

Is Flash Flood an Ignored Hydrometeorological Disaster?

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This has been attempted to respond to a popular belief that flash floods in Indian hinterlands are normally inconsequential, and they are recognized only when the event occurs.

Flash flood events in India

Flash floods preceded by heavy rains were observed in Ahmedabad city and six other districts in Gujarat, on July 11 and 12, 2022. Just two days prior, a cloudburst accompanied by heavy rains had resulted in a flash flood near the holy Amarnath shrine in Anantnag district in Jammu and Kashmir. Marangching village in Noney district in Manipur received heavy rains that caused landslides and flash floods in the first week of July, 2022. Likewise, flash floods were encountered by people of Assam in Darrang, Cachar, Nagaon, Kamrup, Dima Hasao, Dhemaii, Hoiyai, Karbi Anglong West and Guwahati districts. Furthermore, in mid-June this year, East Khasi Hills, and Ri-Bhoi districts in Meghalaya had comparable experiences.

The region specifically between Northern India and south of the Hindu Kush Himalayan (HKH) region, is one of the well-established flash flood prone topographies of India. (Refer Map 1)

This region has most instances of heavy rain followed by flash floods, especially in the monsoon season. The Leh flash floods in 2010,

Kedarnath flash flood in 2013 was a result of cloudbursts, the very recent floods in Kullu district of Himachal Pradesh, Ganderbal district in Jammu and Kashmir, and the Chamoli district flashfloods in Uttarakhand in 2021 were all triggered by heavy rains.

The western part of the country along with the western coast have frequently witnessed flash flood occurrences. Gujarat was recently in news because of the flash flood events. However, this is not the first time that the state experienced this disaster event. Many might recall that similar occurrences had devastated Gujarat in 2001, 2005, 2015, and 2021. The districts of Ahmedabad, Surat, Banaskantha, Patan, Kachchh, Junagarh, Saurashtra, Raikot, and Jamnagar were affected. In 2006 and 2010, Rajasthan's Barmer and Jaisalmer districts had experienced flash floods respectively.

The peninsular region of the country has also witnessed innumerable flash floods in the recent past. The most recent ones being in Kottayam and Idukki districts of Kerala in October 2021, along with flash floods of 2018 in Kochi, 2019 flash floods in Wayanad, Malappuram, Nilambur, and Idukki followed by



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2020 in which Wayanad, Idukki, Pathanamthitta, Palakkad and Kozhikode districts were affected. The Virudhnagar flash floods in Tamil Nadu took place in 2021. Andhra Pradesh and Telangana have also experienced flash floods due to heavy rain and storm surge in the recent past.



Map 1 - The Hindu Kush Himalayan region and 10 major river basins

Central India too has been frequently encountering flash floods events. In 2013, three districts of Uttar Pradesh - Saharanpur, Bijnor, and Lakhimpur Kheri were impacted due to flash floods. Similarly in June 2015, due to cloudburst in Nepal, districts of Bahrach and Lakhimpur Khiri were impacted. The districts of Burhanpur, Harda, Balaghat and Betul in Madhya Pradesh were severely affected by flash floods in July 2014. A similar event took place in August 2021, across Madhya Pradesh in Shivpuri, Sheopur, Datia, Gwalior, Guna, Bhind and Morena districts. Because of the incessant rains over three days in September 2021, three districts, Dhamtari, Gariaband and Jagdalpur literally got disconnected from the capital city of Chhattisgarh and resulted in flash floods.

The north-eastern states, have already witnessed many instances of flash floods this year. High intensity rains triggered flash floods in the states of Assam, Arunachal Pradesh, Meghalaya, and Manipur in the month of May. The second cycle of intense rainfall in June, 2022 caused flash floods in Assam, Meghalaya, and Arunachal Pradesh.

The enumeration of flash flood events in the country indicates its expanse and severity. However, it is observed that flash floods, despite being a common recurring phenomenon in the country, do not get mentioned as a distinctive entity. Instead, it often gets either clubbed, referred, or confused with riverine floods, and ends up getting mentioned merely as floods. With the increase in the incidence of flash floods, it is critical to espouse the use of the relevant terminology while articulating or writing about them to make them visible. Visibility is an important channel for establishing consciousness. Therefore, this paper on several occasions, will be referring to flash floods of North Bihar with the central objective of making the least acknowledged recurring disaster of the state known, and deliberated.

Bihar is prone to flash floods, especially the districts along the India-Nepal border – Pashchim (West) Champaran, Purbi (East) Champaran, Sitamarhi, Madhubani, Supaul, Araria and Kishanganj. The floods in 2017 affected a total of 9.56 million people in the above seven districts. Similarly in 2019, floods triggered

by intense rainfall affected a total 14.9 million people in 27 out of 38 districts of Bihar. Approximately 42 percent of the total affected population in 2019 were from the seven districts. Lack of focused strategies towards riverine and flash floods, has led to total absence of segregated data for these two different typologies of floods in the state. Lack of visibility, absence of related data and apathy towards flash floods in Bihar makes comprehension and substantiation of the disaster extremely difficult too. On the other hand, the field-based observations clearly

authenticate the occurrences and impacts of flash floods in these districts of Bihar. Therefore, this paper intends to provoke thoughts by citing examples from Bihar to deliberate on the importance of acknowledgment, recording and reportage of flash floods as a regular phenomenon but with separate and distinct entity.

Raising questions

The main reason for the unfolding of fear with each burst of high intensity rainfall is the obvious calamitous facet of flash floods. Globally flash floods are recognized as one of the worst kinds of disaster, largely because of their unanticipated character, rarity, small scale, peak discharge, fast and violent movement. They are known for their catastrophic impact on human lives, livelihoods (on farm and off farm), basic services (drinking water, sanitation, medical, health and education facilities), and habitations. The expanse of damages further include movable and immovable properties (public and private), infrastructural facilities (public and private), communication and diverse ecological systems. The element of uncertainty surrounding

flash floods has the most impacting consequences on people who are in the vulnerable region.

In the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (2013), there is an emphasis on the linkage between climate change and intensification of heavy precipitation events, with regard to frequency and severity. The report has clearly articulated that the hydrological cycle will have a far-reaching impact due to the changing climate leading to heavier precipitation, and more severe (flash) flood events.

The elaboration of the chronicle of the country's flash flood events earlier in the paper is proof enough of the increasing incidences over the years. Despite the technological advances and significant improvement of the knowledge base in this field, we always end up being an unwitting accomplice. And eventually the population that is affected by flash floods ends up wanting and waiting. Numerous documents, research papers, and field-based narratives have iterated that flash floods are difficult to predict, thus it not only surprises people but leaves them with extremely limited time to respond and arrange for protection measures for their safety and survival.

In view of the above arguments, there are questions that continue to emerge time and again regarding flash flood and its management. Why flash floods do not get due attention, and priority? Are flash floods actually acknowledged as a distinct typology of floods? Are the preparedness and response approaches and strategies different for flash floods? Have flash floods been typologized in the country as per the location of its occurrences and the triggering factors? Has there been a vulnerability

mapping of flash floods keeping the streams, small and seasonal rivers, tributaries, and main rivers in focus? What measures are being adopted to generate consciousness and recognition about flash floods amidst state functionaries, research, educational and governance institutions, civil society etc.?

By attending to diverse features of flash floods, this paper will attempt to establish a comprehensive understanding on the hydrometeorological disaster.

What is a flash flood and why is it a hydrometeorological disaster?

The increased flow in streams, short and seasonal rivers, tributaries and the main river stem within few hours after the initiation of high intensity rainfall is largely the genesis of flash floods. Globally they are accepted as a short-term event, occurring within six hours of other causative events such as dam break, levee failure, rapid, snowmelt and ice jams. In addition, slow moving or multiple thunderstorms occurring over the same area has high probability of causing flash floods.

It is important to recognize and accept flash floods distinct from other typologies of floods such as

- Waterlogged region (adjacent to the embankment)
- Riverine floods (between the embankments of the same river system)
- Riverine floods and river erosion (adjacent to the embankments – riverside)
- Riverine floods and river erosion (adjacent to the river – no embankment)

- Riverine floods (post the breach of the embankment – countryside)
- Floods, inundation and waterlogging (Between the embankments of two river systems)

Along with a generic understanding of flash floods, it is critical to apprehend the reasons why flash floods are considered as a hydrometeorological disaster. All hydrometeorological hazards are either of atmospheric, hydrological or oceanographic origin. And in terms of flash floods, the intermix of diverse hydrological and meteorological circumstances and their varying intensities often result in the catastrophe. For example, regions located in undulating terrain and at the foothills or in close vicinity to mountains and hills often experience flash floods triggered by relatively less intensity rainfall, as compared to areas in the plains. More often than not, flash floods occur within a small catchment with a truncated response time. These determining factors qualify flash floods as a hydrometeorological disaster.

The different flash flood events mentioned earlier in the paper are examples of diverse hydrometeorological circumstances that trigger them. Of all, the most common factor responsible for the flash floods is the varying intensity of rainfall. Often newspaper articles or thematic papers while reporting or describing flash flood occurrences clearly mention cloudbursts, rainstorms or incessant rains as the causal factors. Hence, it is extremely critical to elaborate on varying characteristics of rains that cause flash floods.

- **Cloudbursts** – In a generic parlance, a cloudburst refers to

an extreme amount of rain that occurs in a short span of time, and at times accompanied by hail and thunder. According to the India Meteorological Department (IMD), any unexpected precipitation exceeding 100 millimetres (mm) per hour over a geographical region of approximately 20 to 30 square km (km²) can be categorized as cloudburst. As per IMD, predicting cloud bursts is extremely difficult due to its small scale in space and time. Mountainous regions and its surrounding terai, valley and plain areas are more prone to incidences of cloudbursts due to orography as compared to the plains. It is extremely important to note that heavy rain in a short period are the main constituents of cloudbursts but all heavy rain in a short period are not cloudbursts if they do not adhere to IMD's criterion.

- **Rainstorms** – Rainfall triggered flash floods are mostly produced by rainstorms. According to IMD, rainstorms are characterised by either substantial, extreme or heavy rainfall over a particular area for a particular period. It is always in association with various weather systems of different spatial scales (monsoon, thunderstorms, cyclonic storms etc.). A rainstorm of any considerable duration typically consists of spurts of high-intensity rain punctuated by variable periods of low-intensity rain.

- **Thunderstorms** – Weather phenomena like thunderstorms are short lived but extremely disastrous. They are either accompanied with rain or hails. Thunderstorms over the Indian region occur throughout the year with large spatial and temporal as well as diurnal, seasonal and annual variability during different seasons. Its frequency varies from region to region. Thunderstorm activities during monsoon, post-

monsoon and winter seasons are mainly governed by the large-scale synoptic weather systems with some alterations caused by local topographical effects. However, the highest frequency and the most severe thunderstorm events occur in general during the pre-monsoon season (March to May) throughout the length and breadth of the country. Flash flood is normally a result of repeated thunderstorms over the same area, and this event is termed as 'training' thunderstorms.

Many times flash floods get triggered only because of heavy rainfall. This happens because of orographic precipitation; as moist air is forced upward over mountains by the wind flow. Whenever the air forced upward is excessively moist, it often results in heavy rainfall. The undulating terrain contributes towards rapid runoff.

However, it is important to enquire whether flash floods are triggered only due to hydrometeorological factors? No doubt that cloudbursts, rainstorms and thunderstorms are the established causes. However, the flash floods of 2013 in Kedarnath valley, Kerala's Kochi district in 2018 and the most recent occurrence in June 2022 in northern Assam's Darrang district along with many others do suggest that flash floods get amplified and triggered due to human induced interventions as well. In June 2022, Assam experienced breaches in 297 embankments in 20 districts, of which 33 were in Darrang district alone. In February 2021, avalanche burst open the Rishiganga Hydroelectric Project dam in Tapovan (Chamoli) destroying it completely, which resulted in a deluge throughout the valley in Uttarakhand.

All the above examples suggest

that it is precarious to limit the discussions regarding the causes of flash floods to only the hydrometeorological factors and excluding the others. For a better understanding of flash flood events it should be mandatory to adopt an approach that will assist in assessing the events and to arrive at accurate reasons behind the occurrences. Alongside, it is equally important to sight, record and highlight flash flood events which often are either ignored or masked. The example of flash floods in North Bihar is a case in point. Hence, the paper focuses on the recurring, ignored and masked flash floods of North Bihar.

Flash floods of North Bihar - Lesser Known Disaster

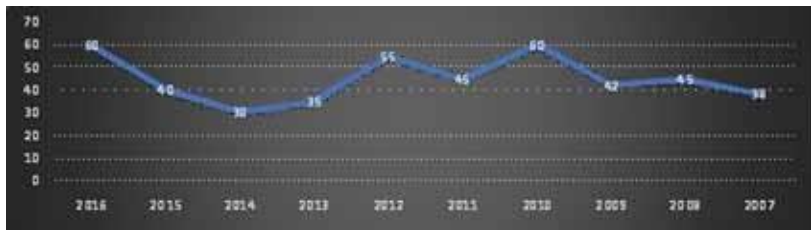
Flash floods are the predominant disaster associated with the small and seasonal transboundary rivers in North Bihar. As they are solely rain-fed, hence flash flood occurs whenever there is a long spell of rainfall in the catchment irrespective of monsoon season. Given the multi-layered dependencies and proximity of these rivers with the densely populated riparian population, hazards like flash flood and its spill off have multidimensional risks.

Research by Megh Pyne Abhiyan (MPA) on small and seasonal transboundary rivers systems in Bihar, brought forth unknown facts regarding the small and seasonal transboundary rivers flowing from Nepal into Bihar. The small and seasonal transboundary river and streams across the India (Bihar) - Nepal border traverse downstream by draining the rainwater either from the Chure, i.e. Shivalik range, or from the terai region in Nepal. These rain-fed rivers and

Table 1 – Months when flash floods normally occur

Years	January	February	March	April	May	June	July	August	September	October	November	December
2016	-	-	-	✓	-	✓	✓	✓	✓	-	-	-
2015	-	-	-	-	✓	✓	✓	✓	✓	-	-	-
2014	-	-	-	-	✓	✓	✓	✓	✓	-	-	-
2013	-	-	-	-	✓	✓	✓	✓	✓	-	-	-
2012	✓	-	-	-	✓	✓	✓	✓	✓	-	-	-
2011	-	-	✓	-	✓	✓	✓	✓	✓	✓	-	-
2010	-	-	✓	-	✓	✓	✓	✓	✓	-	-	-
2009	-	-	-	✓	-	✓	✓	✓	✓	-	-	-
2008	✓	-	-	-	-	✓	✓	✓	✓	-	-	-
2007	-	✓	-	-	-	✓	✓	✓	✓	-	-	-

streams are ephemeral in nature with highly variable flow, and they flow as long as rainfall lasts. The rivers flow into Pashchim (W) Champaran, Purbi (E) Chamapran, Sitamarhi, Madhubani, Supaul, Araria and Kishangani, from the adjoining districts Parsa, Chitwan, Bara, Mahottari, Sariahi, Rautahat, Dhanusa, Siraha, Saptari, Sunsari,



Graph 1 – Frequency of floods in Harkatwa

Morang and Jhapa in Nepal. The research identified 148 small and seasonal transboundary rivers, with stark variations, local reputation, and well-defined individuality. Many of the rivers remain little known hence unexplored. MPA's broad understanding of these small, seasonal and transboundary rivers is based on a collaborative research study in 2016 on Post Disaster Recovery - Assessment of Needs in Moderate Flood Conditions, that MPA had undertaken in Gawnaha block of Pashchim (W) Champaran district for the National Institute of Rural Development and PanchayatiRai (NIRDPR), Hyderabad. The period of the study covered in the research was from 2007 to 2016. Six villages - Harkatwa village (Rupwaliya panchayat), Pashchimi

Tola Rupwaliya (Rupwaliya panchayat), Harpur (Gaunaha panchayat), Naya Tola Manguraha (Gaunaha panchayat) and Poorvi Tola Rupwaliya (Rupwaliya panchayat), were part of the study. The example of Harkatwa village is being used to picture the impact of the recurring flash floods.

River Chegraha in Harkatwa village brings flash floods after it rains heavily for 1-2 hours in the upper catchment of the river. The flash flood trends between 2007 – 2016 suggest that the probability of floods in a year was from January to October. It is only in the months of November and December that flash floods have not occurred in Harkatwa village. The maximum probability of floods is from May till September. (Refer Table 1)

In past 10 years (2007-2016), the frequency of floods in Harkatwa village has been from 30 to 60 times in a year. Between 2007 and 2016, maximum number of flash floods in Harkatwa was 60 in 2016 and minimum was 30 in 2014. (Refer Graph 1)

During normal period, the width of River Chegraha is approximately 60 meters (m), during monsoon it increases to 500 m and during extreme weather conditions, the width of the river expands up to 700 m. The flash floods impact in the following manner

- Destruction of standing kharif crop (Paddy) – In Harkatwa village, on an annual basis approximately 50 acres of standing paddy crop gets destroyed because of flash

floods. The total produce projected in 50 acres is 600 quintal

- Destruction of standing sugarcane crop – Huge quantity of sugarcane is destroyed during the flash floods in the village. During the catastrophic floods of 2010, approximately 2000 quintal of standing sugarcane crop was destroyed
- Indebtedness – In one year (in 2016) almost 140 households out of total 344 households in the village took loans with an average amount of Rs 3000, because of the recurring flash floods
- Loss of compost manure – During flash floods, 30 – 35 tractors worth of compost manure gets destroyed
- Siltation – The flash floods on an average impacts 50 acres of agricultural land in the village which produces 360 quintal of paddy and 3000 quintals of

sugarcane

- Destruction of farm bunds –

Flash floods destroys the farm bunds, reducing the productivity by approximately 25 percent

- Land erosion during floods –The transformed landscape from flat to undulating because of flash floods, impacts the drainage and the irrigation potential for the standing crop. This too reduces the yield. In Harkatwa, annually, 15-20 acre of land gets affected due to flash floods. In which paddy is grown in 15 acre and sugarcane in 5 acre of land
- Restricted safe zones for open defecation – Between 2007-2016, during flash floods people had to invest an extra hour to access safe zones for open defecation. Accessing

sanitation services was extremely difficult for women and adolescent girls

Flash floods induced by River Harkatwa is indicative of the nature of destruction one small and seasonal transboundary river can cause on one habitation. Extrapolating the destruction caused by one river to the 148 small, seasonal and trans-boundary rivers flowing across the India(Bihar)-Nepal border is simply beyond imagination. These small and seasonal transboundary rivers similar to the large ones in the region also have considerable

which parts of the district was affected by riverine floods, and which were devastated by flash floods. The frequency and duration of flash floods in River Harkatwa between 2007 and 2016 suggests the urgency and importance of segregation of typologies of floods in districts along the India-Nepal border to understand the reasons behind the flooding.

The study by MPA showed that flash flood had multiple impacts on the lives and livelihoods, and on several occasions in one calendar year. (Refer table 1)

Destruction of the standing crops	Increase in indebtedness	Loss of compost manure	Loss of household items
Transformation of landscape	Land erosion	Destruction of houses	Psychological stress
Destruction of farm bunds	Destruction of grain storage facility	Inaccessible safe and hygienic sanitation facilities	Increase in migration
Siltation	Loss of agricultural tools	Loss of non-farm livelihoods	Multiple burden on women

Table 2 - Multiple impacts of flash floods

local relevance, influence and impact on the communities.

According to the Disaster Management Department, Government of Bihar flood reports, between 2000 and 2020 cumulatively 393 districts were affected. These districts also included ones from South Bihar. Approximately 28 per cent of 393 districts i.e., seven districts were along the India-Nepal border. In last two decades, the annual tryst with floods along the India-Nepal border districts has continued, though the number of districts vary on an annual basis. Years like 2002, 2004, 2017, 2019, all the seven districts were declared flood affected. Despite being declared as

flood affected, it remains unclear

Even though flash floods triggered by small, seasonal, and transboundary streams and rivers have multiple and consistent impacts, the focus of the administrators and political leaders remains on big-river-centric floods. Strategically, disregarding or masking of flash floods necessitates a change. There is a need to transmute the present system, through constant reminders and consistent iteration promoting legitimate space that flash floods by small, seasonal, and transboundary rivers in Bihar thoroughly deserve. Ironically, flash floods along with the small and seasonal rivers and streams remain inconsequential, unrecognised, and unreported despite impacting lives.

Takeaways

Flash floods are now becoming an increasingly common sight and it would only continue in the future owing to climate change and erratic patterns of rainfall. There are few occurrences that make the headlines but many hinterlands affected by small and seasonal rivers still go unreported. While proceeding towards the end of the paper one must question to oneself as to how many Chegraha's, Pandai's and Amhawa's does one know? To answer this question, the present approach towards flash floods necessitates a change, if the desired outcomes are to

be realized. This change can be possible only if a comprehensive

strategy is developed keeping the following areas of intervention in mind.

Flash flood forecasting is an extremely challenging task because of their short time scales and occurrence on small spatial scales. To overcome this challenge, the IMD commissioned the South Asia Flash Flood Guidance Services (FFGS) on October 22, 2020. IMD acts as the regional centre covering Bhutan, Bangladesh, India, Nepal and Sri Lanka, providing forecast products, data and training. IMD tested the performance of the system during the monsoon of 2020 in the preoperational mode, during which flash flood bulletins were issued to National Hydrological and Meteorological Services (NHMS) in the region for its validation. The FFGS is a robust system designed to provide the necessary products in real-time to support the development of warnings for flash floods about 6-12 hours in advance at the watershed level. The priority in future should be towards ensuring decentralized dissemination of

the real-time warnings, so that the communities in the vulnerable locations are able to access it without having to depend on multi-layered bureaucratic and administrative processes.

Postulating ways for addressing the following concerns relating to flash floods should be of precedence

- Due attention, and priority
- Acknowledgment as a distinct typology of floods
- Different preparedness and response approaches and strategies
- Typologized as per the location, occurrences and triggering

factors

- Vulnerability mapping in view of the streams, small and seasonal rivers, tributaries, and main rivers
- Consciousness and recognition amidst multi-stakeholders

The above highlights aids to apprehend plausible strategies for prioritizing and addressing flash floods in India, and they are

- Formulating state-level policy
- Drafting a state-level standard of practice to ensure that sub-regional and local diversities (rainfall, terrain, hydrology, people, human intervention etc) are recognized while charting the ways forward
- Developing a robust, responsive and contextual methodology for vulnerability and impact assessment to officially register the consequences
- Establishing institutional mechanism at the panchayat, district, state and national level for attending to flash floods (preparedness, planning, response, recovery, relief and

- Institutionalizing social, cultural and localized knowledge and practices for developing local warning systems and to build collective resilience
- Creating a platform for facilitating interaction between disaster-related institutions (grassroots, district, state and national) to prioritize and strategize the inclusion of flash floods in the disaster discourse

The above suggested strategies will assist in elevating the current understanding of flash floods amongst multi-stakeholders, with the objective of a transformation. ■

rehabilitation)