change on water availability, such as droughts or flooding? (Select all that apply)

Developing and implementing climate-resilient water infrastructure Promoting water storage systems (e.g., reservoirs, rainwater harvesting) Enhancing flood control measures (e.g., levees, drainage systems) Conducting public awareness campaigns on climate adaptation Encouraging sustainable agricultural practices to reduce water stress Establishing early warning systems for droughts and floods Partnering with communities for localized climate adaptation efforts Securing international funding for climate adaptation projects No specific measures in place Other (please specify): _____

24) Are there any adaptive measures in Adar village, such as rainwater harvesting or the construction of additional reservoirs? Yes No

25) How has water scarcity contributed to conflict? (Select all that apply)

Competition over limited water resources among communities Disputes between agricultural and domestic water users Tensions between upstream and downstream water users Migration and displacement due to lack of water Increased reliance on informal or illegal water access Escalation of existing ethnic or tribal tensions Reduced agricultural productivity leading to economic hardship and unrest Strain on local governance and resource management systems No significant contribution to conflict Other (please specify): _____

26) How does your office engage with the local community to raise awareness about water conservation and efficient water use practices? (Select all that apply)

Organizing workshops and community meetings Running educational campaigns in schools and public spaces Providing training on water-saving technologies and practices Distributing informational materials (e.g., brochures, posters) Encouraging community-led water management initiatives Offering incentives for adopting water-efficient practices No specific engagement activities in place Other (please specify): _____

Section IV -Water-gender-education

27) How would you describe the current state of education in Adar village?

Sufficient access to schools and resources for all children Limited access to schools but sufficient resources Limited access to schools and insufficient resources Schools are available but frequently disrupted due to conflict Severe lack of educational facilities and resources Other (specify): _____

28) How does the current state of education in Adar village compare to other areas in the region? Significantly better with more resources and facilities Slightly better with some advantages in resources or access About the same as other areas Slightly worse with fewer resources or limited access Significantly worse with severe challenges in education access Other (specify): _____

29) How do water scarcity and the burden of water collection impact the school attendance and academic performance of girls in Adar school?

Reduced school attendance due to time spent collecting water Increased tardiness affecting participation in lessons Reduced time available for homework and studying Increased dropout rates among girls Health issues affecting concentration and performance Other (specify): _____

30) What challenges do girls face in accessing education due to their roles in water collection?

Long distances to water sources reducing school attendance Fatigue from water collection affecting academic performance Increased dropout rates due to household responsibilities Lack of time for homework and study Social and cultural expectations prioritizing domestic roles Other (specify): _____

31) Have you observed any changes in the enrollment or dropout rates of girls compared to boys, and what are the contributing factors? (Select all that apply)

No significant changes observed Higher dropout rates for girls due to household responsibilities Higher dropout rates for boys due to economic activities or migration Girls face more challenges due to early marriage or cultural expectations Boys face more challenges due to conflict or lack of interest in education Both face similar challenges related to school distance or costs Other (specify): _____

32) How effectively do you think the school collaborates with local authorities to address water, education, and gender issues?

Very effective, with strong partnerships and tangible outcomes Effective, but with room for improvement Moderately effective, with occasional collaboration Ineffective, with minimal collaboration No collaboration observed between the school and local authorities Other (specify): _____

33) According to your observations, who is primarily responsible for collecting water in households within your community? (Select all that apply)

Women Men Girls Boys All family members contribute equally Other (specify): _____

34) From your perspective, how does water scarcity affect girls' education in the community? (Select all that apply)

Girls miss school frequently Inadequate school facilities (e.g., lack of toilets) Increased illness due to poor water access Other (specify): _____

35) What actions can your administration take to support girls' education in relation to water access? (Select all that apply)

Ensuring nearby and reliable water sources Improving school facilities, especially sanitation and hygiene Conducting awareness campaigns on the importance of girls' education Partnering with NGOs or other stakeholders for support Other (specify): _____

36) How has the ongoing conflict in the Darfur region impacted the water infrastructure and access to water sources in Adar village? (Select all that apply)

Destruction or damage to water infrastructure (e.g., wells, pipelines) Reduced maintenance and repair of water facilities Increased competition for limited water resources Restricted access to water sources due to insecurity Displacement of communities affecting water access patterns Contamination of water sources due to conflict-related activities Loss of skilled personnel to manage water systems Redirection of resources away from water infrastructure development Dependence on humanitarian aid for water access Other (specify): _____

APPENDIX 3: LIST OF IMAGES DURING DATA COLLECTION



