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Flood's Unwavering Touch: Unveiling the Socio-Economic Symphony of Ghatal Sub- division, Paschim Medinipur, West Bengal

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***Abstract*:** The socio-economic challenges faced by Ghatal, West Bengal, due to frequent floods in the lower Shilavati River basin are the focus of this study. Employing a mixed-methods approach, it combines comprehensive household surveys with advanced statistical analyses to assess the impacts on the local community, particularly within the Ghatal Sub-division. The research highlights how flooding during the monsoon season exacerbates issues in low-lying areas, significantly affecting agriculture and disrupting livelihoods. Key findings reveal that 78% of households remain in flood-prone areas despite the risks, and there is a significant loss of residential and agricultural lands, posing major threats to riverbank communities. The study also emphasizes the public health risks associated with flooding, including outbreaks of waterborne diseases and reduced access to healthcare due to damaged infrastructure. By detailing the adaptive measures that communities have ingeniously adopted in response to these persistent environmental challenges, the research offers valuable insights into community resilience. Furthermore, it provides recommendations for policymakers and researchers aimed at fostering sustainable development and enhancing the capacity to address climatic challenges.

***Keywords*:** Agriculture territory, Lower reaches, Sustainable development, Shilavati River Basin, Socio economic landscape

Geographically and historically, West Bengal is one of India's most prosperous states. Known for its rich ethnic and religious cultural heritage, West Bengal is also distinguished by its diverse physiographic, climatic, and environmental attributes, earning it the reputation as one of the most resourceful states in India (Adhikary 2022). A large part of the state of West Bengal is exposed to frequent natural catastrophes like floods, cyclones, droughts and landslides that often turn into disasters causing significant disruption of socioeconomic life of communities and loss of human lives and properties (Das et al., 2011). The situation in India is not better since 55 per cent of India's landmass is prone to earthquakes; 68 per cent is vulnerable to drought; 12 per cent to floods; and 8 per cent to cyclones apart from the heat waves, and severe storms (Chawla 2012). From 2000 to 2019, floods affected more than 1.5 billion people worldwide. They accounted for 44% of all global disasters during this period. This highlights the significant impact of floods on global populations (UN Office for Disaster Risk Reduction 2020; (Yu et al., 2022). Floods displace millions annually, caused by heavy rain leading to river overflow. They cause secondary effects including structural damage, contamination, and disturbance of life and property, in addition to direct hazards like water contact. (Venkatesan and Mahindrakar 2020). Flooding during the monsoon season in India, especially in July and August, is driven by unpredictable weather and intense rainfall (Chaudhury 2021). In India, the monsoon period sees various types of floods, including riverine floods, dam break floods, and storm surge floods. Flooding is a common phenomenon, occurring every one to two years. Many rural and urban areas regularly experience floods due to the variability of monsoonal behavior. The study employs rural participatory research approaches in developing four vulnerability categories namely socio-economic, ecological, engineering and political; which were used to develop indicators that aided the calculation of total community vulnerability index for each community (Antwi et al., 2015). Floods, among other natural forces like earthquakes and storms, have significantly shaped Earth's landscape. When floods interact with human settlements and infrastructure, they can cause devastating disasters (Chaudhary and Piracha 2021). In the relentless dance between water and human civilization, floods emerge as formidable specters, casting their pervasive shadows over communities and leaving indelible imprints on landscapes. Natural and human-made disasters are prevalent globally and persist without prior notice and are believed to be escalating in terms of their scale, intricacy, occurrence rate, and economic ramifications. These natural calamities, born of water overflow, transcend mere meteorological events, posing existential threats to agriculture, infrastructure, and the very fabric of human settlements. Whether provoked by

the relentless deluge of rainfall or the gradual release of snowmelt, floods unfold as harbingers of chaos, precipitating widespread damage and irrevocable change. The symphony of destruction orchestrated by floods is not confined to physical upheaval alone; it extends its reach to the displacement of entire populations, compromising water quality, and demanding urgent mitigation measures. Navigating the treacherous waters of floods requires a multifaceted approach, incorporating advanced early warning systems, the fortification of resilient infrastructure, and the implementation of sustainable water management practices. Yet, at the heart of this complex equation lies the linchpin of community preparedness-a proactive stance that becomes instrumental in minimizing the devastating impact of these natural cataclysms. In the intricate tapestry of India's climatic embrace, the monsoons unleash torrential downpours that swell rivers and water bodies to their zenith, setting the stage for the perennial drama of floods. The 42.55% of the topography stands susceptible to the capricious whims of flooding in Ghatal sub-division (Annual Flood Report 2019).The Ghatal-Daspur, in Paschim Medinipur District, the landscape epitomizes heightened susceptibility to flooding. This study explores the historical flooding patterns in Ghatal Block by assessing the socio-economic impacts on livelihoods, housing, and agriculture, and delving into adaptive strategies alongside residents' perceptions of risk and vulnerability.

MATERIAL AND METHODS

Study area: The study area is nestled between coordinates N 22°31'53”N to N 22°49'26” and E 87°30'47” to E 87°48'16”E, Ghatalsub-division spans 953.09 sq.km with total cropped area 69787 hectors. Positioned in West Bengal's Paschim Medinipur district, the area boasts a unique river pattern, dividing it into three sections. Ghatal, the focal point, lies at the lowest elevation, intricately intersected by rivers like Shilabati and Rupnarayan. Excessive rainfall poses a flood threat (Dandapat and Panda 2017). Ghatal sub-division encompasses five blocks, with portraying the captivating study area and its vulnerability to natural calamities (Table 1). The survey was conducted within the research area using anthropogenic inquiry methods to engage the local community. Collaborative flood mapping efforts were complemented by symbiotic mapping ventures, and hydrological data were extracted from governmental repositories. Integration of advanced technologies like the Digital Elevation Model (DEM) and Landsat satellite imagery enhanced analytical capabilities, seamlessly blending community perspectives, governmental datasets, and cutting-edge technology within the study.

Methodology: This investigation systematically explores the factors contributing to flooding in the Ghatal block and the significant impacts on local livelihoods. The work combines both primary and secondary data sources to ensure a comprehensive analysis. Flood experiences, impacts, and damages were assessed through focus group discussions and key informant interviews, particularly with elderly residents and those highly exposed to river pollution is an enormous problem in developing countries like India. The main cause attribute could be lack of proper planning and ignorance of local and common people (Roy et al., 2021). Primary data is collected through interviews with local residents and administrative officials, and collaborative flood mapping efforts to capture the direct experiences of those affected. Secondary data was sourced from governmental records, including gauge data and rainfall statistics from the

Table 1. Study area

Area name	Block	Latitude	Longitude
Ramjibanpur	Chandrokona -1	N 22°49'26”	E 87°35'55"
Jara	Chandrokona -1	N 22°46'7”	E 87°35'2”
Kirpai Agi Farm	Chandrokona -1	N 22°43'15”	E 87°36'30”
Mohanpur	Chandrokona -1	N 22°36'33”	E 87°35'18”
Mangrul	Chandrokona -1	N 22°46'41”	E 87°42'4”
Lalghar	Chandrokona -2	N 22°43'56”	E 87°28'32”
Metela	Chandrokona -2	N 22°48'25”	E 87°30'09”
Piyardanga	Chandrokona -2	N 22°46'18”	E 87°31'51”
Ramganja	Chandrokona -2	N 22°43'50”	E 87°32'09”
Pinglash	Chandrokona -2	N 22°39'31”	E 87°31'01”
Chandrokona-	Chandrokona -2	N 22°44'04”	E 87°30'47”
Kharar	Ghatal	N 22°42'55”	E 87°40'07”
Irpala	Ghatal	N 22°44'25”	E 87°42'50”
Ajabnagar	Ghatal	N 22°39'55”	E 87°42'04”
Mansuka	Ghatal	N 22°42'43”	E 87°44'07”
Ghatal	Ghatal	N 22°39'57”	E 87°44'08”
Palaspai	Daspur -2	N 22°30'54”	E 87°46'53”
Goura	Daspur -2	N 22°31'53”	E 87°44'17”
Panchberia	Daspur -2	N 22°32'08”	E 87°44'46”
Basudevpur	Daspur -2	N 22°34'00”	E 87°43'25”
Gochati	Daspur -2	N 22°32'39”	E 87°46'04”
Chaipat	Daspur -2	N 22°34'17”	E 87°48'16”
Rajnagar	Daspur -1	N 22°35'34”	E 87°41'09”
Lankagar Hat	Daspur -1	N 22°33'27”	E 87°37'37”
Harirajpur	Daspur -1	N 22°33'48”	E 87°35'24”
Daspur	Daspur -1	N 22°35'15”	E 87°43'03”
Khanjapur	Daspur -1	N 22°38'31”	E 87°46'01”

Source: Google

sub-divisional irrigation department, to provide empirical support. Yearly damage data was compiled from reports on storm damage and losses. This was followed by flood risk assessments and the creation of flood risk maps, (Asare-Kyei et al., 2015). The study employs a range of methods for detailed analysis include immersive oral interviews with key stakeholders offer nuanced insights into flood dynamics historical flood data, tidal characteristics, and demographic information are drawn from administrative archives and scholarly literature. Geospatial analysis uses a Digital Elevation Model (DEM) and multi-temporal satellite imagery, including Landsat satellite data, to map regional slopes and floodwater paths. The Global Positioning System (GPS) is used to accurately identify flood-prone areas and inundation sites. This combination of methods provides a robust foundation for understanding and addressing the flooding issues in Ghatal.

RESULTS AND DISCUSSION

Climate of the explored area & its relation to flooding: The tropical monsoon climate characterized by hot summers and evenly distributed rainfalland experiences four distinct seasons: a cool winter (mid-December to February), a warm summer (March to May), the South-West monsoon (June to September), and a mild post-monsoon phase (October to mid-November). Flooding is a significant concern during the monsoon season, severely impacting the region (Sahoo and Sivaramakrishnan 2014). The historical flood trends (1959-2021) emphasize the extensive damage incurred with flood history (Table 2). The vulnerability of Ghatal to disasters and water contamination is increasingly exacerbated by climate change and rising pollution levels in the Bay of Bengal as observed by (Dolui and Ghosh 2013). This underscores the urgent necessity for comprehensive strategies to tackle these intertwined challenges and strengthen the resilience of local communities. In these economically challenged areas, homes are built from readily available materials despite frequent flooding. In Ghatal subdivision, residents primarily engage in animal husbandry and lumbering. The analyzed data of river water levels from highlights hydrological conditions and flood risks, with a focus on rainfall distribution (2011-2023) for the Shilabati, Rupnarayan and Old Cossy Rivers (Table 3) .

Cropping intensity in Ghatal sub-division and temporal shift due to flood: Climate change and flood have a great impact on local people's lives including agricultural production, food security and rural live hoods (Table 5, 7). Food grain and commercial grain farming are common, with

Table 2. Flood chronology in Ghatal Sub division: Tabular overview (1959-2023)

Year	More than one month		Less than one month		Total loss (lakh)
	Stagnant flood water (Areasq.km)	Stagnant flood water depth (meter)	Stagnant flood water (Area sq.km)	Stagnant flood water depth (meter)	
1959	100	2	184	1.5	-
1967	100	2.5	69.3	1.5	-
1968	350	2.5	307.64	2	-
1973	208	3	150	2	247.64
1974	61	3	102.83	2	191.85
1975	104	2.5	110	2	309.5
1976	55.17	2.5	108	2	52.79
1977	100	3.5	130	2	1361.92
1978	710	3.5	356	2	5174.19
1999	78.39	3	100	2	8585.34
2000	80	3	120.85	2	16313.09
2007	232.5	3	400	2	49923.05
2013	200	3	125	2	4515.7
2015	700	3.5	330	2	10000
2017	800	3.5	425	2	13847.12
2019	400	2.6	176	2	832.51
2021	400	3.7	512	2.4	14879
2023	86	1.8	205	2	421

Source: Data collected from Irrigation Department, Ghatal sub division

poultry farming being significant in Chandrakona-1 and Chandrakona-2 blocks, but less so in Daspur-1. The area also hosts small-scale industries related to rice, wheat, jute, oilseeds, potatoes, pulses, and various processed foods. Showcasing variations in crop damage underscores the dynamic nature of agricultural outcomes across regions and years. The farmers of this area are mainly affected due to flood mainly *Kharif* paddy crop is totally damaged. *Kharif* vegetables are also damaged. Due to floods from July to October farmer cannot prepare proper seeds for winter cultivation. Monsoon flooding forces Ghatal farmers to rely on other crops, requiring irrigation for cultivation. Approximately 47% use River Lift irrigation, 24% depend on mini shallow tubewells, while others use deep tubewells, canals, or ponds. Agriculture during the non-monsoon period is fully reliant on these irrigation practices, which remain effective despite recurring flood risks. Majority of farmer about 60percent people generally buy the seeds from open market at higher price. About 75% agricultural lands are located in low lying areas where water logging condition prevails about 3 months (Table 2, 3).

Self-perceived vulnerability to flood by location and habitant: The 78% of households remain in flood-prone areas, undeterred by the evident risks. Floods affect around 42% of total land area (Table 5). Between 1960 and 2000, 11% of the state's land was submerged by 13 high-magnitude and 10 medium-magnitude floods (Gayen et al., 2022). In flood days, people have been living in relief camps or on the roadside. Most have sought temporary shelter in the homes of relatives or roadside camps with their children and elderly family members while their own homes are being repaired.

Table 4. Affected and shifted population during flood and sources of drinkable water available during flood

Year	Flood impact: Shifted & affected population (%)	Water source (%)
2017	39.36	25
2019	1.97	28
2020	4.38	28
2021	36.41	24
2023	28.32	21

Source: Sub division disaster management and health department of Ghatal sub division

Table 3. Analysis of river depth gauge and rainfall data (2011 to2023)

Shilabati		Rupnarayan			Old Cossye	Yearly rainfall data	Flooded period in year
Banka	Gadghat	Bandar	Ranichak	Gopiganja	Kolmijore		
Highest flood Record							
P.D.L-4.7 (m) D.L.-5.08 (m) E.D.L-6.9 (m) H.F.L-3.4 (m)	P.D.L-8.38 (m) D.L.- 8.99 (m) E.D.L-9.60 (m) H.F.L-11.12 (m)	P.D.L-6.24 (m) D.L.-6.85 (m) E.D.L-7.46 (m) H.F.L-9.47 (m)	P.D.L-4.72 (m) D.L.-5.33 (m) E.D.L-5.94 (m) H.F.L-9.14 (m)	P.D.L-4.2 (m) D.L.-5.03 (m) E.D.L-5.64 (m) H.F.L-8.41 (m)	P.D.L-.68 (m) D.L.-9.29 (m) E.D.L-9.90 (m) H.F.L-11.12 (m)		
15.69 (m)	8.47 (m)	6.95 (m)	5.91 (m)	4.42 (m)	7.95 (m)	2049.30 mm	18.06.2011 to 27.06.2011
15.34 (m)	7.56 (m)	5.39 (m)	4.78 (m)	3.22 (m)	8.11 (m)	1539.90 mm	07.09.2012 to 26.09.2012
15.58 (m)	8.53 (m)	6.70 (m)	6.06 (m)	4.57 (m)	9.76 (m)	2187.80 mm	28.07.2013 to 21.08.2013
12.14 (m)	5.09 (m)	3.59 (m)	3.81(m)	2.68 (m)	6.40 (m)	1251.60 mm	05.09.2014 to 18.09.2014
15.79 (m)	9.90 (m)	8.41 (m)	7.58 (m)	5.82 (m)	10.24 (m)	1993.80 mm	27.07.2015 to 04.08.2015
15.52 (m)	8.59 (m)	7.40 (m)	6.39 (m)	4.75 (m)	9.600 (m)	1879.20 mm	22.08.2016 to 09.09.2016
15.50 (m)	10.02 (m)	8.38 (m)	7.37 (m)	5.79 (m)	10.700 (m)	1837.40 mm	21.07.2017 to 25.07.2017
14.88 (m)	7.34 (m)	5.45 (m)	4.99 (m)	3.78 (m)	10.150 (m)	1287.40 mm	08.08.18 to 17.08.2018
12.93 (m)	6.79 (m)	5.80 (m)	4.81 (m)	2.59 (m)	7.550 (m)	1728.30 mm	27.10.2019 to 11.11.2019
14.94 (m)	7.92 (m)	6.27 (m)	6.10 (m)	4.11 (m)	9.575 (m)	1910.20 mm	22.08.2020 to 27.08.2020
16.37 (m)	10.42 (m)	8.62 (m)	7.80 (m)	5.99(m)	10.500(m)	2692.00 mm	27.07.2021 21.08.2021

Source: Irrigation Department, Ghatal sub division. (P.D.L- Primary danger level, D.L- Danger level, E.D.L-Extreme danger level, H.D.L-Highest flood level)

Comprehensive health issues due to prolonged flooding: During floods, water becomes polluted, leading to waterborne diseases. Prolonged flooding in the region causes significant health issues, with many residents affected by diarrhea and cholera. Waterborne diseases, food poisoning, and snake bites are also common. In the past, the lack of medical access led to flood-related fatalities. They experience waterborne diseases such as fever, dysentery, cholera, and snake bites, as well as psychological trauma. The flood impact of Ghatal sub-division (2017-2021) on disease patterns and roads can lead to increased waterborne and vector-borne illnesses, disrupted healthcare access, and hampered emergency response efforts, posing significant challenges to public health and community resilience shows a poetic dance between health and infrastructure challenges, reverberates with the imperative to address both facets for the fortification of community resilience shows in (Table 6). Human activities, including engineering structures and dam construction, greatly affect the river basin, altering river flow and increasing flood risks. Nearly every household in Ghatal owns a small boat (Dingi or Donga) for mobility during such times. Medical care in Ghatal block is provided by hospitals, health centers, allopathic doctors, homeopathic practitioners, and unlicensed quacks. The disruptions in local markets compound these

Table 5. Crop damage mouza wise of Ghatal sub-division over seven years of intense rainfall and flooding

Year	Total no.of Mouza affected in different block				
	Ghatal	Chandrakona-1	Chandrakona-2	Daspur-1	Daspur-2
2013	130	46	100	156	87
2015	130	46	100	156	87
2016	151	73	86	Nill	87
2017	153	120	120	120	120
2019	156	148	140	162	87
2020	117	30	8	71	22
2021	156	60	103	162	87
2022	121	41	25	69	59
2023	126	38	21	87	76

Source: Disaster Management Department, Ghatal sub division and personal interviews

Table 6. Impact of floods on medical concerns and road infrastructure (2017-2021)

Year	Medical concern (number of person)			Impaired road (km)
	Diarrhoea & Cholera	Snake bite	Other water bourn diseases	
2017	1257	32cases/Death-2	3596	99.4
2019	258	0	456	184
2020	302	1 cases /Death-1	658	152
2021	1042	21 cases	3456	142

Source: Sub division disaster management andhealth department of Ghatal sub division

Table 7. Crop damaged in Ghatal sub-division due to heavy rainfall andflood (hectare)

Sub-division total (in ha.)	Kharif/Aman paddy seed bed (hector)		Kharif/aman paddy transplanting (hector)		Vegetables (hector)		Jute (hector)		Potato/groundnut (hector)		Flower (in hector)	
	Coverage	Damaged	Coverage	Damaged	Coverage	Damaged	Coverage	Damaged	Coverage	Damaged	Coverage	Damaged
2013	6302	1383.8	22385	15211	2855	2017	600	84.5				
2015	6302	1383.8	22385	15211	2855	2017	600	84.5				
2016	59010	12909			3200	606	795	85.7				
2017	5008	3640	15775	12575	2695	2290	795	590				
2019			59465	45920	865	780			150	5	35	25
2020			58246	13180	2391	1146	720	90	57	20		
2021	3761	2526	22364	20083	2130	1855	650	390				

Source: Sub-division agriculture department and personal interviews

challenges, casting ripple effects on education and livelihoods. A discerning scrutiny of road lengths in Ghatal for 2017-2021, especially within non-pucca road categories, suggests potential deterioration, further expounded upon in our study, "Epidemiological Analysis (2017-2021): Disease Patterns and Flood-Induced Road Impact." Floods, formidable challenges that they are, cast their pervasive shadows on education and livelihoods. Stakeholder opinions converge on Ghatal as a region teetering on vulnerability, beckoning the imperative for comprehensive solutions. This review discussion advocates for a holistic approach, seamlessly integrating hydrological, geomorphological, and community-driven strategies, thus underscoring the exigency for further scholarly exploration in this pivotal domain.

CONCLUSION

The Shilabati River experiences regular flooding due to factors like irrigation, urban development, and changes in hydrology caused by the construction of the Shilabati dam. This has resulted in significant damage to both floodplain residents and agricultural areas, with floods becoming more frequent and severe during heavy rainfall, while the river often dries up in the non-monsoon season. Urbanization has further altered the river's morphology, increasing flood risks. Existing mitigation efforts, such as the Ghatal master plan, have had limited success. Key solutions include building flood shelters, elevating infrastructure, and constructing detention storage facilities to manage floodwaters. Community involvement and sustainable water management are essential for creating long-term flood resilience in the region, making urgent action necessary to address these challenges effectively. The recurrent floods in the GhatalShilabati River severely impact low-lying areas in Paschim Medinipur, damaging homes, infrastructure, and livelihoods, particularly in agriculture, where paddy cultivation has suffered significant losses. Despite the risks, 78% of households remain in flood-prone areas, relying on vulnerable livelihoods such as animal husbandry and small-scale farming. Floods also lead to outbreaks of waterborne diseases, worsened by damaged roads and disrupted healthcare access, highlighting the need for mobile medical camps and infrastructure improvements. Human activities like dam construction further increase flood risks by altering river flow patterns. This study emphasizes the importance of holistic flood management strategies that integrate hydrological, geomorphological, and community-based solutions to enhance resilience in the Ghatal region.

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