Climate Health, Volume 1, Issue 1, Winter 2026: 39-47

Research Article

Post-Disaster Epidemiological Survey of the Gujarat Floods: An Overview of Strategic Lessons and Key Takeaways

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Article info:
Received: 30 August 2025
Revised: 18 October 2025
Accepted: 29 November 2025

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ABSTRACT

Introduction: During the 2017 monsoon, severe flooding in the northwest state of Gujarat, India, led to the loss of over 200 lives and the displacement of approximately 80,000 people. The health impacts of floods are well-documented, with Gujarat experiencing significant public health challenges during this disaster.

Methods: A cross-sectional study was conducted by CHD Group by administering a survey to individuals over the age of 18 attending five rural multi-specialty health camps in the Banaskantha district of Gujarat, India.

Results: The survey of 163 participants affected by the 2017 Gujarat floods showed diverse demographics, with a near-equal gender distribution. The floods led to 34% reporting sickness, 19% property damage, and 17% losing belongings. Support was provided to 91%, mainly by NGOs and the government, with mixed satisfaction levels. Government officials informed 70% of respondents about flood dangers, and television was the most common information source. Health services emerged as the top priority for 24% of respondents, highlighting a crucial area for future disaster preparedness and response efforts.

Conclusions: Post-disaster epidemiology needs more focus with risk-informed planning in Gujarat, which can also be scaled up to other states. Public health campaigns and resilience literacy will need to be factored into disaster management plans to build community resilience and leave no one behind. Local geopolitics, cultural nuances, and available resources ought to be converged into creating better safety nets for vulnerable population groups.

Keywords: Disaster Management; CHD Group; Gujarat Floods; Public Health Resilience; Disaster Response

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Citation: Fernandes E, Sudandiradas R, Shetty A. Post-Disaster Epidemiological Survey of the Gujarat Floods: An Overview of Strategic Lessons and Key Takeaways. Climate Health. 2026;1(1):39-47.

https://doi.org/10.18502/chj.v1i1.22643

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Introduction

Floods are catastrophic events that disrupt normal life and can significantly impact public health, particularly by increasing the transmission of communicable diseases like typhoid and malaria. Floods may be natural or man-made, depending on factors such as geographical location and building resilience. Although warnings for seasonal floods can be issued in advance, flash floods and coastal floods often offer little to no warning. Rapid urbanization, expansion into flood-prone areas, and extreme weather events due to climate change are heightening vulnerabilities to floods. In India, flooding is a recurring issue, with 12% of the land prone to such events.

During the 2017 monsoon in India, severe flooding in the northwest state of Gujarat resulted in the loss of over 200 lives and displaced approximately 80,000 people [1-3]. The Indian subcontinent is highly prone to flooding and other natural disasters because of its vulnerable geography, and floods during the monsoon are common and often unpredictable [4]. While rescue efforts commence immediately, the health impacts and outcomes often do not receive adequate attention. The flooding in Gujarat severely disrupted medical and public health infrastructures and services, obstructing access to essential health services [2,3].

The floods led to increased transmission of water-borne diseases, contamination of water supplies by sewage and dead animals, and the destruction of food stocks, significantly affecting the health of the population. Adverse health outcomes included the spread of infectious diseases, interruptions in chronic disease care, and lapses in immunization coverage [5,6].

Gujarat is prone to flooding due to a combination of geographical, climatic, and hydrological factors. The state has a long coastline of about 1,600 km, making it vulnerable to coastal flooding. It falls within a subtropical climate zone with diverse climatic conditions ranging from humid to arid, which contributes to unpredictable monsoon patterns. The state's physiography includes fertile plains that are densely populated, hilly and mountainous areas, plateaus, deserts, and extensive coastal plains. Gujarat is home to several major rivers, which contribute to the risk of riverine flooding, especially during heavy monsoon seasons. The combination of these factors, along with inadequate natural drainage in some regions, makes Gujarat particularly susceptible to flood disasters. Figure 1 presents the year-wise flood-affected districts in Gujarat from 2005 to 2021, along with the district-wise flood-affected areas measured in hectares (Ha) [7].

Although this survey analysis does not seek to establish a direct causal relationship, the 2018 National Health Profile reported a rise in several communicable diseases, including chikungunya, cholera, diarrheal diseases, measles, whooping cough, and viral hepatitis [8]. Whether these increases are directly linked to the flooding or reflect broader climatic conditions remains a point of investigation. Improved data collection and reporting systems in recent years may also contribute to the observed rise in cases and deaths.

In addition to the health impacts, the flooding wreaked havoc on agriculture, including the cotton farming industry, leading to the loss of 14,300 cattle and causing an estimated Rs. 870 crores in damages to agriculture and horticulture alone. Nearly two lakh hectares of land across 15 districts were eroded [9]. The floods also disrupted air travel, local transportation, and factory operations, further exacerbating the economic toll [9].

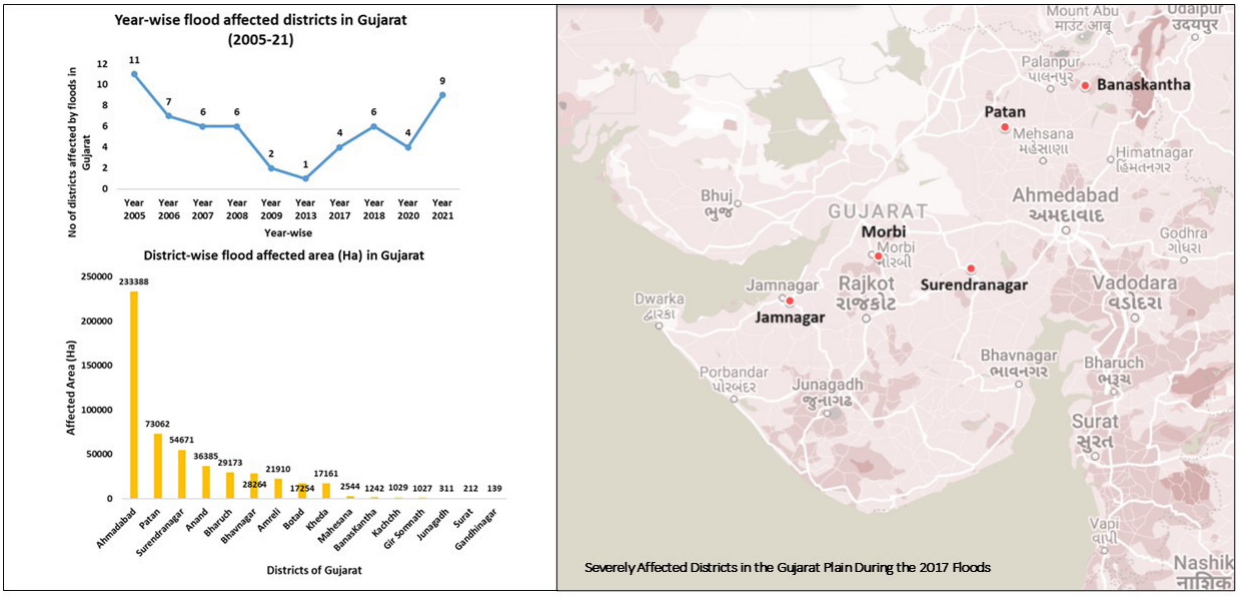

Figure 1: Annual flood-affected districts in Gujarat from 2005 to 2021 and district-wise flood-affected areas

The damage to crops, soil, and infrastructure led to reduced agricultural yields and increased food prices, particularly impacting vulnerable groups such as the poor, women, and children. This disruption in food production affected not only rural farmers but also urban consumers, leading to shortages and inflation in food prices [10].

Of the state's 33 districts, five situated along the Gujarat plain Banaskantha, Patan, Surendranagar, Morbi, and Jamnagar were the areas where the impact was most severe (Figure 1). The state resides in a hilly region, and the lack of natural drain-off results in a high flood risk for this corridor of Gujarat. Despite repeated calls for community preparedness following previous floods in 2006 and 2015, which had highlighted the region's vulnerability due to poor drainage and low-lying areas, Gujarat was again hard-hit in 2017 [11,12]. After the first floods of the monsoon season in Gujarat in 2017, CHD Group responded with partners in rural Banaskantha by running health camp interventions for individuals and families affected by the disaster.

Methods

A field-level study was conducted by CHD Group—a public health organization that was also providing medical relief to communities on the ground. Using a convenience sample of 163 participants from five rural health camps in Banaskantha district, Gujarat, a cross-sectional study was conducted. Banaskantha is one of the thirty-three districts in the state of Gujarat, India. It shares its northern border with the state of Rajasthan, is bordered by Sabarkantha district to the east, Kutch district to the west, and Patan and Mehsana districts to the south. The district's administrative center and largest city is Palanpur [9].

These five health camps were organized by CHD Group as part of their disaster response efforts, along with the Government of Gujarat, SEEDS India, and local partners, with site selection guided by community partners and local mobilizers. The survey instrument was specifically designed by CHD Group for the Gujarat flood operations, focusing on assessing the health impacts and needs of the affected population. The survey was administered by medical doctors during the delivery of health services. The questionnaire was semi-structured and was carefully translated into Gujarati and then back-translated to ensure accuracy and cultural relevance.

Informed verbal consent was obtained from all participants prior to the administration of the survey, ensuring ethical conduct in alignment with public health practices. Data analysis was performed using SPSS (version 16.0) and Microsoft Excel. Categorical variables were analyzed using frequency distribution tables, while continuous variables were summarized using descriptive statistics. Institutional ethics consent in this case was not feasible, as it was a Sudden Onset Disaster (SOD); hence, informed consent was taken from patients who attended the medical camps organized by CHD Group, a public health organization headquartered in Mangalore. Furthermore, the humanitarian charter and minimum standards of technical care were adhered to throughout this process.

Results

Demographic characteristics of survey participants

A total of 163 participants were surveyed, with demographic details captured across various age groups, gender, and education levels. Just under half of the individuals surveyed were male (48%), slightly outnumbering females (42%). The survey participants represented a diverse range of age groups, with the largest proportion (28%) being 18–24 years old, followed by 20% in the 35–44 age group, and 17% each in the 25–34 and 45–54 age groups. Smaller percentages were found in the 55–64 age group (12%) and those aged 65 and older (6%), with 1% of respondents not reporting their age. Individuals between the ages of 18–24, including a third of females and a quarter of males, made up the largest age group, and surveys were not administered to individuals under the age of 18.

Educational levels varied, with 29% having completed primary school, 25% being illiterate, and 21% having secondary education. A smaller proportion had professional qualifications (18%) or were graduates (2%), and 4% of respondents did not report their education level. Regarding occupation, a majority (52%) were laborers or daily wage workers, while 39% were government employees or professionals. A smaller portion (6%) were engaged in business, and 2% did not specify their occupation.

The majority of participants (66%) resided in rural areas, with 30% from urban areas. In terms of family size, 45% of participants had more than four family members, 24% had four members, 14% had three members, and 11% had two members (Table 1).

Effects, Services, and Satisfaction

The survey data showed that among the 163 participants, 34% reported becoming sick due to the flood, while 19% experienced damage to their property or house, and 17% lost belongings. Injuries were reported by 4% of respondents, with 5% reporting both sickness and property damage. Other impacts, grouped under "Other," affected 13% of participants. A small percentage (1–3%) experienced multiple types of impacts, including combined injuries, sickness, and property damage.

Regarding services received post-flood, 20% of respondents received a combination of food, clothes/blankets, and medicines/first aid. Medicines or first aid

Table 1: Demographic characteristics of survey participants in Banaskantha district, Gujarat, 2017

Variables	No of participants (n=163)	
	Number	Percentage
Age group		
18-24	45	28%
25-34	28	17%
35-44	32	20%
45-54	28	17%
55-64	19	12%
65+	9	6%
Unknown	2	1%
Gender		
Male	78	48%
Female	68	42%
Unknown	17	10%
Education		
Illiterate	41	25%
Primary School	47	29%
Secondary School	35	21%
Graduate	3	2%
Professional	30	18%
Unknown	7	4%
Occupation		
Labourer (Daily wage worker)	85	52%
Business	10	6%
Government Employee / Professional	64	39%
Unknown	4	2%
Residential type		
Urban	49	30%
Rural	107	66%
Unknown	7	4%
Number of Family members		
Two	18	11%
Three	23	14%
Four	39	24%
> Four	73	45%
Unknown	10	6%

were provided to 16% of participants, while food was received by 9%, and clothes/blankets by 6%. Support was provided to 28% of participants within two days of the flood, with another 24% receiving assistance within 3–5 days. A smaller portion (13%) received support within 12 hours, and 7% waited for more than two weeks. Notably, 9% of respondents reported not receiving any support.

The majority of participants (56%) received services at or near their home or neighbourhood, while 36% received them elsewhere. For those who had to travel to access services, 55% travelled less than 1 km, while 33% travelled more than 1 km. A notable portion (18%) did not report the distance travelled to receive services (refer to Table 2).

Delivery of services was provided by a variety of actors, and therefore overlap is inherent. According to respondents, 140 were assisted by NGOs and 111 by the government. “Public” and family/relative donations and active help assisted 70, closely followed by “landlords and influential local figures” assisting 65. These figures make up just under three-fourths of the known response of the surveyed population; 27% indicated they “don’t know” who provided them with services. Of the other responses, 53% received services from two or more sources, and 26% selected “don’t know” as well as one or more other source.

Regarding their satisfaction with services provided, two trends emerged. In rating services from Very Bad to Very Good, the responses were much more polarized for government and NGOs than for public/relatives and landlords/local influencers, which were overwhelmingly positive. The range of responses for government and NGOs amounts to a far greater deficit than those given for public/relative and landlord/local influencer-supported services.

Figure 2 presents the satisfaction levels of participants with various support sources during the Gujarat Floods of 2017. For Central/State Government, 58% of respondents rated the support as “Good,” while

Table 2: Impact of Flood and Service Access Among Survey Participants in Banaskantha District, Gujarat, 2017

Variables	No of participants (n=163)	
	Number	Percentage
Affected Type		
Injured	7	4%
Became Sick	56	34%
Lost Belongings	28	17%
Damaged Property / House	31	19%
Other	22	13%
Sick + Damaged Property / House	8	5%
Sick + Other	1	1%
Notknown	5	3%
Injured + Sick + Damaged Property / House	2	1%
Sick + Lost Belongings + Damaged Property / House	1	1%
Lost Belongings + Damaged Property / House + Other	2	1%
Services Received		
Food	15	9%
Shelter	1	1%
Clothes / Blankets	10	6%
Medicines / First Aid	26	16%
Other	26	16%
Food + Medicines / First Aid	19	12%
Food + Other	2	1%
Clothes / Blankets + Medicines / First Aid	2	1%
Clothes / Blankets + Other	2	1%
Food + Shelter + Clothes / Blankets	2	1%
Food + Clothes / Blankets + Medicines / First Aid	33	20%
Food + Clothes / Blankets + Medicines / First Aid + Other	5	3%
Missing data	20	12%
Support Provided		
12 hours after	22	13%
1 day after	21	13%
2 days after	46	28%
3-5 days after	39	24%
1 week after	5	3%
> 2 weeks after	11	7%
Did not receive	15	9%
Missing data	4	2%
Received Services at		
Home / Neighborhood	91	56%
Other	59	36%
Missing data	13	8%
Distance Travelled to Receive Services		
< 1 km	89	55%
> 1 km	54	33%
Unknown	29	18%

30% remained "Neutral." Only 3% found the response "Bad," 4% found it "Very Bad," and 4% rated it "Very Good."

For NGOs, 51% of participants rated NGO support as "Good," with 15% rating it "Very Good." Twenty-nine percent felt neutral, while a small percentage (6%) rated it negatively.

For public and relatives, the majority (53%) were "Neutral" about the support received, 35% found it "Good," and only 2% rated it as "Very Good." However, 10% rated it negatively ("Very Bad" or "Bad").

For landlords/local influencers, 60% were "Neutral" towards the support provided, while 27% found it "Good" and 11% rated it "Very Good." Very few respondents rated it negatively.

Awareness of Safety and Support Services

The survey revealed that 69% of participants were informed about the flood by government officials, while 29% were not, and 2% did not provide a response. Television was the most common source of information, cited by 30% of participants. Other sources included neighbourhood/friends (13%), radio (12%), and various combinations of sources. Notably, 31% of respondents did not specify their source of information.

Regarding awareness of relief services, 66% of

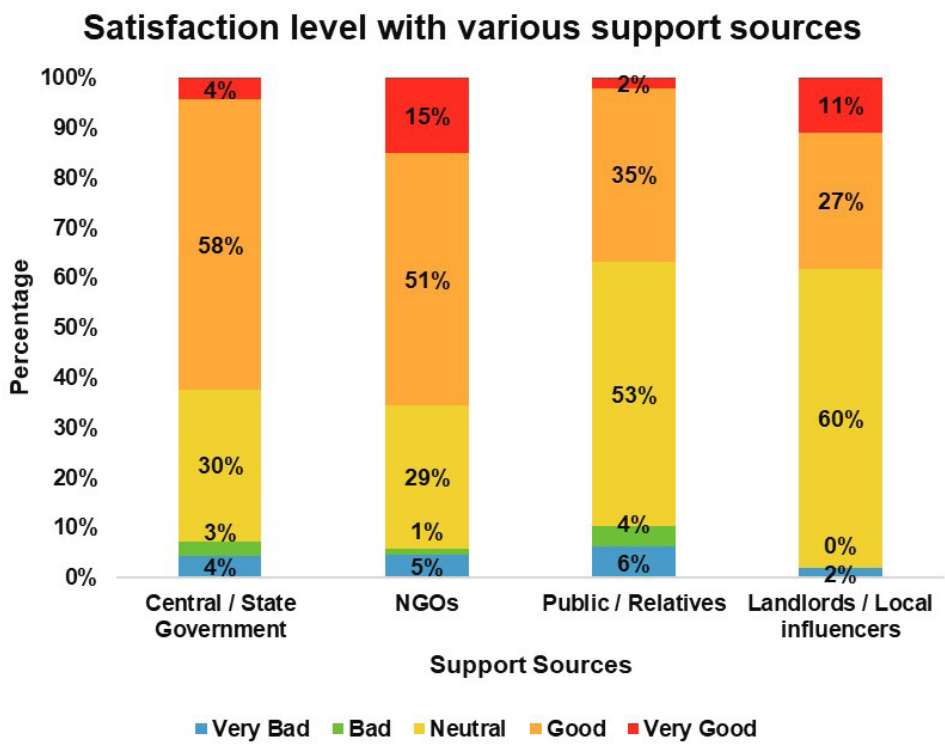

Figure 2: Satisfaction Level with Various Support Sources

respondents reported being informed, while 31% were not, and 2% did not respond. The primary sources of information about relief services were television (28%) and neighbourhood/friends (15%). Radio was used by 12%, while newspapers and other sources were less common. A significant portion (34%) of respondents did not specify their information source.

In terms of food hygiene and safety, 65% of participants were informed about relevant rules, while 28% were not, and 7% did not respond (Table 3).

Those surveyed were also asked to choose their top five greatest needs for themselves and their families since the flood from a list of 13 options: availability of work, pay levels of available work, high levels of debt, availability of land for food growing, option to resettle away from place of origin, price of basic commodities (non-edible), price and availability of food, cost of rented or purchased accommodation, cost and availability of shelter, cost and availability of healthcare, availability and quality of water and sanitation, and schooling for girls and boys.

Eighty-eight percent of respondents chose only one 'greatest need.' Health services were identified as the top priority by 24% of respondents, followed by government compensation (12%). Food and clothing were a concern for 10% of respondents. Some participants reported multiple needs, such as health services combined with government compensation or food and clothing, though each of these combinations was reported by a small percentage (ranging from 1% to 2%).

Discussion

The 2017 disaster has been labelled by some as Gujarat's "worst flood of the century," but it was not an isolated event, as extreme weather events have marked the Indian subcontinent from time to time. Significant floods also occurred in Gujarat and its neighboring states in 2006 and 2015. Following a familiar narrative seen in journalism and popular media—particularly in response to the 2015 Gujarat floods—the Indian government faced criticism for inadequate preparation and response. While government officials and departments often resorted to complaints and blame-shifting, more constructive recommendations were put forth by various experts. Among these, Prajapati and Bansal's (2017) risk assessment stood out, suggesting practical measures such as contour mapping and the construction of a canal system to better manage drainage and mitigate flood risks.

In addition to these infrastructure-focused recommendations, incorporating Water, Sanitation, and Hygiene (WASH) initiatives is critical for improving health outcomes in flood-prone regions. Effective WASH programs can prevent waterborne diseases, reduce post-disaster health burdens, and enhance community resilience [13–15]. Given that the most recent decade of floods in Gujarat has consistently affected its low-lying areas, which are just 108 meters above sea level, implementing these recommendations is crucial for preventing future tragedies similar to those of 2017.

Table 3: Awareness, Information Sources, and Post-Flood Needs Among Survey Participants in Banaskantha District, Gujarat, 2017

Variables	No of participants (n=163)	
	Number	Percentage
Received Information From the Government Officials About Flood		
Yes	112	69%
No	48	29%
Missing	3	2%
Source of Flood Information		
Radio	19	12%
Television	49	30%
Newspaper	2	1%
Neighbourhood / Friend	21	13%
Other	19	12%
Television + Newspaper	1	1%
Television + Friend	1	1%
Missing	51	31%
Informed About Relief Services		
Yes	108	66%
No	51	31%
Missing	4	2%
Source of Information About Relief Services		
Radio	20	12%
Television	46	28%
Newspaper	3	2%
Neighbourhood / Friend	25	15%
Other	14	9%
Missing	55	34%
Informed About Food Hygiene or Safety Rules		
Yes	106	65%
No	45	28%
Missing	12	7%
Greatest Needs for Family Post-Flood		
Health Services	39	24%
Education & Education Material	3	2%
Food & Clothing	17	10%
Government Compensation	20	12%
Others	48	29%
Health Services + Food & Clothing	2	1%
Health Services + Government Compensation	4	2%
Health Services + Others	1	1%
Food & Clothing + Government Compensation	2	1%
Government Compensation + Others	3	2%
Health Services + Food & Clothing + Government Compensation	4	2%
Health Services + Food & Clothing + Others	1	1%
Health Services + Government Compensation + Others	1	1%
Education & Education Material + Food & Clothing + Government Compensation	1	1%
Food & Clothing + Government Compensation + Others	1	1%
Missing	16	10%

Certainly, intermittent disasters will continue to interrupt progress in these areas unless pre-emptive action is taken to prepare communities by "building back better" and ensuring participation down to the individual and household levels, with a focus on disaster resilience and community engagement at all levels. Only through pre-emptive action and comprehensive planning can the state hope to mitigate the impact of future floods and improve the overall quality of life for its residents.

Time will reveal over decades the full implications of the 2017 floods for Gujarat, but proactive measures taken today can help safeguard against future calamities. Despite

Gujarat's relatively higher rates of economic growth and urbanization compared to other parts of India, the state still struggles with health and social outcomes [16].

From a public health perspective, preventing future flood disasters in Gujarat requires a multi-faceted approach that addresses both immediate risks and long-term community resilience. First and foremost, enhancing early warning systems and ensuring their accessibility to all communities, especially vulnerable populations, is critical. This includes leveraging technology to provide timely and accurate information through various channels, such as mobile alerts, community radios, and social media. Strengthening infrastructure, particularly through the construction of proper drainage systems and flood barriers, can mitigate the physical impact of floods. The need to retrofit existing houses and make them flood-resilient cannot be stressed enough, especially in the aftermath of the Gujarat floods of 2017.

Conclusion

Post-disaster epidemiology needs more focus, with risk-informed planning in Gujarat that can also be scaled up to other states. Public health campaigns and resilience literacy must be factored into disaster management plans to build community resilience and ensure no one is left behind. Local geopolitics, cultural nuances, and available resources ought to be converted into better safety nets for vulnerable population groups. Effective partnerships between governments and non-government actors have the potential to deliver sustainable benefits to communities and must be leveraged to suit state government needs.

Financial Support

This research received no external funding support.

Competing Interests

The authors declare that there is no conflict of interest.

Authors' Contributions

Edmond Fernandes designed the study and oversaw data collection and analysis on the ground. Robin drafted the initial manuscript. Aishwarya proofread the document and supported journal-specific alignment and formatting requirements.

Acknowledgements

Ethical Considerations

Informed consent was taken and only willing participants were on-boarded. As such this survey based response falls into exempted category from an ethical standpoint.

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