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Urban Flooding: Case Study of Sri Ganganagar, Rajasthan

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Abstract

Urban flooding has become a significant concern in cities worldwide. Sri Ganganagar city, located in Rajasthan's semi-arid region, is also facing this problem. Despite being known for its low annual rainfall, the city has experienced more intense monsoons in recent years, which have led to flooding. This research identifies the causes and impacts of urban flooding in Sri Ganganagar city, particularly in areas like Purani Abadi, Block Areas, Gurunanak Basti, and Ravindra Path Road, which have seen recurring instances of waterlogging. One of the major issues is the inefficiency of the city's drainage system in zones like Sadbhavna Nagar, Idgah, and the Sugar Mill Sewage Treatment Plant (STP), which struggles to cope with heavy rainfall.

Additionally, rapid urbanisation in the city has increased the number of impervious surfaces, which limits the natural absorption of water and exacerbates the flooding problem. The consequences of these floods are extensive, including property damage, agricultural losses, and health risks. Floods have led to the destruction of crops, especially in the farmlands on the outskirts of the city, and it affects the livelihood of farmers. This paper also explores various risk assessment and mitigation strategies, which include improving drainage infrastructure, promoting rainwater harvesting, and fostering community engagement. By adopting these solutions, Sri Ganganagar could significantly reduce the impact of urban flooding and improve its resilience to future extreme weather events.

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KEYWORDS: Drainage System, Risk Assessment, Mitigation Strategies, Rainwater Harvesting

1. INTRODUCTION

Urban flooding has emerged as a critical issue in many cities across the globe. As cities grow and expand rapidly, their ability to manage the impacts of extreme weather events, particularly floods, is often compromised. Sri Ganganagar, located near the borders of Punjab and Pakistan, is primarily an agricultural hub that relies heavily on the canal system for irrigation, especially through the Gang Canal. However, urban expansion combined with changing climate patterns has made the city increasingly vulnerable to flooding. Urban flooding occurs when there is heavy rainfall or when water systems, such as canals and drainage systems, overflow, causing water to accumulate in built-up areas.

In recent years, Sri Ganganagar has experienced more intense monsoon seasons. For example, in 2022, the city recorded over 224 mm of rainfall in a single day, which overwhelmed the existing stormwater infrastructure. Some areas like Purani Abadi, Block Area and Housing Board saw severe waterlogging, with water levels rising over 3 feet in some places. This led to significant damage to both public and private properties and disruption of daily life. The problem is further ruined by inadequate drainage infrastructure, particularly near the Idgah and Sugar Mill Sewage Treatment Plant (STP).

A major contributing factor to flooding in Sri Ganganagar is climate change, which is bringing about unpredictable and more intense rainfall events. Historically, this region has been considered arid and semi-arid; however, recent years have seen changes in weather patterns, with both increased precipitation and extreme weather events becoming more frequent. These developments make the city more susceptible to flash floods, especially when combined with outdated and inadequate drainage systems that were not designed to handle the volume of water from sudden storms. This lack of preparedness highlights the urgent need for a sustainable approach to urban planning that takes into account future climate conditions.

Addressing the issue of urban flooding in the city requires an integrated approach that includes both structural and non-structural measures. On one hand, improving the city's drainage systems, investing in sustainable urban planning practices and adopting green infrastructure solutions, such as permeable pavements and rainwater harvesting, could significantly reduce the risk of flooding. For instance, promoting rainwater harvesting in local schools and government buildings could help reduce runoff. On the other hand, raising awareness within the community and implementing early warning systems are equally important in building resilience against future flood events.

This research aims to examine the causes and impacts of urban flooding in Sri Ganganagar city, while also exploring potential solutions that can help us to reduce the risk and help develop a flood-resilient urban environment. The focus should be on the city's unique challenges, such as its reliance on the Gang Canal and issues around water management. This study will contribute to a broader understanding of how urban areas can better prepare for and manage the increasing threat of urban flooding.

2. OBJECTIVES OF THE STUDY

1. To Assess/Examine Current Urban Flooding Patterns
2. To Examine Existing Stormwater Drainage Infrastructure
3. To Explore Local Climate and Precipitation Changes
4. To Assess Vulnerable Areas and Populations

3. METHODOLOGY

This study necessarily requires the compilation and analysis of qualitative and quantitative data through a combination of institutional analysis and physical structure and infrastructure surveys, with a focus not only on economic damage but also on the effect of floods on the environment. The scientific emphasis on disaster-related research in India includes important issues such as flood vulnerability, rainfall trends, land use and land cover change, population growth, population density, people's occupation, etc. Given the objectives set for the given study, the data used for the given study includes both primary and secondary sources.

For the given study, the data was collected from various sources, they are as: For Primary Data, we conducted a comprehensive survey, engaging with individuals to gather first-hand insights into their experiences. The survey delved into the day-to-day lives of people affected by urban floods, exploring the challenges they face and the impact on their routines. For Secondary Data, we gathered information from newspapers, reports, websites, and government offices. This diverse range of sources helped us learn more about the topic and make our study complete and more reliable.

4. LITERATURE REVIEW

Urban flooding has become a growing concern in many Indian cities, with factors such as poor urban planning, outdated drainage systems and climate change playing a critical role. Extensive research on urban flooding in India underscores how vulnerable growing cities are to such extreme weather events, with rapid urbanisation often making matters worse. Studies by the National Disaster Management Authority (NDMA) (2010) have emphasised the need for cities to update their infrastructure to cope with sudden, intense rainfall events. Sri Ganganagar is one such city where these concerns have become increasingly pressing.

The work of Gupta (2020) [3] provides a comprehensive review of urban flooding in India, outlining the major causes and the infrastructure gaps that exacerbate flooding risks. Gupta's research highlights how cities with poorly maintained drainage systems, like those seen in Sri Ganganagar's Sugar Mill and Idgah areas, are particularly prone to flooding during the monsoon season. Similarly, a study by Avinash S. (2014) [1] on urban flooding in Bangalore shows that inadequate drainage is a key contributor to waterlogging in urban areas. In both Bangalore and Sri Ganganagar, rapid urban sprawl has resulted

in the paving over of natural drainage routes, worsening the situation. Further literature, such as research on community resilience by Bhuvana N. and Arul Aram I. (2019) [2], has explored how local communities can play a role in mitigating the impact of floods. Their work focuses on the use of social media platforms and community networks to disseminate information during disaster events. In Sri Ganganagar city, there is evidence of such community initiatives, especially during the flood event in 2022 when local WhatsApp groups helped coordinate relief efforts. However, there is still a need for more organised, citywide preparedness initiatives, and the effectiveness of these tools remains underutilised.

Causes and Impact of Urban Flooding

Causes: Urban flooding in the city is the result of a combination of natural and human-made factors. Several causes contribute to this problem:

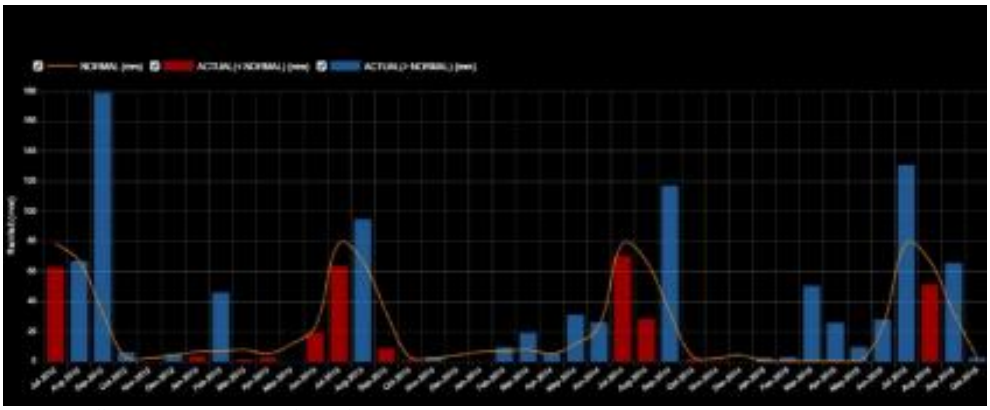
Inadequate Drainage Systems: One of the primary causes of flooding in Sri Ganganagar is the city's outdated and poorly maintained drainage systems. These systems are incapable of managing the heavy rainfall that now frequently occurs during the monsoon season. Key locations such as Gurunanak Basti and Purani Abadi have drainage systems that are easily overwhelmed by even moderate rainfall. For example, in 2022, after a heavy downpour of 224 mm in one day, these Sewage Treatment Plants (STP) failed to cope with the runoff, leading to widespread flooding in surrounding areas. Apart from this, there have been many such incidents when the city's drainage system failed due to a short period of rain, and waterlogging occurred in the city. We are presenting some examples of this below.

Fig 1: Media Coverage

Source: Dainik Bhaskar Newspaper, 06/09/2020

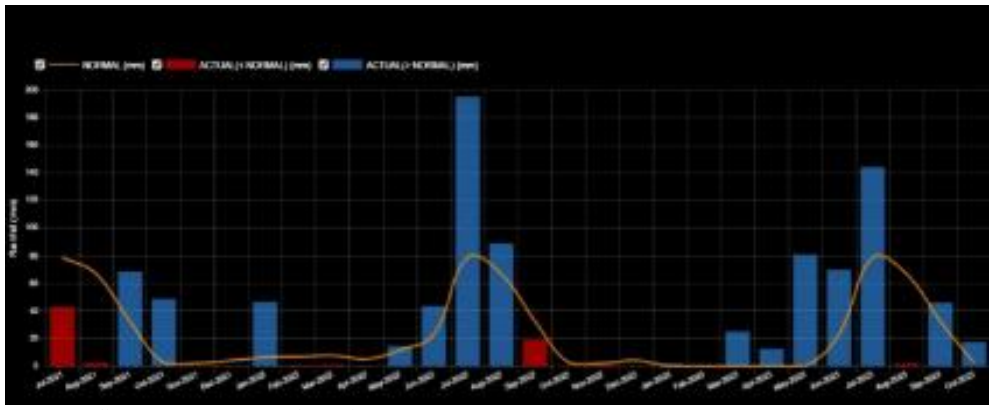
Heavy Rainfall Events: Sri Ganganagar, despite its semi-arid location, has experienced increasingly intense monsoons in recent years. In 2022, the city recorded over 220 mm of rain in a single day, far surpassing the capacity of the existing stormwater infrastructure. This sudden influx of water has caused flash floods, particularly in low-lying areas like Sukhadia Circle, Housing Board and Purani Abadi, where waterlogging persisted for days. Presented below is a record of rainfall in Sri Ganganagar city over recent years.

Diagram 1: Yearly Rainfall Trends for Ganganagar from 2012 to 2015



***Source*:** India Water Resources Information System

Diagram 2: Yearly Rainfall Trends for Ganganagar from 2021 to 2023



Source: India Water Resources Information System

We can clearly see that the city has received more than average rainfall in recent years. Apart from this, the problem of urban flooding has been observed in the city even in those years when there has been average or below-average rainfall. This is because excessive rainfall over a short period has led to waterlogging in the city.

Role of Local Authority: This includes the responsibilities of local authorities, like the Nagar Parishad, which play a big part in causing flooding. The Nagar Parishad is supposed to look after things like cleaning sewers and drains to prevent flooding. However, sometimes they do not do their job properly, especially before the rainy season. When drains and sewers are clogged, water cannot flow properly, leading to flooding in neighbourhoods. This means people have to deal with water problems when it rains a lot, all because the authorities did not do what they were supposed to do.

Fig 2: Critical Media Coverage

पानी निकासी और सफाई के नाम पर परिषद ने 4 साल में 8 करोड़ खर्चे, नतीजा- शून्य, बारिश में पार्कों व मैदान में छोड़ा जा रहा पानी

शहर में स्वीमिंग पूल नहीं, इसलिए हम कई इलाकों में यह सुविधा दे रहे हैं

हमारे शहर को चाहिए पानी निकासी का स्थायी समाधान

जिम्मेदार बोले...

***Source*:** Dainik Bhaskar Newspaper, 28/07/2023

Fig 3: Critical Media Coverage


मानसून बीता; न नए नाले बना पाई नप, न ही पुरानों की सफाई, 54 एमएम

बारिश होते ही पूरे शहर में भरा पानी, पुरानी आबादी के 50 घरों में घुसा

निकासी अवरुद्ध होने की तीन वजहः नालों की अधूरी सफाई, पानी निकासी की कोई व्यवस्था नहीं

***Source*:** Dainik Bhaskar Newspaper, 30/09/2019

Impact: The impact of urban flooding in Sri Ganganagar is far-reaching, affecting both the city's residents and its economy. Some of the major impacts include:

Property Damage: The immediate consequence of flooding is the damage caused to homes, businesses, and infrastructure. Due to the floods in 2014 and 2022, many people in the city suffered huge financial losses to their homes. For relief, the District Collectorate Office provided financial assistance to them. The flood that occurred in 2022, Thousands of people had to suffer financial loss of their homes. Out of these, 3084 people were provided financial assistance. An amount of approximately Rs 1 crore 80 lakhs was provided to these people by the government as relief work. So many people have suffered financial losses in the entire city alone. This in itself is a very big thing.

Now, let us assess the damage caused by the floods in 2014. For this, we could not get sufficient data in written form from any authentic source. However, we got some data from the Collectorate Office. From which we can show that people whose houses were partially damaged were given an amount of Rs 1 crore 56 lakh for relief. Apart from this, people whose houses were completely damaged in the flood were given about Rs 97 lakh as a relief amount. As we can see in the data given above, this loss was compensated only to those people whose houses were damaged. Apart from this, many people's shops, offices, hotels, private property, etc., were damaged, but we could not get any figures or data about it. Due to this, we cannot display their figures. The people face similar losses every year due to the waterlogging problem during the heavy rains in the monsoon season.

Agricultural Losses: Sri Ganganagar's economy is heavily dependent on agriculture. Urban flooding has had devastating effects on the farmlands surrounding the city. During the 2022 monsoon season, substantial amounts of crops were lost due to waterlogging in the fields, particularly in areas near the city limits. This has severely affected local farmers, many of whom rely on these crops as their primary source of income. The floods not only delayed planting but also ruined harvested crops, further compounding the economic impact.

The recurring issue of urban flooding in our city has resulted in significant damage to crops in our fields. We have obtained comprehensive data on this matter from the District Collectorate, which we have detailed below.

Table 1: Crop-wise sown area, Affected area and Total Affected Area of Kharif 2022 (Area in Hectares)

S. No.		Crop Name	Total crop sown area	Total Crop affected area and more than 0 to 100%	Total Crop affected area 33% or more
1		2	3	4	5
A		**Cereals**			
	1	Bajara	7604	0	0
	2	Maize	11	0	0
	3	Jowor	177	0	0
	4	Paddy	5343	0	0
B		**Pulses**			
	1	Moong	91295	0	0
	2	Urad	0	0	0
	3	Moth	2143	0	0
	4	Chaula	0	0	0
	5	Arahar	1	0	0

	Oilseeds				
C	1	Groundhut	2486	0	0
	2	Soya bean		0	0
	3	Til	620	0	0
	4	Castor	0	0	0
	Horticulture Crops				
D	1	Vegetables	1209	0	0
	2	Fruits	11235	0	0
	Other Crops				
	1	Guar	238152	1.984	1.984
E	2	Cotton	22882	18.576	18.576
	3	Sugarcane	2060	0	0
	4	Other	10319	0	0
		Total (A-E)	601537	20.56	20.56

***Source*:** Collectorate Office, Sri Ganganagar

Table 2: Crop-wise sown area, affected area and Total Affected Area of Kharif 2023 (Area in Hectares)

S. No.	Crop Name		Total crop sown area	Total Crop affected area and more than 0 to 100%	Total Crop affected area 33% or more
1	2		3	4	5
	Cereals				
A	1	Bajara			
	2	Maize			
	3	Jowor			
	4	Paddy			
	Pulses				
B	1	Moong	116		
	2	Urad			
	3	Moth			
	4	Chaula			
	5	Arahar			
	Oilseeds				
C	1	Groundhut			
	2	Soya bean			
	3	Til			
	4	Castor			
	Horticulture Crops				
D	1	Vegetables			
	2	Fruits	2		
	Other Crops				
	1	Guar	163	4.807	4.807
E	2	Cotton	262	6.072	6.072
	3	Sugarcane			
	4	Other	6		
		Total (A-E)	549	10.879	10.879

***Source*:** Collectorate Office, Sri Ganganagar

Health Hazards

Flooding in Sri Ganganagar city often leads to the contamination of water supplies, increasing the risk of waterborne diseases such as cholera, dysentery, and gastroenteritis. In 2022, several cases of waterborne diseases were reported after floodwaters mixed with sewage. The stagnant water also provided a breeding ground for mosquitoes, leading to an increase in cases of dengue and malaria during the post monsoon season.

Risk assessment and mitigation strategies

Risk Assessment: Effective risk assessment is critical in addressing urban flooding. Sri Ganganagar's unique topography, combined with its ageing infrastructure, makes some areas more vulnerable to flooding than others. A comprehensive risk assessment would involve:

Hazard Identification: Identifying flood-prone areas is crucial. Areas like Purani Abadi, Housing Board, Gurunanak Basti, and Block Areas are known for recurrent flooding. A detailed mapping of these areas, considering historical flood data and recent rainfall patterns, would allow the city to develop more targeted flood mitigation plans.

Vulnerability Analysis: Vulnerability analysis focuses on the socio-economic factors that determine how different populations are affected by floods. Lower-income communities in the city, particularly in Housing Board and Purani Abadi areas, are disproportionately affected due to a lack of resources

for flood preparedness. Vulnerability assessments should also consider the age and resilience of the infrastructure in these areas, as older buildings and poorly constructed roads are more susceptible to flood damage.

Mitigation Strategies

Several mitigation strategies can help reduce the impact of urban flooding in Sri Ganganagar city:

Upgrading Drainage Infrastructure: One of the most important strategies is upgrading the city's outdated drainage systems. Expanding and modernising the stormwater drains, particularly around key areas like Sadbhavna Nagar, Idgah and the Sugar Mill STP, will help to prevent the recurrent waterlogging issues that plague these areas during the monsoon season. Regular maintenance, such as desilting drains before the monsoons, can also reduce blockages.

Rainwater Harvesting: Promoting rainwater harvesting in both residential and commercial areas can reduce the volume of stormwater that enters the city's drainage system. By capturing and storing rainwater, this approach not only alleviates pressure on drainage systems but also provides an additional water source for households, reducing the demand for groundwater.

Sustainable Urban Drainage Systems (SUDS): Implementing SUDS can help manage stormwater more effectively. These systems incorporate natural drainage solutions, such as bio-swales and retention ponds, which absorb and slow down stormwater, reducing the risk of flash floods.

Community Engagement and Preparedness: Community involvement is critical in flood management. Flood preparedness drills, awareness campaigns and the use of early warning systems through platforms like WhatsApp can significantly enhance the city's ability to cope with urban flooding. Empowering local communities with the knowledge and tools to respond to flood events can help mitigate the impact of future disasters.

CONCLUSION AND RECOMMENDATIONS

Urban flooding in Sri Ganganagar is a complex issue driven by a combination of environmental factors, inadequate infrastructure, and unplanned urbanisation. The impacts of these floods are wide-ranging, from property damage and agricultural losses to public health risks and environmental degradation. Addressing these challenges requires a multi-faceted approach that combines improved infrastructure, community engagement, and sustainable urban planning.

To reduce the frequency and severity of urban flooding, the city must prioritise upgrading its drainage infrastructure, particularly in flood-prone areas like Valmiki Mandir, Shastri Basti, Gurunanak Basti, Purani Abadi, etc. Expanding and maintaining the stormwater drains, along with regular desilting efforts, will help reduce the risk of blockages during heavy rains. Additionally, promoting rainwater harvesting and incorporating SUDS into the city's urban planning framework can provide long-term solutions to managing stormwater runoff. Furthermore, community engagement is crucial in building resilience to urban flooding. Implementing flood preparedness drills, establishing early warning systems and improving communication between government agencies and residents will ensure that the city is better equipped to respond to future floods. Strengthening the coordination between government agencies and local communities will also enhance disaster management efforts.

By adopting these strategies, Sri Ganganagar can improve its resilience to urban flooding and safeguard its residents, economy and environment from the adverse effects of extreme weather events.

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