Chapter 10
Agrarian and Socio-Infrastructural Vulnerability in the Wake of Flood: An Example from the Mayurakshi River Basin, India

Aznarul Islam, Susmita Ghosh, Mohan Sarkar, Suman Deb Barman, Pravat Kumar Shit, and Abdur Rahman

Abstract The present work intends to portray the impact of the flood on the agrarian decline and socio-infrastructural vulnerability in a tropical river basin like the Mayurakshi River Basin (MRB), India. The study has been carried out based on the questionnaire survey of over 2366 households spreading over 43 villages and two municipality wards across the five community development (C.D.) blocks coupled with some secondary data (annual flood reports, district census reports, topographical maps, and satellite images). The flood magnitude has been portrayed in terms of flood frequency, depth, duration, and inundation over MRB while the agricultural and socio-infrastructural vulnerability is measured using cropping intensity, crop diversification index, and relative importance index. The results portray that during the last 20 years (1998–2017), the average flood frequency ranged from 9 to 12 times and flood depth on agricultural land varied from 1.89 to 3.72 m and average flood duration ranged from 15 to 40 days. The severity of floods wrecks havoc on the agrarian economy reducing the cropping intensity and crop diversity of the study regions especially those located in low-lying areas like Kandi. Thus, flood triggers seasonal unemployment in these areas acting as the catalyst for labor migration mainly in the Middle East countries. Besides, infrastructural vulnerabilities like the collapse of the kutcha houses, and rural muddy roads are notable. More than 90% of

A. Islam (✉) · S. Ghosh
Department of Geography, Aliah University, Kolkata, West Bengal, India

M. Sarkar
Department of Geography, Visva-Bharati, Santiniketan, West Bengal, India

S. D. Barman
Independent Researcher, Barasat, Kolkata, India

P. K. Shit
PG Department of Geography, Raja N. L. Khan Women's College (Autonomous), Midnapore, West Bengal, India

A. Rahman
Department of Geography, Dr. Kanailal Bhattacharyya College, Howrah, West Bengal, India

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people were affected with diarrhea during floods due to the intake of contaminated flood water. Furthermore, skin diseases are also common in the flood and post-flood periods of the study area. Regarding psychological health, the C.D. block Kandi demonstrates that the higher flood-prone block has the lowest phobia as flood is very common in the region but maximum shock due to the huge agricultural loss.

Keywords Riverine floods · Infrastructural vulnerability · Agrarian economy · Health issues · Social psychological problems

1 Introduction

Vulnerability is determined based on people's exposure to natural hazards and their level of social development. Recently, it has been advocated that strengthening local communities is a more efficient approach to minimizing vulnerability than creating infrastructure (Birkmann et al., 2011; Chinnasamy et al., 2021; Islam & Sarkar, 2020; Perdikaris, 2010; Wisner et al., 1994). Identifying a community's strengths and weaknesses in terms of knowledge distribution, social allocation, and welfare programs are central to the vulnerability assessment (Bhowmick, 2015; Wisner et al., 1994). Therefore, vulnerability is defined as "the characteristics of a person or group in terms of their capacity to anticipate, cope with, resist and recover from the impact of a natural hazard" (Wisner et al., 1994). This includes both the social and physical dimensions of a system (Vittal & Karmakar, 2019). The recent definition of vulnerability proposed by the Intergovernmental Panel on Climate Change (IPCC, 2014) includes climate variability and climate change in the definition and has given a broader perspective synergizing the recent issues related to climate change, variability, and also societal variables. However, the inclusion of social parameters in assessing vulnerability was first taken into consideration in the twentieth century. Before that, natural phenomena were considered the main factor for vulnerability assessment (Rufat et al., 2015).

Perdikaris (2010) classified vulnerability into five categories, viz., monetary vulnerability, economic vulnerability, social vulnerability, environmental vulnerability, and critical infrastructure vulnerability. Being one of the common measures of vulnerability, social vulnerability considers exposure to a natural system, demographic profile, household characteristics, education, and health status to calculate the final index (Karmakar et al., 2010; Laura et al., 2020; Vittal et al., 2020). The application of social vulnerability has been used extensively in Himalayan and sub-Himalayan regions (Dasgupta & Badola, 2020), coastal regions (Ahammed & Pandey, 2019; Gayen et al., 2022; Sahana et al., 2019), arid regions (Kar et al., 2018; Khetwani & Singh, 2020; Steinbach et al., 2016), and riverine floodplain region (Islam & Guchhait, 2015; Islam et al., 2016) of India and at national level (Karmakar et al., 2010; Vittal & Karmakar, 2019) as well. Improvement of socioeconomic indicators of local communities is emerging in India and reducing vulnerability (Karmakar et al., 2010). On the other hand, the increasing population density and unplanned growth of cities are acting in opposite directions.

Identification, measurement, and assessing the condition of the infrastructure of a region help to cope with adverse natural hazards that increase resilience and help to take proactive measures for risk management in a flood-affected region (Pant et al., 2016). Still, no clear definition of infrastructure has been made by the Government of India (GoI), but the national statistical commission in 2001 included railway, roads, bridges, airports, electricity, telecommunication networks, and pipelines for water, oil, canal, and sewage in the first stage of infrastructure. The infrastructure is identified as critical in the highly vulnerable region (Len et al., 2018; Pant et al., 2016). In other words, the regions with a high level of vulnerability and the infrastructure are the safeguards against natural hazards and destruction, which will fail the community to cope with the hazards. The issue has gained attention in recent times, and focus is being directed to supporting climate-resilient infrastructure (TERI, 2010) because it has been found that infrastructure development has a major role in reducing community vulnerability (Vittal et al., 2020). Notwithstanding, the construction of the infrastructures like the hospital, school, rehabilitation center, and roads should be on an elevated or dry-point area. Moreover, motor-boat facilities during flood and technological advancement may reduce rural people's vulnerability (Kumar et al., 2016).

IPCC (2021) stated about the changing climate due to anthropogenic stressors and is also concerned about the increasing community vulnerability. The marginalized, the poor, farmers, and fishing communities will be the most affected due to frequent natural hazards and disasters (Chinnasamy & Srivastava, 2021). Therefore, to gauge the vulnerability level, a divisive approach to natural hazards and social factors should be avoided because separating social aspects will generate an extra burden on natural hazards in assessing vulnerability (Birkmann et al., 2022). Flood has been considered one of the major natural hazards highly affecting livelihoods. Opinions of communities and researchers regarding the role of floods in shaping society and the economy have shifted from optimism to pessimism after floods started costing lives and wealth due to interventions by structural controls in the fluvial system (Mukhopadhyay & Let, 2014; Mukhopahyay, 2010). The frequency of floods has increased in recent decades worldwide (Svetlana et al., 2015). In the vulnerability assessment framework, exposure, sensitivity, and coping capacity are the three major indices among which flooding due to proximity to the channel comes under biophysical characteristics and is considered as exposure (Porter et al., 2021). Previous studies demonstrate that floods have widespread effects on the economy, education, gender, and health and also control psychological behavior in the form of trauma (Gayen et al., 2022; Rufat et al., 2015). Since agricultural activities are concentrated in floodplain regions, the most affected economy is agriculture. Long-duration floods with high velocity have a large impact on crop damage (Wang et al., 2022). Coastal floods around the world also affect agricultural production due to the accumulation of salt in the land that causing economic loss to the farmers as lands are noncultivable for a long time (Gould et al., 2019). The effects of natural hazards on mental health can be direct or indirect, and prolonged exposure to a certain natural hazard may lead to mental block, posttraumatic stress disorder (PTDS), and traumatization (Cianconi et al., 2020). This aspect of natural hazards needs a comprehensive study considering mental health as an important aspect of life.

India is severely affected by flood events almost every year, and the state of West Bengal, being located in the Ganga–Brahmaputra–Meghna Delt, portrays a higher severity of floods. Due to diversified physiographic conditions, West Bengal faces different types of floods in different regions. For example, the Himalayan and sub-Himalayan region faces flash flood (Chakraborty & Mukhopadhyay, 2015a, b; Gayen et al., 2022) while the western part is characterized by nontidal fluvial flood (Ghosh & Mistri, 2015) and the coastal part is affected of tidal floods (Bandyopadhyay et al., 2014; Rudra, 2014, 2018). Teesta, Torsa, Jaldhaka, Raidak in North Bengal and Pagla-Bansaloi, Dwarka-Brahmani, Mayurakshi-Babla, and Ajay in South Bengal are responsible for making 42.55% of the landmass, and 18 out of 23 districts are susceptible to flood events in West Bengal (Irrigation and waterways directorate, 2019). The Mayurakshi River Basin is a part of the Rarh Bengal that suffers from severe floods (irrigation and waterways directorate, 2014; Jha & Bairagya, 2013; Mukhopadhyay & Let, 2014; Roy, 2012). The average flood frequency in the last 20 years was measured as 9–12 times (Islam & Ghosh, 2021b). The major studies conducted in the region focused on geohydrometeorological effects on flood occurrence (Islam et al., 2022; Islam & Deb, 2020; Islam & Sarkar, 2020), and the other studies focus on the identification of the main drivers of flood risk emphasizing on community-based flood risk assessment (Islam & Ghosh, 2021a) and the economic transformation of the local communities induced by flood events (Islam & Ghosh, 2021b). Previous studies also show that developing countries need more studies related to rural floods, and more focus should be given to site-specific vulnerability assessment (Rehman et al., 2019). The Mayurakshi River Basin lacks studies related to social and infrastructural vulnerability with regard to flood events. Along with social factors, the assessment of infrastructure at risk will help the policymakers with long-term development plans by identifying the most crucial infrastructure for the local communities in the region. The present study aims to bridge the gaps identified in the existing literature and will focus on the issues such as: (1) to find out the nature of flood hazards in the study area, (2) to trace out the nature of agrarian decline due to flood hazards, and (3) to relate floods with the education and health and other infrastructural issues of the concerned areas.

2 Study Area

The Mayurakshi River travels 250 km from its source at Trikut Hill in Deoghar, Jharkhand, and is meeting with the Bhagirathi River at Narayanpur. The Mayurakshi Basin extends from 23°37′43″ to 24°37′36″N and from 86°50′16″ to 88°15′52″E, covering an area of 9596 km^2. Nabagram, Khargram, Kandi, Burwan, and Bharatpur-I are the five C.D. blocks of Murshidabad Districts that make up the lower portion of the Mayurakshi River. Of the five C.D. blocks, Kandi is the most susceptible area to flooding (Mollah, 2016; Islam & Ghosh, 2021a). The region is inundated every year by floods. For the present study, two municipality wards (Wards no. 8 and 13) and 43 villages have been selected using purposive sampling after conducting a pilot survey (Fig. 10.1).

The research location is situated in the Murshidabad district's *Rarh* plain, where the Mayurakshi–Dwarka and kuea River systems frequently cause flooding. Due to the feeble slope, the lower Mayurakshi River Basin has drainage congestion and regular floods (Islam & Ghosh, 2021b). Mayurakshi, Dwarka, Brahmani, and kuea are the main rivers to drain the water from the C.D block Kandi. Moreover, numerous spill channels and impoundments are spread over the region. The usual geographical features and outflow of rivers like the Dwarka–Brahmani and the kuea with the Mayurakshi River in a low-lying area of Hijal are what cause the intensity of the flood in this area. The mighty Bhagirathi River flows north to south; however, during the monsoon season, the Mayurakshi system finds it challenging to cross since the water level of the Bhagirathi also stays higher.

3 Database and Methodology

The present study has been carried out using a systematic methodology that starts with data collection and its processing for the assessment of the agrarian and socioeconomic vulnerability of the MRB (Fig. 10.2).

3.1 Database

The study area has a homogeneous population and the primary data on the kind of flood, and its socioeconomic elements are collected by employing a statistically significant sample size (n) for each village. The sample size was calculated based on the United Nations Framework Convention on Climate Change (UNFCC, 2020) based on Eq. 10.1:

$$n \geq \frac{1.645^2 NV}{(1-N)x0.1^2 + 1.645^2 V} \text{ and } V = \frac{p\,(1-p)}{p^2} \tag{10.1}$$

where n denotes sample size; N is the total number of households in the villages as of the 2011 Census (Table 10.1); p denotes the proportion of households experiencing economic marginalization (loss of food crops and infrastructure devastation minus adaptive capacity) as a result of the flood of 2000 (Table 10.1), as determined by a pilot survey conducted in the field; 1.645 is for a needed level of 90% confidence; and 0.1 is for a level of 10% relative precision (Table 10.1).

Survey of India topographical maps (1:50,000) have been collected for the study area bearing the top sheet numbers 72 P/16, 78 D/4, 73 P/13, and 79 A/1. Moreover,

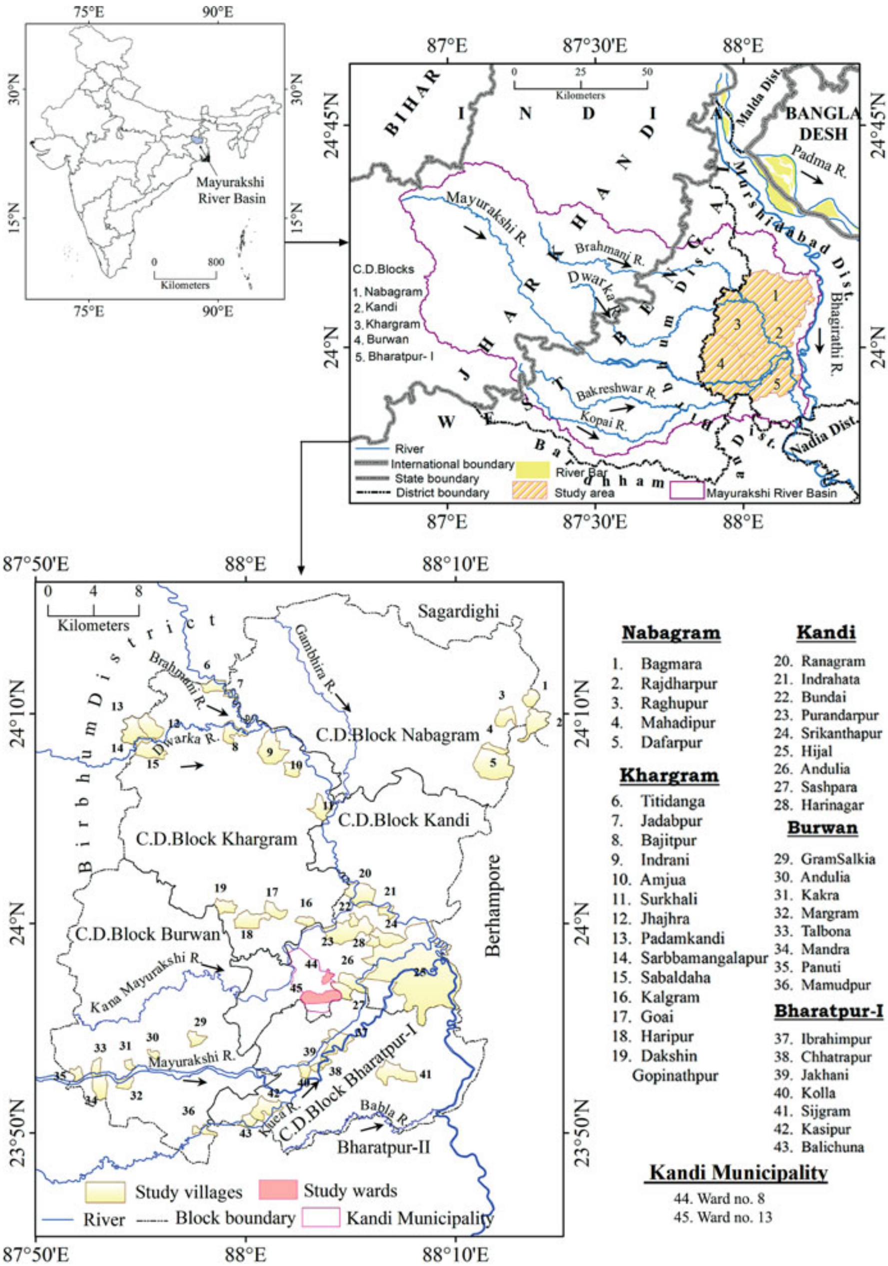

Fig. 10.1 Location of the Mayurakshi River basin and the study area

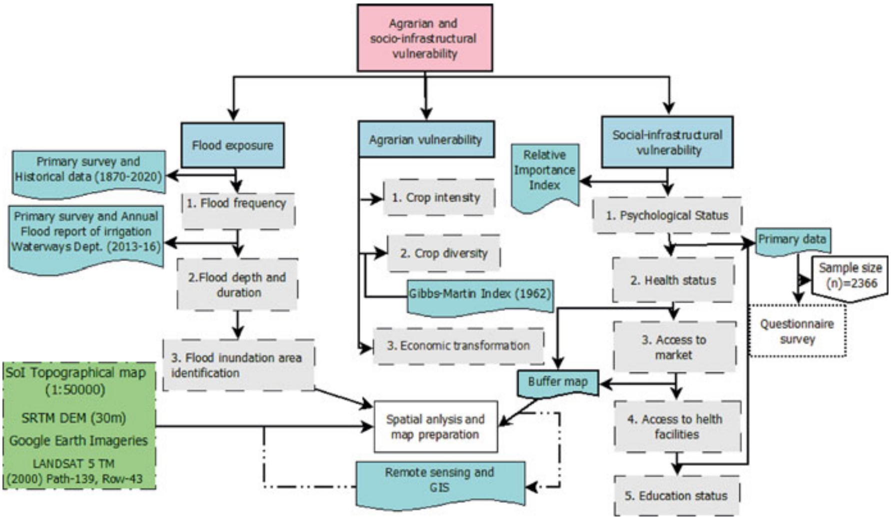

Fig. 10.2 Methodological flow chart adopted for the present investigation

Shuttle Radar Topography Mission Digital Elevation Model (SRTM DEM) 30 m and District Resource Maps of the Geological Survey of India have been used in the present context of the assessment of flood. Furthermore, the annual reports (2013, 2014, 2015, and 2016) of the Irrigation and Waterways Department, Govt. of West Bengal, District Census Handbook for Murshidabad (2011), and District Disaster Management Plan for Murshidabad (2016–17) are utilized for the present investigations.

3.2 Methodology

3.2.1 Measuring Flood Hazard

Computation of flood hazards intensity has been executed with the aid of four components of flood hazards, i.e., flood frequency, flood depth, flood duration, and flooded area using annual reports of the Irrigation and Waterways Department, Government of West Bengal (2013–2016), Sanyal and Lu (2006), Landsat 5 TM (2000), and field observations (2017–2018) as well. The flood frequency concerning the whole basin has been computed from 1870 to 2020 whereas block-level flood hazards (flood frequency, depth, and duration) have also been measured for 20 years (1998–2017). The inundation area has been identified for the massive flood of 2000 using ArcGIS 10.4 software.

Table 10.1 Representative households of each village and ward

C.D. blocks/ municipality	Villages/wards	Sample households	Total households (2011)
C.D. block Nabagram	Bagmara	43	427
	Rajdharpur	75	746
	Raghupur	46	459
	Mahadipur	17	167
	Dafarpur	123	1228
C.D. block Khargram	Tithidanga	43	433
	Jadabpur	18	184
	Bajitpur	8	82
	Indrani	189	1885
	Amjua	39	392
	Surkhali	80	801
	Jhajhra	18	175
	Padamkandi	60	603
	Sarbamangalapur	10	97
	Sabaldaha	83	828
	Kalgram	40	401
	Goai	29	294
	Haripur	76	762
	Dakshin Gopinathpur	21	208
C.D. block Kandi	Ranagram	45	445
	Indrahata	51	505
	Bundai	39	389
	Purandarpur	111	1109
	Srikanthapur	88	881
	Hijal	271	2713
	Andulia-I*	52	521
	Sashpara	105	1045
	Harinagar	27	269
C.D. block Burwan	Gram Salkia	72	715
	Andulia-II*	12	116
	Kakra	10	98
	Margram	11	106
	Talbona	7	69
	Mandra	32	320
	Panuti	22	221
	Mamudpur	9	90
C.D. block Bharatpur I	Ibrahimpur	20	195
	Chhatrapur	11	108
	Jakhani	10	95
	Kolla	24	240
	Sijgram	119	1185

(continued)

Table 10.1 (continued)

C.D. blocks/ municipality	Villages/wards	Sample households	Total households (2011)
	Kashipur	25	249
	Balichuna	8	75
Kandi municipality	Ward no. 8	73	757
	Ward no. 13	94	870
	Total	**2366**	**23,558**

Source: Computed from the Census of India, 2011 (* Both having the same village name (Andulia) in the census and for the distinguishing purpose they have been renamed as Andulia-I and Andulia-II)

3.2.2 Measuring Flood Vulnerability

The social and infrastructural vulnerability has been measured with the help of the agricultural threat, health and psychological status of the villagers, and the impact of the flood on education, market, house condition, and transport. The agricultural threat is measured by the crop intensity, crop diversity and transferring the occupation from agriculture to other sectors, calculated from the field survey data 2017–2019, and the health and psychological status measured with the questionnaire survey 2017–2019. The data are collected regarding the preflood, flood, and post-flood conditions. The access to the health center during the flood is assessed by drawing the buffer from the village and ward geocenter and then plotting the health center on the map. Similarly, the availability of the market during flood has been assessed by creating the 1 km buffer from the geocenter of each village and ward and plotting the market location collected from the extensive field survey. The impact of the flood on education has been assessed by comparing the status of education field data of flood-affected households to the data of the District Census Handbook (2011). The road condition and the house condition have been portrayed as shown in the field photographs.

3.2.3 Cropping Intensity and Diversification

Cropping intensity (Ci) implies the degree of growing crops on a unit of land. This is used as a strategy to secure food for the growing population of a region. This may be computed using Eq. 10.2:

$$\mathrm{Ci} = \frac{\mathrm{GCA}}{\mathrm{NSA}} \times 100 \tag{10.2}$$

where NSA stands for the net sown area and GCA stands for the gross cropped area.

A method of absorbing shocks in the agrarian economy is crop diversification. In the event of natural threats like floods or droughts, it may boost farmers' revenue and lower the overall crop failure rate (Khanam et al., 2018). There is a movement in India to switch from conventional, unprofitable crops to more lucrative ones. In the study area, crop diversification is measured by the Gibbs–Martin (GM) index (1962) using Eq. 10.3:

$$\mathrm{GM} = 1 - \frac{\Sigma x^2}{(\Sigma x)^2} \tag{10.3}$$

where x denotes the percentage of total cropped area accounted for by an individual crop.

3.2.4 Relative Importance Index

The relative importance index (RII) can be used to identify block-wise variations in perceptions of the local people to reveal the psychological traits regarding the fear, phobia, and shock scenario of a community. The algorithm to compute RII is mentioned using Eq. 10.4:

$$\mathrm{RII} = \frac{\Sigma \mathrm{w}}{\mathrm{AN}} = \frac{1\mathrm{n}_1 + 2\mathrm{n}_2 + 3\mathrm{n}_3 + 4\mathrm{n}_4 + 5\mathrm{n}_5 + 6\mathrm{n}_6 + 7\mathrm{n}_7 + 8\mathrm{n}_8 + 9\mathrm{n}_9 + 10\mathrm{n}_{10}}{10N} \tag{10.4}$$

where “W” is the respondent’s weighting or rating of each element, which varies from 1 to 10, and “n1” denotes the number of respondents who gave the lowest rating (1), and “n10” denotes the highest rating (10). “A” stands for the greatest weight (10 in the study), and “N” stands for all of the samples combined.

3.2.5 Student’s T-Test

The student’s t-test has been used to test the significance of the coefficient of correlation (r) based on the number of observations(N). This is computed using Eq. 10.5 as per Das (1991):

$$t = \sqrt{\frac{r^2\ (\mathrm{N}-2)}{1-r^2}} \tag{10.5}$$

It is important to keep in mind that the null hypothesis is accepted for a degree of freedom at a selected significance level if the calculated value of “t” is larger than the tabulated value. The “t”-test has been used to examine the level of relevance between flood risk and economic vulnerability.

4 Results and Discussion

4.1 Nature of Flood

The historical accounts confirm that floods are annual, covering roughly 80% of the study area (Islam et al., 2022). The flood frequency, depth, duration, and flood inundation area of the study region vary from one C.D. block to another (Table 10.2). For example, C.D. block Kandi and Bharatpur-I are the most flood susceptible block. From 1870 to 2020, the flood frequency in the study area is gradually increasing (Fig. 10.3a). In the last 20 years, the villages of the C.D. block Kandi were affected by many flood events (9–15) while for Nabagram and Burwan, it is 8–10 times. The villages of the southeast portion of C.D. block Kandi (Hijal,

Table 10.2 Spatial variation of flood frequency, depth, and duration in different C.D. Blocks

		Nabagram	Khargram	Kandi	Burwan	Bharatpur-I
Flood frequency	Average	9	10	12	9	11
	Range (highest to lowest)	10–8	11–8	15–9	10–8	13–9
	SD	0.84	0.85	2	0.93	1.29
	Skewness	−0.51	−0.43	0.48	0.00	0.00
	Standard error	0.37	0.23	0.67	0.33	0.49
Flood depth (m)	Average	0.91 (2.13)	1.28 (3.09)	1.35 (3.43)	0.53 (1.89)	1.73 (3.72)
	Range (highest to lowest)	1.46–0.57 (2.83–1.70)	2.89–0 (5.34–1.41)	2.44–0.32 (6.07–1.48)	1.24–0 (2.91–1.17)	2.32–1.01 (5.37–2.28)
	SD	0.35 (0.42)	0.78 (1.05)	0.74 (1.61)	0.45 (0.63)	0.39 (1.03)
	Skewness	1.10 (1.37)	0.47 (0.40)	0.06 (0.24)	0.29 (0.34)	−0.61 (0.31)
	Standard error	0.16 (0.19)	0.21 (0.28)	0.25 (0.54)	0.16 (0.22)	0.15 (0.39)
Flood duration (days)	Average	4.60 (20.20)	8.29 (22.29)	11.67 (40.22)	3.25 (15.38)	11.57 (30.29)
	Range (highest to lowest)	10–2 (26–16)	32–0 (67–14)	22–2 (80–11)	9–0 (45–7)	16–6 (41–18)
	SD	3.21 (4.49)	7.61 (13.22)	7.97 (24.27)	3.06 (12.22)	3.64 (9.71)
	Skewness	1.66 (0.61)	2.47 (3.41)	−0.13 (0.26)	0.92 (2.60)	−0.50 (0.13)
	Standard error	1.44 (2.01)	2.03 (3.53)	2.66 (8.09)	1.08 (4.32)	1.38 (3.67)

Source: Computed from the annual reports of Irrigation and Waterways Department, Govt. of West Bengal (2013–2016), Sanyal and Lu (2006), and field data (2017–2019); note: figures within parentheses denote the situation for agricultural land

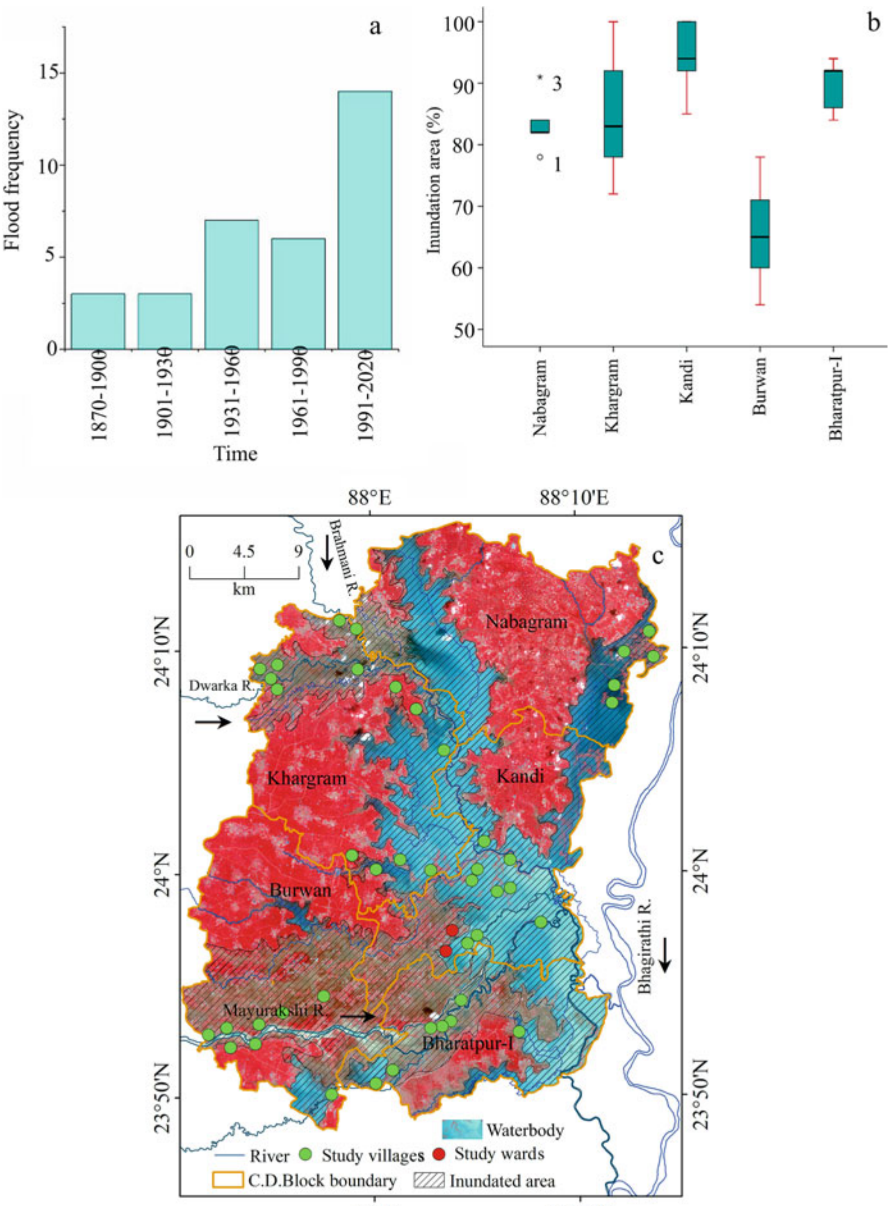

Fig. 10.3 Nature and severity of flood hazards in the lower MRB. (**a**) Flood frequency during 1870–2020, (**b**) variation of flood inundation area across the selected C.D. blocks during 2000, and (**c**) spatiality in the flood inundation area during 2000

Sashpara, Srikantapur, and Andulia) are most flood prone due to the typical physiographic setup and drainage congestion of the area. Both Nabagram and Burwan are situated in the elevated portion, decreasing flood susceptibility. The average flood depth in the agricultural area ranges from 1.89 (Burwan) to 3.72 (Bharatpur-I) and in the settlement area from 0.53 (Burwan) to 1.73 (Bharatpur-I). In the C.D. block Kandi, both the flood duration and flood inundation are higher. Figure 10.3b, c depict that about 90% of the villages of Kandi block are flood inundated in the 2000 flood. Torrential rainfall, physical set-up, drainage congestion, and mostly the structural interventions, i.e., dams and barrages have been responsible for the flood characteristics. Regarding the study area, Massanjore dam and Tilpara barrage take an important role. As the study area is spread over 9596 km^2 area, spatial variation of flood hazard is not solely dependent on rainfall. Rather, the differential relief condition of villages and congestion of rivers due to the convergence of Hijuli, Banki, Kana Mayurakshi, Mayurakshi, Uttarason, Kuea, and Babla in the southeast portion of the study area are more responsible.

4.2 Threat to the Agricultural Economy

Cropping intensity is a measure of how intensively agriculture is practiced. The land is under strain from the large population, particularly in monsoon Asia. For this reason, farmers are keen to cultivate the land all year long. About 7% of the cropland in the study region is used for various crops, and double cropping dominates in the majority of the communities (more than 80 percent) (Fig. 10.4a). At the block level, all the C.D. blocks have 100% crop intensity during the *rabi* (winter) season while Kandi has the lowest cropping intensity (about 70%) during the *kharif* (monsoon) season. Moreover, Nabagram and Burwan have about 95% cropping intensity during the *kharif* season. In the C.D. block Kandi, the cropping intensity varies from 26.58 to 100 in the *kharif* season as the agricultural land of severe flood-prone villages (e.g. Andulia-I and Hijal of C.D. block Kandi) becomes inundated (Fig. 10.4b–d) and some villages (e.g. Srikanthapur) do not cultivate in the monsoon to avoid the risk of crop damages due to sudden flood (Fig. 10.4e). Therefore, the reduction in crop intensity brought on by the flood stimulates the prompted diversification of the occupational structure.

Crop diversity is also recorded as higher during the *rabi* season and higher diversity found in Nabagram (0.57) and lower in Khargram (0.33) while in the *kharif* season crop specialization is mostly preferred by the farmers than the diversified cropping. Except for Nabagram (0.49), the rest of the blocks have crop diversification during *kharif* less than 0.2 with the lowest (0.08) found in Bharatpur-I. It is also noticed that the flood-affected villages ($n = 19$), i.e., Indrani,

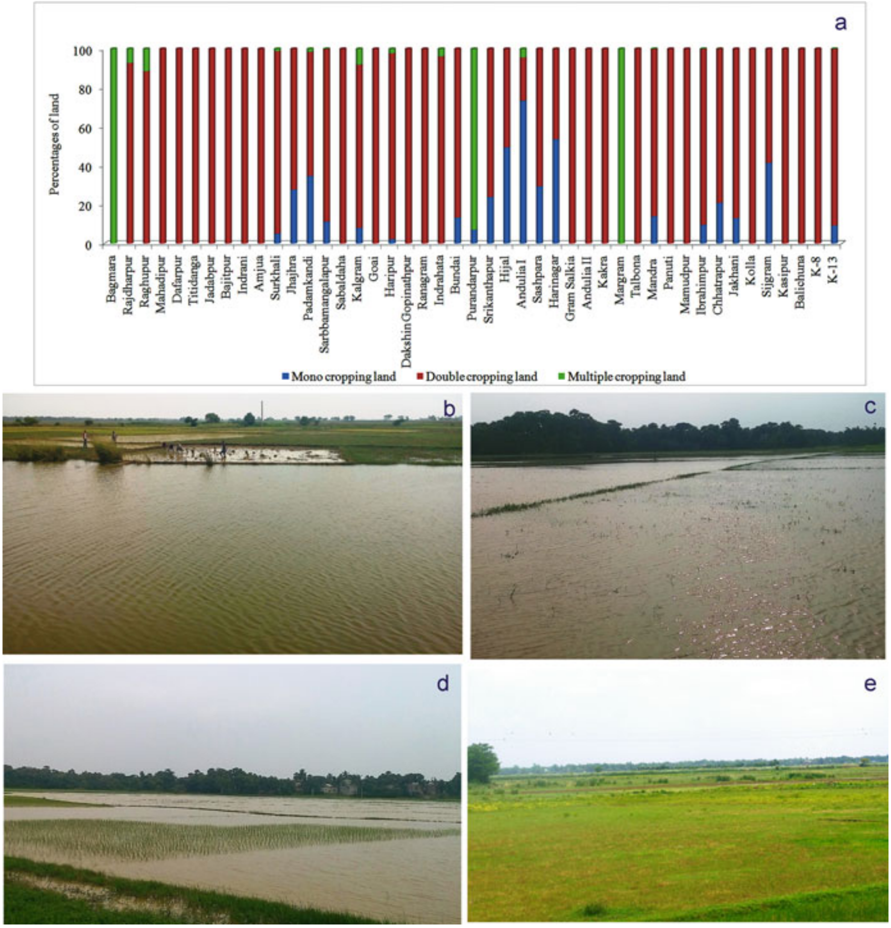

Fig. 10.4 Cropping land and flood hazard: (**a**) distribution of cropping land, (**b** and **c**) inundated land in Andulia-I, (**d**) inundated land in Hijal, and (**e**) fallow land during monsoon in Srikanthapur. (Source: Field Survey, 2017–2019)

Hijal, and Sashpara, follow the crop specialization of rice during *kharif* season (Table 10.3). The flood hazard reduces the choice of crops for the farmers. It is observed that with the increasing flood depth, the GM index has fallen ($r = -0.346$) because farmers in different communities have similar psychological profiles for growing traditional crops. Comparatively, lower flood-prone C.D. blocks like anagram scored higher GM index in all the three seasons (*rabi, kharif,* and *zaid*) while flood-prone blocks like Kandi and Bharatpur-I have a lower GM index for *kharif* seasons in monsoon.

Flood reduces crop diversity and intensity, paralyzing agriculture. On the other hand, supplying rich silt may improve agriculture. However, because the Mayurakshi system deposits coarse (coarse sand) sediments on the agricultural land,

Table 10.3 Dynamics of agricultural pattern and occupational shifting

C.D. block	Season	Crop diversity		Crop intensity		Farmers shifted to other occupations[a]	
		Mean ± SD	Range	Mean ± SD	Range	Mean ± SD	Range (maximum to minimum)
Nabagram	*Rabi*	0.57 ± 0.06	0.49–0.64	100 ± 0	100–100	(7.67) ± 3.03	4.64–10.7
	Kharif	0.49 ± 0.09	0.36–0.61	96.26 ± 4.78	88.51–100		
	Zaid	0.22 ± 0.31	0–0.44	23.74 ± 38.38	7.22–100		
Khargram	*Rabi*	0.33 ± 0.27	0–0.69	100 ± 0	100–100	2.53 ± 6.71	16.67–(−3.22)
	Kharif	0.2 ± 0.2	0–0.57	93.63 ± 10.79	65.29–100		
	Zaid	n/a	n/a	0.92 ± 2.1	0–8.06		
Kandi	*Rabi*	0.46 ± 0.11	0.29–0.61	100 ± 0	100–100	(11.12) ± 9.12	(24.57)–(−3.68)
	Kharif	0.19 ± 0.23	0–0.59	70.79 ± 23.37	26.58–100		
	Zaid	0.2 ± 0.35	0–0.61	11.24 ± 28.91	0–92.87		
Burwan	*Rabi*	0.45 ± 0.11	0.25–0.65	100 ± 0	100–100	(0.91) ± 0	0.91–0
	Kharif	0.15 ± 0.21	0–0.47	98.26 ± 4.62	86.05–100		
	Zaid	0.24 ± 0.34	0–0.48	14.24 ± 32.73	0–100		
Bharatpur I	*Rabi*	0.5 ± 0.78	0.38–0.64	100 ± 0	100–100	(10.52) ± 7.39	25–0
	Kharif	0.08 ± 0.19	0–0.51	87.85 ± 14.06	58.57–100		
	Zaid	n/a	n/a	n/a	n/a		

[a]Note that transformation from farmers to other occupations is denoted by positive and the reverse trend is marked as negative

the current study region does not enhance significant fertility following the flood. Additionally, because the dams retain the sediments in the reservoir, the agricultural area directly beneath the dams at Tilpara, Massanjore, and Bakreswar is devoided of any sediment. And the sediment-free water does not increase soil fertility. Hence, according to the local communities, the flood has become only a threat to them rather than a factor that is used to increase soil fertility. This results in agrarian distress, and it becomes acute especially when farmers and laborers are jobless for about one to one and half months during a flood. Thus, seasonal unemployment touches a limit of economic marginalization in the study area. Almost every village registered this type of seasonal unemployment. Kandi shows the highest seasonal unemployment (IQR =23, Med = 31), followed by Burwan and Khargram (IQR = 5, Med = 12, 28). This unemployment is a cyclic mechanism rather than a linear process. The lower income leads to agricultural poverty and reduces the capacity for buying agrarian inputs. As a result, the farmers are found to take high-interest loans from *mahajans* (persons who lend money at a high-interest rate) creating a debt trap for themselves.

However, when the harvest is reaped, the money they get from selling their produce is used to repay the previous loan. Moreover, the level of economic marginalization increases if a flood occurs before the crop matures. However, the general economic structure that has been shown in the study communities is not as bleak. This is simply because of the remittances that may back up utter agricultural failure. Remittances are therefore only a short-term fix, and the integration of the village economy with the foreign multiplier inside the agricultural system is what will ensure the local economic prosperity.

4.3 Impact on House Condition

The condition of the house portrays the socioeconomic status of a family. In some villages of the study area like Hijal, most of the people have two types of houses: (a) *khamarbadi* (farmhouse) and (b) *Basatbadi* (residential place). The *khamarbadi* is especially constructed for raising livestock and cultivating crops. Generally, these houses are located on the embankment or the elevated path between agricultural fields. On the other hand, some of the residential houses are on the embankments while others are located in low-lying areas. Therefore, houses become often vulnerable to flood attacks. It is mentioned that disaster intensity has also been measured by counting the number of houses damaged by the flood. The houses of the study villages are mainly *pucca* and a few are *katcha* constructed with mud, thatch, and clay pantiles (Fig. 10.5a–d). The *katcha* houses of the economically backward people are fragile to flood. Before the devastating flood of 2000, virtually, all the houses of study villages were *katcha*, which were washed away by the flood. Thus, the poor people became temporarily homeless, and some of them were fortunate to have been accommodated in the flood shelter while the rest were bound to take shelter under the trees. While describing the misery of the flood victims, Sultan (male, 46) said that *"before the colossal flood 2000, there was virtually no pucca house in our village. As a result, the severity of flood swept away almost every house, leaving the people under open sky. Some took shelter on the trees for couple of days while those who could not even afford that died."* Similarly, another senior person of the study area shared his pathetic experience of 1963 flood. According to Jiyarul Haque (male, 76) *"during the flood of 1963 in our area, virtually all houses were smashed in few minutes following the cyclone like flood wave. People seeing the severity of flood cried and sat on the top of the demolished building."*

Thus, having lost everything after the flood in 2000, the rate of labor migration started increasing especially in the Middle East countries. With the remittance from

Fig. 10.5 Transformation of houses due to flood at Hijal: (**a**, **b**) represents the *kutcha* houses, and (**c**, **d**) *Pucca* house was constructed after the flood of 2000. (Source**:** Field Photographs, 2018)

the labor migrants, villagers constructed *pucca* houses (Fig. 10.5c, d). Moreover, some of them also got help from the government to build *pucca* houses under the scheme of Indira Awas Yojana (now Pradhan Mantri Awas Yojana). In the most flood-prone areas, all the houses are high from the ground (avg. 3 ft) so that in a small magnitude of flood the water cannot submerge the houses.

4.4 Impact on Road and Transport

The transport system is often called the lifeline of a society. The mobility of the people and the movement of goods are determined by the connectivity and accessibility of the network (Rodrigue et al., 2016). The percentage of road space in a particular region is important. However, the physical condition of the road is more

Fig. 10.6 Condition of the village road: (**a**) Typical *katcha* road during the monsoon and (**b**) breaching of the *pucca* road by flood. (Source: Field photographs, 2018)

important for mobility. In the study area, before the flood of 2000, almost all the village roads were *katcha*. Consequently, due to the flood of 2000, *katcha* roads were broken down. It is worth mentioning that Pradhan Mantri Gram Sadak Yojana, which was introduced in 2000, aimed at connecting the villages (with a minimum population of 500 persons) with the all-weather road to increase accessibility all throughout the year (PMGSY, 2015). Though most of the rural roads have been replaced by the *pucca* roads by this scheme, some village roads are still *katcha*. During the monsoon, the *katcha* roads become muddy and hence become inaccessible for cycles, bikes, or any type of vehicle (Fig. 10.6a).

Moreover, the *pucca* roads are frequently breached by the flood (Fig. 10.6b), which disrupts normal life by creating a lot of problems. Besides, small bridges connecting one village to another are also damaged due to floods. Similar conditions are reported for Bangladesh in 2004 due to the monsoon flood, which reduced the movement of the people (Rahman, 2014). Under these circumstances, boats become the only means of communication.

4.5 Accessibility to Market

Society depends on the market for the requirements of necessary goods and services. A combination of goods and services from the market depends on the distance from the villages. A market is absent within a radius of 6 km of the village center for Bagmara, Raghupur, Rajdharpur, Mahadipur, Dafarpur of the C.D. block Nabagram, Surkhali of the C.D. block Khargram, and Mandra of the C.D. block Burwan (Fig. 10.7). In the study area, the location of the market during flood varies to a certain extent from one village to another. Therefore, these villages are mostly affected by floods regarding access to the market service. The people of Hijal village of the C.D. block Kandi and Padamkandi, Sarbamangalapur, Jhajhra, Sabaldaha of the C.D. block Khargram have to travel 4.5 km to access the market.

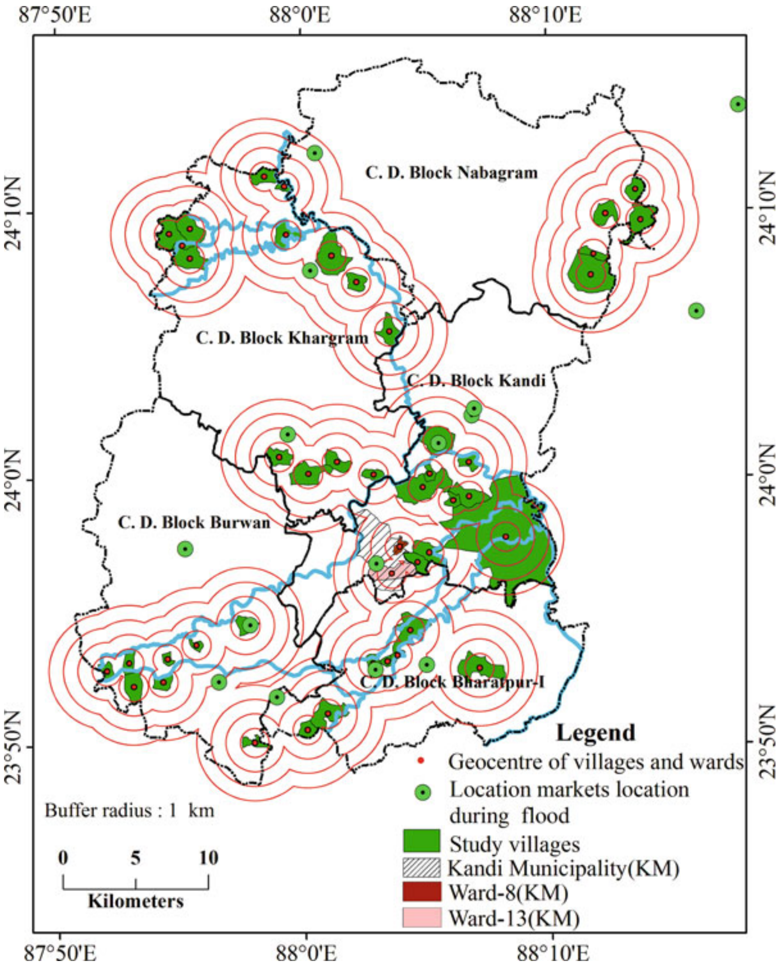

Fig. 10.7 Location of markets in different buffer zones during the flood. (Source: Field Survey, 2017–2019)

In the C.D. block Bharatpur, all the study villages can assess the market within 3 km of their village center. Ranagram village of the C.D. block Kandi, Gram Salkia of the C.D. block Burwan, and Kolla of the C.D. block Bharatpur-I have the market in close proximity to the village center. During the normal period (nonflood affected), 87.5% of households of Mahadipur, 95.24% of Bagmara, and 43.33% of Rajdharpur can avail of the market within a radius of 2 km from their village center. However, during flood cent percentage of households of these three villages have to travel about 5 km to reach the market. Similarly, all households of Jhajhra can access the market by travelling only about 5 km in normal conditions, which are extended to more than 10 km in flood periods. In the C.D. block Kandi, 69% of households of

Srikanthapur and 22% of households Purandarpur also travel more than 10 km during floods whereas all households of Ibrahimpur, Chattarpur, Kolla, Sijgram, Kasipur, and Balichuna of C.D. block Bharatpur-I, more than 84% of households of Indrani, about 97% of Sabaldaha, 98% of Kalgram, and 100% of the household of Dakshin Gopinathpur villages of C.D. block Khargram travel 5 km distance to reach the market. Throughout the flood period, the essential commodities are insufficient in the market. All the study villages of C.D. block Kandi are found to face difficulty to get essential commodities. However, other villages of the four study blocks can access almost all essential commodities in the market during the flood. But the price of the commodities is also high due to the higher transport cost and huge demand for the goods available in insufficient quantity. The flood victims face the music because they cannot afford the basic requirement due to higher prices (more than double) during flood episodes. The problem further aggravates when the shopkeeper did not agreed to provide goods for lend. Besides, reaching the market often becomes difficult because during normal period people reach the market by cycling or by walking, but during flood, boat is the only medium to reach the market, and sometimes they have to expense more than 50 rupees 4 km distance to reach the market.

4.6 Health Problems

Flood has an immediate adverse effect on both physical and mental health. Flood is associated mainly with communicable diseases, which are mainly of two types: (a) waterborne disease and (b) vector-borne disease. In rural areas, waterborne diseases break out quickly because of the inadequacy of safe drinking water and sanitation problem. However, the entire health risk during flood depends on the availability of doctors, adequate supply of medicine, proper service from the nearby health center, access to safe drinking water, and good sewage system coupled with the proper transfer facility of patients to health centers. In the study area, more than 90% of people are affected by diarrhea. Besides, skin disease, typhoid, and dysentery are also common. The symptoms of diarrhea are frequent watery bowel motion, and it is an infectious disease and breaks out readily because of unsafe drinking water and contaminated food. In the study area, more than 99% of households are bound to use unsafe drinking water.

During the flood, 100% of households of all the study villages of C.D. block Nabagram; Surkhali, Sarbamangalapur, Kalgram, Goai, Haripur, and Dakshin Gopinathpur of C.D.Block Khargram; Ranagram, Indrahata, Bundai, and Purandarpur of C.D. block Kandi; Andulia-II, Kankra, Mandra, and Mamudpur of C.D. block Burwan; and Sijgram of C.D. block Bharatpur-I use tube well as the source of their drinking water (Fig. 10.8a). It is worth mentioning that the cent percent households of Panuti, 96% of Kasipur, 50% of Kolla, 43% of Sabaldaha, 38% of Jhanjra, 36% of Harinagar, and 33% of Chhatrapur use flood water as their drinking purpose while 81% of households of Indrani and 43% of Padamkandi use

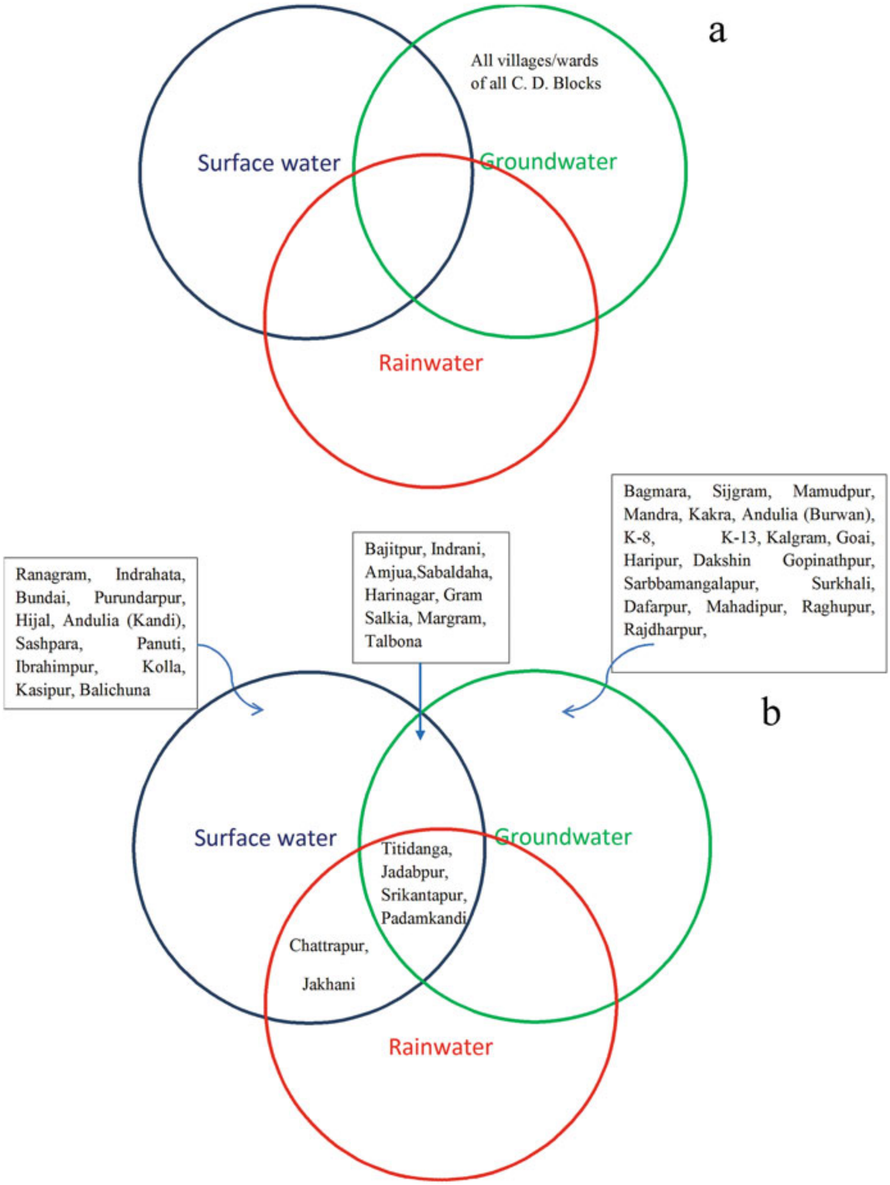

Fig. 10.8 Sources of drinking water during (**a**) preflood and (**b**) flood in the study area. (Source: Field Survey, 2017–2019)

both flood and rainwater. Besides, all households of Sashpara, Andulia-I, Kolla, Kasipur, Balichuna, and 90% of Jakhani use flood water, and about 94% of the household of Indrani and 92% of Hijal use floodwater or rainwater (Fig. 10.8b). Only 18% of the household of Margram and 57% of Talbona use safe drinking water. For this reason, diarrhea, cholera, and skin diseases are common in the study area (Table 10.4).

The village-wise investigation shows that the majority of the villages (e.g., Bagmara, Rajdharpur, Raghupur, Goai, Gram Salkia, Mandra, and Panuti) have 100% cases of diarrhea while few villages (e.g., Talbona) have only about 42% of people affected by diarrhea (Fig. 10.9).

Furthermore, skin diseases triggered by flood-contaminated water spread through infection. And this is aggravated in the post-flood period. From the survey in the study area, it is observed that doctors are not available during the flood. Besides, the inadequate supply of medicine further deteriorates the health conditions of the local people. During the flood, villagers even spend days without food, which deteriorated their health. After, Mohammad Asgar Ali (male,56) from Hijal, *"During flood of 2000 we were left with no food except eating uncooked rice wet in floodwater. When floodwater depth reduced, some cooked food reached us from village langarkhana through boat. Thus we suffered like anything during that time which cannot be expressed in language even".* More than 95% of households do not have a proper sewage system at all. Almost all the village dwellers use *katcha* toilet and pit latrine before the flood. And during floods, their toilets and latrines go underwater, and it induces an unhygienic condition when the floodwater is mixed with the toilet, and ultimately it gives birth to different waterborne diseases.

Furthermore, flood triggers serious health issues for pregnant mother. It is difficult to avail the health facilities during this time. During the flood, they are often bound to use contaminated water for daily uses and unsafe drinking water, which leads to the spread of different waterborne diseases among pregnant mothers. These types of contaminants sometimes become fatal because the health centers are situated far away from the village as shown on the buffer map. There are some villages that do not have health center within a 3 km radius of the geocenter of the villages (Fig. 10.10). That's why the main problem of the pregnant mother is to reach the health center for their checkup on time. This condition is aggravated especially for the *katcha* village road and deteriorating transport. During the flood, the indoor environment of the hospital is also unhealthy, and proper treatment is not available because most of the doctors are also out of the station. Some villages in the study area face the death of a mother during delivery. In Titidanga, Sarbamangalapur Jhajra, and Padamkandi villages, more than 50% families faced death during delivery. In the C.D. block Khargram, the death during delivery is high, but in the C.D. block Nabagram, there is not a single family facing it. Only Chhatrapur village from the C.D. block Bharatpur-I and Margram from the C.D. block Burwan faced death during delivery.

In the C.D. block Kandi Srikanthapur (4.49), Hijal (5.45), Andulia-I (2.5), and Sashpara (4) have a negligible percentage of death during delivery among the surveyed family.

Table 10.4 Descriptive statistics of diseases

	Diarrhea	Cough	Skin disease	Cholera	Dysentery	Malaria	Typhoid	Dengue
Mean	87.77	6.99	16.52	8.20	0.05	0.02	1.00	0.32
Standard deviation	18.46	12.43	20.30	22.88	0.12	0.13	3.37	1.49
Kurtosis	1.35	5.56	0.40	7.17	8.87	45.00	23.81	19.99
Skewness	−1.57	2.35	1.19	2.91	2.89	6.71	4.59	4.59
Range	61.84	55.00	70.00	90.48	0.56	0.85	20.00	7.45
Minimum	38.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	100.00	55.00	70.00	90.48	0.56	0.85	20.00	7.45

Source: Field Survey, 2017–2019

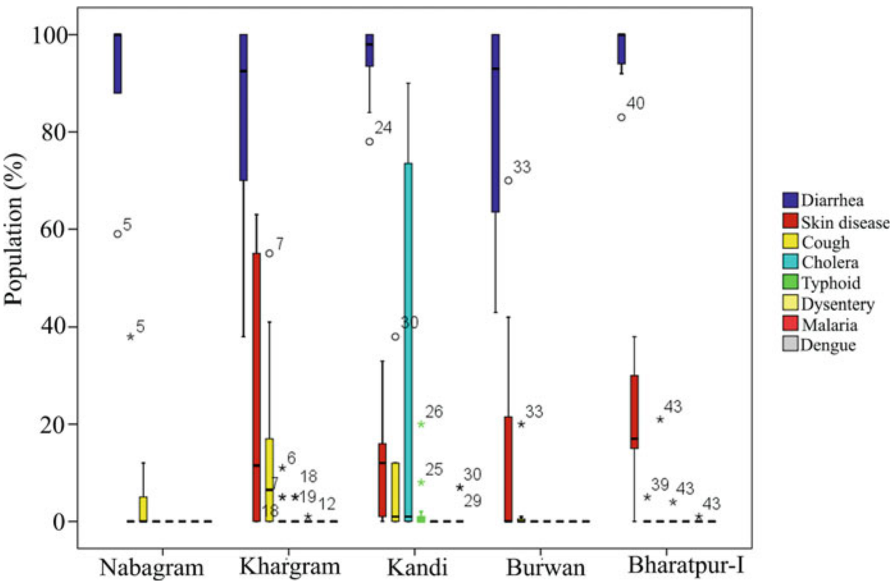

Fig. 10.9 Magnitude of different diseases in the study villages. (Source: Field Survey 2017–2019)

4.7 Education and Related Issues

The education system, the backbone of society, portrays the level of cultural attainments (Breen & Jonsson, 2005). Through education, people acquire knowledge of how to increase the coping capacity to live better with floods minimizing the adverse effects of flood vulnerability. Thus, education has an indirect correlation with the magnitude of vulnerability (Muttarak & Lutz, 2014). In the study area, more than 60% people of Mamudpur, Goai, Dafarpur, Talbona, Gram Salkia, Kakra, Bajitpur, Panuti, Rajdharpur, Mandra, Kalgram, Mahadipur, Padamkandi, Andulia-II, Surkhali, Indrahata, Ranagram, and Purandarpur did not attend school. School education is dependent on the nature and severity of the flood. Students' attendance in school is directly related to the accessibility to reach school during the flood. The perception survey depicts that attendance falls sharply in tune with the flood. The maximum fall rate has been observed in the Bajitpur, Dafarpur, and Panuti villages while the minimum fall rate has been observed in the Chhatrapur, Ibrahimpur, Balichuna, Sarbamangalapur, and Indrani villages. During the flood, sending children to school is nothing but a luxury for them. The attendance of school students during the flood is very low, below 50%. Thus, it has been observed that the areas experiencing floods do not have an alternative source of income from outside and have a low literacy rate. For example, the literacy rate of the flood victim villages is far below the census villages of the C. D. blocks Nabagram, Khargram, and Burwan (Table 10.5).

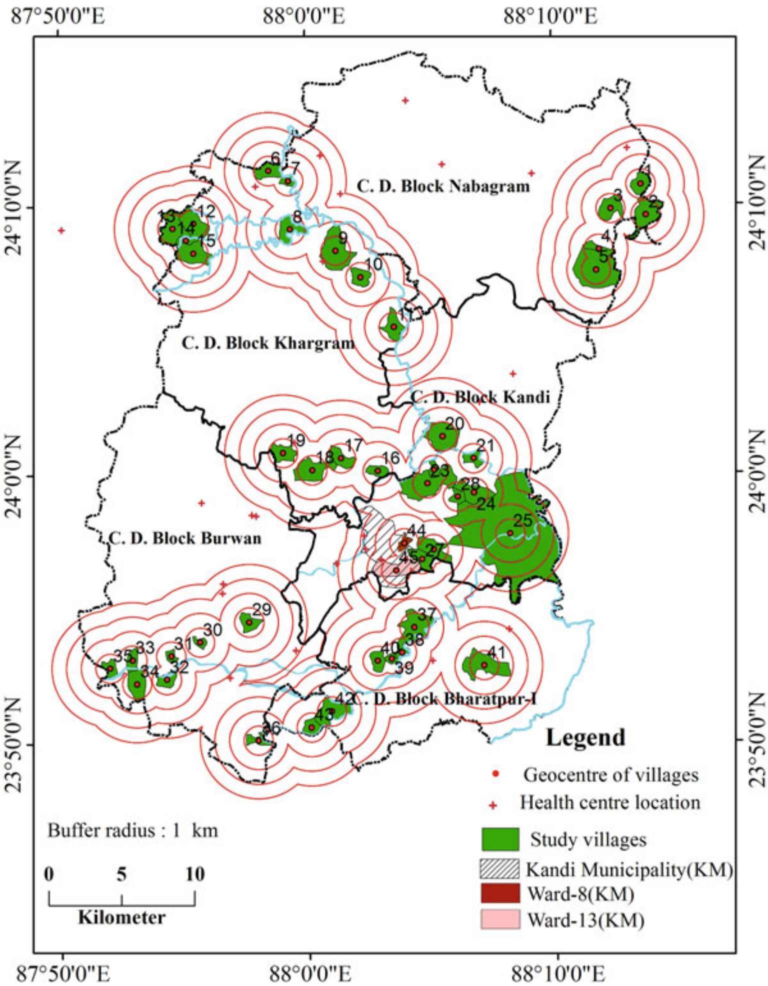

Fig. 10.10 Location of health centers in different buffer zones. (Source: State Bureau of Health Intelligence, Directorate of Health Services, 2015–2016)

However, receipt of remittance from the outside is a dominant control factor for literacy. The villages of the C.D. blocks Kandi and Bharatpur-I are mostly flood prone, and sample village literacy exceeds the total literacy of the block. This is due to the receipt of the remittance in flood-prone areas.

To find out any significant differences between the literacy rate of the sample villages and the total villages of each C.D. block, a student's t-test has been performed using the field data and census data. For C.D. block Nabagram, the computed value of the t-test for total literacy is 3.98, and for male and female literacy values of t-test are 3.68 and 4.32, respectively, while the tabulated value is 2.78 for 4 degrees of freedom at a 95% confidence level. Therefore, the computed

Table 10.5 Mean and SD of literacy rate in different study blocks

	Mean (census)			Mean (sample)			SD (sample)			Number of villages (N)	
Name of the block	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total villages	Sample villages
Nabagram	70.83	76.44	64.98	42.87	48.43	36.37	15.71	17.03	14.81	118	5
Khargram	63.56	69.69	57.16	57.72	61.74	52.96	21.30	22.32	21.01	155	14
Kandi	65.13	71.66	58.25	65.31	69.86	59.70	23	20	27.10	93	9
Burwan	68.96	74.97	62.6	37.27	43.81	29.08	3.22	5.56	4.68	160	8
Bharatpur-I	62.93	67.94	57.57	79.86	80.52	78.84	13.10	15.17	12	92	7

Source: Field Survey, 2017–2019

value for total, male, and female literacy exceeds the tabulated value implying the significant differences in the percentages between literacy of the sample villages and total villages of C.D. block Nabagram (Table 10.6).

The computed t-test value for male literacy is lesser than female literacy, which indicates that across the villages and wards, female literacy varies more than that of the males. It may be reasoned that the spatial difference in literacy in this block may be due to variations in the flood character. About 60% area of this C.D. block is above 25 m altitude, and hence, maximum villages of this C.D. block are not flood prone. However, some villages are located in low-lying flood-prone areas. The average literacy of flood-prone villages, i.e., study villages, is lower, but other villages of this C.D. block have a higher literacy rate. In this block, a few persons are engaged in the international labor market. For example, Raghupurhas has about 2.5% labor migration while Dafarpur has only about 1%. Thus, these flood-prone villages do not receive huge remittances, which can give them courage for the expenses of educating their children. This ultimately makes remarkable differences between the literacy of the sample villages and total villages. In the C.D. block Khargram, the computed value for the t-test is 1.03 for total literacy while 1.33 and 0.75 for male and female literacy, respectively, against the tabulated value of 2.16 for 13 degrees of freedom at a 95% confidence level. The computed value for all kinds of literacy rates is lesser than the tabulated value, implying no significant differences between the sample village's literacy and the total village literacy of this C.D. block. All the villages of C.D. block Khargram are moderate to highly flood-prone. It is observed that five villages (Jadabpur, Bajitpur, Padamkandi, Sabaldaha, and Kalgram), which are less flood prone, attract no remittance while the rest of the more flood-prone sample villages receive remittances by sending their family members aboard. Thus, on the one hand, lower flood magnitude supports higher literacy by lesser socioeconomic marginalization, and on the other hand, higher flood magnitude supports education via remittances. This typical mechanism actually balances out the gap between the more flood-vulnerable and less flood-vulnerable areas. The C.D. block Kandi is the highest flood-prone block among all the study blocks. The computed t-test value for total, male, and female literacy are −0.02, 0.27, and −0.16, respectively, whereas the tabulated value of the t-test is 2.31for 8 degrees of freedom at a 95% confidence level. The computed value for all kinds of literacy is far lesser than the tabulated value indicating no significant difference between the sample villages and total villages. All the villages of this C.D. block are flood prone, and the rate of labor migration to Arabian countries is higher than in other study blocks. The most flood-prone village in this C.D. block is Hijal, which has registered more than 10% labor migration. Besides, other villages like Srikanthapur, Andulia-I, Sashpara, and Harinagar are also highly flood-prone villages. These villages have recorded an average literacy rate of more than 80% because the rate of labor migration is high in these villages and thus receive a huge amount of remittances that help the villagers to increase their courage for the expense of children's education. This implies a strong positive relationship between the remittances and literacy rate among the flood-prone villages ($r^2 = 0.67$). The field data indicates a picture of literacy level similar to that of the C.D. block

Table 10.6 Student's t-test for detecting the difference between sample mean and population mean of literacy rate

Name of the C.D. Block	T value (computed)			T value (tabulated)	df	Significance level	Remarks		
	Total	Male	Female				Total	Male	Female
Nabagram	3.977	3.676	4.316	2.776	4	0.05	Alt	Alt	Alt
Khargram	1.025	1.332	0.747	2.16	13	0.05	Null	Null	Null
Kandi	−0.023	0.270	−0.161	2.306	8	0.05	Null	Null	Null
Burwan	27.791	15.837	20.234	2.365	7	0.05	Alt	Alt	Alt
Bharatpur-I	−3.419	−2.193	−4.692	2.447	6	0.05	Alt	Null	Alt

Source: Field Survey, 2017–2019

Nabagram. The computed t-test values for total, male, and female literacy are 27.79, 15.84, and 20.23, respectively, whereas the tabulated value is 2.37for 7 degrees of freedom at a 95% confidence level. This portrays that the computed value for all types of literacy far exceeds the tabulated value (Table 10.6), which indicates that there are significant differences between the literacy of the sample villages and the census villages. About 85% area of this C.D. block is above 25 m of which 40% area is above 30 m. And the low-lying area, which is situated at the edges of Mayurakshi and Kana–Mayurakshi, is flood prone. Except Mamudpur, other study villages of this C.D. block do not receive any remittances, which increases the remarkable differences between the literacy rate of the sample and total villages. This may be because the sample villages are flood prone and do not receive remittances as well. Thus, the villagers are reluctant to incur more costs on the kid's education. This results in a lower level of literacy in the flood-victim villages. However, the other villages, which are not at all flood prone have a bright picture in education. This contrasts between the sample and census villages of the C.D. blocks. The last study block is Bharatpur-I, which experiences a totally different scenario from the rest of the C.D. blocks. The computed t-test values for total, male, and female literacy are −3.42, −2.19, and −4.69, respectively, while the tabulated value is 2.45 for 6 degrees of freedom at 95% confidence level, which implies that there is a significant difference between a sample and total village regarding total and female literacy. However, there is no significant difference in the male literacy rate. The most interesting observation of this C.D. block is that the total literacy of sample villages is far better than that of the total villages. About 50% of areas of these C.D. block are below 15 m altitudes while the rest are below 20 m altitudes. Besides, the three rivers (Kuye, Mayurakshi, and Babla) crisscross the block. All the villages of this C.D. block are moderately high to highly flood prone. However, labor migration is found only in some severely flood-prone villages, which indicates that the highly flood-prone sample villages receive remittances that help to increase their literacy rate.

4.8 Sociopsychological Problems

The psychological health of people related to their thoughts, feelings, and behavior is influenced by the surrounding conditions (Kahn, 1990). To cope with the situation, the behavioral pattern of people has changed (Carver et al., 1989). Moreover, social psychology is mostly controlled by environmental hazards like floods and river bank erosion (Smith et al., 2000; Islam & Guchhait, 2018). In this section, the impact of the flood on social psychology especially fear/phobia, physical and psychological stress, and shock has been examined. Fear and phobia are interlinked. According to Wilson (1996), "phobia involves the experience of persistent fear that is excessive and unreasonable". Fear and phobia are common in the preflood stage. Physical and psychological stress are observed during and post-flood periods while shock is a post-flood event. Regarding fear/phobia, there is sharp spatial variation across the

Table 10.7 Descriptive statistics of fear/phobia, physical stress,psychological stress and shock

	Fear/ Phobia	Physical stress			Psychological stress			Shock
		Before flood	During flood	After flood	Before flood	During flood	After flood	
Mean	6.10	3.15	5.53	6.16	2.34	5.11	5.39	6.77
SD	0.62	0.16	0.34	0.28	0.10	0.23	0.26	0.52
Kurtosis	3.35	0.65	12.24	5.09	0.67	4.87	−0.15	−0.38
Skewness	−1.56	−0.63	−2.42	1.88	−0.7	−2.15	0.28	0.83
Range	3.06	0.78	2.35	1.61	0.47	1.06	1.26	1.98
Minimum	3.84	2.71	3.93	5.65	2.10	4.29	4.81	5.80
Maximum	6.91	3.5	6.28	7.27	2.58	5.36	6.08	7.79

Source: Field Survey, 2017–2019

villages and wards on a 10-point Likert scale. The minimum score for fear (3.84) has been registered for Ward 8 while the maximum by Kolla (6.9). The average score for fear is quite high (>6). It is quite natural because floods are annual and the people of the locality have an image of the devastating flood of 2000 and 1978, which indicates a feeling of fear and phobia, which they came to know about the impending flood. Regarding physical stress, there is a gradual increase in the average score from preflood to post-flood. The average physical stress in the preflood period has been recorded as 3.15, which has increased to 5.5 during the flood and ultimately reached the maximum score of about 6 in the post-flood period (Table 10.7).

It may be argued that during the flood, male members of the family are busy reaping their harvest to save it from the flood. Besides, they have to shoulder the duty of shifting household assets to a safer place and also relocating family members to the flood shelter camps, which magnifies their physical stress. Similarly, female members are busy taking care of their children and aged people and preparing the food. Moreover, in the post-flood period, physical stress reaches the maximum limit because male members of the society have to be responsible for reconstructing their damaged buildings while the females have to take the burden of rearranging household assets and nurturing kids and old people. Regarding psychological stress, a picture similar to that of physical stress has been observed. The most intriguing factor is the shock, which is maximum out of the fear, physical stress, psychological stress, and shock. This may be due to their obsessed thinking about the losses after the flood gets over. In other words, during and immediately after the flood, they are generally busy with their physical survival and have lesser scope to contemplate the losses of their belonging, but later on, when they think of their losses, they go in a pensive mood, and thus, shock increases.

The intensity of the perceptional assessment concerning the sociopsychological characteristics increases with RII value. The bar graphs (Fig. 10.11a–e) are indicating the values of RII while the error bar upon the bar graph shows the consistency of the opinion of the respondents, i.e., the shorter the error bar, the higher the consistency of opinion. Regarding the spatial variation of phobia across the different C.D. blocks, it is observed that phobia is comparatively lower for the C.D. block

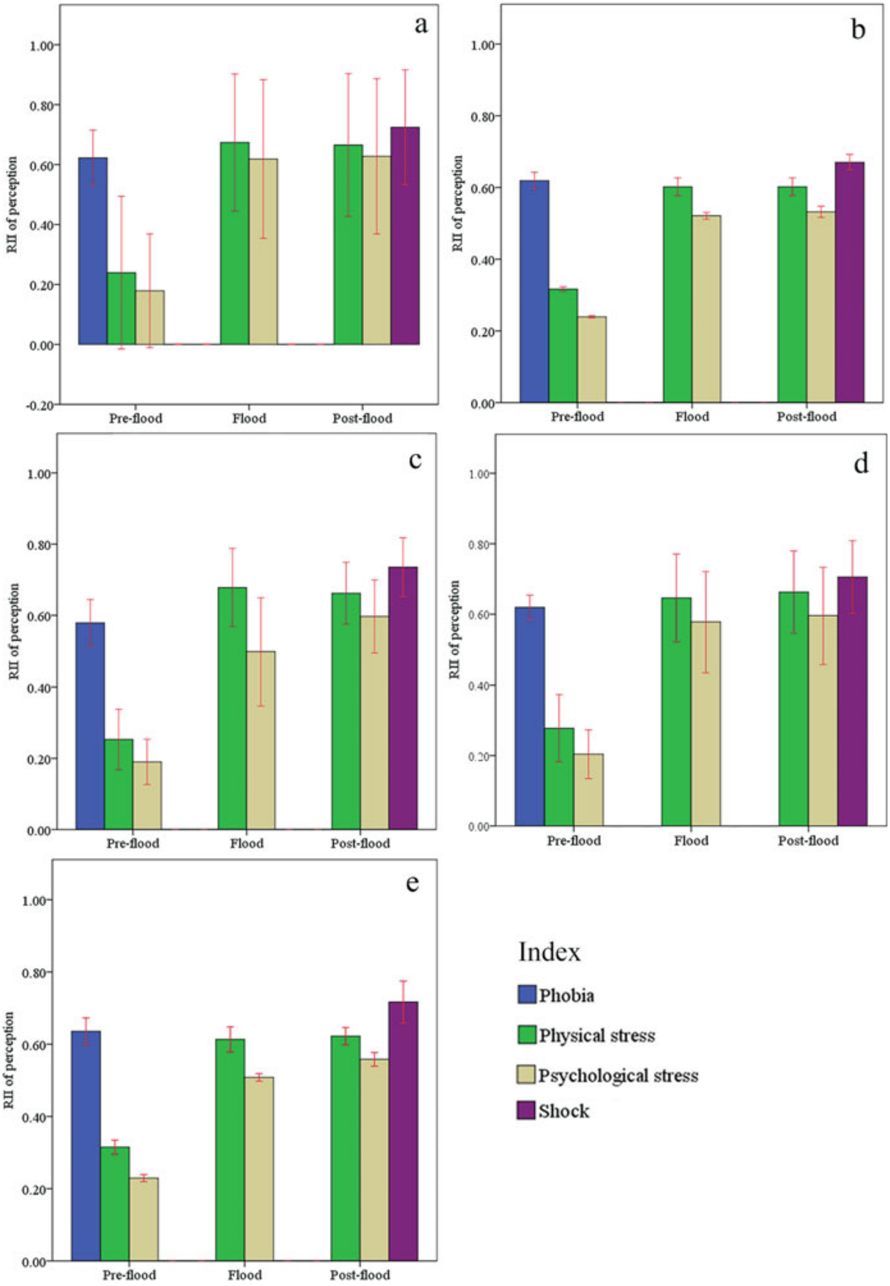

Fig. 10.11 Level of fear/ phobia, physical stress, psychological stress, and shock before the flood, during the flood and after the flood: (**a**) C.D. Block Nabagram, (**b**) C.D. Block Khargram, (**c**) C. D. Block Kandi, (**d**) C.D. Block Burwan, and (**e**) C.D. Block Bharatpur-I. (Note: Error bars at 95% confidence limit) (Source: Field Survey, 2017–2019)

Kandi because this block is the most flood prone than others. Therefore, people are habituated to the annual flood. Moreover, they know if rainfall intensity becomes high during monsoon, a flood may occur, and they are mentally prepared for that. Regarding physical stress, the C.D. block Kandi tops the list followed by Bharatpur-I (Fig. 10.10a–e). This is due to the higher magnitude of flood in these two blocks inducing the people to toil in the field for reaping the crops and in the households for tying down the household assets. However, the consistency of the opinions is comparatively low in Kandi than Bharatpur-I because some villages in the C.D. block Kandi have huge marginalization due to floods than the others. Regarding psychological stress, C.D. block Nabagram portrays the maximum score. Though this block is comparatively less flood vulnerable, they are psychologically torn out because of the recipient of minimum remittance and dependence on agricultural income. The reverse scenario has been observed for the more flood-vulnerable block like Kandi where there is an alternative source of income from outside. However, shock is maximum for the C.D. block Kandi because of the huge agrarian loss. Besides, there is a variation of opinion across gender. Though there is no such variation regarding social psychology in the preflood and flood periods, it has been observed that women have more psychological stress in the post-flood period.

It may be reasoned that females have to play a pivotal role in running the family while the males have more physical stress in the post-flood period as they move out of their native place for sustaining their families by remittance. And they experience less psychological stress as they are not directly in front of their families.

5 Conclusions

The present study shows that flood is frequent in the study area with a grave consequence on the marginalization of the agricultural portfolio as depicted by the lowering of the cropping intensity, diversity, and productivity of the monsoon agriculture. Moreover, the *kutcha* houses collapsed during the monsoon period almost every year. The maximum loss in the house, road, and transport network was found during the colossal flood of 2000. After that event, the majority of the houses were upgraded to *pucca* houses either by the government (Pradhan Mantri Awas Yojana) or by taking loans from the banks. However, in the rural areas, many kutcha roads still exist, and vulnerable culverts and bamboo bridges tend to collapse during the floods. Furthermore, the study found that accessibility to the market falls remarkably during the flood season because of the threats to the transport networks. The issues of health like the outbreak of diseases and limited access to the health care units pose great challenges, especially for child and maternal health. Similarly, regarding literacy, flood propensity also plays a vital role. The general trend is that in the absence of a remittance economy, the higher the flood, the lesser the literacy. However, the trend reverses while remittances are received by the villages, i.e., higher remittances in the higher flood-prone areas and hence better literacy rate in these areas. The study also found that fear/phobia is less among the flood-prone villagers; however, shock after the occurrence of a flood is really enormous. These typical study findings may help the various stakeholders to grasp the ground reality of the flood-prone villages in terms of the social and economic infrastructure and social psychological terrain. This will certainly help the local planners and people to get involved in participatory planning. However, in formulating a detailed plan for the reduction of infrastructural vulnerability, an in-depth assessment is needed in respect of the economic and ecological evaluation of the floods in a broader spatial and temporal framework.

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