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Flood–Induced Vulnerabilities, Household Losses, and Access To Essential Services among Adolescent Girls in Riverine Communities of Sonitpur District, Assam

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Abstract: *Floods are among the most frequent and destructive natural hazards in Assam, disproportionately affecting socially and economically vulnerable populations residing in riverine areas. Among these populations, adolescent girls experience multiple and intersecting disadvantages that extend beyond physical losses to include social, health, educational, and protection-related challenges. This study examines the impacts of recurrent flooding on adolescent girls belonging to flood-affected riverine households in Sonitpur district, Assam. Specifically, it aims to examine the extent of internal and external household losses experienced during floods, analyse the social, health-related, and protection vulnerabilities of adolescent girls, and assess the availability, accessibility, and effectiveness of essential services, including healthcare, nutrition menstrual hygiene management (MHM), nutrition, and education, during and after flood events. The study adopts a convergent parallel mixed-methods design, integrating quantitative data collected through household surveys with qualitative evidence obtained from key informant interviews with adolescents. The findings indicate that recurrent floods result in substantial external losses, including damage to housing, livelihoods, household assets, educational facilities, and community infrastructure, while also generating internal losses such as psychological distress, educational disruption, and diminished social well-being. The study further reveals that adolescent girls face heightened social, health, nutritional, menstrual hygiene, and protection vulnerabilities, which are exacerbated by existing gender inequalities and geographical isolation. Access to essential services including healthcare, education, nutrition programs, and menstrual hygiene facilities is frequently disrupted during flood events, limiting effective recovery and increasing long-term vulnerability. The findings also suggest that existing disaster response mechanisms remain largely gender-neutral and inadequately address the specific needs and priorities of adolescent girls. The study recommends integrating gender-responsive and adolescent-centred disaster risk reduction (DRR) strategies into flood management policies and programs. Strengthening equitable access to healthcare, education, nutrition, menstrual hygiene management, and protection services, alongside community-based preparedness and inclusive service delivery, is essential for enhancing resilience and safeguarding the rights, health, and well-being of adolescent girls in flood-prone riverine communities.*

Keywords: *Adolescent girls; Flood vulnerability; Riverine communities; Gender-responsive disaster risk reduction; Essential services, Menstrual hygiene management*

I. Introduction

1.1 Background and Rationale

The Brahmaputra River basin is one of the most flood-prone regions in Northeast India, with recurrent monsoon floods causing extensive damage to human lives, livelihoods, infrastructure, agriculture, and the natural environment. Assam, situated in the lower reaches of the Brahmaputra basin, experiences annual monsoon flooding that affects millions of people and disrupts socio-economic development. While floods play a vital ecological role by replenishing soil fertility and supporting agricultural productivity, increasing climate variability, changing rainfall patterns, glacial melt, and riverbank erosion have intensified the frequency, duration, and severity of flood events in recent decades. Consequently, floods have evolved from seasonal natural phenomena into recurring humanitarian and developmental challenges, disproportionately affecting socially and economically vulnerable populations.

Among those most adversely affected are adolescent girls (10–19 years) residing in the flood-prone riverine areas of Sonitpur district, Assam. These communities are characterized by geographical isolation, fragile housing, poor transportation and communication networks, limited healthcare facilities, inadequate educational infrastructure, and frequent riverbank erosion. Such conditions increase the exposure and sensitivity of adolescent girls to flood hazards while simultaneously reducing their capacity to cope with and recover from disaster-related shocks. Adolescence represents a critical stage of physical, emotional, cognitive, and social development, making girls particularly vulnerable to disruptions caused by recurrent flooding.

The consequences of floods for adolescent girls extend well beyond visible material losses. Recurrent flooding damages homes, educational institutions, roads, sanitation facilities, and healthcare infrastructure, thereby interrupting access to essential services. School closures and damaged transportation networks contribute to prolonged educational disruption, increasing absenteeism and the risk of school dropout. Floods also restrict access to healthcare services, nutritious food, clean drinking water, and safe sanitation facilities, exposing adolescent girls to infectious diseases, malnutrition, anaemia, and reproductive health complications. Menstrual hygiene management becomes particularly challenging due to the limited availability of sanitary products, inadequate privacy, and poor sanitation conditions in temporary shelters and relief camps. Furthermore, overcrowded displacement camps, unsafe environments, and weakened community protection mechanisms heighten the risks of gender-based violence, harassment, exploitation, trafficking, and psychological distress. These interconnected challenges have lasting implications for the health, education, dignity, safety, and overall well-being of adolescent girls.

Despite the increasing recognition of gender dimensions in disaster research, the experiences of adolescent girls remain underrepresented in the literature on flood vulnerability in Assam. Previous studies have predominantly concentrated on household economic losses, agricultural damage, infrastructure destruction, flood forecasting, disaster management, and community resilience. While these studies have significantly contributed to understanding flood impacts, they often treat households as homogeneous units and pay limited attention to the distinct vulnerabilities experienced by specific demographic groups such as adolescent girls. Consequently, the complex interactions between gender, age, health, education, protection, and access to essential services during disasters remain insufficiently explored.

Moreover, existing research rarely differentiates between the tangible and intangible consequences of flooding. Material losses, such as damage to houses, crops, livestock, and household assets, are generally documented, whereas non-material impacts including psychological stress, educational disruption, menstrual hygiene challenges, reduced healthcare access, nutritional insecurity, and protection risks receive comparatively little attention. As a result, important dimensions of adolescent girls lived experiences remain overlooked in disaster planning and policy formulation.

The present study addresses these important knowledge gaps by focusing specifically on adolescent girls living in flood-affected riverine communities of Sonitpur district, Assam. Unlike earlier studies that primarily examined

floods from economic or infrastructure perspectives, this research adopts a multidimensional and gender-sensitive approach to investigate how recurrent flooding affects adolescent girls across multiple aspects of their lives. The study examines both external (material) losses, including damage to housing, educational facilities, livelihoods, and essential infrastructure, and internal (non-material) vulnerabilities, including social exclusion, health problems, educational disruption, menstrual hygiene challenges, nutritional insecurity, psychosocial stress, and protection concerns. This distinction provides a more comprehensive understanding of flood vulnerability beyond conventional economic assessments.

To achieve this, the study employs a convergent parallel mixed-methods design, integrating quantitative household survey data with qualitative evidence obtained through key informant interviews. This methodological approach enables the triangulation of statistical findings with lived experiences, thereby providing a richer and more nuanced understanding of the multidimensional impacts of recurrent flooding. The study further examines the availability, accessibility, and effectiveness of essential services, including healthcare, menstrual hygiene management, nutrition and education during and after flood events, allowing for a comprehensive assessment of service delivery gaps and institutional responses.

By generating primary empirical evidence from the flood-prone villages of Sonitpur district, this research makes an important contribution to the limited body of literature on adolescent girls and disaster vulnerability in Northeast India. It extends existing knowledge by integrating gender, age, and disaster perspectives into the analysis of flood impacts and by highlighting the interconnected nature of material losses, social vulnerabilities, health outcomes, educational challenges, nutrition and protection concerns. The findings provide evidence to inform policymakers, disaster management authorities, health professionals, educators, and development practitioners in designing adolescent-centred and gender-responsive disaster risk reduction, preparedness, response, and recovery interventions. Furthermore, the study contributes to broader discussions on inclusive disaster governance by demonstrating the importance of recognising adolescent girls as a distinct population group whose specific needs and experiences must be incorporated into disaster planning, resilience-building strategies, and sustainable development initiatives.

1.2 Research Problem

Disaster response mechanisms in Assam largely adopt a household-based approach that often overlooks the specific needs of adolescent girls. Flood-induced displacement, inadequate sanitation, limited menstrual hygiene facilities, and disruption of education and healthcare increase their health, protection, nutrition and psychosocial risks. Despite growing emphasis on gender-responsive disaster management, empirical evidence on the multidimensional impacts of floods on adolescent girls in Assam's riverine communities remains limited.

1.3 Objectives of the Study

The study aims to:

1. To examine the extent of internal and external losses experienced by adolescents belonging to flood-affected riverine households in Sonitpur district.
2. To analyse the social, health-related, nutrition and protection vulnerabilities experienced by flood-affected adolescent girls.
3. To assess the availability, accessibility, and effectiveness of essential services, including healthcare, menstrual hygiene management, and education, during and after flood events.

1.4 Methodology

1.4.1 Research Design

The study adopted a convergent parallel mixed-methods research design to examine the impact of recurrent floods on adolescent girls in the flood-affected areas of Sonitpur district, Assam. Quantitative and qualitative data were collected concurrently, analysed separately, and integrated during interpretation to provide a comprehensive understanding of the research problem.

1.4.2 Study Area

The study was conducted in selected flood-affected villages of Sonitpur district, Assam. The villages were purposively selected based on their frequent exposure to floods, extent of displacement, and vulnerability of the population.

1.4.3 Sampling and Participants

A combination of purposive and multistage sampling techniques was employed for the study. Initially, household surveys were conducted in 80 flood-affected households to collect information on flood-related losses, livelihood disruptions, and coping strategies. During the survey, it was found that 9 households did not have an eligible adolescent girl (10–19 years) available for participation. These households were therefore excluded from household-level analysis. Consequently, the final quantitative sample comprised 71 adolescent girls aged 10–19 years, who were interviewed using a structured interview schedule.

1.4.4 Inclusion and Exclusion Criteria

The study included adolescent girls aged 10–19 years residing in the selected flood-affected villages who had experienced the impacts of recurrent floods.

1.4.5 Data Collection Tools

Primary data were collected using a structured interview schedule for adolescent girls and a household survey schedule to document flood-related losses, livelihood disruptions, and coping strategies.

1.4.6 Ethical Considerations

Ethical principles were strictly followed throughout the study. Verbal consent was obtained from participants aged 18–19 years, while parental consent and adolescent assent were obtained for participants below 18 years. Confidentiality, anonymity, and voluntary participation were ensured.

1.4.7 Data Analysis

Quantitative data were coded and analysed using descriptive statistics, including frequencies and percentages.

1.5. Significance of the study

The present study contributes to the literature on flood vulnerability in Assam by shifting the focus from household-level economic losses to the lived experiences of adolescent girls, a group that has received limited attention in previous research. Unlike earlier studies that primarily emphasize economic and infrastructural impacts, this research examines the internal and external losses experienced by adolescents, the social, health, and protection vulnerabilities of flood-affected adolescent girls, and their access to essential services during and after flood events.

Using a convergent parallel mixed-methods approach, the study integrates quantitative household survey data with qualitative evidence from key informant interviews to provide a comprehensive understanding of the multidimensional impacts of recurrent flooding. By generating empirical evidence from the flood-prone riverine areas of Sonitpur district, the findings address an important research gap and provide evidence-based recommendations to strengthen gender-responsive disaster risk reduction, improve access to healthcare, menstrual hygiene management, nutrition, and education, and promote inclusive disaster governance and resilience-building.

II. Literature Review

2.1 Disaster Vulnerability, Gender, and the Intersectionality Framework

Disaster impacts are increasingly understood not merely as the physical consequences of natural hazards but as outcomes shaped by entrenched social, economic, political, and institutional inequalities. This perspective builds on the foundational work of Amartya Sen (1981), whose entitlement approach demonstrated that vulnerability

during crises is tied to unequal access to resources, assets, and social opportunities rather than a simple scarcity or hazard occurrence. Expanding on this, Piers Blaikie, Terry Cannon, Ian Davis, and Ben Wisner (1994), in *At Risk: Natural Hazards, People's Vulnerability and Disasters*, emphasized that disasters are socially constructed. They argued that unequal distributions of power and protective mechanisms systematically place specific marginalized groups at much higher risk.

To fully capture how these inequalities compound, recent scholarship heavily relies on the concept of intersectionality, originally introduced by Kimberlé Crenshaw (1989). Intersectionality explains how multiple social identities such as gender, age, poverty, and geographical location interact to produce overlapping and unique forms of vulnerability. Susan Cutter (1996) similarly argued that socially marginalized populations frequently reside in hazard-prone areas and experience disproportionately greater disaster impacts due to structurally limited capacities for preparedness, response, and recovery.

Recent studies published in the *International Journal of Disaster Risk Reduction* (2023–2025) and *Natural Hazards* (2024–2025) further reinforce this framework. This contemporary literature demonstrates that climate-related disasters disproportionately affect adolescents, women, and marginalized populations due to deep-seated structural inequalities. Modern disaster risk research emphasizes that vulnerability is shaped by more than physical exposure; it is heavily dictated by unequal access to healthcare, education, social protection, digital communication, and institutional support. Consequently, contemporary experts advocate for gender-responsive and adolescent-inclusive disaster risk reduction (DRR) strategies that explicitly account for age, gender, poverty, disability, and geographical isolation as intersecting determinants of risk.

These theoretical perspectives are highly relevant to the empirical realities of Assam, where recurrent seasonal floods and severe riverbank erosion intersect with systemic poverty, geographical isolation, and gender inequality. In the riverine regions (*chars*) of the Sonitpur district, adolescent girls face unique, overlapping vulnerabilities. Within these flood-affected environments, their daily realities are restricted by compromised access to education, healthcare, safe sanitation, sustainable livelihoods, and formal social protection networks. Therefore, this integrated intersectionality framework provides a robust conceptual foundation for examining disaster-related losses, localized vulnerabilities, and systemic barriers to essential services among flood-affected adolescent girls in Sonitpur.

2.2 Internal and External Losses Experienced by Flood-Affected Riverine Households

Disaster literature increasingly recognizes that flood impacts extend beyond physical destruction to include economic, educational, social, and psychological losses. While traditional disaster assessments primarily measured infrastructure and economic damage, more recent studies acknowledge that disasters disrupt livelihoods, household assets, education, health, and social relationships.

Hinoni Goyal and Manik Goyal (2018) observed that India is highly vulnerable to floods due to its geo-climatic conditions, resulting in repeated losses of agricultural land, housing, household assets, and livelihoods. Such losses disproportionately affect vulnerable populations who possess limited coping capacities and fewer recovery resources.

Similarly, Elaine Enarson (2000) argued that disasters generate invisible losses alongside physical damage, including disruptions in family life, emotional well-being, caregiving responsibilities, and social security. Doreen Massey (1994) further emphasized that geographical isolation intensifies existing inequalities by restricting mobility and access to services, making remote riverine communities especially susceptible to prolonged disruptions.

Research conducted in the Brahmaputra floodplains has consistently documented the repeated loss of housing, agricultural production, educational materials, livestock, community infrastructure, and livelihood opportunities. Seasonal displacement further disrupts household routines, social networks, and educational continuity. These

studies collectively suggest that adolescent members of flood-affected households experience both external losses, such as damage to property and livelihoods, and internal losses, including psychological distress, educational disruption, reduced social participation, and diminished feelings of safety.

Recent empirical evidence indicates that recurrent flooding causes multidimensional losses extending beyond physical and economic damage. Studies published in *Climate Risk Management* (2023) and the *International Journal of Disaster Risk Reduction* (2024) demonstrate that repeated flood exposure leads to prolonged educational disruption, livelihood insecurity, displacement, psychological distress, and reduced adaptive capacity among vulnerable households. These studies argue that distinguishing between material (external) losses and non-material (internal) losses provides a more comprehensive understanding of disaster impacts, particularly among adolescents and other socially vulnerable groups.

2.3 Social, Health, and Protection Vulnerabilities of Flood-Affected Adolescent Girls

Gender significantly shapes disaster experiences because women and girls often occupy disadvantaged social and economic positions before disasters occur. Elaine Enarson (2000) demonstrated that unequal gender roles, caregiving responsibilities, restricted mobility, and limited participation in decision-making increase women's vulnerability during disasters.

Similarly, Naila Kabeer (1999) argued that women's limited access to resources and decision-making authority reduces their ability to cope effectively during crises. For adolescent girls, these disadvantages are often compounded by age-related dependency, making them particularly vulnerable during emergencies.

Repeated flood exposure also affects adolescents' mental health and psychosocial well-being. Lori Peek (2008) emphasized that disasters interrupt children's developmental processes, emotional security, and future opportunities, contributing to anxiety, stress, and emotional instability. Likewise, Susan Cutter and colleagues (2003) identified income insecurity, social exclusion, and weak institutional support as important determinants of post-disaster recovery.

Health vulnerabilities extend beyond psychological impacts. The World Health Organization recognizes adolescence as a critical period requiring adequate nutrition, especially iron and essential micronutrients. During flood-induced food shortages, gender-biased intra-household food allocation may place adolescent girls at greater risk of malnutrition and anaemia.

Protection concerns also become more severe during disasters. Azad, Hossain, and Nasreen (2013) found that women in flood-affected Bangladesh experienced displacement, food insecurity, restricted healthcare access, harassment, and domestic violence. Likewise, Elaine Enarson and Briar Schneider (2007) reported that overcrowded emergency shelters lacking privacy increase risks of harassment and gender-based violence. United Nations Population Fund has similarly emphasized the need for gender-responsive protection mechanisms, reproductive healthcare, and safe spaces during emergencies. Economic hardship may also contribute to negative coping mechanisms such as early marriage, as highlighted by Robert Jensen (2003). Furthermore, Ariyabandu and Maithree Wickramasinghe (2005) argued that gender intersects with class, ethnicity, disability, and age to produce differential disaster vulnerabilities, reinforcing the importance of gender-responsive disaster management.

Recent public health research has highlighted the disproportionate impact of climate-related disasters on adolescent girls' physical and mental health. Studies published in *BMC Public Health* (2023–2025) report increased levels of anxiety, depression, nutritional deficiencies, menstrual hygiene challenges, and reduced access to reproductive healthcare following floods. Similarly, recent articles in *Natural Hazards* emphasize that

displacement, overcrowded shelters, disrupted education, and weakened protection systems increase the risks of gender-based violence, child marriage, and social exclusion among adolescent girls. These findings further support the need for gender-responsive disaster policies that prioritize adolescent health, protection, and psychosocial well-being.

2.4 Availability and Accessibility of Essential Services During and After Floods

Access to essential services is a critical determinant of disaster resilience and recovery. However, recurrent flooding frequently disrupts healthcare, nutrition, education, water, sanitation, and hygiene services in geographically isolated riverine communities.

Menstrual Hygiene Management (MHM) has emerged as an important component of gender-responsive disaster management. The UNICEF and WaterAid have highlighted that floods often interrupt access to safe water, sanitation facilities, privacy, and menstrual hygiene materials, disproportionately affecting adolescent girls. Marni Sommer (2010) further argued that inadequate menstrual hygiene facilities compromise girls' dignity, mobility, school participation, and overall well-being.

Healthcare and nutrition services are similarly disrupted during disasters. Damage to health facilities, transportation barriers, and shortages of medical supplies reduce access to maternal and adolescent health services, immunization, nutritional supplementation, and reproductive healthcare, especially in remote flood-prone settlements.

Education also suffers significantly during flood emergencies. Rebecca Winthrop and Jackie Kirk (2008) observed that disasters disproportionately interrupt girls' education because schools are often damaged or converted into relief shelters, while increased domestic responsibilities and safety concerns discourage school re-enrollment.

In India, programmes such as the Right to Education Act and the Integrated Child Development Services seek to ensure access to education, nutrition, and child development services. Nevertheless, repeated flooding frequently disrupts these systems, particularly in remote riverine regions where transportation, communication, and public infrastructure remain weak.

Studies conducted in the Brahmaputra basin, including research by Ranjan Ramesh and other scholars working on Assam's flood vulnerability, emphasize that improving resilience requires strengthening localized service delivery systems, community-based preparedness, and gender-responsive disaster governance. These findings underscore the importance of assessing not only the availability but also the accessibility and effectiveness of healthcare, education, nutrition, and menstrual hygiene services for flood-affected adolescent girls in Sonitpur district.

Recent studies published in *Climate Risk Management* (2024), the *International Journal of Disaster Risk Reduction* (2025), and *BMC Public Health* (2024) demonstrate that repeated flooding significantly disrupts the continuity of healthcare, education, nutrition programmes, menstrual hygiene management, and social protection services in vulnerable communities. These studies emphasize that service availability alone is insufficient; accessibility, affordability, quality, and continuity of services are equally important for ensuring resilience among adolescents. The literature increasingly recommends integrating gender-responsive healthcare, adolescent-friendly services, resilient educational infrastructure, and community-based disaster preparedness into local disaster management planning.

2.5 Research Gap

Although substantial literature exists on disaster vulnerability, gender, and flood impacts, important knowledge gaps remain. Most studies conducted in Assam and other flood-prone regions primarily focus on household economic losses, infrastructure damage, livelihood disruption, or community resilience, with limited emphasis on adolescent girls as a distinct population group. Recent international studies have increasingly recognised the importance of gender-responsive and intersectional approaches to disaster research; however, empirical evidence from the riverine communities of Northeast India remains scarce. In particular, few studies simultaneously examine the internal and external losses experienced by adolescent girls, their social, health, and protection vulnerabilities, and the availability, accessibility, and effectiveness of essential services during and after floods. Furthermore, localised evidence from Sonitpur district is largely absent. The present study addresses these gaps by adopting a convergent parallel mixed-methods approach to generate empirical evidence on the multidimensional experiences of flood-affected adolescent girls and to inform adolescent-centred, gender-responsive disaster risk reduction policies.

III. Extent of Internal and External Losses among Flsood-Affected Adolescent Girls (Objective 1)

The findings of the study demonstrate that recurrent flooding resulted in both external material losses and internal losses affecting the physical, nutritional, educational, and psychosocial well-being of adolescent girls. The external losses were reflected in damage to houses, agricultural land, livestock, stored food, educational materials, clothing, medicines, and other household assets. These material losses subsequently contributed to internal consequences, including educational disruption, nutritional deficiencies, health problems, menstrual difficulties, weakness, and increased household responsibilities. Thus, the findings indicate that flood-related losses extend beyond visible physical damage and have implications for the overall well-being and developmental opportunities of adolescent girls.

3.1 External Losses: Housing, Livelihoods and Essential Household Assets

The household-level findings indicate considerable material losses as a result of recurrent flooding. Among the 71 surveyed households, riverbank erosion was reported as the major cause of shelter destruction by 43.66% of households, while 28.17% reported prolonged waterlogging and associated structural damage, and another 28.17% reported weakening or collapse of houses due to foundation damage. These findings demonstrate that recurrent flooding creates substantial insecurity in relation to housing and physical living conditions.

The loss of agricultural resources was also substantial. 84.51% of households reported loss of agricultural land and stored grains, while 70.42% reported loss of livestock. Since agriculture and livestock constitute important livelihood resources for many households in the study area, these losses can directly reduce household income and food availability. The loss of productive assets therefore represents an important external dimension of flood-related loss.

Loss of essential household belongings was particularly widespread. 98.59% of households reported losing clothes, books, medicines, valuable documents, and other important belongings during flood events. The destruction or loss of educational materials is particularly significant for adolescent girls because it can create additional barriers to educational continuity after the flood. Similarly, the loss of medicines and important documents may complicate access to healthcare and other essential services during the recovery period.

The findings also show that 28.17% of households experienced loss of jewellery, indicating that flood-related material losses extended beyond livelihood assets and included household savings and valuables. Taken together, the loss of housing, agricultural land, livestock, stored food, clothing, educational materials, medicines, documents, and valuables demonstrates the extensive material burden experienced by flood-affected households.

3.2 Displacement and Loss of Residential Security

Displacement represents another important dimension of external loss because the destruction or unsafe condition of housing forced households to temporarily or permanently change their usual living arrangements. The findings show that 47.89% of households shifted to relief camps, 35.21% stayed along roadsides or under temporary and unsecured shelters, and 16.90% shifted to other locations during floods.

The loss of a secure home has consequences beyond physical shelter. Temporary displacement can interrupt access to education, healthcare, livelihoods, sanitation, food, and social networks. For adolescent girls, displacement may additionally affect privacy, personal hygiene, menstrual hygiene management, and the ability to maintain regular educational routines.

Therefore, the findings suggest that the external losses experienced by flood-affected households include not only the destruction of physical assets but also the loss of residential security and stability, which subsequently contributes to the internal and social consequences experienced by adolescent girls.

3.3 Internal Losses: Educational and Developmental Consequences

The external losses experienced by households were accompanied by significant consequences for the education and development of adolescent girls. Among the 71 adolescent girls surveyed, 35.2% were studying at the upper-primary level, 21.3% at the high-school level, and 14.0% at the higher-secondary level, while 29.5% had dropped out of school.

The qualitative findings indicate that recurrent floods contributed to educational discontinuity through school closures, damage to books and uniforms, inaccessible roads, displacement, and household financial difficulties. Some participants reported remaining away from school for extended periods after floods because families had to rebuild houses or replace damaged educational materials.

These findings demonstrate that educational loss is an important form of internal and developmental consequence of flooding. Although school dropout may have multiple causes, the qualitative evidence from the study indicates that recurrent floods can intensify existing educational disadvantages by disrupting schooling and increasing household economic pressures.

3.4 Internal Losses: Nutritional and Food-Related Consequences

The findings demonstrate substantial nutritional consequences among adolescent girls. 64.8% reported inadequate access to nutritious food, while 73.2% depended on relief food during floods. In addition, 47.9% experienced food shortages due to livelihood loss, 40.8% reported reduced meal frequency, and 43.7% reported weakness or fatigue.

These findings indicate that external livelihood and agricultural losses translated into internal nutritional consequences for adolescent girls. Loss of agricultural land, livestock, and stored grains reduced household access to food and income, while dependence on relief supplies limited dietary choice and diversity.

The qualitative findings further demonstrate that girls frequently depended on basic relief foods and had limited access to vegetables, eggs, milk, and other nutrient-rich foods during flood periods. Thus, food insecurity during floods was not restricted to the availability of food but also involved reduced dietary diversity and inadequate nutritional quality, which may affect adolescent growth, energy levels, and overall well-being.

3.5 Internal Losses: Physical Health Consequences

The health findings provide further evidence of the internal consequences of recurrent flooding. Among the 71 adolescent girls surveyed, 35.2% reported anaemia or iron deficiency, followed by 28.1% reporting other undernutrition-related deficiencies. Furthermore, 16.9% reported menstrual problems or irregular periods, 9.8% reported urinary tract or other vaginal infections, 5.8% reported gastrointestinal disorders, and 4.2% reported respiratory problems or skin infections.

The high proportion reporting anaemia or iron deficiency and other nutritional deficiencies is particularly important because adolescence is a period of rapid physical growth and increased nutritional requirements. The findings suggest that food insecurity and inadequate dietary intake during recurrent flood periods were accompanied by adverse health outcomes.

The qualitative findings further indicate that inadequate nutrition, unsafe drinking water, poor sanitation, and disrupted healthcare services contributed to health problems among adolescent girls. Participants described weakness, skin infections, urinary problems, and menstrual difficulties during and after flood events.

3.6 Internal Losses: Menstrual Health and Personal Well-being

Menstrual health emerged as an important internal consequence of flooding. 16.9% of the adolescent girls reported menstrual problems or irregular periods, while 9.8% reported urinary tract or other vaginal infections. These findings indicate that recurrent flooding affected aspects of girls' reproductive and personal health.

The qualitative evidence indicates that girls experienced particular difficulties in managing menstruation in relief settings because of limited availability of sanitary pads, inadequate access to clean water, and insufficient private spaces. These conditions affected their ability to maintain menstrual hygiene and personal comfort during displacement.

Thus, menstrual health represents an important form of internal loss because flood-related disruption affected girls' physical comfort, health, and ability to manage menstruation with privacy and dignity.

3.7 Loss of Basic Necessities and Increased Household Burden

Flooding also resulted in the loss of clothing and other personal necessities. 54.9% of adolescent girls reported loss of clothing and personal belongings. The qualitative interviews further revealed that some girls lost school uniforms and other essential belongings when floodwater entered their homes.

In addition, 43.7% of the surveyed girls reported increased caregiving responsibilities during flood emergencies. Girls were required to assist younger siblings, elderly family members, or sick relatives. This represents an important indirect consequence of flooding because increased domestic responsibilities may reduce the time and opportunity available for education, rest, personal care, and other developmental activities.

3.8 Overall Extent of Internal and External Losses

The findings demonstrate a clear relationship between external material losses and internal consequences among flood-affected adolescent girls. The destruction of houses and agricultural resources, loss of livestock and stored grains, and damage to essential belongings created economic and living-condition pressures at the household level. These external losses were accompanied by educational disruption, food insecurity, nutritional deficiencies, health problems, menstrual difficulties, loss of personal belongings, and increased caregiving responsibilities among adolescent girls.

Type of Loss	Empirical Evidence from the Study
Housing loss	43.66% reported riverbank erosion; 28.17% reported prolonged waterlogging; 28.17% reported weakening/collapse of houses
Agricultural loss	84.51% of households reported loss of agricultural land
Food-stock loss	84.51% reported loss of stored grains
Livestock loss	70.42% reported loss of livestock

Essential belongings	98.59% of households reported loss of clothes, books, medicines, documents and other valuables
Displacement	47.89% shifted to relief camps; 35.21% stayed in roadside/temporary shelters
Educational loss	29.5% of adolescent girls were school dropouts
Food insecurity	64.8% reported inadequate nutritious food
Dependence on relief food	73.2% depended on relief food
Reduced meals	40.8% reported reduced meal frequency
Weakness/fatigue	43.7% reported weakness or fatigue
Anaemia/iron deficiency	35.2% reported anaemia/iron deficiency
Other nutritional deficiencies	28.1% reported other undernutrition deficiencies
Menstrual problems	16.9% reported menstrual problems/irregular periods
UTI/vaginal infections	9.8% reported urinary tract or other vaginal infections
Loss of clothing/personal belongings	54.9% of girls reported such losses
Increased caregiving responsibilities	43.7% reported increased caregiving responsibilities

Overall, the findings establish that the extent of flood-related losses was multidimensional. External losses were predominantly reflected in housing destruction, livelihood assets, agricultural land, stored food, livestock, and essential household belongings. These losses were followed by internal consequences affecting education, nutrition, physical health, menstrual health, personal well-being, and household responsibilities. The evidence therefore demonstrates that recurrent flooding does not merely result in temporary material damage; it can also produce sustained consequences for the health, education, development, and everyday well-being of adolescent girls.

Accordingly, Objective 1 is addressed through the empirical evidence showing that external material losses and internal developmental and well-being consequences are closely interconnected among flood-affected adolescent girls in Sonitpur district.

IV. Social, Health and Protection Vulnerabilities among Flood-Affected Adolescent Girls in Sonitpur District (Objective 2)

The primary findings demonstrate that recurrent flooding creates interconnected social, health, and protection vulnerabilities among adolescent girls in the study area. The vulnerabilities identified through the field survey include educational disruption, displacement, inadequate nutrition, health problems, menstrual hygiene challenges, limited access to healthcare and sanitation, insufficient privacy in relief shelters, and increased caregiving responsibilities. These findings indicate that the effects of flooding extend beyond immediate material losses and affect the everyday well-being, safety, dignity, and developmental opportunities of adolescent girls.

4.1 Social Vulnerabilities

The social vulnerability of adolescent girls was evident in the disruption of education, displacement, loss of essential belongings, food insecurity, and increased household responsibilities.

The educational findings indicate a substantial level of educational vulnerability among the surveyed adolescent girls. Of the 71 girls included in the study, 35.2% were studying at the upper-primary level, 21.3% at the high-school level, and 14.0% at the higher-secondary level, while 29.5% had already dropped out of school. The findings further indicate that recurrent flooding contributed to educational disruption through school closures, damage to educational materials, displacement, and household financial difficulties. Qualitative interviews similarly indicated that girls experienced prolonged interruptions in schooling because schools were sometimes used as relief shelters, roads became inaccessible, and books, uniforms, and other learning materials were damaged during floods.

Displacement further intensified social vulnerability. Among the 71 surveyed households, 47.89% shifted to relief camps, 35.21% stayed along roadsides or under temporary and unsecured shelters, and 16.90% shifted to other locations during flood events. The findings indicate that temporary displacement disrupted normal household arrangements and created difficulties in accessing education, healthcare, sanitation, and other essential services.

Loss of personal belongings also affected adolescent girls during flood events. The household-level findings show that 98.59% of households reported the loss of clothes, books, medicines, valuable documents, and other essential belongings. Among adolescent girls specifically, 54.9% reported loss of clothing and personal belongings. Such losses can affect girls' ability to continue education and maintain personal hygiene and dignity during displacement.

Food insecurity represented another important dimension of social vulnerability. 73.2% of the adolescent girls depended on relief food during floods, while 64.8% reported inadequate access to nutritious food. In addition, 47.9% experienced food shortages because of livelihood losses and 40.8% reported reduced meal frequency. These findings indicate that disruption of household livelihoods and dependence on emergency food assistance can reduce dietary diversity and affect the nutritional well-being of adolescent girls.

The qualitative findings further demonstrate that recurrent floods affected girls' daily lives through irregular meals, limited dietary diversity, loss of clothing and school materials, and dependence on relief supplies. Thus, the social vulnerability identified in the study is closely associated with displacement, educational interruption, material losses, food insecurity, and changing household responsibilities.

4.2 Health Vulnerabilities

Health vulnerability emerged as a major concern among the adolescent girls surveyed. The health assessment of the 71 girls showed that 35.2% reported anaemia or iron deficiency, making it the most frequently reported health condition. This was followed by other undernutrition deficiencies (28.1%), menstrual problems or irregular periods (16.9%), urinary tract or vaginal infections (9.8%), gastrointestinal disorders (5.8%), and respiratory problems or skin infections (4.2%).

The findings indicate that health problems were closely associated with nutritional deficiencies, inadequate sanitation, unsafe water, and disruption of healthcare services during recurrent floods. The high prevalence of anemia/iron deficiency and other nutritional deficiencies is particularly significant because adolescence is a period of rapid physical growth and increased nutritional requirements.

The food and nutrition findings reinforce this pattern. 43.7% of girls reported weakness or fatigue, while 64.8% reported inadequate nutritious food and 40.8% experienced reduced meal frequency. The qualitative interviews also indicated that girls frequently depended on basic relief foods and had limited access to vegetables, eggs, milk, and other nutrient-rich foods during flood periods.

Healthcare access was also substantially affected. 62.0% of the surveyed adolescent girls reported limited access to healthcare services during floods. This indicates that health vulnerability was not only a consequence of exposure to adverse environmental conditions but was also associated with difficulty accessing appropriate healthcare when illness occurred.

Menstrual and reproductive health constituted an additional area of vulnerability. 16.9% of the girls reported menstrual problems or irregular periods, while 9.8% reported urinary tract or other vaginal infections. Qualitative evidence further indicated difficulties in obtaining sanitary pads, accessing clean water, and maintaining hygiene and privacy during menstruation in relief shelters. These findings demonstrate that menstrual health needs were particularly difficult to manage during flood displacement.

4.3 Protection, Privacy, and Dignity Vulnerabilities

Protection-related vulnerability was primarily reflected in inadequate privacy and sanitation, insecure temporary shelter, and increased responsibilities within households.

The survey found that 49.3% of adolescent girls reported insufficient privacy and protection in relief camps, while 59.2% reported a lack of safe sanitation and bathing facilities. These findings are particularly significant for adolescent girls because inadequate privacy and sanitation can affect personal safety, menstrual hygiene, dignity, and comfort during displacement.

The type of shelter used during floods further illustrates the protection concerns. More than one-third of surveyed households (35.21%) stayed along roadsides or under temporary and unsecured shelters, while 47.89% moved to relief camps. Such temporary living arrangements can reduce privacy and make it more difficult for adolescent girls to maintain personal hygiene and access gender-sensitive facilities.

In addition, 43.7% of adolescent girls reported increased caregiving responsibilities during flood emergencies. Girls were required to assist with younger siblings, older family members, or sick relatives, which may increase their domestic burden at a time when education and personal well-being are already disrupted.

The findings therefore indicate that protection vulnerability in flood-affected settings is closely linked to the availability of safe shelter, sanitation, privacy, and support within households and relief settings. While the present survey establishes significant concerns regarding privacy, sanitation, and increased caregiving responsibilities, it does not provide sufficient quantitative evidence to determine the prevalence of specific forms of gender-based violence or harassment. Such claims should therefore be treated cautiously and should not be presented as established findings unless supported by the study's qualitative data.

4.4 Menstrual Hygiene and Gender-Specific Vulnerability

Menstrual hygiene management represents an important gender-specific dimension of vulnerability identified in the study. 69.0% of the surveyed adolescent girls reported inadequate menstrual hygiene materials during floods, while 59.2% reported inadequate access to safe sanitation and bathing facilities. These conditions can make it difficult for girls to maintain menstrual hygiene safely and privately during displacement.

The qualitative findings reinforce the survey evidence. Participants described difficulties in obtaining sanitary pads, accessing clean water, and maintaining privacy during menstruation in relief camps. The findings therefore demonstrate that menstrual hygiene should be treated as an essential component of emergency response rather than as an additional or secondary need.

4.5 Interrelationship of Social, Health, and Protection Vulnerabilities

The empirical findings demonstrate that social, health, and protection vulnerabilities among adolescent girls are closely interconnected. Educational disruption and dropout occur alongside displacement and material losses; food insecurity contributes to nutritional deficiencies and weakness; inadequate sanitation and limited healthcare

access increase health risks; and insufficient privacy in relief camps affects menstrual hygiene, dignity, and protection.

The findings from the present study can therefore be summarized through several key indicators:

Vulnerability domain	Primary finding
Education	29.5% of girls had dropped out of school
Nutrition	64.8% reported inadequate nutritious food
Relief dependence	73.2% depended on relief food
Anaemia/iron deficiency	35.2% reported this condition.
Menstrual health	16.9% reported menstrual problems/irregular periods.
Menstrual hygiene	69.0% reported inadequate menstrual hygiene materials.
Healthcare access	62.0% reported limited access to healthcare
Sanitation	59.2% lacked safe sanitation and bathing facilities
Privacy/protection	49.3% reported insufficient privacy and protection in relief camps
Caregiving burden	43.7% reported increased caregiving responsibilities

Overall, the primary evidence shows that recurrent flooding produces a multidimensional vulnerability profile among adolescent girls, affecting their education, nutrition, physical health, menstrual hygiene, access to healthcare, privacy, and household responsibilities. The findings directly address Objective 2 by demonstrating, through field-level quantitative and qualitative evidence, how flooding interacts with existing social and economic conditions to intensify the vulnerabilities of adolescent girls in Sonitpur district.

V. Status of Essential Services During and After Floods (Objective 3)

The findings indicate that recurrent flooding significantly affected adolescent girls' access to essential services during the emergency and post-flood recovery periods. The primary data show gaps in menstrual hygiene materials, healthcare, sanitation and bathing facilities, nutritious food, privacy and protection, and household support. These findings demonstrate that although emergency relief mechanisms were available, access to essential services remained inadequate for a substantial proportion of adolescent girls.

5.1 Access to Healthcare Services

Healthcare access was substantially disrupted during flood emergencies. Among the 71 adolescent girls surveyed, 62.0% reported limited access to healthcare services during floods. This indicates that a considerable proportion of girls experienced difficulties in obtaining healthcare when it was needed.

The health findings further demonstrate the consequences associated with these service limitations. Among the surveyed girls, 35.2% reported anaemia or iron deficiency, 28.1% reported other undernutrition deficiencies, 16.9% reported menstrual problems or irregular periods, 9.8% reported urinary tract or other vaginal infections, 5.8% reported gastrointestinal disorders, and 4.2% reported respiratory problems or skin infections.

The qualitative findings support the quantitative evidence. Interviews indicated that damaged roads, transportation difficulties, and disruption of healthcare services made it difficult for adolescent girls to reach health facilities

after floods. The findings also highlighted the need for health services that respond specifically to adolescent girls' nutritional, menstrual, and reproductive health needs.

Thus, the findings suggest that the availability of healthcare during flood emergencies does not necessarily ensure effective accessibility. Physical access, transportation, continuity of services, and the availability of adolescent-specific health support remain important concerns.

5.2 Menstrual Hygiene Management Services

Menstrual hygiene management emerged as one of the most significant gaps in essential services. 69.0% of the surveyed adolescent girls reported inadequate access to menstrual hygiene materials during floods. This represents the largest proportion among the service-related challenges measured in Table 8.

The problem was further compounded by inadequate sanitation and bathing facilities. 59.2% of girls reported a lack of safe sanitation and bathing facilities, making it difficult to maintain menstrual hygiene safely and privately during displacement.

The health data also indicate that 16.9% of girls reported menstrual problems or irregular periods and 9.8% reported urinary tract or other vaginal infections. While these findings cannot establish a direct causal relationship between service gaps and health conditions, they demonstrate the coexistence of menstrual and reproductive health concerns with inadequate access to hygiene facilities and materials.

Qualitative evidence further illustrates the practical difficulties experienced by girls during menstruation in relief settings, including limited access to sanitary pads, clean water, and private spaces. These findings demonstrate that menstrual hygiene management should be incorporated as a core component of emergency relief planning rather than treated as an optional welfare provision.

5.3 Water, Sanitation and Bathing Facilities

Access to safe sanitation represented another major gap in essential services. 59.2% of the surveyed adolescent girls reported a lack of safe sanitation and bathing facilities during flood situations.

This finding is particularly significant because inadequate sanitation affects multiple aspects of adolescent girls' well-being, including personal hygiene, menstrual hygiene, privacy, and protection. The health findings showing gastrointestinal disorders, urinary tract or vaginal infections, and skin-related problems provide further evidence of the health concerns present among the surveyed girls.

The study therefore indicates that emergency shelter arrangements need to include adequate water, toilets, bathing facilities, and privacy provisions. The provision of shelter alone is insufficient if essential WASH facilities are not available and accessible to adolescent girls.

5.4 Access to Nutrition and Food Support

Access to nutritious food was another significant service-related concern. 54.9% of the surveyed adolescent girls reported difficulty accessing nutritious food during floods.

The nutritional findings provide additional evidence of this problem. 73.2% of girls depended on relief food, 64.8% reported inadequate nutritious food, 47.9% experienced food shortages due to livelihood loss, and 40.8% reported reduced meal frequency. Furthermore, 43.7% reported weakness or fatigue.

The health findings are consistent with these nutritional challenges, with 35.2% reporting anaemia or iron deficiency and 28.1% reporting other undernutrition deficiencies.

These findings indicate that emergency food assistance was available to many households, but access to adequate and nutritionally diverse food remained a concern. The findings therefore support the need for nutrition-sensitive relief measures that consider the specific nutritional requirements of adolescent girls.

5.5 Privacy and Protection in Relief Settings

The availability of safe and private spaces was also inadequate for a considerable proportion of adolescent girls. 49.3% reported insufficient privacy and protection in relief camps.

This finding is particularly important when considered alongside the high proportion of households staying in temporary shelters. The household-level data show that 47.89% of households shifted to relief camps, while 35.21% stayed along roadsides or under temporary and unsecured shelters.

The combination of temporary accommodation, inadequate sanitation, and insufficient privacy can make it difficult for adolescent girls to manage personal hygiene and menstruation comfortably and safely. However, the available data establish insufficient privacy and protection but do not quantify the prevalence of harassment or gender-based violence. Therefore, the present findings should be interpreted specifically in terms of privacy, shelter conditions, and access to protection rather than making unsupported claims regarding the prevalence of GBV.

5.6 Household Support and Increased Caregiving Responsibilities

The study also identified an indirect service-related burden arising from increased caregiving responsibilities. 43.7% of the adolescent girls reported increased caregiving responsibilities during flood emergencies.

This finding indicates that flood emergencies may increase girls' domestic responsibilities at a time when access to education, healthcare, nutrition, and other services is already disrupted. Increased caregiving responsibilities may therefore reduce girls' ability to access available services and participate in education or other developmental activities.

This dimension highlights the importance of considering adolescent girls not only as recipients of relief services but also as members of households whose responsibilities may increase during disasters.

5.7 Overall Status of Essential Services

The primary findings demonstrate that essential services were available to some extent during flood emergencies, but significant gaps remained in accessibility and adequacy. The major service-related challenges reported by the 71 adolescent girls are summarized below:

Essential Service	Girls Reporting the Challenge	Percentage
Menstrual hygiene materials	49	69.0%
Healthcare services	44	62.0%
Safe sanitation and bathing facilities	42	59.2%
Nutritious food	39	54.9%
Privacy and protection in relief camps	35	49.3%
Increased caregiving responsibilities	31	43.7%

Source: Field Survey,2023- 2025.

The findings indicate that menstrual hygiene management represented the largest reported service gap (69.0%), followed by healthcare access (62.0%) and safe sanitation and bathing facilities (59.2%). More than half of the

respondents also reported difficulties accessing nutritious food (54.9%). Nearly half reported inadequate privacy and protection in relief camps (49.3%), while 43.7% experienced increased caregiving responsibilities.

Overall, the evidence demonstrates that the essential service needs of adolescent girls were not fully addressed during flood emergencies and the subsequent recovery period. The major gaps identified through the primary data relate to menstrual hygiene, healthcare, WASH facilities, nutrition, privacy and protection, and household support. These findings directly address Objective 3 by demonstrating the extent to which adolescent girls could access essential services during and after floods.

The findings further suggest that effective disaster response for adolescent girls requires a shift from general relief provision towards gender-responsive and adolescent-sensitive service delivery, ensuring that healthcare, menstrual hygiene materials, safe sanitation, nutritious food, privacy, and protection are available continuously throughout the emergency and recovery phases.

VI. Data Analysis and Interpretation

The findings reveal that recurrent floods in the riverine areas of Sonitpur district cause both external (material) and internal (non-material) losses that significantly affect adolescent girls. External losses include damage to houses, agricultural land, livestock, household assets, food grains, and essential documents, while internal losses involve poor health, psychological distress, educational disruption, food insecurity, and increased safety concerns. Together, these impacts deepen household vulnerability and hinder post-flood recovery.

Sonitpur district remains highly flood-prone due to its location between the Brahmaputra River and the Himalayan foothills, with rivers such as the Pachnoi, Belsiri, Gabharu, and Jia Bharali causing frequent flooding and riverbank erosion. Recurrent floods result in displacement, loss of livelihoods, and disruption of essential services, disproportionately affecting economically vulnerable households.

The analysis of Tables 1–7 highlights the extent of damage to housing, livelihood losses, displacement, educational disruption, health challenges, and limited access to essential services. The findings show that material losses are closely linked to long-term social and developmental consequences for adolescent girls, including interrupted education, poor sanitation, limited healthcare, and psychological stress.

Overall, the study demonstrates that flood vulnerability is multidimensional and shaped by the interaction of gender, poverty, and geographical isolation. These findings underscore the need for gender-responsive disaster management that ensures resilient infrastructure, uninterrupted education and healthcare, menstrual hygiene support, psychosocial care, and child protection for adolescent girls in flood-prone communities.

Table 1: Patterns of Shelter Destruction among Flood-Affected Households

Opinion on Losses	Frequency	Percentage
Prolonged waterlogging and destruction (mud/clay, wooden frame, pillars, etc.)	20	28.17
Weakening/collapse of houses (foundation weakening and collapse)	20	28.17
Riverbank erosion (destruction of houses)	31	43.66
Total	71	100.00

Source: Primary data collected from the field during 2023–2025.

Table 1 presents the distribution of households according to their reported causes of shelter destruction during floods. The findings indicate that 43.66% of the surveyed households identified riverbank erosion as the major

cause of housing destruction. This was followed by 28.17% of households who reported prolonged waterlogging and associated structural damage, while another 28.17% reported weakening or collapse of houses due to foundation damage.

Riverbank erosion emerged as a major threat to residential security, as it can result in the permanent loss of houses, agricultural land, and livelihood assets and may lead to displacement. Prolonged waterlogging can also weaken housing structures and damage materials such as mud, clay, wooden frames, and pillars. Similarly, weakening or collapse of foundations can make houses unsafe for habitation, particularly where households live in kutcha or semi-pucca structures.

The findings demonstrate that shelter destruction during floods extends beyond physical damage to houses and can contribute to displacement, livelihood insecurity, disruption of education, and increased vulnerability among adolescent girls. The loss or unsafe condition of housing may also reduce privacy and security and increase difficulties in accessing essential services. These findings highlight the need for flood-resilient housing, effective riverbank protection measures, timely evacuation and relocation support, and community-based rehabilitation to reduce the long-term impacts of recurrent flooding on vulnerable households and adolescent girls.

Table 2. Extent of External Losses among Flood-Affected Households

Opinion/Type of loss	No. of Households	Total Households	Percentage (%)
Loss of livestock	50	71	70.42
Loss of agricultural land	60	71	84.51
Loss of stored grains	60	71	84.51
Loss of jewellery	20	71	28.17
Loss of clothes, books, medicines, valuable documents, etc.	70	71	98.59

Source: Primary data collected from the field during 2023–2025.

Table 2 presents the major forms of external losses experienced by flood-affected households. The findings indicate that the most common losses were clothes, educational materials, medicines, valuable documents, and other essential household belongings, reported by 98.59% of the surveyed households. This was followed by the loss of agricultural land and stored grains, reported by 84.51% of households each. Livestock losses were reported by 70.42% of households, while 28.17% reported losses of jewellery.

These losses significantly disrupted household livelihoods, food security, education, and access to essential resources. Riverbank erosion and prolonged inundation can damage cultivable land, destroy crops, and reduce agricultural productivity, while the loss of livestock can further weaken household income and livelihood security. The loss of educational materials, medicines, and important documents may also create additional difficulties for families in maintaining education, accessing healthcare, and obtaining essential services after floods.

The findings indicate that flood-related material losses can have substantial and longer-term socio-economic consequences for affected households. Financial insecurity may compel families to adopt coping strategies that can disproportionately affect adolescent girls, including increased domestic responsibilities, interruptions in education, engagement in income-generating activities, and reduced opportunities for personal development. Thus, the findings demonstrate that the consequences of flooding extend beyond immediate property damage and can undermine household resilience and the overall well-being and future opportunities of adolescent girls.

Table 3: Shelter Displacement Patterns among Flood-Affected Households

Shelter displacement Status	No. of Households	Percentage
Roadsides (under unsecured shades for immediate relief)	25	35.21
Relief camps (in schools)	34	47.89
Shifted to other places	12	16.90
Total	**71**	**100.00**

Source: Primary data collected from the field during 2023–2025.

Table 3 presents the distribution of flood-affected households according to the type of shelter they shifted to during flood events. The findings indicate that the largest proportion of households (47.89%) took shelter in relief camps, mainly established in schools. This was followed by 35.21% of households who stayed along roadsides or under temporary and unsecured shelters to obtain immediate protection from floodwaters. A further 16.90% of households shifted to other places, including safer locations outside their immediate flood-affected areas.

The relatively high proportion of households staying in temporary roadside shelters indicates gaps in the availability and accessibility of safe emergency accommodation during the initial stages of flooding. Such temporary shelters may lack adequate sanitation, privacy, security, clean drinking water, and access to essential healthcare services, thereby increasing health and protection risks, particularly for women and adolescent girls.

Although relief camps provided shelter to nearly half of the surveyed households, the availability and adequacy of essential services within these camps remained important concerns. Adolescent girls may face particular difficulties in maintaining menstrual hygiene and personal privacy in crowded emergency shelters due to inadequate sanitary products, water, toilet facilities, and designated spaces for personal hygiene. Households that shifted to other places also experienced disruption to their normal living arrangements, access to livelihoods, education, and essential services. These findings highlight the need for timely, safe, accessible, and gender-responsive shelter arrangements during flood emergencies, with particular attention to the specific needs of adolescent girls and other vulnerable household members.

Table 4: Distribution of Flood-Affected Households by Family Size

Nos. of Family Members	No. of Households	Percentage
3–4	10	14.08
4–5	20	28.17
5–6	33	46.48
6–7	8	11.27
Total	**71**	**100.00**

Source: Primary data collected from the field during 2023–2025.

Table 4 presents the distribution of surveyed households according to family size. The findings indicate that the largest proportion of households (46.48%) had five to six family members, followed by 28.17% of households with four to five members. About 14.08% of households had three to four members, while 11.27% had six to

seven members. Overall, the findings indicate that most of the surveyed households had relatively moderate to large family sizes.

Larger family sizes may increase household dependency and place additional pressure on available resources, particularly when families experience loss of income, livelihood disruption, or damage to household assets during floods. Under such circumstances, households may face difficulties in meeting essential needs such as food, healthcare, education, sanitation, and shelter. These pressures can have particular implications for adolescent girls, who may experience reduced access to nutritious food, interruptions in education, increased domestic and caregiving responsibilities, and fewer opportunities for personal and educational development. In economically vulnerable households, prolonged financial hardship may also increase the likelihood of educational discontinuation or engagement in income-generating activities among adolescent girls.

Table 5. Educational Status of Adolescent Girls

Level of Education	Frequency	Percentage (%)
Upper Primary	25	35.2
High School	15	21.3
Higher Secondary	10	14.0
School Dropout	21	29.5
Total	71	100

Table 5 presents the educational status of the 71 adolescent girls included in the study. The findings indicate that 35.2% were studying at the upper primary level, 21.3% were enrolled in high school, and 14.0% were pursuing higher secondary education. However, 29.5% had discontinued their education. While poverty, household responsibilities, and early marriage contribute to school dropout, recurrent flooding further intensifies educational disruption by damaging school infrastructure, interrupting transportation, destroying learning materials, and converting schools into temporary relief shelters.

Qualitative Theme 1: Flood-Induced Disruption of Educational Continuity

The thematic analysis of interviews revealed that educational disruption was one of the most frequently reported consequences of recurrent flooding. Participants described prolonged school closures, loss of textbooks and uniforms, damaged roads, and financial hardship as major barriers to continuing their education. These experiences often resulted in irregular attendance and, in some cases, permanent school dropout.

One adolescent girl shared that:

"Every year the flood comes during the school session. Our books and school bag get damaged, and the school remains closed for many days because it becomes a relief camp. After the flood, it becomes difficult to continue studying." (Adolescent Girl, 16 years)

Another participant explained:

"My parents could not afford to buy new books and uniforms after the flood. I stayed at home for several months and later stopped going to school because we had to rebuild our house." (School Dropout, 17 years)

The qualitative findings reinforce the quantitative results by illustrating how recurrent floods create educational barriers beyond economic hardship. They demonstrate that educational discontinuity is influenced not only by poverty but also by damaged infrastructure, displacement, interrupted schooling, and limited access to educational

resources. These findings underscore the need for disaster-resilient schools, temporary learning centres, timely replacement of educational materials, and targeted educational support to ensure continuity of learning for adolescent girls during and after flood events.

Health Status of Adolescent Girls During and After Floods

Floods expose adolescent girls to significant health risks due to contaminated water, poor sanitation, overcrowded shelters, inadequate nutrition, and disrupted healthcare services. These conditions increase the prevalence of waterborne diseases, infections, and nutrition-related health problems during and after flood events.

In addition to physical illnesses, displacement, uncertainty, and disrupted daily routines contribute to anxiety, emotional stress, and psychological insecurity among adolescent girls. These findings highlight the need for gender-responsive healthcare, improved sanitation, mental health support, and uninterrupted access to essential health services during flood emergencies.

Table 6: Distribution of adolescent girls across conditions of health (during post-floods)

Health disorders	No of girls	Percentage
Anaemia/ Iron deficiency	25	35.2
Respiratory Problems/skin infections.	3	4.2
Other undernutrition deficiencies	20	28.1
Menstrual Problems/Irregular periods	12	16.9
Gastro-intestinal disorders	4	5.8
Urinary tract/other vaginal infections	7	9.8
Total	71	100

(Source: Primary data collected from the field for the year 2023-25)

Table 6 presents the health conditions of the 71 adolescent girls surveyed. The most common health problem reported was anaemia or iron deficiency (35.2%), followed by undernutrition (28.1%), menstrual disorders (16.9%), urinary tract and vaginal infections (9.8%), gastrointestinal disorders (5.8%), and respiratory and skin infections (4.2%). These health conditions were primarily associated with poor nutrition, inadequate sanitation, contaminated drinking water, and disrupted healthcare services during recurrent flood events.

Qualitative Theme 2: Flood-Induced Health and Menstrual Hygiene Challenges

The thematic analysis of interviews revealed that recurrent flooding significantly affected the physical and reproductive health of adolescent girls. Participants described limited access to nutritious food, unsafe drinking water, poor sanitation, and interruptions in healthcare services as major factors contributing to illness during and after floods. Many girls also reported difficulties in managing menstruation due to the lack of sanitary pads, clean water, private spaces, and proper sanitation facilities in relief camps.

One adolescent girl explained:

"During the floods, we mostly eat whatever food is available in the relief camp. There are very few vegetables, and sometimes we do not get enough food. After the flood, I often feel weak and dizzy." (Adolescent Girl, 15 years)

Another participant shared:

"When I got my period in the relief camp, there were no sanitary pads available. I had to use old cloth because there was no other option, and it was difficult to keep it clean." (Adolescent Girl, 16 years)

The qualitative findings complement the quantitative results by demonstrating how recurrent flooding exacerbates existing health vulnerabilities among adolescent girls. The interviews indicate that inadequate nutrition, poor menstrual hygiene management, unsafe water, limited sanitation, and disrupted healthcare services collectively contribute to adverse health outcomes. These findings underscore the need to strengthen adolescent-friendly healthcare services, nutrition support programmes, menstrual hygiene management, and reproductive health services as integral components of gender-responsive flood disaster preparedness, response, and recovery.

Table 7. Food, Nutrition, and Clothing Challenges Reported by Adolescent Girls (n = 71)

Challenges Experienced	Frequency (n)	Percentage (%)
Inadequate nutritious food	46	64.8
Loss of clothing and personal belongings	39	54.9
Food shortage due to livelihood loss	34	47.9
Reduced meal frequency	29	40.8
Dependence on relief food	52	73.2
Reported symptoms of weakness/fatigue	31	43.7

Source: Field Survey, 2025

Table 7 presents the food, nutrition, and clothing-related challenges experienced by the 71 adolescent girls surveyed. The findings indicate that 73.2% of the respondents depended primarily on relief food during floods, while 64.8% reported inadequate access to nutritious food. More than half (54.9%) lost clothing and other personal belongings during flood events, 47.9% experienced food shortages because of livelihood disruptions, 40.8% reported a reduction in daily meal frequency, and 43.7% experienced weakness or fatigue associated with inadequate nutrition.

These findings suggest that recurrent floods significantly affect the nutritional status and overall well-being of adolescent girls. Damage to agricultural land, disruption of livelihoods, and displacement reduce access to diverse and nutritious foods. Relief assistance generally provides staple foods such as rice and lentils but often lacks protein-rich foods, fruits, vegetables, and iron-rich dietary supplements necessary for adolescent growth and development.

Qualitative Theme 3: Food Insecurity, Nutritional Deficiencies, and Loss of Basic Necessities

The thematic analysis revealed that food insecurity was one of the most frequently reported challenges during and after flood events. Participants described irregular meals, limited dietary diversity, and dependence on relief supplies, which were often insufficient to meet their nutritional needs. Many girls also reported losing clothing and other essential belongings during floods, making displacement more difficult and affecting their dignity and comfort.

One adolescent girl stated:

"During the flood we mostly survive on rice and dal provided in the relief camp. We rarely get vegetables, eggs, or milk, and many times we eat only twice a day." (Adolescent Girl, 15 years)

Another participant explained:

"The floodwater entered our house and washed away my clothes and school uniform. After moving to the relief camp, I had only one set of clothes to wear." (Adolescent Girl, 16 years)

The qualitative findings complement the quantitative results by demonstrating that recurrent flooding affects adolescent girls not only through food shortages but also through reduced dietary diversity, nutritional deficiencies, and the loss of essential clothing and personal belongings. These experiences highlight the need for nutrition-sensitive and gender-responsive disaster management programmes, including adolescent nutrition support, micronutrient supplementation, dignity kits, clothing assistance, and improved relief distribution systems that address the specific needs of adolescent girls during and after flood emergencies.

Table 8 Availability and Accessibility of Essential Services During Floods (n = 71)

Essential Service Challenge	Frequency (n)	Percentage (%)
Inadequate menstrual hygiene materials	49	69.0
Limited access to healthcare services	44	62.0
Lack of safe sanitation and bathing facilities	42	59.2
Difficulty accessing nutritious food	39	54.9
Insufficient privacy and protection in relief camps	35	49.3
Increased caregiving responsibilities	31	43.7
Total Respondents	**71**	**100.0**

Source: Field Survey, 2025.

Table 8 presents the challenges faced by adolescent girls in accessing essential services during floods and the post-flood recovery period. The findings reveal that 69.0% of the respondents experienced inadequate access to menstrual hygiene materials, 62.0% reported limited access to healthcare services, and 59.2% lacked safe sanitation and bathing facilities. More than half (54.9%) experienced difficulties in accessing nutritious food, while 49.3% reported inadequate privacy and protection in relief camps. Additionally, 43.7% assumed increased caregiving responsibilities for younger siblings, elderly family members, or sick relatives during flood emergencies.

These findings indicate that although emergency relief measures such as rescue operations, relief camps, and mobile medical units were implemented, they often failed to adequately address the gender-specific needs of adolescent girls. Gaps in healthcare, menstrual hygiene management, nutrition, sanitation, and protection services increased their vulnerability during both the emergency response and recovery phases.

Qualitative Theme 5: Barriers to Essential Services and Gender-Responsive Support

The thematic analysis revealed that inadequate access to essential services was one of the most persistent challenges experienced by adolescent girls during and after floods. Participants emphasized that shortages of

sanitary pads, limited healthcare services, overcrowded relief camps, and the absence of private sanitation facilities compromised their health, dignity, and safety. Many girls also described taking on additional caregiving responsibilities while managing their own educational and health needs.

Table 8 Representative Quotations on Essential Service Challenges

Respondent	Representative Quotation	Emerging Theme
Adolescent Girl (16 years)	"There were no sanitary pads in the relief camp, and we had no private place to change. It was very uncomfortable and embarrassing."	Inadequate menstrual hygiene management
Adolescent Girl (15 years)	"The health centre was far away, and the roads were flooded. We could not visit a doctor even when I became sick."	Limited access to healthcare
ASHA Worker	"During floods, health services become difficult to deliver because many villages remain cut off. Adolescent girls often miss treatment for anaemia and menstrual health problems."	Disruption of healthcare services
Village Leader	"Relief camps provide basic shelter and food, but facilities for girls, such as separate toilets, bathing spaces, and sanitary materials, are often inadequate."	Gaps in gender-responsive disaster services

Source: Key Informant Interviews and Field Survey, 2025.

The qualitative findings reinforce the quantitative results by illustrating how disruptions in healthcare, menstrual hygiene management, nutrition, sanitation, and protection services affected the daily lives of adolescent girls during flood emergencies. Participants consistently highlighted the lack of privacy, inadequate sanitation facilities, interrupted healthcare, and increased caregiving responsibilities as significant barriers to their health and well-being. These findings underscore the need for gender-responsive disaster management that ensures uninterrupted access to adolescent-friendly healthcare, menstrual hygiene products, nutritious food, safe sanitation facilities, psychosocial support, and protection services throughout both the emergency response and post-flood recovery periods.

Table 9: Distribution of households across opinion of essential services in the relief camps or temporary shelters (during floods)

Services	Agree	Partly agree	Totally disagree	Total
Adequate food supplies (Rice, Dal, Salt, nutritional food items etc)	10	20	50 (62.5%)	80
Adequate drinking water	5	10	65 (81.25)	80
Safe sanitation facility (Clean toilets with privacy maintained)	7	8	65 (81.25)	80
Hygienic bathing, washing and cleaning facility	3	5	72 (90.00)	80
Adequate living space with privacy maintained			80 (100)	80

Adolescent girls'/women's **essential needs:** 1. Adequate supply of sanitary napkins 2. Adequate Facilities for cleaning during menstruation 3. Facilities for throwing disposables. 4. Extra healthcare for adolescent girls/pregnant women	10 6	8 4 10	72 (90) 70 (87.5) 80 (100) 70 (87.5)	80 80 80 (100) 80
Overall, health care facilities in falling sick	10	5	65 (81.2)	80
Supply of medicines for water-borne diseases, fever, cough	15	10	55 (68.7)	80

Table 9 presents household perceptions of the adequacy of essential services during flood emergencies. The findings reveal widespread dissatisfaction with relief services, particularly in menstrual hygiene management. Around 90% of respondents reported inadequate availability of sanitary napkins, 87.5% reported insufficient menstrual hygiene facilities, and 100% indicated the absence of safe menstrual waste disposal systems. Most respondents also expressed dissatisfaction with access to safe drinking water, sanitation, bathing facilities, and privacy in relief camps.

Healthcare services were also perceived as inadequate, with 81.2% of respondents reporting insufficient healthcare support for adolescent girls and pregnant women and 68.7% expressing dissatisfaction with the availability of essential medicines. Overall, the findings suggest that disaster response efforts prioritise immediate survival needs while neglecting gender-specific health, sanitation, nutrition, and protection requirements. This underscores the need for a comprehensive, gender-responsive disaster management approach that ensures continuous healthcare, menstrual hygiene support, psychosocial care, and protection services during both emergency response and post-flood recovery.

VII. Discussion

The findings show that recurrent flooding in the riverine communities of Sonitpur district extends beyond physical damage, intensifying existing inequalities related to gender, poverty, age, and geographical isolation. Adolescent girls are disproportionately affected through disruptions in education, nutrition, health, personal safety, and psychosocial well-being. These results demonstrate that flood vulnerability is shaped not only by the hazard itself but also by unequal access to resources and essential services.

The findings support the Pressure and Release (PAR) Model of Piers Blaikie et al. (1994), which explains that disasters result from the interaction between natural hazards and social vulnerability. In Sonitpur, poverty, fragile housing, dependence on agriculture, recurrent riverbank erosion, and inadequate disaster preparedness increase flood vulnerability, placing adolescent girls at greater risk of long-term social and developmental disadvantages.

7.1 External and Internal Losses among Flood-Affected Households

The study identified two major categories of flood-induced losses: external (material) and internal (non-material). External losses included damage to houses, agricultural land, livestock, food grains, educational materials,

medicines, clothing, and household assets. These findings are consistent with studies showing that recurrent floods in Assam cause severe economic losses and weaken the livelihoods of riverine communities.

Beyond material damage, the study highlights significant internal losses, including psychological distress, nutritional deprivation, educational disruption, loss of dignity, and reduced well-being among adolescent girls. The flood-prone geography of Sonitpur district, combined with poverty and fragile housing, intensifies these vulnerabilities. The findings support Lori Peek (2008), who argued that disasters have lasting developmental and emotional impacts on children and adolescents beyond immediate physical losses.

7.2 Housing Displacement and Protection Risks

Displacement was one of the most significant consequences of flooding, with many households taking shelter in roadside settlements, embankments, or overcrowded relief camps that lacked adequate sanitation, privacy, lighting, and security. These conditions disproportionately affected adolescent girls by increasing challenges related to personal safety, menstrual hygiene, and psychological well-being.

The findings are consistent with studies showing that poorly designed emergency shelters increase the risks of harassment, exploitation, and emotional insecurity among women and adolescent girls. They also support Kimberlé Crenshaw's (1989) concept of intersectionality, demonstrating that gender, age, poverty, and geographical isolation combine to intensify the vulnerabilities of adolescent girls during flood disasters.

7.3 Educational Disruption and Long-Term Development

The study shows that recurrent floods disrupt the education of adolescent girls by damaging schools, converting them into relief camps, destroying educational materials, and causing prolonged displacement. These disruptions, combined with poverty and increased household responsibilities, significantly increase the risk of school dropout.

The findings support Rebecca Winthrop and Jackie Kirk (2008), who argued that humanitarian emergencies disproportionately affect girls' education. Interrupted schooling limits future employment opportunities, economic independence, and social empowerment, highlighting the need to ensure educational continuity during disasters.

7.4 Nutritional Vulnerability and Health Outcomes

The study identifies nutritional insecurity as a major internal consequence of recurrent floods among adolescent girls. Damage to agriculture, reduced household income, and disrupted food supplies limit access to balanced diets, leading to anaemia, undernutrition, menstrual disorders, and other health problems. Poor sanitation and limited healthcare further worsen these conditions.

The findings support the United Nations Children's Fund view that adolescence is a critical period requiring adequate nutrition for healthy growth and reproductive health. They also align with Naila Kabeer (1999), who argued that unequal access to resources increases the vulnerability of women and girls, particularly during times of crisis.

7.5 Menstrual Hygiene Management and WASH Challenges

The study identifies menstrual hygiene management as one of the most neglected aspects of flood response. Damage to sanitation facilities, contaminated water, inadequate bathing spaces, and limited access to sanitary products compromised the health, dignity, and mobility of adolescent girls, increasing the risk of reproductive and urinary tract infections.

These findings support Marni Sommer (2010), who emphasized that poor menstrual hygiene management adversely affects girls' health, education, and psychosocial well-being. Despite the growing emphasis on gender-sensitive WASH interventions, the study indicates that their implementation remains inadequate in flood-prone communities of Assam.

7.6 Gaps in Essential Service Delivery

The study identified major gaps in healthcare, nutrition, sanitation, education, and protection services during floods and the recovery period. Although relief assistance was provided, it mainly focused on immediate survival needs, with limited attention to the specific requirements of adolescent girls. Disruptions in healthcare, Anganwadi services, reproductive health support, and education further delayed their recovery.

These findings support the recommendations of Sumesh S. S. et al., emphasizing the need for stronger primary healthcare, mobile health services, coordinated governance, and gender-responsive disaster planning. The results highlight the importance of shifting from a relief-based approach to a comprehensive resilience framework that integrates health, nutrition, education, protection, and psychosocial support.

7.7 Overall Interpretation

The present study demonstrates that floods in Sonitpur district function as catalysts that magnify existing structural inequalities rather than creating vulnerability independently. Poverty, fragile housing, dependence on agriculture, inadequate public services, and entrenched gender norms collectively shape the experiences of adolescent girls during and after flood events.

The findings contribute to disaster risk reduction literature by distinguishing between external losses, which are immediately visible and measurable, and internal losses, which are less visible but often have more enduring developmental consequences. This conceptual distinction highlights the need to broaden disaster assessment frameworks beyond economic losses to include psychosocial well-being, educational continuity, nutritional security, reproductive health, and personal dignity.

The findings of the study reveal that recurrent floods expose adolescent girls to multiple and interrelated social, health, and protection vulnerabilities. These vulnerabilities extend beyond the immediate physical impacts of flooding and significantly affect their overall well-being.

The household survey showed that floods caused substantial losses to livelihoods and essential household assets. Most households reported the loss of clothes, books, medicines, and important documents, while many also experienced damages to agricultural land, stored food grains, and livestock. These losses reduced household resources, affecting adolescent girls' access to education, nutrition, healthcare, and basic necessities.

The survey of adolescent girls indicated several post-flood health problems. Anaemia and iron deficiency were the most commonly reported conditions, followed by undernutrition, menstrual irregularities, urinary tract and vaginal infections, gastrointestinal disorders, respiratory illnesses, and skin infections. These health problems were mainly associated with poor sanitation, unsafe drinking water, inadequate nutrition, and limited access to healthcare services during and after floods.

The study also identified significant social vulnerabilities. School attendance was frequently disrupted due to damaged infrastructure, displacement, and the use of schools as relief camps. Many adolescent girls experienced interruptions in their education and difficulties in accessing learning materials. Financial hardship further increased their vulnerability by limiting access to nutritious food, sanitary products, and medical care.

Protection-related vulnerabilities also emerged from the primary data. Inadequate privacy in relief camps, overcrowded living conditions, and the absence of gender-sensitive sanitation facilities created discomfort and insecurity among adolescent girls. The lack of menstrual hygiene materials and separate toilets further affected their dignity, health, and personal safety during displacement.

The qualitative findings supported these observations. The five medical practitioners consulted during the study reported an increase in cases of anaemia, menstrual hygiene-related infections, diarrhoeal diseases, and skin infections during the post-flood period. ASHA workers highlighted difficulties in providing continuous maternal and adolescent health services because of damaged roads and disrupted transportation. Village leaders observed that relief measures largely focused on immediate survival needs, while the specific health and protection requirements of adolescent girls often received limited attention.

Overall, the empirical findings demonstrate that recurrent flooding creates interconnected social, health, and protection vulnerabilities among adolescent girls, emphasizing the need for gender-responsive disaster preparedness, accessible healthcare services, uninterrupted education, and adolescent-focused relief and rehabilitation programmes.

VIII. Policy Recommendations

Based on the study findings, the following measures are recommended to enhance the resilience of adolescent girls in flood-prone riverine communities:

- Develop gender-responsive relief camps with safe shelters, separate toilets, private bathing areas, adequate lighting, and menstrual waste disposal facilities.
- Integrate menstrual hygiene management into disaster response by including dignity kits with sanitary products and hygiene essentials in emergency relief packages.
- Strengthen resilient education and nutrition services by constructing flood-resilient schools and Anganwadi Centres and establishing temporary learning centres and mobile nutrition services during floods.
- Improve adolescent healthcare through mobile medical teams and boat clinics providing reproductive health, nutrition, mental health, and menstrual health services.
- Strengthen community-based protection by involving ASHA workers, Anganwadi workers, teachers, and local leaders to prevent child protection risks, early marriage, and gender-based violence.
- Promote adolescent participation in disaster preparedness and risk reduction programmes to ensure their needs are reflected in disaster planning and resilience-building initiatives.

IX. Conclusion

The study demonstrates that recurrent flooding in the riverine communities of Sonitpur district is not merely a recurring environmental hazard but a multidimensional development challenge with significant consequences for adolescent girls. The findings show that flood impacts extend from visible material losses to less visible consequences affecting education, nutrition, health, menstrual hygiene, privacy, and everyday well-being.

The findings related to Objective 1 demonstrate the substantial extent of both external and internal losses associated with recurrent flooding. At the household level, losses included shelter destruction, agricultural land, stored grains, livestock, clothing, books, medicines, documents, and other essential belongings. These external losses were accompanied by internal and developmental consequences among adolescent girls, including educational disruption, food insecurity, nutritional deficiencies, health problems, menstrual difficulties, weakness and fatigue, and increased caregiving responsibilities. The findings therefore establish that the consequences of flooding extend beyond immediate physical and economic damage and can affect girls' educational continuity, health, development, and overall well-being.

The findings for Objective 2 further demonstrate that adolescent girls experience interconnected social, health, and protection vulnerabilities during recurrent flood events. Educational discontinuity, displacement, inadequate nutrition, limited healthcare access, sanitation problems, menstrual health challenges, insufficient privacy, and increased household responsibilities emerged as important areas of vulnerability. These findings indicate that flood vulnerability is shaped by the interaction of gender, age, household socioeconomic conditions, and geographical isolation, rather than by flood exposure alone.

With regard to Objective 3, the study identified significant gaps in access to essential services during floods and the subsequent recovery period. The most prominent challenges were inadequate menstrual hygiene materials, limited healthcare access, insufficient sanitation and bathing facilities, difficulty accessing nutritious food, inadequate privacy and protection in relief settings, and increased caregiving responsibilities. Although relief and emergency support were available, the findings suggest that general relief provision did not fully address the specific and gender-responsive needs of adolescent girls.

Taken together, the three objectives demonstrate that the vulnerability of adolescent girls is produced through the interaction of material losses, disrupted services, and social and health vulnerabilities. The study therefore highlights the need to move beyond relief-centred disaster management towards a gender-responsive and adolescent-sensitive approach throughout the disaster management cycle. Such an approach should integrate flood-resilient education, accessible healthcare, adequate nutrition, menstrual hygiene management, safe water and sanitation, privacy and protection measures, and appropriate support for girls during both emergency response and post-flood recovery.

Strengthening the resilience of adolescent girls is essential not only for reducing their immediate vulnerability to recurrent floods but also for protecting their education, health, dignity, and future development opportunities. A disaster-management framework that places adolescent girls' specific needs at the centre can contribute to more inclusive, equitable, and sustainable resilience-building in the flood-prone riverine communities of Sonitpur district and the wider Brahmaputra Valley.

References

[1.] Ariyabandu, M. M., & Wickramasinghe, M. (2005). *Gender dimensions in disaster management: A guide for South Asia*. ITDG South Asia.

[2.] Azad, A. K., Hossain, K. M., & Nasreen, M. (2013). Flood-induced vulnerabilities and problems encountered by women in northern Bangladesh. *International Journal of Disaster Risk Science, 4*(4), 190–199. https://doi.org/10.1007/s13753-013-0020-z

[3.] Blaikie, P., Cannon, T., Davis, I., & Wisner, B. (1994). *At risk: Natural hazards, people's vulnerability and disasters*. Routledge.

[4.] Boruah, M. (2026). *Assam's "left-behind" women wage lonely, futile battle against extreme floods*. 101Reporters. https://101reporters.com/article/environment/Assams_leftbehind_women_wage_lonely_futile_battle_against_extreme_floods

[5.] Crenshaw, K. (1989). Demarginalizing the intersection of race and sex: A Black feminist critique of antidiscrimination doctrine, feminist theory and antiracist politics. *University of Chicago Legal Forum, 1989*(1), 139–167.

[6.] Cutter, S. L. (1996). Vulnerability to environmental hazards. *Progress in Human Geography, 20*(4), 529–539. https://doi.org/10.1177/030913259602000407

[7.] Cutter, S. L., Boruff, B. J., & Shirley, W. L. (2003). Social vulnerability to environmental hazards. *Social Science Quarterly, 84*(2), 242–261. https://doi.org/10.1111/1540-6237.8402002

[8.] Enarson, E. (2000). *Gender and natural disasters*. International Labour Organization.

[9.] Enarson, E., & Schneider, B. (2007). Women, gender and disaster: Global issues and initiatives. In H. Rodríguez, E. L. Quarantelli, & R. Dynes (Eds.), *Handbook of disaster research* (pp. 130–146). Springer.

[10.] Goyal, H., & Goyal, M. (2018). *Disaster management in India*. CBS Publishers & Distributors.

[11.] India Water Portal. (2024). *Assam relief operations: Over 5 lakh people impacted so far*. https://www.indiawaterportal.org/governance-and-policy/governance/assam-relief-operations-over-5-lakh-people-impacted-so-far
[12.] Jensen, R. (2003). Early marriage in the developing world. *Gender & Development, 11*(2), 42–49.
[13.] Kabeer, N. (1999). Resources, agency, achievements: Reflections on the measurement of women's empowerment. *Development and Change, 30*(3), 435–464. https://doi.org/10.1111/1467-7660.00125
[14.] Kerketta, S., Saraswat, A., et al. (2022). Menstrual hygiene management during times of complex humanitarian crisis: Listening to the voices of rural adolescent girls of Assam. In *Water, sanitation and hygiene in humanitarian contexts* (pp. 325–335). Springer. https://link.springer.com/chapter/10.1007/978-3-030-96760-4_13
[15.] Massey, D. (1994). *Space, place and gender*. Polity Press.
[16.] National Council of Applied Economic Research. (2025). *Survey of women's conditions in Assam with a focus on health and nutrition conditions, educational attainments, skills and employability and incidence of crimes against women*.
[17.] Pandey, A. (2024). *Water, sanitation, and health: The overlooked impact of floods on women in India*. Observer Research Foundation.
[18.] Peek, L. (2008). Children and disasters: Understanding vulnerability, developing capacities, and promoting resilience. *Children, Youth and Environments, 18*(1), 1–29.
[19.] Saha, J. (2023). The pattern of morbidity and access to healthcare service in the riverine flood-prone villages of Assam, India. *The Open Public Health Journal, 16*.
[20.] Sen, A. (1981). *Poverty and famines: An essay on entitlement and deprivation*. Oxford University Press.
[21.] Sommer, M. (2010). Where the education system and women's bodies collide: The social and health impact of girls' experiences of menstruation and schooling in Tanzania. *Journal of Adolescence, 33*(4), 521–529. https://doi.org/10.1016/j.adolescence.2009.03.008
[22.] Sumesh, S. S., et al. (2024). "We suffer, they don't bother": Narratives of primary healthcare vulnerabilities during floods in Assam, India. *Social Change and Development, 21*(2).
[23.] Sur, P. (2015). *Conflict and climate change collide in Assam as trafficking thrives*. News Security Beat.
[24.] UNICEF. (2022). *Situation report: Assam, India floods 2022 (8 July 2022).* https://www.unicef.org/media/124046/file/India-Assam-Floods-Humanitarian-SitRep-8-July-2022.pdf
[25.] United Nations Population Fund. (2015). *Women and girls in emergencies*. https://www.unfpa.org
[26.] Ullah, W., et al. (2024). Behind the floodwaters: Violence against women and disaster management capacities in flood-affected areas of Pakistan. *Climate Risk Management*.
[27.] WaterAid. (2012). *Menstrual hygiene matters: A resource for improving menstrual hygiene around the world*. WaterAid.
[28.] Winthrop, R., & Kirk, J. (2008). Learning for a bright future: Schooling, armed conflict, and children's well-being. *Comparative Education Review, 52*(4), 639–661.
[29.] World Health Organization. (2014). *Health for the world's adolescents: A second chance in the second decade*. World Health Organization.