

# Recurrent floods and prevalence of diarrhea among under five children: observations from Bahraich district, Uttar Pradesh, India

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**Background:** Diarrhea is an important problem among the under-five children in India.

**Objective:** The paper examines long-term impacts of recurrent floods on diarrhea among under-five children in Uttar Pradesh, India.

**Design:** A two stage stratified cluster survey was conducted in flood affected (exposed) and non-flood affected areas (unexposed).

**Results:** The long-term impact of the floods was not clearly marked in the overall prevalence of diarrhea with the exposed group having prevalence of 55.1% as against 56.2% in the unexposed group of children under five. Economic condition of the household is associated with the prevalence of diarrhea in both exposed and unexposed strata. Anemia was found to be a significant risk factor for diarrhea among children in both the flood exposed and non-flood exposed populations. The recurrent floods did not have any significant effect on the prevalence of diarrhea in relation to gender, religion, caste, and household size.

**Conclusions:** The study indicates that the long-term impacts of floods are very differently manifested than the immediate impacts.

Keywords: *diarrhea; recurrent flood; under-five children; Uttar Pradesh*

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Diarrhea is a major cause of mortality among the under-five children in India and is considered an important public health problem (1). The economic burden on health services caused due to diarrheal diseases is immense, as up to one-third of total pediatric admissions are due to diarrheal diseases and up to 17% of all deaths in indoor pediatric patients are diarrhea related (2). An estimation of mortality due to diarrhea in India was carried out by the National Institute of Cholera and Enteric Diseases, Kolkata (3). According to their estimates, the crude death rate due to diarrhea in rural India is 9.3 per 1,000 population. The total number of deaths due to diarrhea in the age group of 0–6 years accounted for 22% of total rural deaths (3). Diarrhea, as a prominent killer for 0–5 years children possess a

formidable challenge to health planners. The challenge is further aggravated due to complex interplay of multiple factors contributing to the occurrence of diarrhea among infants and small children.

Earlier studies have reported that floods also play an important role in aggravating the public health problems including the spread of water related communicable diseases like diarrhea (4, 5). The study site, however, is such where some villages have been continuously affected by floods for the last 40 years. It is an appropriate site for comparing villages having continuous exposure to floods every year (recurrent floods) with the ones having no such exposure. As such, studies that report on recurrent flood impacts on health are very scarce in India. Therefore, the objective of the present study is to examine and

understand the long-term impacts of recurring floods on the morbidity pattern of the under-five children in relation with diarrhea.

## Present investigation

### Methods

#### Site for the study

The study was conducted in the most flood-affected *Fakharpur* block of *Bahraich* district of eastern Uttar Pradesh. According to the Uttar Pradesh statistical report, Bahraich was the most flood-affected district in the year 2007 with around 173 villages flooded (6). In the year 2008, around 183 villages were affected due to floods (the period of floods in the district is from the end of July till mid-September). District Bahraich is mainly agrarian in nature with 70% of the farmers in the district being small and marginal. The district is least developed in the state of Uttar Pradesh. It qualifies as one of the most backward districts in the state on account of a very large population of poor Muslims (35%), having third lowest literacy rate (35.79%) in the state and being the most flood-affected district. It is in this background that the present study was carried out in the first half of July (from July 5–15) 2009.

In the *Fakharpur* Block of district *Bahraich* runs the river *Ghaghra*, a tributary of river *Ganges*. An embankment runs parallel to this river. The villages in this Block lie on the river side of the embankment and across. The villages that are lying on the river side of the embankment are the ones inundated by the river water every year while the villages lying across the embankment are protected from the flood water. We have called the first type of villages as exposed villages while the second type of villages as unexposed villages in our study. The study villages are located on alluvial plains of the district.

#### Sampling procedure

A two-stage stratified cluster survey was carried out to collect the data. The sample size was calculated using the Emergency Nutrition Assessment (7), given an expected Global Acute Malnutrition (GAM) rate of 15% in both flood exposed and unexposed strata design effect of two. The total under-five population in the exposed and unexposed strata was calculated as 6,957 and 27,905, respectively, giving the sample size as 381 and 389. The sample size was increased by 5% in each stratum to account for non-response and attrition. Therefore, 40 clusters were selected in all, 20 each in exposed and unexposed strata for the cluster sampling. The size of each cluster was 20 households, which means 400 final sample sizes in each stratum. Children of age 6–59 months were considered for the present study.

Selection of village was done through a systematic procedure. After arriving at a village where the cluster was

assigned, the research team went to the centre of the village. From the centre, a bottle was hurled and the direction indicated by the mouth of the bottle was followed. After reaching the end of the village in that direction, the bottle was again hurled and the new direction indicated the location for the sample. After this, the households were numbered and the study household was selected by means of a simple random sampling method. Starting from this reference household, 20 children under 5 years of age were covered for the present study in series. Following this procedure, 807 under-five children (6–59 months) were examined, consisting of 401 exposed children and 406 unexposed children.

#### Anthropometry

The data collected on each child included anthropometric measurements of height (in cm), weight (in kg), and mid-arm circumference (in cm). This data was collected by 13 trained data collectors who already had theoretical and practical knowledge of taking anthropometric measurements and validated it by a medical doctor. Height of the infants between 6 months to 1 year were measured in a lying down position using the infantometer while others beyond 1 year of age were measured in standing position without shoes. All the children were weighed using a calibrated weighing machine that can detect change in weight by 100 gms. Body weight was measured on dressed children wearing light clothing without shoes. Age of the children was checked on the presentation of the birth certificate, wherever available. Otherwise, it was estimated using a local calendar or the festival calendar and by asking the mothers or caretakers the history of the past events closest to the birth of the child. These above measurements were taken to calculate the deviation from normal (*z*-score) of three standard measures: weight for age (*waz*) to measure underweight, height for age (*haz*) to measure stunted growth, and weight for height (*whz*) to measure wasting or acute malnutrition based on the standard guidelines by the World Health Organization (WHO). Individuals were classified as normal if they have a *waz* equal to or above  $-2$  *z*-scores (or 80% of the median). If they were less than  $-2$  *z*-scores (or below 80% of the median) and equal to or above  $-3$  *z*-scores (or 70% of the median), they have moderate-acute wasting. If they were below  $-3$  *z*-scores (or 70% of the median) or if they have edema on both feet, they have severe-acute malnutrition (8).

#### Data collection

The questionnaire was used as a tool for collecting the data on prevalence of diarrhea among the under-five children. However, in its entirety it was meant to capture the status of malnutrition in the exposed and unexposed areas of the region and prevalence of diarrhea. A diarrhea episode was defined as a passage of loose

watery stools more than three times a day or change in the consistency of stool to semi-solid or watery nature. The other socio-economic dimensions that were explored with the help of the questionnaire were: annual income of the household, land holding, caste status, religion, type of house, etc. Other indicators of malnutrition that formed a part of the questionnaire were: height, weight, age in months, MUAC (mid-upper arm circumference), vitamin A deficiency signs that were defined by the reported history of night blindness, presence of bitot's spots in any eye, or diagnosed vitamin A deficiency based on doctor's report in prescription. Respiratory infections were defined by the presence or history of cough and cold with or without a runny nose or the presence of fast breathing, chest indrawing at the time of interview or reported by mother or diagnosed by a doctor in one prescription during the previous 2 weeks.

### Analysis

The analysis of the data obtained through the questionnaire was done using SPSS software version 16.0. Two levels of analysis were carried out; that is, at first the exposed and unexposed strata were split and bivariate analysis was done to ascertain if there was any significant difference between variables like caste, religion, gender, economic condition, and so on for prevalence of diarrhea across the exposed and the unexposed group. Since we dealt with categorical data (nominal and ordinal data values), Pearson's chi-square was used as a measure to establish the significance of difference. Risk factors were also calculated using Odds Ratio and their respective 95% Confidence Interval.

### Results

The overall prevalence rate of diarrhea was very high among the whole population 55.6% (449/807) in Fakharpur Block, Bahraich district. The prevalence rate was 55.1% (221/401) among the flood exposed group. Out of the total 414 male children, 54.8% had diarrhea while out of 393 female children, 56.2% had diarrhea in the total population studied. There were no significant differences regarding prevalence of diarrhea between the exposed and unexposed groups in either of the gender (Table 1).

Similarly, the prevalence of diarrhea among Hindus was 54.9% and 58.0% was among the Muslims. The difference in the prevalence of diarrhea was not significant in both the religion with regards to exposure to floods or not.

It was observed that the prevalence of diarrhea was significantly higher in scheduled caste category among unexposed group (69.2%) than exposed group (48.1%). The prevalence of diarrhea was higher among scheduled tribes (100%) among the exposed group than the unexposed group (66.7%). However, it was not statistically significant. The prevalence of diarrhea showed no significant differences in various other caste categories.

The prevalence of diarrhea varied between 43.5% in the age group 42–53 months to 69.3% in the age group 6–17 months. The prevalence was higher among the unexposed children in the age group of 18–29 months (64.6%), 51.9% in the age group of 30–41 months, among the exposed group in the age groups 6–17 months (71.3%), 42–53 months (45.0%), and 54–59 months (56.2%). The prevalence of diarrhea was significantly higher in children aged 6–17 months (71.3%) as compared to other age groups in the exposed population to floods ( $p = .007$ ). Similarly, the prevalence of diarrhea was significantly higher (67.4%) in the unexposed group ( $p = .003$ ). The prevalence of diarrhea was also higher in the age group of 6–17 months (71.3%), 42–53 months (45%), and 54–59 months (56.2%) as compared to the similar age groups among unexposed population to floods (67.4%, 42.1%, and 45.5%, respectively). But the differences were not statistically significant. The overall prevalence of diarrhea in the study population showed higher prevalence in 6–17 months children (69.3%) as compared to other age groups ( $p = <.001$ ).

The prevalence of diarrhea was slightly higher among unexposed children belonging to small, medium, large, and very large household size families; but these were not statistically significant.

The prevalence of diarrhea was highest in very poor per capita income families (59.0%) and least in the rich per capita income families (50.0%). The prevalence was also higher among children belonging to very poor per capita income families (70.5%) in unexposed group than the exposed children (50.8%;  $p = .003$ ). However, in the middle income per capita families the prevalence of diarrhea was higher in exposed group (63.2%) than unexposed group (49.1%;  $p = .045$ ).

Father's literacy status also had a significant relation with the prevalence of diarrhea among the exposed and unexposed children. The prevalence of diarrhea was higher among exposed children whose fathers were literate (62.2%) as compared to unexposed children (52.9%;  $p = .041$ ). A reverse finding was also seen among children of non-literate fathers where the prevalence of diarrhea was higher among the unexposed group (59.3%) as compared to exposed group (49.6%;  $p = .031$ ).

The prevalence of diarrhea also shown to be significantly higher among children whose mothers were literate (70.7%) among exposed group as compared to unexposed group (46.7%;  $p = .008$ ). Considering the place of delivery, children born in the hospitals in exposed group showed higher prevalence of diarrhea (70.7%) as compared to unexposed group (47.1%;  $p = .01$ ).

The prevalence of diarrhea was observed to be higher among families that have taken loans (73.8%) than those families that did not take any loans (49.9%). However the difference between exposed and unexposed groups in relation to prevalence of diarrhea was not statistically

**Table 1.** Socio-demographic factors associated with the prevalence of diarrhea in Bahraich district, Uttar Pradesh

Variables	Children reporting diarrhea					
	Exposed to flood No (%)	p-value within group	Unexposed to flood No (%)	p-value within group	Total No (%)	p-value within group
<b>Gender</b>						
Male	110(54.7)	0.87	117(54.9)	0.63	227(54.83)	0.65
Female	111(55.5)		110(57.3)		221(49.77)	
<b>Religion</b>						
Hindu	181(54.0)	0.32	156(56.1)	0.52	337(54.97)	0.40
Muslim	40(60.6)		72(56.7)		112(58.03)	
<b>Caste</b>						
General	35(56.5)	0.22	56(49.1)	0.25	91(51.78)	0.39
Schedule caste	39(48.1)		27(69.2)		66(55.00)	
Other backward caste	103(54.8)		71(58.2)		174(56.12)	
Schedule tribe	4(100.0)		2(66.7)		6(85.71)	
Others	40(60.6)		72(56.2)		112(57.73)	
<b>Age group (months)</b>						
6–17	62(71.3)	0.007*	62(67.4)	0.003*	124(69.27)	0.000**
18–29	45(55.6)		53(64.6)		98(60.12)	
30–41	37(50.0)		41(51.9)		78(50.98)	
42–53	45(45.0)		40(42.1)		85(43.58)	
54–59	9(56.2)		10(45.5)		19(50)	
<b>Household size</b>						
Small	43(53.8)	0.27	36(58.1)	0.27	79(55.63)	0.10
Medium	160(55.6)		163(56.9)		323(56.17)	
Large	18(58.1)		21(59.6)		39(58.20)	
Very large	0(0.0)		7(37.0)		7(30.43)	
<b>Per capita income</b>						
Very poor	62(50.8)	0.43	62(70.5)	0.01*	124(59.04)	0.61
Poor	86(55.5)		91(56.2)		177(55.83)	
Middle income	43(63.2)		54(49.1)		97(54.49)	
Rich	13(54.2)		16(47.1)		29(50)	
<b>Father's literacy status</b>						
Literate	107(62.2)	0.01*	117(52.9)	0.19	224(56.99)	0.38
Non-literate	112(49.6)		108(59.3)		220(53.92)	
<b>Mother's literacy status</b>						
Literate	29(70.7)	0.03*	43(46.7)	0.03*	72(54.13)	0.70
Non-literate	192(53.3)		108(59.0)		300(44.64)	
<b>Place of delivery</b>						
Home	192(53.3)	0.03*	204(57.5)	0.16	396(55.38)	0.68
Hospital	29(70.7)		24(47.1)		53(57.60)	
<b>Has the family taken any loan?</b>						
Yes	146(61.1)	0.009*	170(60.8)	0.059	316(73.83)	0.002*
No	74(47.7)		108(51.4)		182(49.86)	

\*\*Significant at <0.001.

\*Significant at <0.05.

significant. Within exposed group, prevalence of diarrhea was significantly higher in families who have taken loan (61.1%) than families without loan (47.7%;  $p = .009$ ).

Table 2 shows univariate analysis of factors associated with the prevalence of diarrhea among under-five children in the study population. Prevalence of diarrhea was higher among children showing ARI (Acute Respiratory Infection) symptoms in the last 2 weeks (74.0%) as compared to those children who did not have ARI symptoms (32.1%; OR = 0.97) but not statistically significant.

There was no significant association between children receiving any form of treatment for ARI or diarrhea (82.8%) than those children who did not receive any form of treatment (66.7%) irrespective of the exposure status to flood (OR = 1.09).

Difficulty at seeing at night did not have any significant association with the prevalence of diarrhea in either exposure groups (OR = 1.01).

The prevalence of diarrhea showed to be significantly lower among children who did not have signs of anemia (55.2%) as compared to those children who showed signs of anemia (59.2%; OR = 2.03).

Children showing signs of moderate and severe underweight had higher prevalence of diarrhea (58.6% and 56.7%, respectively) as compared to the normal children (children who did not show any signs of underweight). Children with moderate and severe stunting were showing higher prevalence of diarrhea than those children who were not showing any signs of stunting among the exposed as well as unexposed group.

Children showing signs of severe malnutrition had higher prevalence of diarrhea (63.6%) as well among the unexposed group in comparison to the exposed group (OR = 1.17). Prevalence of diarrhea was also more among the children with moderate malnutrition than the children who were normal (children who did not show any

**Table 2.** Univariate analysis of factors associated with the prevalence of diarrhea among under-five children in Bahraich district, Uttar Pradesh

Variables	Children reporting diarrhea			
	Exposed No (%)	Unexposed No (%)	Total No (%)	OR (95% CI)
Child showing ARI symptoms in the last 2 weeks				
No	55(31.2)	58(33.0)	113(32.10)	Ref
Yes	166(74.1)	170(73.9)	336(74.00)	0.97(0.63,1.48)
Did your child receive any treatment?				
No	44(62.0)	42(72.4)	86(66.66)	Ref
Yes	177(84.7)	185(81.1)	362(82.83)	1.09(0.68,1.75)
Difficulty seeing at night				
No	162(52.1)	171(52.3)	333(52.19)	Ref
Yes	30(65.2)	32(72.7)	62(68.88)	1.01(0.58,1.74)
Children showing signs of anemia				
No	186(55.4)	167(54.9)	353(55.15)	Ref
Yes	33(57.9)	60(60.0)	93(59.23)	2.03(1.26,3.25)*
Children showing signs of being underweight				
Normal	85(54.5)	81(51.3)	166(51.59)	Ref
Moderate	73(57.0)	81(60.0)	154(58.55)	1.16(0.75,1.8)
Severe	58(54.7)	64(58.7)	122(56.74)	1.15(0.72, 1.85)
Children showing signs of stunting				
Normal	67(53.6)	63(48.1)	130(50.78)	Ref
Moderate	55(54.5)	50(52.6)	105(53.57)	1.00(0.58, 1.62)
Severe	95(57.6)	113(64.2)	208(60.9)	1.26(0.81,1.96)
Children showing signs of malnutrition				
Normal	161(55.1)	174(54.9)	335(55.00)	Ref
Moderate	44(58.7)	38(60.3)	82(59.42)	0.79(0.49,1.29)
Severe	11(45.8)	14(63.6)	25(54.34)	1.17(0.52,2.67)

\*Significant at  $<0.05$ .

OR = Odds Ratio; CI = Confidence Interval; Ref = Reference.

signs of malnutrition) in both the exposed and unexposed groups.

## Discussion

Over all prevalence rate of diarrhea in both the exposed and unexposed population is much higher than all of the India prevalence rate of diarrhea (9%) as reported by National Family Health Survey (9). The flood affected population has a high prevalence of diarrhea with more than half of the children showing symptoms of diarrhea. Similar findings were reported in the Midnapur district of West Bengal where diarrheal disease was the most common morbidity among the flood prone population (10). Another study by Biswas et al. (11) also reported that incidence of diarrhea, other enteric diseases, and respiratory infections were significantly higher ( $p < .05$ ) among the population in flood affected blocks, compared to the unaffected ones. The attack rate of diarrhea in the flood affected population had increased significantly following flood ( $p < .05$ ). A bulletin on the floods in Pakistan also reported that prevalence of water-borne diseases like diarrhea increases enormously during the flood (12). The present study, however, showed that the prevalence rate of diarrhea remains high in the case of the non-flood exposed group as well.

The present study showed that children of low age groups are associated with high prevalence of diarrhea in both flood exposed and non-flood exposed groups since the prevalence of diarrhea increases as the age of the children decreases. Earlier studies had also reported about the significantly high association with the low age group of the children with high diarrhea morbidity (13–15). A study from Kolkata, India also reported that one of the strongest factors for reporting a history of diarrhea was age less than 60 months (16). This shows that children of a younger age group should be given proper medical care and attention in the aftermath of the flood as they are more vulnerable and bear the brunt of long lasting effects of the water-related communicable disease like diarrhea. The present study showed that the most vulnerable age group to diarrhea was 6–17 months age group irrespective of the exposure status to floods.

Economic condition also seems to be a major factor that affects the prevalence rate of diarrhea. It was found that within the exposed and unexposed groups, families/households that received loans had children suffering from diarrhea more than those that did not receive any loans. Receiving a loan may indirectly reflect having insufficient resources to counter diarrhea. Floods also impact on the morbidity pattern of diarrhea. It was found that households that had received loans in the flood affected areas reported more cases of diarrhea in their children than the households in the non-flood affected area. Very poor per capita income families were significantly associated with the high prevalence of diarrhea

among the unexposed groups while among the flood exposed group, the high prevalence of diarrhea was associated only with the middle income families. According to a study in Bangladesh about the impact of flood on health, it was found that the number of family members and poor economic status were also factors associated with the worsening of diarrhea (17). Therefore, economic burden and flooding seemed to have a direct and a long lasting association with diarrhea in these study areas.

The relation between literacy status of the parents and prevalence of diarrhea shows an interesting pattern in the study. In line with other studies (14), the literacy status of parents correlates positively with the prevalence of diarrhea with the under-five children of literate parents showing lower prevalence of diarrhea. But, in the families long exposed to a flood situation, the under-five children of literate parents show higher prevalence of diarrhea than the illiterate parents. Thus, the advantage of literacy seems to be nullified in the overall disturbance that the flood may be causing to a family.

Another factor that affects the morbidity of diarrhea is ARI, even though it is not statistically significant. In both the exposed and unexposed groups, there is a high association of diarrhea with ARI. Similar findings were reported from West Bengal and Bangladesh where the high incidence rate of diarrhea was highly associated with a high incidence rate of ARI in the flood affected areas (18, 19). This could be due to drinking contaminated water as well as overcrowding, which is also a secondary or indirect contributor for spreading diarrhea (4). Even though diarrhea and ARI are two different illnesses and could be attributed to different causes, both of them show co-morbidity due to the effect of flood and the incidence rate of both of them are usually high in the aftermath of flood (4, 18).

Stunting was also found to be associated with the high prevalence of diarrhea in both the exposed and unexposed groups although it did not show any statistical significance among the study groups. It is also supported by the findings from rural Sudanese community where stunting was reported to be highly associated with diarrhea (18). A study in India among hospitalized children also reported a high association of diarrhea with severe stunting (20). In earlier studies, stunting and malnutrition were usually associated. It has been documented in several studies that one of the underlying causes of diarrhea is malnutrition among children (21). We also found a higher prevalence of diarrhea among children suffering from moderate malnutrition but it was found to be not statistically significant. However, children suffering from anemia were found to be significantly associated with high prevalence of diarrhea. Anemia is usually associated with malnutrition and poor economic status (22). Severe malnutrition was observed to be a significant risk factor for the prevalence of diarrhea in a

study from Gambella region of Ethiopia, which reported that impacts of flooding were found mainly on diarrhea, notable consequences on the economy, and the subsequent malnutrition (23). There also exists a strong relationship between economic condition and the standard of living and environmental and personal hygiene (24). These factors are responsible for greater morbidity as a result of poor economic condition.

The prevalence of 'inability to see in the dark (result of vitamin A deficiency)' among the children is associated with diarrhea morbidity for both exposed and unexposed groups. A study on mild vitamin A deficiency among the pre-school children and the school children reported that there is a greater risk of diarrhea and respiratory diseases in children with mild vitamin A deficiency. Supplementation of vitamin A also reduced the incidence of both diarrhea and respiratory diseases for at least 2 months (25). However, the present study findings regarding vitamin A deficiency may not be accurate because of the reporting bias associated with this type of assessment.

Even though 84.7% children had received treatment for diarrhea, a significantly large number of children (62.0%) still did not receive any treatment among the exposed group ( $p = .001$ ). This is more than twice the number of children who did not receive any treatment for diarrhea in India as a whole according to National Family Health Survey (9). Therefore, the challenge here is how to increase awareness among the mothers and the community about the causes and treatment of diarrhea. It could also be recommended that the Oral Rehydration Therapy launched by the Government of India should be given more emphasis in the frequent flood affected areas in order to prevent high incidence rate of diarrhea in the aftermath of flood.

The greater morbidity across exposed and unexposed groups, as a result of poor economic condition can be explained on the basis of understanding the 'process' that leads to poor economic condition (20). It is a fact in the flood prone district of Bahraich that, floods wash away the land holdings of the people. People who generally are farmers had to work as laborers on daily wages as a result of land erosion. This indicates that a flood adds to the process of poor economic condition and, hence, a difference between flood exposed and unexposed households.

Overall, the study indicates that the long-term impacts of floods are very differently manifested than the immediate impacts. In normal flash flood situations, the poor economic status, literacy, hospitalized birth would show an advantage for the prevalence of diarrhea. The same advantage seems to be lost when the community is long exposed to floods like the present one.

## Conclusion

Prevalence of diarrhea is very high among the under-five children of the Fakharpur Block of Bahraich district, the most vulnerable age group for diarrhea was 6–17 months. Middle income families were the worst affected by flooding with regards to the prevalence of diarrhea. Recurrent flooding also seems to invalidate the advantages of literate parents over non-literate parents in terms of protecting their children from diarrhea, which is the other way round under normal conditions. Children born at home rather than at hospitals coped better against diarrhea among the flood exposed group. Anemia was found to be a significant risk factor for diarrhea among children in both the flood exposed and unexposed groups. The economic status of families seems to be an important factor that leads to a high prevalence of diarrhea. The recurrent floods did not have any significant effect on the prevalence of diarrhea in relation to gender, religion, caste, and household size. Overall, the long-term impact of recurrent floods on the prevalence of diarrhea showed variable association with different socio-economic and demographic factors. Our findings stress the importance of a broad health system and analytical approach to flood-related disaster prevention and mitigation, cutting across sectoral boundaries.

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