DOI:https://doi.org/10.18485/ijdrm.2023.5.2.3

Research article

WATER CRISIS IN THE RANGAMATI HILL DISTRICT OF BANGLADESH: A CASE STUDY ON INDIGENOUS COMMUNITY

Swarnali Chakma[1*]

[1] Graduate School of International Cooperation Studies, Kobe University, Japan

Correspondence: chakma.swarnali@gmail.com

Received: 5 October 2023; Accepted: 30 November 2023; Published: 31 December 2023

Abstract: The ethnic communities are the most underprivileged and exposed areas in Bangladesh's Chittagong hill tracts. Since the last decade, these areas have been facing severe challenges from climate change, such as drought leading to water scarcity, prolonged rainfall triggering landslides, dry-up of watersheds due to lack of rain, soil erosion, etc. This research aims to identify the key indicators of the causes and consequences of the water crisis caused by climate change and traditional water scarcity adoption practices in terms of sustainable upland water management. However, semi-structured and Key Informant Interviews were conducted following open-ended questionnaires in the Rangamati district. The study found that the locals in this region have few pure drinking water sources and often rely on nearby springs and lakes. It has also been discovered that rising deforestation is drying up the waterways. About 44% of the community states that deforestation is the main reason for the water crisis. According to the community, the situation gets worse during the dry season. The study results also show that women face difficulties because they are more likely to collect water for their family members and carry out their daily activities. Future studies should examine various mitigation strategies that are feasible for implementation locally, with a focus on expanding forest cover and afforestation, which could raise the groundwater level and improve the availability of water in the mountainous region. Finally, the findings can assist policymakers, practitioners, and the government in developing policies to benefit this community soon.

Keywords: water crisis, climate change, adaptation, indigenous community, Chittagong hill tracts.

1. Introduction

The water crisis is a global issue. According to UNICEF, by the year 2025, half of the world will experience a water crisis as a result of poor management of water resources, the growth in population, conflict, contamination, etc (UNICEF, 2019). WHO reported, that more than 2.2 billion people worldwide do not have access to a source of safe drinking water (WHO, 2019). People in developing countries are most at risk in places with high population increases and demand for water resources (Luijten et al., 2001). The problem is particularly frequent in rural areas, where water scarcity impacts the most people (FAO, 2007). A major water shortage and freshwater crisis exist in developing countries, where a large portion of the world's population resides (Sivakumar, 2011). Unsafe drinking water is linked to over 80% of infections in developing nations (Abedin et al., 2019). Water scarcity in hilly places may result from the overuse of natural resources, deforestation, and soil erosion (Verner, 2019; Alam & Mong, 2004). Rural farming communities rely on rainfed agriculture for their food and income, but the resulting water scarcity threatens their ability to survive (Santiago et al., 2022). Previous studies research reveal that the availability of water is no longer assumed to remain the same in many nations (Zhang et al., 2021). In 2006, UNDP reported, that the growing frequency of droughts, floods, and other weather events coupled with the effects of climate change endanger the livelihoods of poor rural people (UNDP, 2011). All spheres of society and commerce are impacted by water scarcity, which directly threatens the long-term viability of the natural resource base.

The World Health Organization estimates that in Bangladesh, more than 97% of people have access to water, 40% have access to adequate sanitation, and over 60% have access to contaminated drinking water (Saima, 2022). According to earlier investigations, three Chittagong Hill Tracts districts Bandarban, Ranamati, and Khagrachari are at risk as a result of the decline in hill streams brought on by global warming (UNDP, 2011). The worst part of the year is from March to June since water flow substantially decreases during this time (Saima, 2022). Chittagong Hill tract is one of the climate change hotspots in Bangladesh (UNDP, 2011). Variations in average temperature and rainfall will have the biggest effects on the hill regions (Saima, 2022). Large-scale landslides, property damage, and water poisoning have all been caused by the disaster. Over 98 % of the worldwide fresh water is stored as groundwater in saturated zones (Hiscock,1994). The Chittagong Hill Tracts area has about 16 lakh residents and nearly 50% of them lack access to water facilities (Khan, 2015). The areas are facing a severe water shortage (Kabir, 2000). During a water crisis, people in hill tracts collect water and use it without a filter, which causes a variety of water-borne diseases such as diarrhea, cholera, typhoid, and so on. When there is a lack of clean drinking water, individuals consume contaminated water. They are under severe pressure to obtain adequate water and resources to live a sustainable life (Chakma et al., 2020). It can be extremely difficult for many communities in the Chittagong Hill Tracts to obtain enough drinking water.

Due to the difficult terrain, huge distance, and remote position, government extension agencies typically pay little attention to the Chittagong Hill Tracts regions (Danida, 2019; Md et al., 2017). Limited access is also present to both physical and social infrastructure. Through effective community participation, local planning can considerably reduce inequities in these types of access to land use (Danida, 2019). A study by Sulayman Hossain's fund that thousands of indigenous people in southeast Bangladesh's Chittagong Hill Tracts were forced out of their traditional houses as a result of the drying up of water supplies brought on by climate change (Sulayman, 2021). The expert in these villages claims that because the hill streams are drying out, the region's eating habits have changed. Aside from that, the environment of this mountainous region as well as many types of forests, including reserved natural and mead-

ows, are deteriorating. Furthermore, streams in hilly locations are linked to memories and feelings in specific elements of indigenous people (Alam & Mong, 2004; Sulayman, 2021).

2. Method and Materials

2.1. Discerption of the Study Area

The Barkal Upazila is located in the southwest corner of the Chittagong Division's Rangamati District. The Upazila area is 760.88 sq km and is situated between latitudes 23°39' and 23°14' north and longitudes 92°11' and 92°29' east (Banglapedia, 2022). It is bordered on the east by Mizoram (India), the north by Bagaichair and Langudu Upazila, the south by Jurachari Upazila, and the west by Rangamati Sadar. There are five union parishads in it. It is made up of 87% hills and hillocks from the Himalayan formation, with the remaining portion being the Karnaphuli River's drainage basin.

The northern and eastern hill physiographic unit with sedimentary rock formations includes Upazila. In Upazila, 70% of the population are indigenous peoples, and 30% are immigrants from the lowland plains (Rahman, 2007). The primary land use activity and source of income for these people is shifting cultivation. The pre-monsoon season, which runs from April to May and is extremely hot and humid, is followed by the monsoon season, which runs from June to September and is warm, cloudy, and wet. The dry and warm season is from November to March. The annual average rainfall of Barkal is 997 mm (Figure 1). Approximately 80% of the yearly rainfall falls between June and October, with June, July, and August receiving the most (CEGIS, 2008).

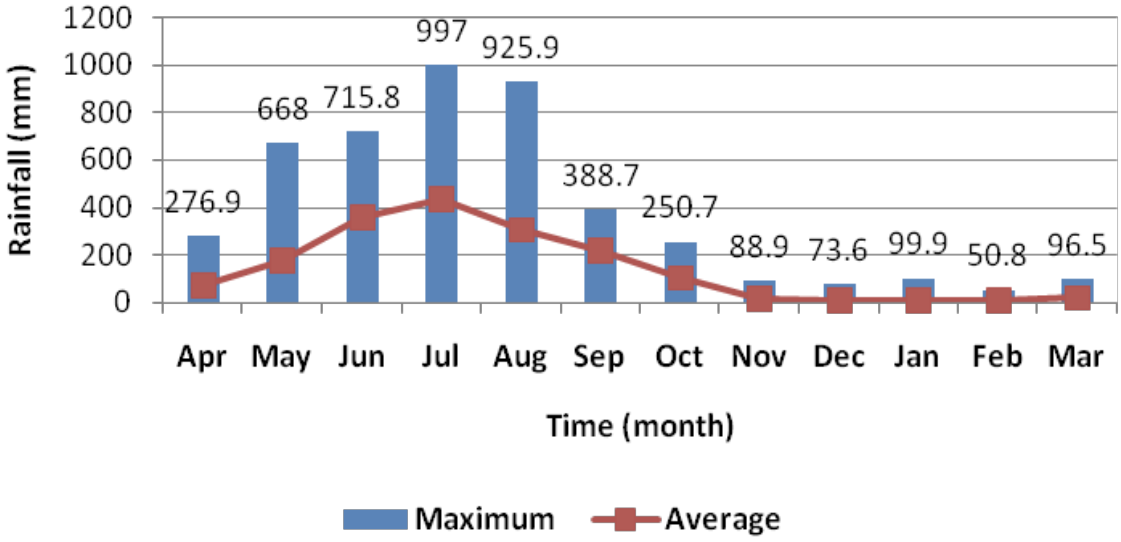

Figure 1. Annual Rainfall over Barkal, Rangamati (source: BMD)

2.2. Theoretical Framework

This study uses the "Cultural Theory" and the "Cause-Effect Link Model" to support its research questions and comprehend how indigenous groups can get properly managed water. The cultural theory addresses threats and risks related to functions, community activities, institutions, and the environment. This study aims to advance the field of rural water services by drawing on the socio-cultural variability viewpoint of cultural theory. Exploring the spe-

cific values that have emerged within these theories will help us understand whether or how they have acknowledged cultural values. The prevalence of cultural theory rooted in indigenous knowledge offers a chance for water management research to broaden its disciplinary connections. Finally, the cause-and-effect relationship model apply to address the current rural water scarcity to the environment and livelihoods of the research area. The main source of variations in precipitation is an increase in climate variability, which is brought on by a variety of factors including local human activity, production of greenhouse gases, and deterioration of the environment and the forest.

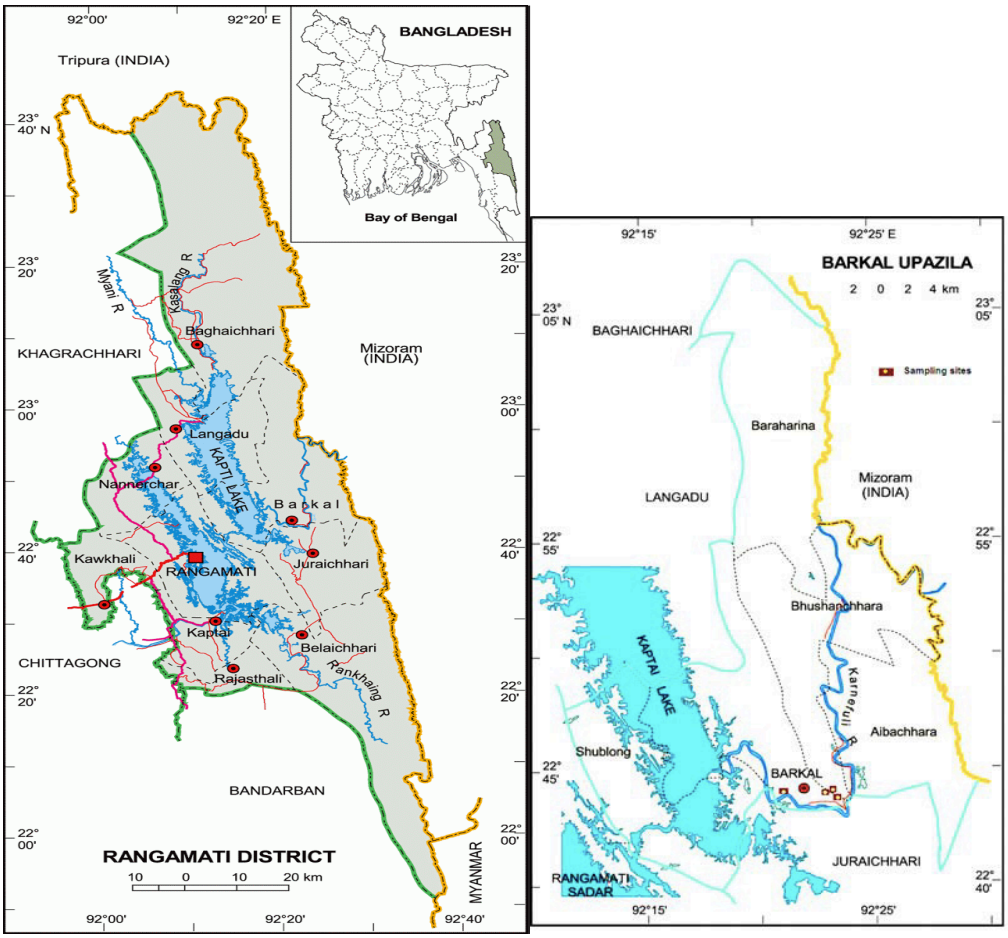

Figure 2. Map of the Study Area

2.3. Data Collection Method

This research design includes the collection of both qualitative and quantitative data. Primary data were gathered utilizing a variety of methods, including a semi-structured questionnaire, key informant interviews, and focused group discussions (FGD). In the study area, a total of 220 households were surveyed in Barkal Sadar (Table 1). Personal visits to the field were used to obtain research data from community members in the selected area by applying random sampling based on house numbers. If the randomly selected household respondents were not present during the survey, they were interviewed later. The questionnaire is divided into four sections and has a total of 30 questions. Sections of the questionnaire are as follows: 1. General information, 2. Water sources 3. Information on the water crisis 4. Adaptation strategies and suggestions. A total of four Focus Group Discussions (FGDs) were held with residents of the spring locations as well as residents who rely on the spring water to meet their

household water demands. FGDs help to identify collective opinions and perceptions about the factors caused by the water crisis and as well as their effects on community life and livelihoods. This process allowed participants to freely express their opinions. Additionally, information about the policies, tactics, and difficulties has been obtained from relevant expert bodies using an unstructured questionnaire to gain fresh or additional perspectives on the issues under research, which are also not present in the literature or the official documents. The relevant expert bodies included the indigenous community's chief, government officials, NGO officials, and community leaders; a total of six important Key Informants interviews were interviewed. The qualitative study method concentrated on specific issues, difficulties, and problems prevalent in the context of the water crisis. Relevant literature on water scarcity, water harvesting strategies, climate change, water crisis, and other water-borne diseases was reviewed. Data were gathered through published research papers, websites, and publications from various government and non-government organizations' programs.

Table 1: Data collection sources.

District	Upazila	Union	Questionnaire Respondents	Focus Group Discussion	Key Informant Interview
Rangamati	Barkal	Barkal Sadar	220	4	6

3. Results and Discussion

3.1. Socioeconomic Condition of the Study Area

All of the respondents are marginalized people. The respondents interviewed were adult and age ranges from 20 to 50 years. The respondents were from different occupations. Among them maximum (48%) were engaged in shifting cultivation which also means that majority of them are lower income people. Followed by job holders (14%), housewives (28%) and businessmen (10%). Also, respondents have 1- 4 family members including single and joint families. The community know that they live in water crisis area but they did not have any choice but to move other places because of their occupation and land.

3.2. Source of Water in the Study Area

The main sources of water in Barkal Upazila (sub-district) are natural springs, lake water, narrow spring (chara) so on. It is observed that natural spring is the most common source of water among all types of sources (Figure 3). It is found that the respondents' choice of water sources varied due to the geographical location of villages. Approximately 56% of respondents used spring as their primary water source. Respondents also collect the water from natural wells, narrow springs, lakes other sources, which is 16% from a natural well, 15% from narrow springs (chara), and 5% from lakes/rivers respectively. The remaining 7% of them collect the water from another source (for example; rainwater, deep well). However, the soil is rocky in this area, and not enough tube-well has been installed there. The majority of households have been advised that the water from their current sources is safe, During the rainy season, mud and dirt are present in the water. Because trees lose their leaves and mix them with spring water during the dry season, the water flow is drastically reduced and the quality is degraded. A major difficulty for the locals has been recognized as providing safe drinking water throughout the dry season because spring-dependent sources also dry up at this time.

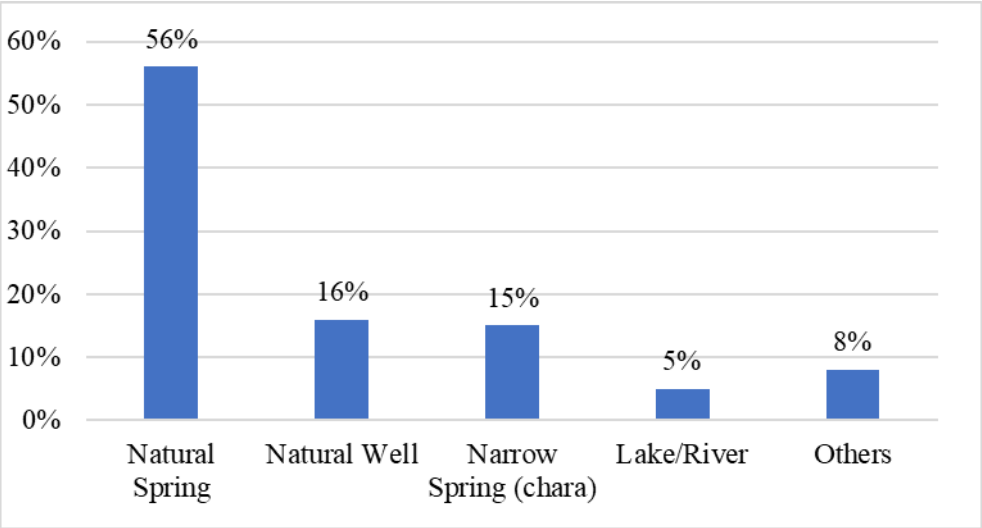

Figure 3. Source of water in the study area

3.3. Distance of Water Sources from Home

According to the World Health Organization (WHO), everyone has the right to adequate, safe, acceptable, physically accessible, and affordable water for personal and domestic use. Basic easy access to water means less than 1 km or 30 minutes round trip (Howard, G., Bartram, J. Domestic. 2003). During the dry season, especially from January to April, indigenous communities face severe water shortages. The water source for the fountains is rapidly depleting due to the shifting cultivation and deforestation leading to the destruction of green spaces. In the study area, it can be seen that most people had to fetch drinking water from remote natural sources. It is found that, distances a one factor in water availability in the study area. About 42% of people had to walk 1.1-1.5 km to fetch water, and 32% of respondents mentioned they had to walk 1.6-2 km. Five percent of the respondents lived in remote hilly areas and had to walk 2.1.-2.5 km to collect water. 20% of respondents who lived close to the water sources had to walk less than 1 kilometer (Figure 4).

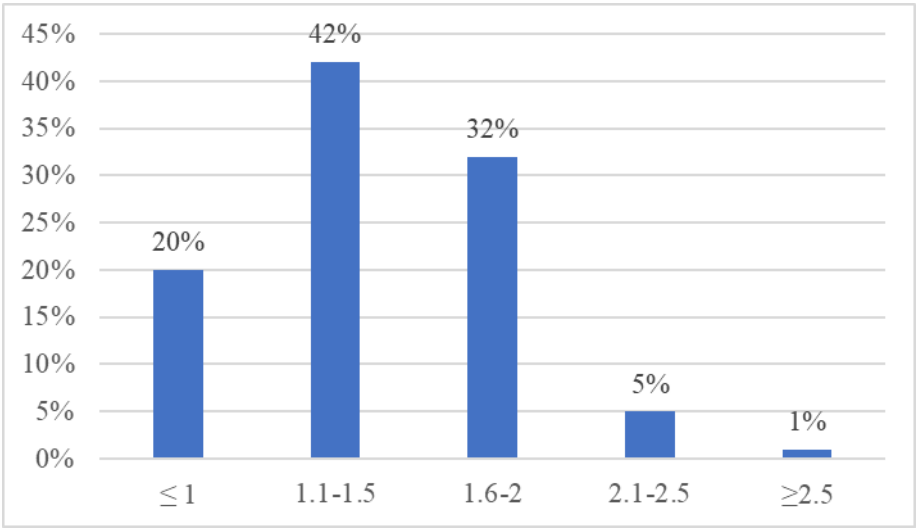

Figure 4. Distance of water sources from home

3.4. Water Crisis Seasons

In the study area, water availability depends on different seasons. The community has been struggling for water for the past 10-12 years, especially in the summer season. Previous studies also found that hilly habitats are usually suffered from drinking water during the hot summer season (Majumder, 2013). Figure 5 shows that the maximum number of respondents (32% and 42 %) experienced water crises during the early summer and late summer seasons. However, 17% of respondents in this village said that water is less available during early winter and 9% of respondents suffered from a water crisis during the late winter. A significant number of water sources have dried up as a result of the hot summer season, which is another factor contributing to the study area's water shortage. Furthermore, it has been discovered that during the rainy season, mudslides can sometimes cause water sources to be damaged.

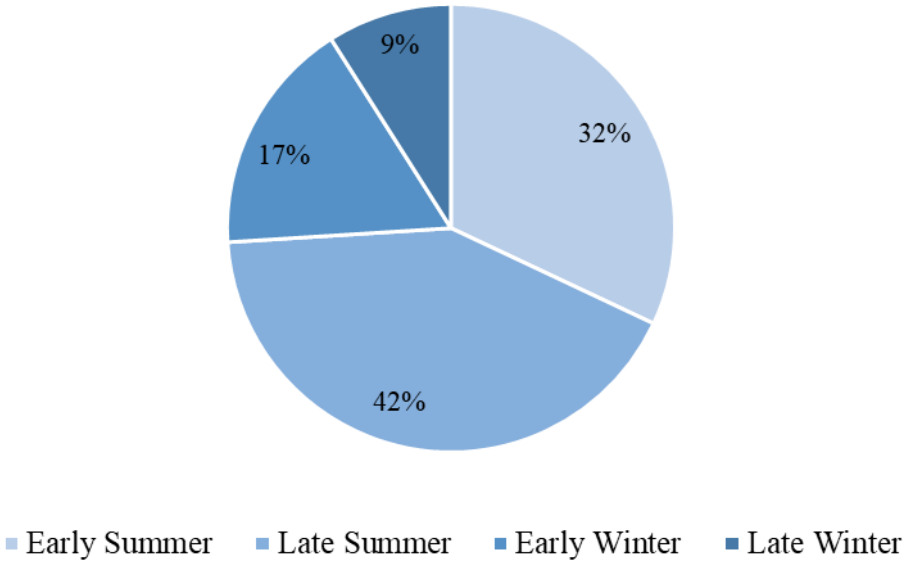

Figure 5. Water crisis seasons

3.5. Water Quality and its Color

The clarity of water is referred to as its color. The sources' water quality and color were determined by asking the residents' opinions. The majority of households stated that the water from their existing sources is safe, but the quality is poor. Although seasonal variations have caused a quality reduction. The water is muddy and dirty during the rainy season. Mud and dirt are present in the water during the rainy season. They have to purified and filter it. It is observed from the table 2 that about 48% respondents claimed with unsatisfactory answers that they got unclean water from the various sources in the study area. On the other hand, 32% respondents claimed that they got comparatively clean water Remaining 11% and 9%respondents claimed that they got blackish and reddish water during dry season. During the dry season, the water flow is much reduced, and the quality suffers as trees drop their leaves, which mingle with the spring water. One of the leaders from the indigenous community said;

"During rainy season, sometimes water from streams is contaminated, and consuming it can lead to a variety of illnesses and some community does not have water purification tablets".

Table 2: Water quality and its color

Color of water	Frequency	Percentage
Clean	70	32%
Not clean	105	48%
Blakich	25	11%
Reddish	20	9%
Total	220	100%

3.6. Women Faced Difficulty to Fetch the Water

The society is directly affected by the water crisis. Women and girls traditionally manage the household water supply and sanitation in the majority of poor nations (UNICEF, 2019 and Chakma et al., 2021). Women are more concerned with enhancing water and sanitation services and maintaining facilities since they are the primary decision-makers at the household level. Figure 6, presents the sufferings that women face in the study area. Among the total respondents, 43% said they face physical stress and 30% replied waste of time. There is frequently insufficient water in the well. Sometimes, we have to return home without any water. About 15% and 12% of respondents identified that sometimes they were attacked by insects as well as occurred accidents in hilly tracts respectively.

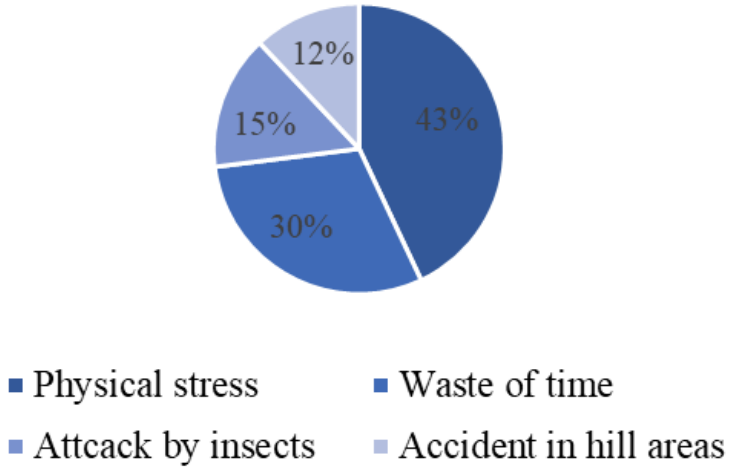

Figure 6. Women faced difficulty to fetch the water

The female respondents from the community express their difficulties in collecting water: who was interviewed,

"There is no water supply system in our area and natural springs are far from home. They said it would take more than an hour. Climbing high hills while carrying water in pots is difficult. But there is not another option." (Swapna Chakma)

"Water from a nearby spring is not available during the dry season. In order to get water, we have to go to another community. My adolescent kids assist me by bringing water from a distance". (Mitali Dewan)

In this area, women were mostly responsible for collecting water. Men occasionally engage in these activities, because they have their work. However, since the entire community is dealing with the issue, they work together to find a solution.

Figure 7. Road condition of the study area

3.7. Reasons for Water Scarcity

The community believes that water sources have shifted in the last ten years. The district of Rangamati is expected to have water shortages in February. The majority of respondents (44%) said that deforestation was to blame for the water shortage. Deforestation, improper land use practices, and unregulated construction can disrupt the natural water cycle. Around 28% thought that rising temperatures and decreasing groundwater levels (16%) were to cause. Changing weather patterns due to climate change can lead to irregular rainfall, affecting the availability of water. Increased temperatures and altered precipitation patterns can contribute to longer dry periods and reduced water availability. Approximately 8% of families believe that soil erosion seems to be responsible for the water shortage. The lack of forest cover has caused soil erosion. The rate of precipitation is decreasing in hilly areas as a result of climate change, adding to the water shortage. Remaining 4% things rock harvesting cause also water scarcity.

Through interviews with the households in the springs near the area, various causes of inadequate water supply or spring water drying up were identified. The most frequent reasons include irregular rainfall, altered land use, altered land cover, population increased extensive shifting cultivation, and siltation and sedimentation.

A high school teacher from the neighbourhood claimed that there is a severe water deficit in the area. We are unable to find a lasting solution. We have set up a very insufficient gravity flow system using plastic pipes to supply water from little streams.

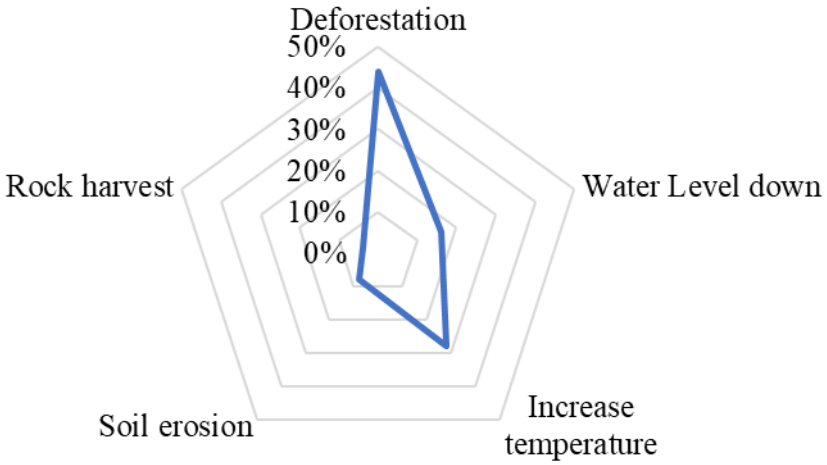

Figure 8. Reasons for water scarcity * Multiple answers are considered

3.8. Community Practices to Minimize Water Scarcity

Water crisis adaptation measures are not well developed in Barkal Upazila. Figure 9 represents the most commonly observed water crisis strategies and activities by residents in the study area. The majority of the residents are dealing with the water issue. About 27% of people utilized store water in a tank/pitcher. They also mention that they have to walk for a kilometer to collect water from the neighboring village (19%). The community also dug deep natural wells (14%) to keep the water cool. Another practice is to harvest rainwater to use for future purposes (22%). However, not all communities cannot maintain the process of rainwater harvesting. It is also found that community reduced use of water also another strategy mentioned by some respondents (18%).

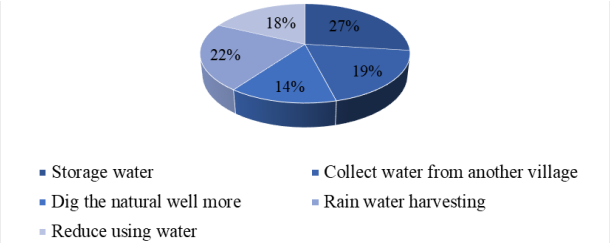

Figure 9. Community practices to minimize water scarcity

A high school teacher from the neighborhood claimed that,

"There is a severe water deficit in this area. We have set up a very insufficient gravity flow system using plastic pipes to supply water from the nearby streams. But this is not the permanent solution. Villagers are responsible for regular maintenance".

3.9. Suggestion from the Community to Reduce Water Crisis

According to questionnaire survey, 27% respondents said to control deforestation is important. About 11% respondents suggested controlling shifting cultivation in the study area. Slush and burn method of farming is a great barrier for sustainable upland water management. 15% respondent suggested for tree plantation of highly leaf trees instead of teak trees in both sides of the spring. Alternative sources, such collecting rainfall and using surface water, have been proposed as a way to ease pressure from relying solely on groundwater-dependent sources. 17% of responders recommended installing a piped water supply that would be connected to either the springs or other water sources like rivers, canals, or lakes. During FDG in Barkal Upazila, a local NGO official believed,

"*The current water crisis has an effect on agriculture and farming, which impacts peoples' livelihoods and income. Therefore, it's crucial to find some alternative livelihood alternatives to keep the community alive".*

Table 3: Suggestion from community to reduce water crisis *Multiple answer

Issues	Frequency	Percentage
Control deforestation	180	27%
Planning for reduce water crisis	150	23%
Control shifting cultivation	70	11%
Technologies for water management	110	17%
Plantation	100	15%
Prohibition to stone aquation	50	8%

4. Discussion and Conclusion

Bangladesh's Chittagong Hill Tracts are home to hills, rivers, valleys, streams, waterfalls, and a significant amount of forest. About half of the 1.6 million people who live in the Chittagong Hill Tracts in southeast Bangladesh do not always have access to water during the summer because of climate change (CEGIS, 2008 and Rijsberman, 2006). There are currently many natural disasters there as a result of climate change, deforestation, and hill-cutting.

Figure 10 shows an analysis of the cause-and-effect relationship model of the current rural water scarcity to the environment and livelihoods in the research area. The main source of variations in precipitation is an increase in climate variability, which is brought on by a variety of factors including local human activity, production of greenhouse gases, and deterioration of the environment and the forest. The main issues with water scarcity also include the degradation of water quality and quantity, the drying up of water sources, and many more. Additionally, it highlights water-borne illnesses, poor sanitation, and inadequate livelihood due to water scarcity.

The average air temperature in the Chittagong Hill tracts has increased by 0.5 to 1 degree Celsius merely in the last 20 years, according to data from the Bangladesh Meteorological Department (CEGIS, 2008). The evaporation of water has accelerated because of the increase in soil temperature. Additionally, the annual rainfall has decreased over the past 10 to 12 years due to climate change, which harms the region's water security. The inhabitants attribute the changes to a variety of factors, such as deforestation, internal migration, sporadic low rainfall, and even their farming technique, which comprises cutting trees and clearing land by burning the lower vegetation. The rising population may directly put pressure on water resources and necessitate increased water demand (Rijsberman, 2006).

Water security is under threat daily as a result of climate changes causing variations in rainfall patterns. According to the study, more than half of the people in the study area collect water from waterfalls and other bodies of water. According to the CEGIS report, it has been observed that the indigenous people have to endure a day with only 5 liters of water on average (CEGIS, 2008). The quality of the water decreases as the water table drops throughout the dry season, which leads to an increase in numerous water-borne illnesses such as diarrhea, cholera, and dysentery. In most cases, children are the most vulnerable sufferers of these disorders. Furthermore, it is evident from the study that women and girls in particular face difficulties because they are more prone to gathering water for their family members as well as carrying out their daily duties. Physical stress, time wasted, and accidents in steep areas are more prominent problems among the many obstacles. The safe and hygienic sanitation infrastructure in this area is also being impacted by water degradation. Due to the lack of water, the area's sanitation is at risk. During FGDs with the community, it is found that the community drinks unsafe water when there is a lack of fresh drinking water. In their research, the WHO also discovered that people frequently contracted various waterborne illnesses as a result of contaminated water (WHO, 2003).

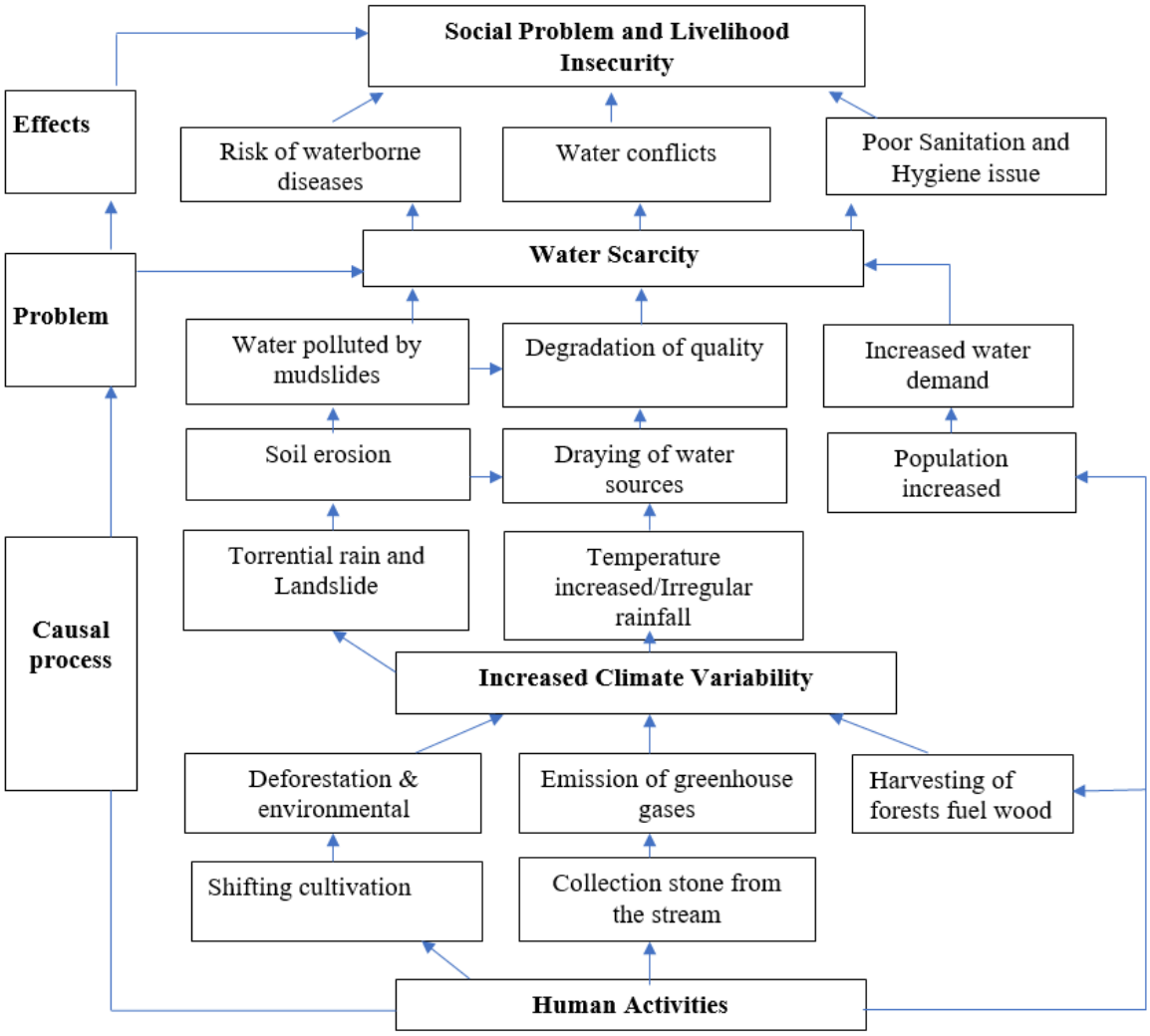

Figure 10. Cause-effects link model of water scarcity to the environment in the study area (Adopted from Malley et al., 2008)

The livelihood of the local community has been severely damaged by water deterioration. For instance, the centuries-old tradition of shifting cultivation in this region is now declining day by day. Degradation of water quality was also linked to shifting cultivation in the upland catchment, fewer conservation efforts, and excessive agricultural water consumption. Due to population growth and the requirement for less shifting farming, the entire forest cover is being removed. The lack of forest cover harms infiltration rates, increasing surface runoff water. In light of the shifting conditions, the altered rainfall makes it challenging to maintain agricultural output and yield. As a result, the villagers are now focusing on growing a variety of crops on a single plot of land.

Numerous social issues, including domestic disputes, waterborne illnesses, and inadequate sanitation, are caused by a lack of water. The delays in cooking sometimes cause disputes among family members. The local population is experiencing financial difficulties as a result of the water shortage because their product is no longer affordable and competitive in the market, resulting in business losses. Additionally, commercial stone harvesting from streams and fuelwood harvesting for brickfields added to the already severe water shortage.

The rural livelihood activities dependent on natural resources (fuel and timber wood gathering, edible fruit and vegetable cultivation) continue to put pressure on forests, land, and water resources for agricultural production, which is harming the environment. The

forest resources have a significant impact on the indigenous people's culture, way of life, and lifestyle in the CHTs (Jashimuddin & Inoue, 2012, and Miah & Ahmed, 2013). Additionally, it has been discovered that excessive rainfall reduces rainwater entry into groundwater aquifers by causing runoff and soil erosion (Eriksen, 2001, and Chakma et al, 2021). There are issues with water sources, water availability and seasonal variation, water management, the duration of water scarcity, and societal issues. The environment is affected by natural resource-based livelihood activities that put a strain on forests for fuel wood, timber, and charcoal as well as on land and water resources for agricultural production. Malley et al., (2008) recent study proved the existence of societal conflicts linked to the destruction of land and water resources (Malley et al., 2008)

The community relies completely on natural water sources, for all domestic needs like drinking, cooking, washing, and bathing as well as for agricultural tasks like irrigation and agriculture. As a result of this practice, every community in the region was constructed next to a spring so that there would always be access to water. To cope with the water shortage during the dry season, the indigenous community developed certain adaptation strategies such as constructing dams' streams, digging wells, rainwater harvest, etc. They think increased forest coverage via assisted natural regeneration, afforestation, and reforestation may raise the groundwater table, limit surface runoff, and boost water availability in natural water courses, reducing water shortage in hilly terrain. The majority of respondents expressed a desire for viable alternative sources. In order to improve water resources, a variety of possible alternative sources, including both existing natural springs and other feasible alternative sources, need to be investigated. It is crucial to create a community-based integrated water resource management plan that tackles difficulties with water availability as well as long-term implications like adaptation to land use change. Addressing water scarcity in Rangamati requires a comprehensive approach that involves sustainable land management, water conservation strategies, improved water infrastructure, public awareness campaigns, and local governance initiatives. Collaborative efforts between government authorities, local communities, NGOs, and other stakeholders are essential to ensure equitable and sustainable access to water resources in the region.

References

Abedin, M.A., Collins, A.E., Habiba, U. et al. (2019). Climate Change, Water Scarcity, and Health Adaptation in South-western Coastal Bangladesh. Int J Disaster Risk Sci., 10, 28–42. https://doi.org/10.1007/s13753-018-0211-8

Aktar, M. A., Shohani, K., Hasan, M. N., & Hasan, M. K. (2021). Flood Vulnerability Assessment by Flood Vulnerability Index (FVI) Method: A Study on Sirajganj Sadar Upazila. International Journal of Disaster Risk Management, 3(1), 1-14.

Alam, M. F., & and Mong. N. (2004). Indigenous people in CHT face worst water crisis. The Daily Star, June 18, 2004. Retrieved fromhttp://archive.thedailystar.net/2004/06/18/d406181801103.htm.

Banglapedia, Barkal Upazila (2022). Retrieved from https://en.banglapedia.org/index.php/Barkal_Upazila [Accessed on 12 January 2022]

CEGIS. (2008). Assessment of underlying causes for the deterioration of water flow in the natural springs of Chittagong Hill Tracts Districts.

Chakma, S., Hossain M. N., Islam, M. K., Hossain, M. M., Sarker, M. N. I. (2021). Water Scarcity, Seasonal Variation and Social Conflict in Mountain Regions of Bangladesh. *Grassroots Journal of Natural Resources*, 4(1), 62-79 https://doi.org/10.33002/nr2581.6853.040105

Chakma, U. K., Hossain, A., Islam, K., Hasnat, G. T., Kabir. (2020). Water crisis and adaptation strategies by tribal community: A case study in Baghaichari Upazila of Rangamati District in Bangladesh. International Journal of Disaster Risk Management, (2), 37–46.

DANIDA (2009). The Issues of Conflict, Human Rights, Development, and Land of the Indigenous Peoples of the Chittagong Hill Tracts, Bangladesh 2003-2006, Jumma Net Chittagong Hill Tracts White Paper, Rangamati, p.103.

Eriksen, S. (2001). The linkage between Climate Change and Desertification in East Africa. *Arid Lands*,2001, 2(49). Retrieved from https://cals.arizona.edu/OALS/ALN/aln49/eriksen-part2.html [Accessed on 5 January 2021].

Food and Agricultural Organization of the United Nations (2007). Water News, Hot Issues: Water Scarcity, http://www.fao.org/nr/water/issues/scarcity

Hiscock, K. (1994). Groundwater pollution and protection. In: Riordan, T.O. (Ed). Environmental Science for Environmental Management. Longman. UK, pp. 246-262.

Howard, G., Bartram, J. Domestic. (2003). Water Quantity. In: Service Level and Health. 2003, World Health Organization, Geneva.

Iftikhar, A., & Iqbal, J. (2023). The Factors responsible for urban flooding in Karachi (A case study of DHA). International Journal of Disaster Risk Management, 5(1), 81-103.

Jashimuddin, M and Inoue, M.(2012). Management of village common forests in the Chittagong Hill Tracts of Bangladesh: Historical back- ground and current issues in terms of sustainability." Open Journal of Forestry. 2(3):118-134.

Kabir, MR & Faisal, IM. (2000). Indigenous Practices for Water Harvesting in Bangladesh, 1st edn, AHDPH, Dhaka.

Khan, ZH. (2015). Study on Water Supply System at Rangamati Municipal Area, Journal of Environmental Engineering, Vol.3. no.1, pp.15-22.

Luijten. J.C., Knapp, E.B. and Jones, J.W. (2001). A tool for community-based assessment of the implications of development on water security in hillside watersheds. *Agricultural Systems*, 2001, 70: 603– 622. DOI: https://doi.org/10.1016/S0308-521X(01)00061-0

Majumder, MK. (2013). Drinking water crisis in CHT acute, Green Watch Dhaka, 28 September, p.01

Malley, Z.J.U., Taeb, M., Matsumoto, T. and Takeya, H. (2008). Environmental sustainability and water availability: Analyses of the scarcity and improvement opportunities in the Usangu plain, Tanzania. *Physics and Chemistry of the Earth*, 34(1–2): 3–13. DOI: https://doi.org/10.1016/j.pce.2008.02.034

MD. A. C., Fatima, Z., Md. S. A. (2017). Conservation and Uses of Water Resources as Climate Change Adaptation in Komolchari Village Common Forest (VCF), Khagrachari, Bangladesh International Journal of Scientific & Engineering Research, Volume 8, Issue 2, February, ISSN 2229-5518

Miah, M.D. and Ahmed, .F.U. (2013). Conservation of a Tropical Wet- evergreen Forest Ecosystem by an Indigenous Community in the Bandarban Hill District of Bangladesh: The Role of Intervention. Small-scale Forestry 13:319-331.

Rahman A. (2007). Barkal Upazila. In: Banglapedia, the National Encyclopedia of Bangladesh. The Asiatic Society of Bangladesh., Available at: http://www.banglapedia.org / barkalupazila [Accessed on 25 April 2022].

Rijsberman, F.R.(2006). Water scarcity: Fact or fiction? *Agricultural Water Management*, 80(1-3): 5–22. DOI: https://doi.org/10.1016/j.agwat.2005.07.001

Saima H.(2022). Water in crisis-spotlight on Bangladesh. Retrieved from https://thewaterproject.org/water-crisis/water-in-crisis-bangladesh [Accessed on 19 March 2022]

Santiago Reyes MdR, Méndez García E, Sánchez Medina PS. (2022). A Mixed Methods Study on Community-Based Tourism as an Adaptive Response to Water Crisis in San Andrés Ixtlahuaca, Oaxaca, Mexico. *Sustainability*. 14(10):5933. https://doi.org/10.3390/su14105933.

Sivakumar, B. (2011). Water crisis: From conflict to cooperation—an overview, *Hydrological Sciences Journal*, 56 (4): 531-552. DOI: https://doi.org/10.1080/02626667.2011.580747

Sulayman H. (2021). In pictures: Global warming forces Bangladeshi tribals to migrate. Retrieved from https://www.aljazeera.com/gallery/2021/1/25/in-pictures-bangladesh-climate-change [Accessed on 19 March 2022]

UNDP (2011). Promotion of Development and Confidence Building in the Chittagong Hill Tracts, Annual Report., Chittagong Hill Tracts Development Facility, Bangladesh.

UNICEF. Progress on household drinking water, sanitation and hygiene 2000-2017. Special focus on inequalities. New York: United Nations Children's Fund (UNICEF) and World Health Organization. Geneva, Switzerland (2019). Retrieved from https://www.who.int/water_sanitation_health/publications/jmp-2019-full-report.pdf. [Accessed on March 3, 2022].

Verner, D. (2010). Reducing poverty, protecting livelihoods, and building assets in a changing climate: social implications of climate change in Latin America and the Caribbean. The World Bank. Washington DC, United States.

WHO, WHO and UNICEF launch updated estimates for water, sanitation and hygiene. (2019). Retrieved from https://www.unwater.org/who-andunicef- launch-updated-estimates-for-water-sanitation-and-hygiene/. [Accessed on April 2, 2022].

WHO. (2003). Water Sanitation and Health. United Nations World Health Organization. Geneva, Switzerland.

Zhang D, Sial MS, Ahmad N, Filipe AJ, Thu PA, Zia-Ud-Din M, Caleiro AB. (2021). Water Scarcity and Sustainability in an Emerging Economy: A Management Perspective for Future. *Sustainability*. 13(1):144. https://doi.org/10.3390/su13010144