URBAN INDIA

Urban India • Vol 43 • Issue II July-December, 2023 ISSN 0970-9045

A JOURNAL OF THE NATIONAL INSTITUTE OF URBAN AFFAIRS

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Post Disaster Debris Management: A Case Study of the Srinagar Flood, 2014

G. N. Qasba

Senior Advisor, Integrated Research and Action for Development, Delhi
Former Commissioner, Srinagar Municipal Corporation

Rohit Magotra

Deputy Director, Integrated Research and Action for Development, Delhi

Ananya Bhatia

Consultant, Integrated Research and Action for Development, Delhi

Abstract

The 2014 Kashmir flood was declared a national disaster by the Govt. of India. Srinagar, the capital city of Jammu & Kashmir (J&K) was the worst flood-affected city. Urban infrastructure, namely, roads, houses, commercial buildings, and other urban services infrastructure were damaged to a great extent. More than 5000 houses collapsed, around 75,000 houses, hospitals, govt. buildings and other critical infrastructure were damaged, and over 85,157 metric tons of waste material was generated. The construction debris hindered mobility and disrupted the delivery of relief items and lifeline services like water , electricity and communications. This paper highlights the approach, governance, and coordinated action of the Srinagar Municipal Corporation (SMC), which resulted in the swift clearance of debris.The paper also discusses how the coordinated action and timely intervention of the administration facilitated the quick disbursal and settlement of insurance claims for domestic and commercial reconstruction. This case study documents the best practices and lessons learned from SMC's model of debris management, which can be considered for incorporation in the National guidelines for post-disaster can be considered forreconstruction, rehabilitation and debris management.

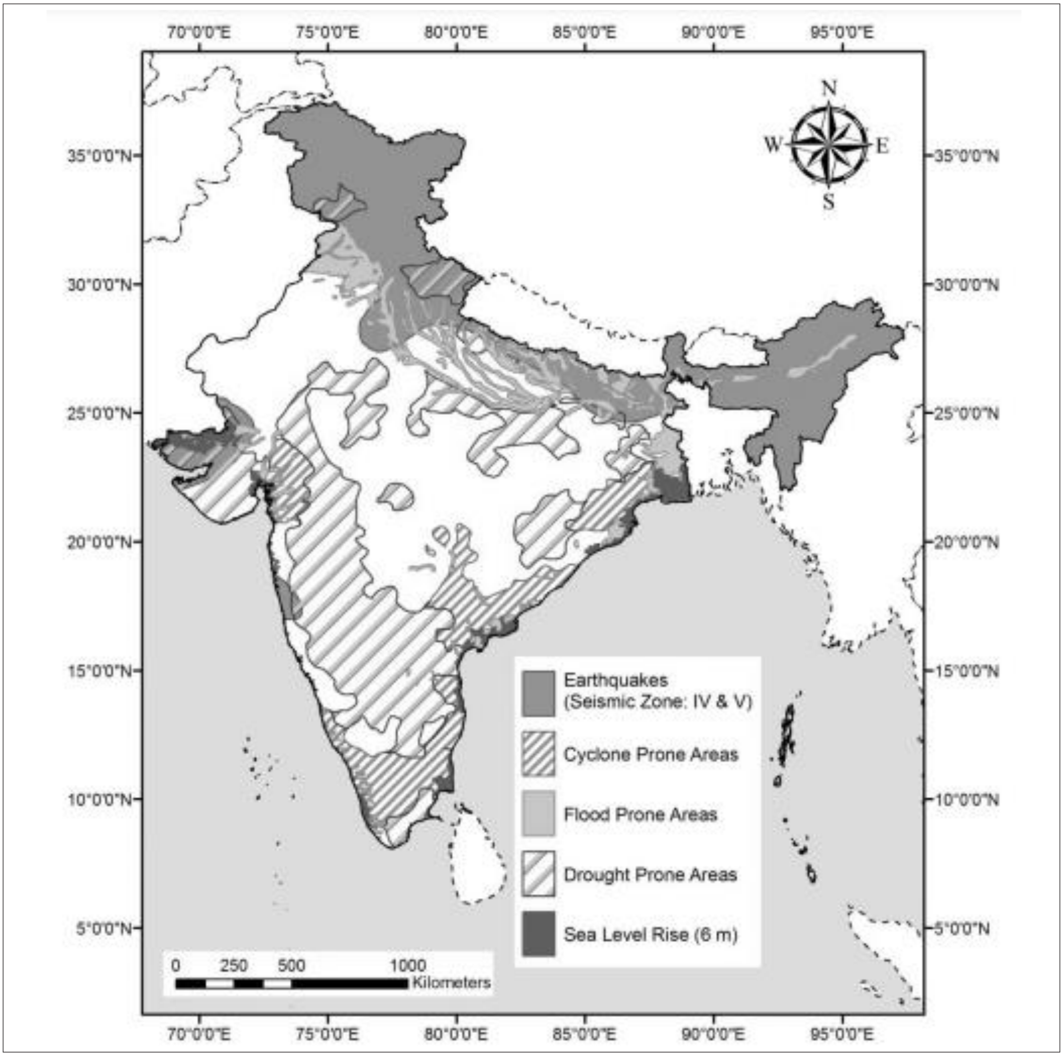
Keywords: Urban Floods, Construction Debris, Waste Management, Disaster Management, Srinagar

Introduction

Globally, in 2018, about 83 per cent of cities were at high mortality risk variously from at least one type of natural disaster, and nearly 89 per cent of cities were highly vulnerable to economic losses from at least one type of natural disaster (United Nations, 2019). According to the Global Risk Report, 2023 published by the World Economic Forum (WEF, 2023), India is among the top three countries with the highest number of natural disasters in the past 20 years (2000 –2019).

In India, between 2000 to 2019, 79,732 people have lost their lives, and 1083 million people have been affected by 321 incidences of natural disasters (UNDRR, 2020). About 58.6 per cent of the landmass of India is prone to earthquakes of moderate to very high intensity. An area of over 40 million hectares (12% of land) is prone to floods. Out of the 7516 kilometre (km) long coastline, close to 5700 km is prone to cyclones and tsunamis. About 68 per cent of cultivable land is vulnerable to drought. About 15 per cent covering over 0.49 million square kilometres is prone to landslides and the Himalayan and Trans Himalayan mountains are susceptible to avalanches (NIDM, 2014). Given the above statistics, it is evident that India is highly vulnerable to all kinds of disasters, natural and climate induced as shown in Figure 1.

Figure 1: Natural and Climate-induced Disasters in India



Source: Chakraborty et al., 2016

One of the critical issues faced by the disaster-affected areas is the debris generated by disaster events and its management for restoring the normal functioning of the area. A few examples of the flooding disasters faced by India in the last two decades are provided in Box 1.

Box 1: Major Flood Events in Contemporary India

In the Maharashtra floods of 2005, 20 million people were affected, 437 Primary Health Centres and hospitals were destroyed, and 97 school buildings collapsed. In Cyclone Aila, 2009, 2.2 million people were displaced, 175,000 homes were destroyed. 71 towns and villages were affected in the 2010 Ladakh floods. Over 0.16 million people were impacted in the 2013 Uttarakhand flash floods, and as many as 2052 houses, 147 bridges and 1307 roads were destroyed. The 2014 Jammu and Kashmir floods caused damage to over 75,000 houses and otherother critical infrastructure. The 2018 Kerala floods were the worst in the history of Kerala, where unusually high rainfall during the monsoon season displaced over 140,000 people and claimed 504 lives.

Post Disaster Debris

Debris is 'a mixture of collased building waste and rubble typically arising from damaged buildings and demolitions. The term disaster debris generally refers to waste materials created by or in the aftermath of a man-made or natural disaster such as an earthquake, tornado, fire, flood, hurricane, or winter snow or ice storm (Luther, 2011). This waste stream can include natural materials such as clay and mud, trees, branches, bushes etc.' (UNEP, 2016). The debris generated during disasters includes:

- Construction and demolition waste from damaged infrastructure
- Vegetation waste (caused by the uprooting of trees)
- Sediment waste (caused by landslide rubble, rocks, soil, stones)
- Hazardous wastes (from industries, oil spills, other toxic wastes),
- Rotting waste (including corpses, food, perishable material, human waste, hospital waste)
- E-waste (electronic items)
- Metal and plastic waste (from vehicles, vessels, carriers).

Disasters can generate a huge amount of waste in a very short time, overwhelming the capacities of municipalities and waste management facilities. The subsequent generation of large quantities of waste is a huge challenge for the public and administrative authorities. Research from various disasters indicates that the waste generated in each community was equivalent to between 5 and 15 times the normal annual waste generation (Reinhart et al., 1999; Basnayake et al., 2006). Disaster waste can affect human health by contaminating drinking water and, through exposure to hazardous waste, cripple local infrastructure and hinder rescue and rehabilitation efforts; for example, debris blocking access routes and roads etc. (UNEP, 2016). A few global examples of the volume of disaster debris generated are given in Table 1.

Table 1: Volume of Post-Disaster Debris

Year	Event	Volume of Debris (million m³)
2005	Katrina Hurricane	76
2010	Haiti Earthquake	23–60
2008	Sichuan Earthquake, China	20
1995	Great Hanshin-Awaji Earthquake, Kobe, Japan	15
1999	Marmara Earthquake, Turkey	13
2004	Indian Tsunami	10
2004	Hurricanes Frances and Jeanne, Florida, US	3
2009	L'Aquila Earthquake, Italy	1.5–3

Source: Booth (2010)

The nature of waste depends on the type of disaster and the characteristics of the affected area. The largest proportion of disaster waste is construction and demolition waste, comprising concrete, steel, wood, and other building materials, including asbestos insulation and other hazardous waste (UNEP, 2016).

Type of Disasters and Debris

The composition of debris may vary depending on the nature of the hazard, demography and the economic characteristics of the city (EPA, 2008). Table 2 shows typical debris streams for different types of disasters.

Table 2: Typical Debris Streams for Different Types of Disasters

		Typical Debris Streams								
		Vegetative	Construction and Demolition	Personal Property	Hazardous Waste	Household Hazardous Waste	E-Waste	Soil, Mud and Sand	Vehicles and Vessels	Rotting waste
Disasters	Cyclones	X	X	X	X	X	X	X	X	X
	Tsunamis	X	X	X	X	X	X	X	X	X
	Tornadoes, Hurricanes	X	X	X	X	X	X		X	X
	Floods	X	X	X	X	X	X	X	X	X
	Earthquakes		X	X	X	X	X	X		
	Fires	X	X	X	X	X	X	X	X	
	Snow storms, Avalanches	X				X				

Source: Federal Emergency Management Agency, 2007

Floods

Debris from floods is caused by structural inundation and high-velocity water flow. It includes erosional debris, structural collapse debris, damaged infrastructure debris, and sediment debris. As soon as floodwaters recede, people dispose of flood-damaged household items. Mud, sediment, sandbags, and other reinforcing materials also add to the volume of debris needing management, as do materials from demolished and dismantled houses (EPA, 2008).

Flash Floods and Cloudbursts

Flash floods are short-lived extreme events, which usually occur under slowly moving or stationary thunderstorms lasting less than 24 hours,and are a common disaster in mountain areas. As a result of the high velocity of the currents, which can wash away all obstacles in their way, this phenomenon may result in enormous loss of life and property in various parts of the region. Debris includes erosional debris, structural collapse debris, damaged infrastructure debris and sediment debris (EPA, 2008).

Figure 2: Post Flood Waste in Srinagar, 2014

Source: SMC Archives, 2014

Figure 3: Huts Destroyed by Delhi Slum Fire, 2014

Source: BBC News, 2014

Figure 4: Bhuj Earthquake, 2001

Source: Bob Mckerrow, 2001

Figure 5: Cyclone Fani, Odisha, 2020

Source: Times of India, 2020

Earthquakes

Earthquakes can bring down and damage buildings and other tangible infrastructure. w Earthquakes are characterised by structural collapse debris, damaged infrastructure debris, and vegetative debris. Secondary damage from fires, explosions, and localised flooding from broken water pipes can increase the amount of debris (EPA, 2008).

Cyclones, Tsunamis, Tornadoes, and Hurricanes

Damage from high-velocity rotating winds includes damaged and destroyed structures, green waste, and personal property. The debris comprises construction materials, damaged buildings, sediments, green waste, and personal property. The debris obstructs roads and disables electrical power and communication systems over wide areas (EPA, 2008).

Fire

Houses demolished by fire contribute non-combustible debris. Burned-out cars and other metal objects, as well as ash and charred wood waste need to be managed; large-scale loss of plants serving as ground cover can lead to mudslides, adding debris to the waste stream (EPA, 2008).

Snow Storms, Avalanches

Snow storms and avalanches can generate different kinds of debris, depending on the type and intensity of the event. Some common types of debris are snow debris, rocks, and vegetation, among others (NDMA, 2009).

Importance of Debris Management in Cities

As a result of population growth, rural-to-urban migration and an increasing shortage of space, cities in developing countries are sprawling outwards, often into hazard-prone areas such as alongside river banks or steep hillsides, which were previously devoid of development (Schuster et al., 2007; Jeschonnek et al., 2014). The growth of these cities often exceeds the capacity of authorities to develop and maintain adequate infrastructure, resulting in the development of informal settlements and slums that are highly vulnerable to natural hazards (Jeschonnek et al., 2014).

Table 3: Examples of Debris Management

Disaster	Amount of Waste	Strategies Used for Management	Issues Encountered
Marmara Earthquake Turkey, 1999	13 million tons	Recycling plant, 17 dumpsites	Large quantities of reinforcement bars cause operational problems in the recycling plants, and illegal dumping in coastal areas (Baycan et al., 2002)
Kobe Earthquake Japan, 1995	15 million tons	A small proportion was recycled, and the majority ended up in land reclamation	Segregation is time-consuming and costly (Eerland, 1995)
Kosovo, 2005	10 million tons	A mobile recycling plant, decentralised depots for collection and storage	Spread of the damage over a large rural area (Pasche et al., 2005)

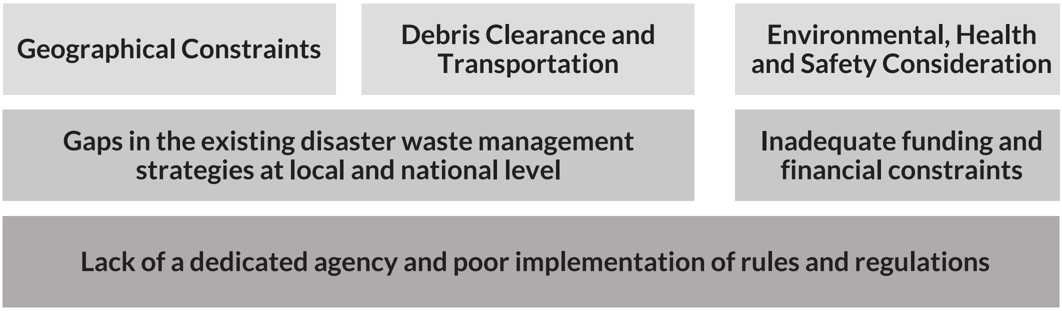
Source: Baycanet al., 2002; Eerland, 1995; Pascheet al., 2005

Cities worldwide face common challenges, especially due to rapid urbanisation and climate change. Waste management is one of the most basic and important services for maintaining a good quality of life and thus making it stronger and vital for a strong society against disasters. In the short term, debris removal is necessary to facilitate the recovery of a geographic area and the normal functioning of the city. In the long term, the methods of managing such waste require proper consideration to ensure that their management will not pose future threats to human health or the environment. If managed effectively, debris can become a valuable resource in the recovery and rebuilding process and can positively affect social and economic recovery. Table 3 gives some examples of debris management strategies and issues during a disaster.

Constraints in Debris Management

Mountain areas are particularly vulnerable to earthquakes, landslides, and floods, which can cause immense amounts of waste. Immediate waste management is needed to facilitate rescue efforts and reduce the spread of disease and environmental impact (UNEP, 2016). Debris management is a complex and challenging task that involves many constraints and difficulties. Some of the gaps and constraints are provided in Figure 6.

Figure 6: Constraints in Debris Management



Source: Authors

Some of the key constraints are,

Geographical constraints: The location, size, and accessibility of the affected area may limit the options and methods for debris removal and disposal.

Debris clearance and transportation: The quantity, quality, and composition of the debris may pose logistical problems for sorting, loading, and transporting the waste to suitable sites.

Environmental, health and safety considerations: The debris may contain hazardous or infectious materials that require special handling and treatment to prevent environmental contamination and health risks for workers and communities.

Gaps in the existing disaster waste management strategies at the local and national level: The existing policies, plans, and regulations for disaster waste management may be inadequate, outdated, or inconsistent with the current situation and needs.

Inadequate funding and financial constraints: The resources and budget for debris management may be insufficient or unavailable, especially in developing countries or regions with low economic capacity.

Lack of a dedicated agency and poor implementation of rules and regulations: The roles and responsibilities of the various stakeholders and authorities involved in debris management may be unclear, overlapping, or conflicting, leading to poor coordination and accountability.

Existing Provisions and Guidelines on Debris Management in India

There are gaps in debris management due to the lack of existing norms, standards, and strategies dedicated specifically to disaster debris. In India, several government bodies have issued guidelines on waste management during disasters. A snapshot of the same is provided in Table 4.

Table 4: Guidelines for the Management of Construction and Demolition (C&D) Waste

S.No.	Agency	Guidelines
1	Ministry of Housing and Urban Affairs (MoHUA)	Video circular dated 28 June, 2012, directs the states to set up facilities in all cities with a population of one million-plus to establish environment-friendly C&D recycling facilities (reference base: C&D waste processing facility commissioned in Delhi (Burari model).
2	Ministry of Environment, Forests & Climate Change (MoEF&CC)	Environmental considerations have been integrated at all levels. In the National Environment Policy of 2006, incorporating 3 Rs (Reduce, Reuse, Recycle) is reflected in all the notified waste management rules.
3	Bureau of Indian Standards (BIS)	BIS's National Building Code ,2016 has practices and standards for using recycled materials and construction and demolition waste products in construction activities.
4	Building Material & Technology Promoting Council (BMTPC)	BMTPC, 2016 released 'Guidelines for utilisation of C&D waste in construction of dwelling units and related infrastructure in housing schemes of the government'.
5	Central Public Works Division (CPWD)	Part IV of the 'Guidelines for Sustainable Habitat' discusses 'Guidelines on reuse and recycling of Construction and Demolition (C&D) waste'. (March, 2014)
6	CPWD & National Buildings Construction Corporation (NBCC)	Approximately 25 –30 million tons of C&D waste is generated annually in India, of which 5% is processed. Along with CPWD, NBCC has recommended using recycled portions of C&D waste in their construction activities if the same is available within 100 km of the construction site. (2016)
7	Indian Road Congress (IRC)	Under the C&D Waste Management Rules, 2016, Rule 11 indicates the role of IRC in the preparation of a code of practices/standards for the use of recycled materials and products of C&D waste in road works.

Source: Authors

Overview of Disasters in Jammu & Kashmir

Jammu and Kashmir has had a long history of natural disasters, ranging from earthquakes, floods, snow blizzards, avalanches, landslides and windstorms, all owing to its peculiar topography, rugged terrain, extreme weather conditions, and unique geographical and geo-climatic settings. The state is highly vulnerable to earthquakes as it lies in seismic zones 4 and 5. In February 2005, Waltengu Nar in the Kulgam district of south Kashmir was hit by a snow blizzard. The 7.6 magnitude earthquake on 8 October, 2005 was a major earthquake at a depth of 26 km (Rai et al., 2006). The worst affected major towns were Tangadhar in the Kupwara district and Uri in the Baramulla district. There was substantial damage to the infrastructure and basic services. Landslides and fissures destroyed and badly damaged roads, well over 1000 government buildings (health, education, administrative) were affected. Nearly 30,000 families were left without a liveable permanent shelter, whilst another 83,000 families suffered significant damage (World Bank, 2006).

In August 2010, a sudden cloudburst occurred in Laddakh (Leh), followed by flashfloods and mudslides. The situation was equivalent to the total rainfall recorded in the entire year. Jammu & Kashmir witnessed devastating floods in September 2014, affecting almost entire state. Colossal damage was recorded to the public service infrastructure, residential houses, and business establishments. Due to recurring disasters, Jammu and Kashmir has suffered heavily both in terms of life and property loss.

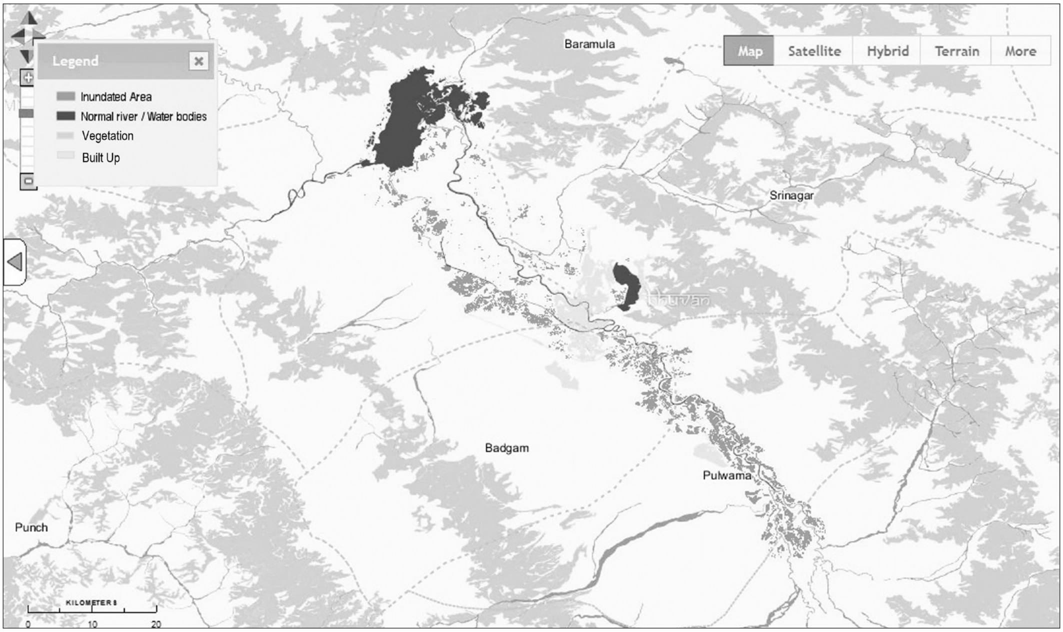
Debris Management during Srinagar Flood, 2014

Between 2 and 7 September, 2014, after a continuous spell of five days of rainfall in Jammu and Kashmir, the total cumulative rainfall during the week over several districts was 309 mm (Anantnag), 256 mm (Baramulla), 243 mm (Pulwama) and 148 mm (Srinagar), which is higher than the average rainfall for the entire monsoon season in these districts (Ray et al., 2015). A total of 77 per cent of the city area was inundated under water, and of the inundated areas, 47 per cent was fully or almost submerged (SMC, 2014). The Jhelum River overflowed 0.6 –1.5 metres high above its banks, creating 16 breaches along the weaker sections of its embankments before entering the city (Romshoo, 2015). Many parts of the city were submerged for 28 days; the flood control department recorded the discharge rate in the river as 70,000 m^3/s (cubic metre per second) against the normal discharge of 25,000 m^3/s; three times more than the normal discharge. Several important roads, lanes, and bylanes were submerged due to water-logging. The Srinagar Jammu highway, which is part of National Highway 7 (NH 7), connecting Srinagar to Jammu, was badly hit during the deluge. Out of the five major hospitals in Kashmir, situated in Srinagar, four were completely shut down due to the flood as floodwater entered the hospital premises. Fuel stations ran out of stock. Government assets and many emergency operation centres were completely submerged. Telecommunication and internet network towers were destroyed. There was a continuous power cut in the valley as the 134 kilovolt (KV) transmission line tower supplying power to Kashmir and Jammu was also washed away by flood. Sources of water supply were inundated and contaminated. As per the data assessed by SMC (7 September, 2014), out of a total of 59 affected wards, 12 were fully submerged. These wards were mostly located along the Jhelum River and nallahs. Furthermore, around seven Municipal wardswere partially submerged,

Post-disaster debris management was one of the most important operational management systems designed to help affected communities restore their habitat and the lifeline services to a stable state. The Srinagar flood generated alarmingly huge debris, which resulted in road blockades and difficulties in relief and rehabilitation work. The most important challenges were:

- Assessment of damage.
- Mapping of the adversely affected critical infrastructure.
- Setting up the priorities with a focus on relief operations.

Figure 7: Inundated Areas in Srinagar, 10 September, 2014



Source: Ray et al., 2015

Facilitating communication like ambulances, transportation, relief material carrying trucks, and municipal transport equipment (trucks, tippers, loaders, bulldozers, septic tank suction/cleaning equipment).

Post the flood waste management operations in Srinagar involved the collection of over 85,157metric tons (MT) of waste material, which included huge tonnage of construction debris of collapsed buildings and other infrastructure. As many as 75,000 houses were damaged. To reconstruct the damaged buildings within the municipal limits, A policy direction in the form of a Govt. order, enabled SMC to fast track the building permissions under a single window system. SMC implemented this order and made an integrated decision-making system for on and off-site issuance of permissions for rebuilding collapsed domestic buildings, which enabled a fast track debris removal as well. To rebuild the collapsed or damaged houses and rehabilitate the flood victims, the state government waived off the building permission fee. As per the Government Order, the competent authorities in the state, in whose jurisdiction the structure fell, were directed to grant permissions within three days in favour of the affected building owners. SMC also focused on generating livelihoods during the rehabilitation phase and introduced certain reconstruction policy revisions to clear the debris efficiently. SMC handled the networks in the operation of debris, waste collection and separation sites, processing and recycling of debris, disposal sites and even free transportation of debris for reuse.

Government Order on Granting Building Permissions for Rebuilding

As the biggest cleaning and sanitisation drive was carried out successfully within two months of the flood, putting a fullstop to an epidemic outbreak, the focus subsequently shifted to rebuilding and reconstructing damaged buildings. Heavy rainfall had caused massive damage to the residential and government buildings of the city. More than 5000 houses collapsed, and 75,000 houses were damaged. After the deluge, people had no home to ive in and take shelter. Some shared their homes with relatives and friends, whereas some were in relief and rehabilitation camps.

Figures 8a & b: Damaged Buildings in Srinagar

Source: File photos, SMC *Source: File photos, SMC*

To rebuild the collapsed and damaged houses to rehabilitate the flood victims, the government announced Government Order (GO) No. 265 dated 8 October, 2014 (Early Times, 2014). The order stated that the submission of building permission would be without any fees/charges. The Jammu and Kashmir government authorised all 72 local bodies, two municipal corporations and the Jammu and Kashmir Lake Conservation and Management Authority (LCMA) to issue building permissions to the domestic damaged building owners. Accordingly, camps were set up by the SMC in public parks, community centres and at major road junctions. This initiative was of great help in the post-disaster rebuilding of damaged infrastructure in the state. As per the Government Order, the competent authorities in SMC, Srinagar Development Authority (SDA), Lake Conservation and Management Authority (LCMA), Jammu Municipal Corporation (JMC), Jammu Development Authority (JDA) and other local body institutions of the state in whose jurisdiction the structure fell, were all authorised to grant permissions within three days in favour of the affected owners (Daily Excelsior, 2014; Mushtaq, 2014; PTI, 2015).

Single Window Building Permission Process

The process ensured that the flood victims could get the required necessary documents at the front office, without going through the long-drawn hassle of applying for permissions. Two divisional town planners supervised such cases and issued and delivered permissions under the single window system at the SMC front office. As per the Government Order, the following documents were required to be produced while applying for building permission:

- Copy of the First Information Report (FIR) registered with the nearest police station.
- An affidavit to the effect that the applicant is a lawful owner of the premise for which permission is being sought that will not deviate from the original structure and that the construction was legal.
- Four copies of proposed building plans and standard format. Three copies at A3 size and one copy at A4 size.
- Two self-attested photographs of the applicant.

To ensure a speedy process, SMC also worked on sites to grant the necessary building permission and due to the fast-track method under a single window system, SMC granted thousands of quick permissions. In total, the municipality had received 4375 requests and was able to grant permission to 3560 persons (Table 5) to build houses devastated by the flood, while 104 cases were under disposal at various levels. 114 cases were rejected, and 310 cases were sent for a No Objection Certificates (NOCs) from various Govt. Departments.. SMC restored existing a facility for online applications. As per the news reports, 1002 cases were received online (SMC, 2014).

Table 5: Break-up of Applicants for Building Permission

Total number of building permission cases received	4375
Number of cases approved	3560
Number of cases referred for NOC	310
Number of cases rejected	114
Number of cases withheld on complaints	30
Number of cases not covered under the ambit of G. O.	120
Migrant cases referred to Divisional Commissioner	2
Number of cases that did not fulfil the requisite formalities	135
Number of cases under disposal at various levels.	104

Source: SMC, 2014

Figures 9a & b: On-site Application and Grant of Building Permissions by SMC

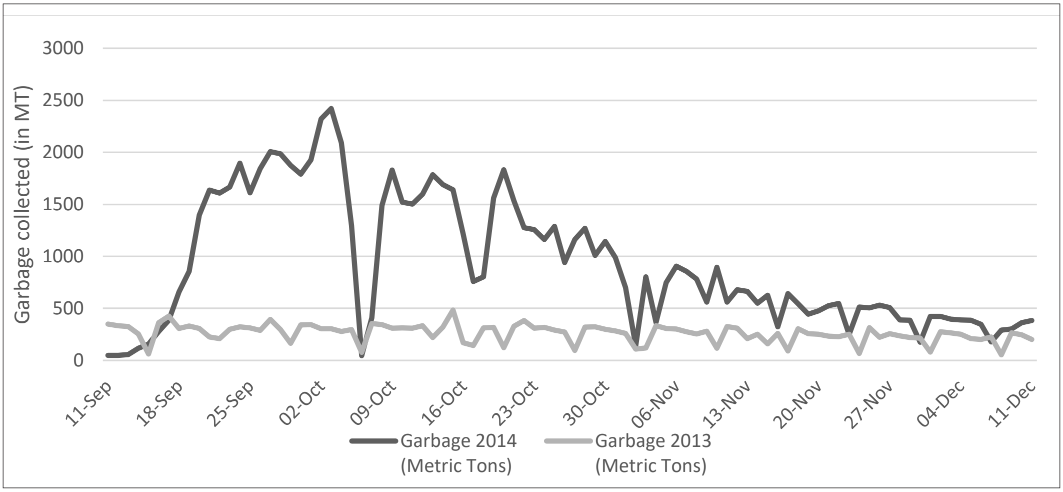
Source: File photos, SMC

Source: File photos, SMC

Debris and Waste Clean-up

To clean the post-flood waste, SMC mobilised over 5000 employees and as many as 200 machines of sorts The SMC team cleaned the city by removing garbage and disposing of it; a total of 85,157 metric tons (MT). SMC also widely used various insecticides and antibacterial sprays, including sanitreat, lime powder, and methanol while cleaning garbage and other debris from roads and lanes to ensure a fully disinfectant-covered Srinagar city. The collected garbage was loaded into trucks and disposed of at the Achan landfill site located north of Srinagar. On an averge, SMC collected between 200 and 300 MT of garbage each day before the flood. However, due to the floods, volume of debris generated increased substantially. On September 11, 2014, various constraints resulted in a collection of only 48 MT. However, by systematic planning and innovative practices, an average of 1051 MT of garbage was daily lifted during this period, which was almost five times more than usual. On October 3, 2014, record collection of 2,422 metric tons debris was collected. (Figure 10). The trucks carrying garbage normally make 7542 trips to the landfill site, but during this period, they made 17,836 trips, three times more than usual. The massive amounts of post-flood city garbage included building materials, animal carcasses which totalled 1685 (687 small and 998 large), food items, and sewage.

Figure 10: Daily Garbage Collected during Selected Months of 2013 and 2014



Source: SMC, 2014

Livelihood Generation

While addressing the post-disaster restoration of life support systems in Srinagar, a major focus was on hiring trucks, tippers, bulldozers, and other heavy operational equipment to remove debris and fallen buildings and trees. This hiring exercise created huge livelihoods for otherwise idle workforce/equipment from non-flood areas of Kashmir (because the entire state was suffering from different magnitudes of the devastation due to the flood). It is important to mention that most of the relevant equipment in flood-hit areas, including commercial/passenger vehicles, were damaged and non functionalafter remaining submerged under flood water for a long period.

Most of the commercial vehicles owned by the Govt, private companies and individualsneeded specialised repairs (including ambulances and other earth-moving equipment). "Majority of these vehicles had to be outside Jammu and Kashmir for repairs for repairs or had to be scrapped. Hordes of woodcutters were also on the job of cutting and removing the debris of fallen trees. debris.

Figure 11: Debris at Lal Chowk

Source: File photos, SMC

Figure 12: Debris Collection by SMC

Source: File photos, SMC

Figure: 13: Team Deployed by SMC

Source: File photos, SMC

Free Transportation

Government departments like the Public Works Department were offered the free facility of trucks, tippers and loaders so that they could lift the debris from critical locations and transport it to the ongoing government projects wherein landfilling was envisaged. These novel approaches had a manifold impact on restoring communications, that is, vehicular traffic, movement of ambulances, tankers carrying fuel, lifesaving machines and medicines, baby food, and essential supplies.

Figure 14: Vehicles Arranged for Debris Clearance

Source: File photos, SMC

Recommendations

Guidelines for debris management: The existing disaster management plans have gaps in debris management norms, standards, and guidelines. There is a need to develop detailed debris management guidelines under disaster waste management.

Best practices for debris management: A compendium should be developed by National Disaster Management Authority (NDMA) and the National Institute of Disaster Management (NIDM) ffor necessitating building agencies/Urban Local Bodies to document best practices on the management of debris generated by hazards/disasters.

Building bye-laws and guidelines: The building bye-laws and guidelines should be followed strictly in new structures. It was noticed during the Srinagar flood of 2014 that the houses made of mud and brick collapsed easily, whereas structures made of sturdy building materials like concrete were able to withstand the flood. It should be ensured that all construction related to residential and commercial uses and, in particular connected with, critical infrastructure like hospitals, communication, administration, and social/education facilities are based on appropriate design and materials that can withstand the disasters depending on the area's vulnerability.

Governance practices: The management of the Srinagar flood provided an innovative and quick way to remove and manage debris. This included quick settlement and disbursal of property insurance. The fast-track single window clearance process for reconstruction of the building was the first of its kind in the countryThis was further accelerated by the timely intervention/order of the Division Bench of Jammu and Kashmir High Court allowing quick disbursal of the amount of building insurance; 95 per cent of the sum insured up to INR 2.5 million and 50 per cent of the sum insured above INR 5 million. Fast-track reconstruction of damaged buildings based on the Srinagar model should be adopted.

Free transportation: This was an important initiative provided during the Srinagar flood in 2014. Government departments were offered the facility of trucks, tippers and loaders and were able to lift the debris from critical locations. The debris was lifted and utilised for the public good for the ongoing road construction, landfilling and building constructions for restoration

Restoration of critical infrastructure: Restoration of critical infrastructure should be prioritised in debris management. The restoration of damaged heritage structures should be permitted under the supervision of experts. Thus, heritage structures damaged in the flood were restored under the expertise and supervision of Indian National Trust for Art and Cultural Heritage (INTACH) India.

Livelihood generation: This can be done by providing job opportunities through the hiring of trucks, tractors, and loaders from disaster-hit and other areas. Generating livelihoods is very important in reconstruction programmes during post-disaster restoration exercises. Training and emergency employment offering cash for work supports and strengthens the community.

Loss and damage: The state government projected a loss and compensation of INR 440 billion to the government of India, whereas the Kashmir Chamber of Commerce and Industries projected an estimated loss of INR 10 billion to the industries. Immediately after the flood in September 2014, the state government sought a special financial package "from the federal government for the rehabilitation and restoration of damaged infrastructure. TA detailed approach and methodology should be evolved to assess the loss and damage caused due to urban flooding.

Conclusion

Debris management is a critical aspect of disaster response and rehabilitation in India, a country highly prone to natural disasters. Disasters can generate significant amounts of waste, such as construction and demolition debris, vegetation waste, hazardous waste, and rotting waste, among other types of waste. Post disaster, the management of this waste is essential for restoring the normal functioning of the affected area. However, debris management poses numerous challenges, including geographical constraints, debris clearance and transportation, environmental and health considerations, and inadequate funding. Therefore, effective management of disaster waste is crucial for public health, environmental safety, and the overall recovery of an area.

Post-disaster debris management plays a crucial role in facilitating the recovery of a geographic area and ensuring the normal functioning of a city. Moreover, it serves as a crucial element in restoring infrastructure and ensuring the well-being of the affected population. The rapid and effective removal of waste generated post a disaster is essential in preventing environmental contamination and health risks, while facilitating the overall recovery and restoration of the affected area.

India, with its history of disasters such as earthquakes, floods, landslides, and tsunamis, has witnessed significant challenges in post-disaster debris management. The government's issuance of guidelines on waste management during disasters has been instrumental in shaping the management strategies for disaster debris in the country. Furthermore, the example of Srinagar's flood in 2014 highlights the significance of efficient post-disaster waste management, from the collection and disposal of garbage to the generation of livelihoods through hiring heavy operational equipment for debris removal. It demonstrates the crucial role of governmental policies and initiatives in ensuring effective disaster waste management and the subsequent recovery of affected areas.

Declaration of Conflict of Interest

The authors declared that there is no conflicts of interest with respect to the research, authorship and/or publication of this article.

Funding

The authors received no financial support for research, authorship and/or publication of this article.

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NATIONAL INSTITUTE OF URBAN AFFAIRS

1st Floor, Core 4B, India Habitat Centre,
Lodhi Road, New Delhi - 110003
Phone: (+91 11) 24634971, 24643576
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National Institute of Urban Affairs

National Institute of Urban Affairs
1st Floor, Core 4B, India Habitat Centre, Lodhi Road, New Delhi - 110003, INDIA
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