

POST DISASTER WASTE MANAGEMENT DURING THE 2014 SRINAGAR FLOOD

GN Qasba, Rohit Magotra, Sonika Rajput and Ananya Bhatia

ABSTRACT

Post-flood sanitation, waste handling, collection, and disposal is a major challenge for any city. Huge layers of garbage including the carcasses of animals threaten the outbreak of epidemics of vector-borne diseases and water-air borne infections. Post disaster waste management is thus a crucial step in restoring cities back to their normal livability. Early implementation of sanitation, cleaning and disinfecting operations will enable the affected communities to return to normal life. This paper documents post-flood waste management operations carried out after the flood in Srinagar (Jammu and Kashmir, India), in September 2014. Post-flood waste management operations in Srinagar involved collection of 85,157 metric tonnes of waste material and 17,836 truck trips to the city landfill site at Achan, Srinagar. 11.90 lakh litres of disinfectants and 29,500 kgs of anti-odor formulation were used to improve the level of cleanliness, livability and control odor. 1686 animal carcasses were removed and disposed of as per standard protocol. This paper highlights procedures, processes and practices to be followed during post flood waste management operations by urban local bodies and disaster management authorities.

Keywords: *Disaster Response, Epidemics, Srinagar Flood, Waste management*

GN Qasba

*Former Commissioner, Srinagar Municipal Corporation, Senior Advisor,
Integrated Research and Action for Development (IRADe)
gnqasba@irade.org*

Rohit Magotra

Deputy Director, Integrated Research and Action for Development (IRADe)

Sonika Rajput

Intern, Integrated Research and Action for Development (IRADe)

Ananya Bhatia

Research Associate, Integrated Research and Action for Development (IRADe)

1. INTRODUCTION

Climate change has magnified the frequency and severity of natural disasters over the last decade globally. Rapid urbanisation leads to loss of vegetation, topography, over concretisation, effecting natural drainage and intensive use of hydrocarbons. Unplanned development and encroachment on water bodies such as canals, lakes, streams, and wetlands are further deteriorating the sustainable ecosystems. The recent calamities of flood in India in Kerala, Uttarakhand, Ladakh, Mumbai, Gurgaon, Chennai, and Srinagar are enlisted in the table below (Refer Table 1). Approximately 20,000 people have lost their lives due to floods and cyclones alone in India during the past 15 years (NDMA, 2019).

Name of event	Year	State & Area	Death toll
Flood	2018	Kerala	438
Flood	2015	Tamil Nadu	500
Flood	Sept, 2014	Jammu & Kashmir	248
Flood/ Landslides	June 2013	Uttarakhand & Himachal Pradesh	4,094
Flood	July- Aug 2012	Assam	-
Cloudburst	2010	Leh, Ladakh in J&K	257
Flood	2009	Andhra Pradesh, Karnataka	300
Flood	2008	North of Bihar	527
Flood	2005	Maharashtra	1,094
Tsunami	2004	Coastline of Tamil Nadu, Kerala, Andhra Pradesh, Pondicherry and Andaman and Nicobar Islands of India	10,749
Retrieved from https://ndma.gov.in/en/			

There is a need to develop sustainable resilience to minimize the adverse effects and enable fast recovery to normalcy through policy and infrastructural initiatives. In Srinagar, the September 2014 flood was declared as a National Disaster (calamity). The floods were the first instance, in recent times, where 70% of the city was submerged by the flood. Srinagar floods have now become a reference point for urban flood response and management in the country, as many post-flood management practices were successfully implemented in Srinagar city. The success of the waste management drives lead to the speedy recovery to normalcy from devastation and prevention of any major health and environmental crisis.

1.1 Background

Waste management is a perennial problem in developed and developing countries (UN Habitat, 2010). Solid waste management and liquid waste management are an important component of the complex urban management system. Before and after the disasters, the absence of a robust waste management system can increase the damage by blocking the drainage, accumulation of debris and harboring of diseases and vectors. During a flood, waste and other debris carried by floodwater can cause increased damage to property and lead to higher flood losses. (Nichols Jet al, 2002). Floods can also have an impact on waste management systems leading to leaching of toxins into groundwater (Pilapitiya, et al, 2006).

During the flood of 2018, Kerala had a spurt in communicable diseases and in August 2018 alone, the state government's Integrated Disease Surveillance Project recorded 171 cases of leptospirosis with four deaths (Livemint, 2018). Following the flood of 2019, Patna registered almost 250 dengue cases between September 27 and October 10, which is more than half of the entire dengue cases the city registered in that year until the floods (News 18, 10 October 2019). An explosive epidemic of cholera in the district of Malda in the state of West Bengal was induced by devastating flood resulting from overflowing of the two main rivers of the district, at the end of July 1998, affecting 15 blocks and 2 municipalities (Sur, al, 2000). These are some of the many cases which highlight the importance of post flood waste management.

1.2 Brief on Srinagar City

Srinagar is the summer capital of the Indian state of Jammu and Kashmir (now a union territory). It lies in the centre of the Kashmir valley on the banks of the Jhelum River. (Figure 1). Geographically, it is located between 33° 59'14"N to 34° 12'37"N and 74° 41'06"E to 74° 57'27"E at an average elevation of 1600 meters

above mean sea level. There are several world-famous lakes and swamps in and around the city. The city is the most urbanized in the state with population of 12.06 lakhs (with additional 5 lakh floating population) and an area of 294 Sq.km as per census of India of 2011.



Figure 1 Location of Srinagar District within Jammu & Kashmir union territory
Retrieved from https://en.wikipedia.org/wiki/Srinagar_district

1.3 History of flood events in Srinagar

Location of Srinagar in Kashmir Valley, with large pockets of low-lying areas, makes it prone to flooding and water logging almost every year. History of Kashmir Valley's flooding dates back since the year 1841. The 1902 flood was considered an unprecedented event when the valley was converted into a lake.

Figure below shows some major flood events in the valley (Refer Figure 2)

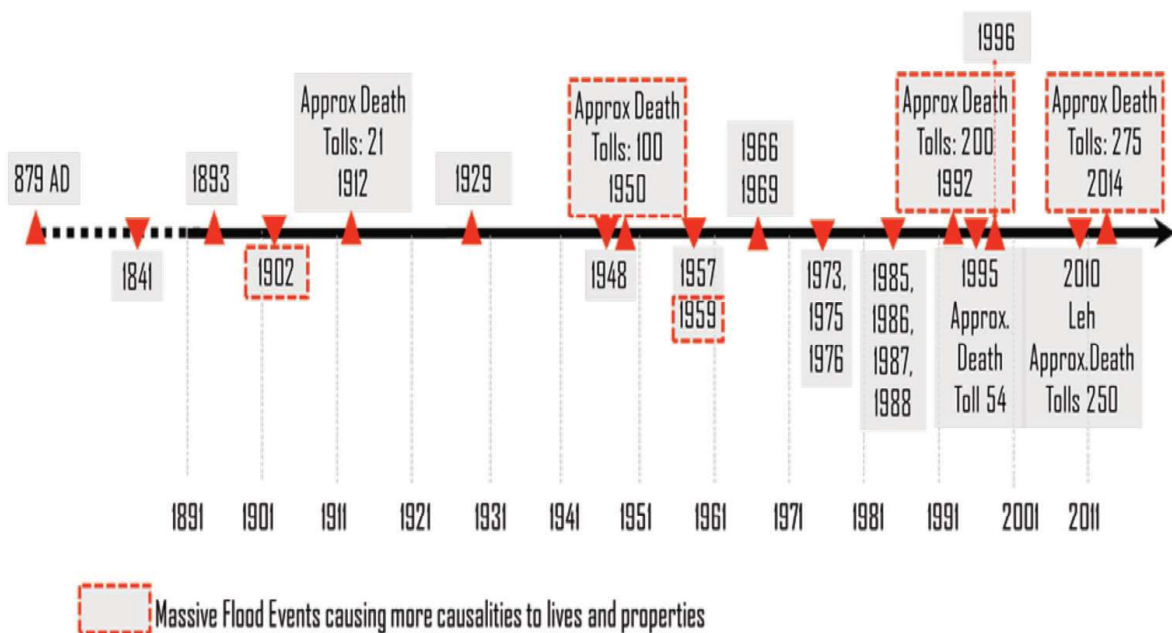


Figure 2 History of Major Flood Events in Kashmir Valley

Source: Srinagar Municipal Corporation, 2015

In the year 1981-1991, four flood events occurred on consecutive years causing high economic losses. The flood event of September 2014 killed around 275 people in the J&K state with 45 in Srinagar city. The increased frequency of the floods could be attributed to the rapid and unplanned urbanization in the city to accommodate the soaring population, including huge migration from rural areas in the last 3 to 4 decades. The south of Srinagar has been traditional “flood sponge” and acted as a barrier to the flood waters. But the built-up area in this region has increased in last few decades, resulting in increased exposure to potential floods. Besides the unprecedented intense rainfall around the first week of September 2014, Encroachment on river banks, natural drainage and wetlands and reduction in carrying capacity of Jhelum River and its tributaries - were the main cause of flooding during 2014 Srinagar flood.

2. SRINAGAR FLOOD 2014 AND ITS EFFECT

On 2nd September 2014, a continuous spell of heavy rainfall for 5 days flooded Srinagar and most parts of the city were submerged as the river Jhelum spilled over its normal water level, flowing at 23 feet above normal (5 ft. above danger mark). The Flood Control department recorded discharge rate in the river as 70,000 cusecs, which was three times more than the normal discharge. On



Figure 3: People walking in Knee deep water,

Source: Greater Kashmir Archives, 2014

the second consecutive day of heavy rainfall Pahalgam, Kulgam, and Qazigund were inundated. Fearing widespread flooding, the Government sounded alert on the second day of heavy rainfall. Rescue operations were initiated

around the same time, evacuating the people from flood-affected areas to safer places. According to the Indian Meteorological Department (IMD), the weekly cumulative rainfall (4-10 Sept 2014) exceeded the average rainfall of the entire monsoon season (Jun-Sept) in the state (Ray et al, 2015). Medical infrastructure, hospitals, houses, schools and government offices in localities like Sonawar, Indira Nagar, Raj Bagh, Jawahar Nagar, and Gogji Bagh were all submerged underwater. Some low-lying areas in the Srinagar city like Rajbagh, Kursoo and Jawahar Nagar remained under floodwater for over 4 weeks. In many areas, the speed with which the water entered the city was alarming, giving no time for residents to flee or plan for evacuation before being trapped by gushing floodwater. Figure 3 shows the situation during the flood (Refer Figure 3)

The magnitude of catastrophe prompted the Govt. of India to declare it as a 'National Disaster'. An estimate is that the flood caused losses worth INR 40,000 crores (Srinagar Municipal Corporation, 2015). A preliminary survey by the Government revealed that in worst-hit regions of Kashmir, 2.60 lakh structures got damaged with 95,000 houses in Srinagar alone.

As per Srinagar Municipal Corporation (SMC) data, by 7th September, out of the total of 34 municipal wards, 12 wards were fully submerged (Refer Figure 4). These wards are mostly located along the flood channel, River Jhelum (its

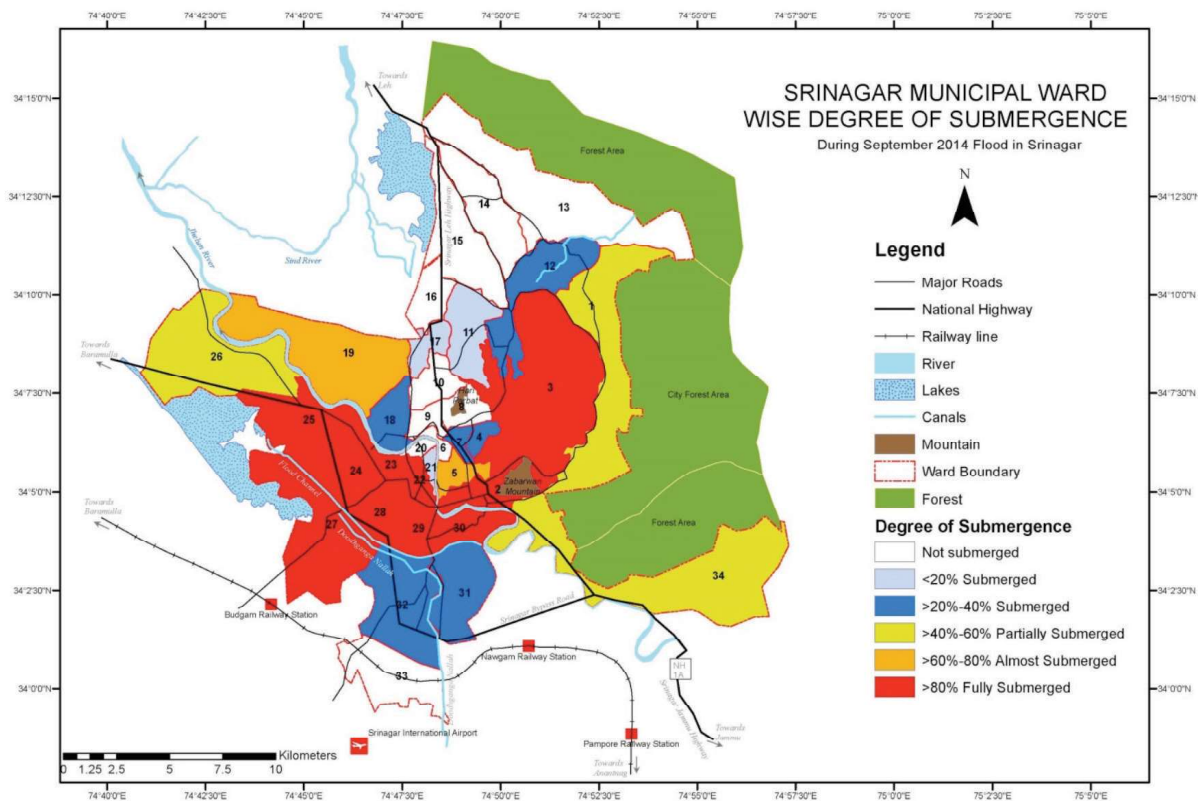


Figure 4 Ward wise degree of submergence in Srinagar during the 2014 flood

Source: Prepared by IRADe

other tributaries/canals) and the Dal lake. 7 municipal wards were partially submerged. Seventy-seven percent of the city area was inundated, out of which, 47% of the area was fully or partially affected. (Refer Figure 5 and 6).

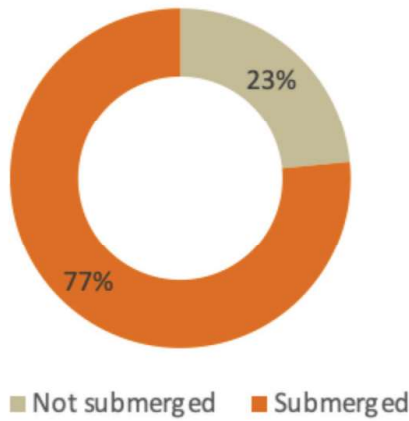


Figure 5 Area under water in Srinagar during flood

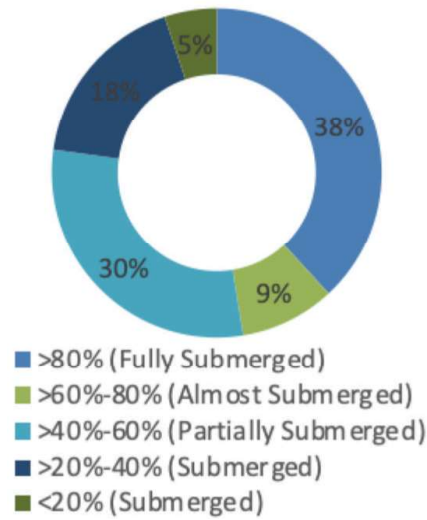


Figure 6 Proportions of areas of land submerged during the Srinagar flood

Source: Prepared by IRADe

2.1 Effect on Critical Infrastructure

All emergency services and critical infrastructure like roads, transport, water supply, hospitals, power, fuel, and telecommunications were paralyzed in the city. Roads and bridges were either damaged or were washed away (Refer to figure 7 and 8), resulting in shortage of medicine and allied provisions. Breakdown of telecommunication and power was directly impacting the relief measures. The dearth of clean portable water caused severe health threats. Most hospitals like SMHS (Shri Maharaja Hari Singh) hospital, Government Medical College, SKIMS (Sher-e-Kashmir Institute of Medical Sciences) Medical College in Bemina, LD (Lal Ded) Women Hospital, Children Hospital and Bone Joint Hospital were flooded, causing the patients to be evacuated/ relocated. This resulted in a virtual collapse of health-related infrastructure in the city.

The only functional hospitals were Sher-e-Kashmir Institute of Medical Sciences (SKIMS), Soura, Jawahar Lal Nehru Memorial Hospital (JLNMH), Rainawari and Chest Diseases Hospital, Drugjan Buchwara (located on hillocks, however was rendered inaccessible due to flooding of the entire surroundings and connecting roads). SKIMS, A Tertiary Care Hospital at Soura, bore the brunt of the entire patient load including the patients who were relocated from inundated hospitals of the city (Refer to Figure 9). The condition was worst for the patients who were on life support systems, suffering from chronic and life-threatening diseases, patients with medical emergencies and pregnant women.

Schools and colleges remained closed as floodwater damaged the buildings and its infrastructure. Srinagar-Jammu Highway (lifeline for Kashmir and Ladakh) part of NH 7, was damaged at many places, due to deluge and with heavy landslides on the 300 km long highway.

Seventy percent of the core area of Srinagar got submerged under flood water and the minimum recorded highest flood level (HFL) was between 10 to 20 feet. The administrative centres like Civil Secretariat, Divisional Civil / Police Headquarters, SMC head office, police control room, District Administrative head offices, major hospitals, and fuel stations were all submerged, leaving the people and the authorities scattered and disconnected (Refer to Figure 10). The J&K High Court Complex along with Lower Court Premises at Momina Abad, Bemina in the city came under floodwater.



Figure 7 Inundated Batmaloo -Qamarwari road near Civil Secretariat, Srinagar



Figure 8 Municipal Transport Yard (Tattoo Ground), Batmaloo

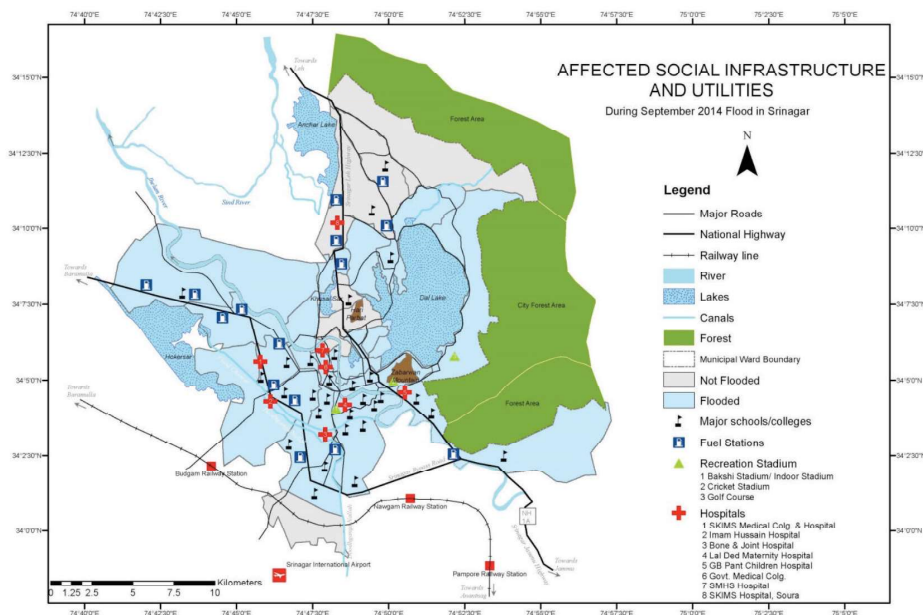


Figure 9 Map showing affected Infrastructure and Utilities during the flood

Source: Prepared by IRADe

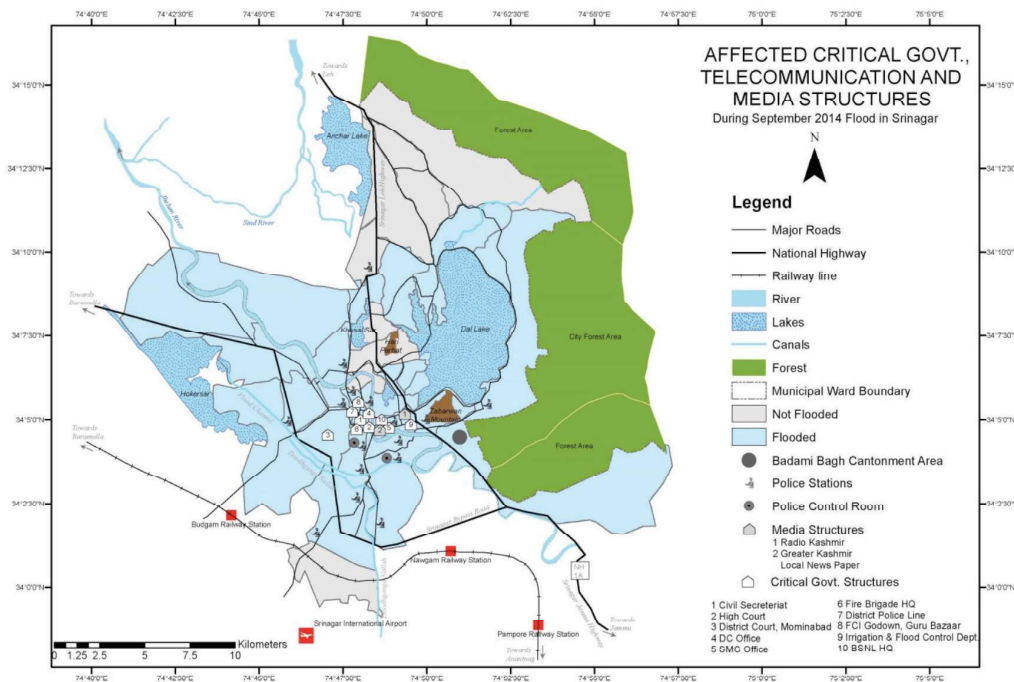


Figure 10 Map showing affected Government Structures

Source: Prepared by IRADe

3. POST FLOOD CHALLENGES- A FEAR OF EPIDEMIC OUTBREAK

After the rescue operations, the water level in deluged areas started to recede, exposing huge mounds of silt, mud, and stinking waste. SMC pooled in heavy-duty dewatering pumps (number of them dispatched from other states, Govt. of India corporations and Industrial houses) to de-water the low-lying areas. Besides the existing stationary dewatering stations (76 in number), most came under floodwater and needed immediate revamping and repairs. The fleet of SMC vehicles of all sizes and utility needed immediate repairs at the SMC Truck Yard at Tattoo Ground Batamallo, which was also under 3-4 feet flood water for less than one week. SMC, had a policy of updating readiness focusing on building middle-level leadership, training of the field staff including working during nights, vehicle repairs, operation of its dewatering pumping stations, and timely procurement and safe stocking of materials. SMC had procured and stocked safely 15,000 litres of diesel oil on the late evening of 6th of September, 2014. It was because of this diesel oil that initial rescue, relief and SMC operations were facilitated, for at least two weeks after September 7.

As the water started receding, Srinagar presented a very grim picture of blocked roads, lanes, bye lanes full of mud, garbage and malodor. Hundreds of tons of stinking garbage had piled up all over the flooded areas and more was expected to be thrown on roads as the exercise of cleaning homes, offices, and shops had started in areas that were out of submergence or were partially submerged. A huge quantity of post-flood trash and garbage, including collapsed buildings, mixed rotten house-hold items, food stocks, sewage waste, animal carcasses

and rotten packaged food items, threatened public health at large. Dewatering Pumping stations were totally blocked with garbage, dirt and siltation and needed immediate cleaning/drying and repairs of electromagnetic parts.

At Chattabal, Bemina (the Army Dairy Farm), hundreds of dead cattle were scattered within and outside the dairy farm premises, which posed a threat of an eminent epidemic in the city. (refer Figure 11). The city sanitation, waste collection and disposal operations had to begin on war footing as the first priority of the SMC. It was at this point, that SMC took the charge of the situation to take on this challenge head on. Thus, began the operation “Mission Clean Srinagar”.



Figure11: Images showing pile of garbage and dead animals and damaged buildings

Source: SMC, 2014

4. TACKLING POST FLOOD CHALLENGE

Initial steps of this mammoth and ambitious clean-up task was not easy as SMC’s central office, sub offices, ward offices, and transport yard were under water. Vehicles parked at Municipal Transport Yard were also damaged. Breakdown in communication had further complicated the problem as people were stranded without any source of communication. Amidst these challenges, SMC had to begin the sanitization and cleanliness operations immediately. Army provided satellite phones and CDMA communication sets to the Civil administration. Jammu and Kashmir police’s telecommunication wing, provided hand held communication sets to the SMC officers including fixed communication units on the vehicles. SMC municipal commissioner was also provided a satellite phone.

4.1 Operational Strategies

The measures adopted to provide post flood relief can be summarized by the following five steps (in their given order):

- Setting-up teams and assigning responsibilities
- De-odorizing/Disinfecting Strategy

- Lifting and disposal of garbage and animal carcasses
- Thorough cleaning of public and private premises to remove the accumulated soil
- Fogging and spraying of disinfectants

a) Setting-up teams and sub-teams

As an immediate step, the cleaning operation for Srinagar city was launched without any major resources such as equipment, vehicles and manpower. Under the supervision of Commissioner, SMC the operation began at the earliest and they were assisted by the Municipal Secretary from a makeshift office located at Buchpora in the northern part of Srinagar. Three to four days after the flood, a small group of employees managed to find their way to the SMC makeshift office, which later grew to a large group of around 3000 personnel's (Officers, engineers, technicians, and field staff) and an equal number of temporary sanitation staff. As the water level began receding on September 11, SMC established its Camp Office at its Truck Yard at Tattoo Ground, Batmaloo.

The expert teams supervised operations in various flood ravaged municipal wards, with the Ward Officers directly reporting to the respective team heads for drawing out required support for men, materials and machinery (Figure 12). The following units constituted the Special task groups:

- Hiring and Vehicle Deployment Unit
- Vehicles Repairs and Overhauling Unit
- Management and Procurement Unit
- Animal Carcasses Removal Unit
- Cleaning and Sanitation Unit
- Application of Disinfectants and Deodorizing Chemicals Unit
- Data analysis and recording Unit



Figure 12 The team of workers for the Cleaning Operation

Source: SMC, 2014

b) De-odorizing/ Disinfecting Strategy

As the putrefied garbage comprising of household items (also collapsed building materials), sewage, decomposed food items, commercial food stocks (including that of Food Corporation of India) and big/small animal carcasses (over 1,685) started stinking, it made cleaning and sanitation operations almost difficult. Thus to start working on the ground it became necessary to remove and disinfect the putrefied waste material and control the foul smell. Liberal use of disinfectants, phenyl (including black phenyl) and an anti-odor/deodorising formulation Sanitreet - were used profusely. Tetanus Toxoid and Hepatitis-B injections were administered to the entire workforce and supervisors to ensure further safety (Refer figure 13). Mass distribution of chlorine tablets was undertaken by the Health Department and SMC health officer for mixing with drinking water, to check the possible spread of water-borne diseases in Srinagar City.



Figure 13 Workers being vaccinated

Source: SMC, 2014

c) Lifting and disposal of garbage and animal carcasses

For the operation, “Mission Clean Srinagar”, SMC used over 5000 employees, 200 machines (JCB’s, bulldozers, trucks, loaders, garbage compacters etc.) including a large number of trucks from the non-flooded areas and sanitation tools including disinfectants and anti-odour treatment. The field staff was provided safety clothing, gloves and gumboots. At various locations in Srinagar, SMC organized resting rooms with adequate provisions of clean water and hot meals (Dal and rice).

The sanitation work was thus carried out day and night without breaks. During the operation, 85,157 metric tonnes of waste materials was collected, involving around 17,836 truck trips to the city landfill site at Achan, Srinagar. 11.90 lakh

litres of disinfectants and 29,500 kgs of anti-odour formulation -Sanitreet was used to achieve a reasonable level of cleanliness, odour control and liveability. 1686 animal carcasses were carefully picked up (with hugely swollen bodies) and disposed, as per standard protocol. The strategic location of landfill site at dry elevated area added great advantage to these operations, as it was free of any inundation. The problems would have multiplied had this landfill site got affected with flood. The SMC landfill site at Achan, Saidapora has been developed by Jammu and Kashmir Economic Reconstruction Agency (J &K ERA) under the financial support of Asian Development Bank.

During normal days SMC lifts daily 200 to 300 MT of garbage, but during post-flood operations, the quantity of garbage and waste collected increased from 48MT on September 11, 2014, to 2422 MT by October 3, 2014. An average of 1051 MT's of waste was lifted daily which was almost 5 times more than the usual quantity. On a normal day, the usual trucks carrying garbage make 7,542 trips to the landfill site but after the flood 17,836 trips of trucks to landfill sites were recorded which is almost three times more than usual (Refer Figures 21). The team also lifted 320 dead cows from Bemina Dairy Farm (Refer Figure 15) within 48 hours by working round the clock, using robotic arms, JCBs, highly specialised loaders and hydraulic tippers (Refer Figure 16). Little more than a month was taken to collect and dispose of most of the garbage.

A total of 1685 animal carcasses (687 small and 998 large) were removed and disposed-off from the city (Refer figure 14, 15). These animal carcasses were buried and to augment decomposition process, chemicals like lime and Bioculum were used. Within a week, most of the animal carcasses were disposed. Awareness related to the disposal of small dead animals at household level was disseminated. Many notable officials, public representatives, trade unions and media representatives also visited the city to witness post flood cleaning operations and rehabilitation works.



Figure 14 Floating Animal Carcasses and accumulate garbage

Source: SMC, 2014

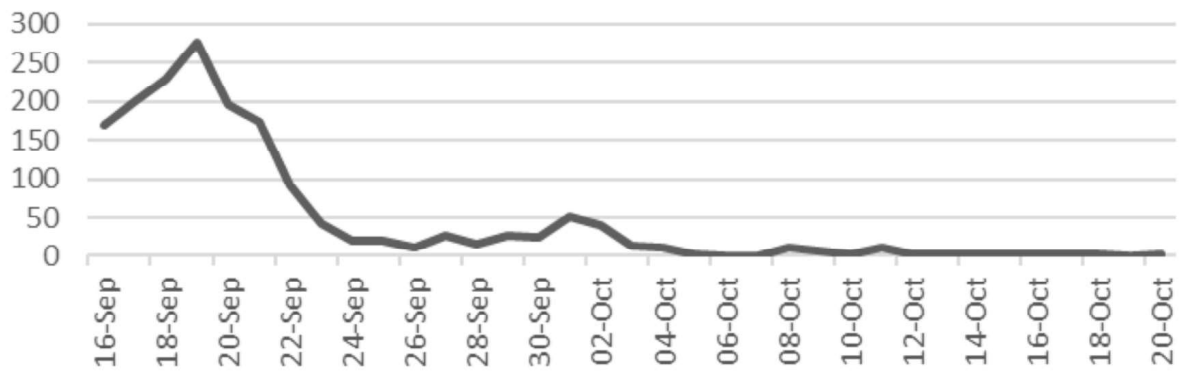


Figure 15 Number of animal carcasses lifted in two months

Source: SMC, 2014



Figure 16: Fleet of trucks and JCBs to lift the waste

Source: SMC, 2014



Figure 17. Thorough washing

Source: SMC, 2014

d) Thorough cleaning to remove accumulated soil

As garbage and animal carcasses were removed, mud and sludge still remained which could become a breeding ground for all sorts of harmful microorganisms. After disposing the garbage and animal carcasses to landfill site, the next task was to remove the thick layer of accumulated soil, by thorough washing and cleaning which if left unattended would cause respiratory tract disorder and other unwanted diseases. (Refer Figure 17)

e) Fogging and Spraying of disinfectants

Removing the accumulated soil and muck was followed by fogging and spraying of disinfectants covering the 100 percent households in the flooded areas. The city was disinfected using liberal quantities of disinfectant chemicals and phenyl. Fogging was done using Corporation’s battery fogging machines. SMC widely used various other insecticides and antibacterial sprays including anti-odour formulation - sanitreat, lime powder, and Methanol while cleaning of Hospitals, Government Offices, Colleges and Schools, Civil Secretariat, High Court Complex, roads and lanes, in order to ensure a full disinfectant cover and high-quality cleaning.

To disinfect individual houses, people were provided a liberal supply of black phenyl and anti-odour formulation.

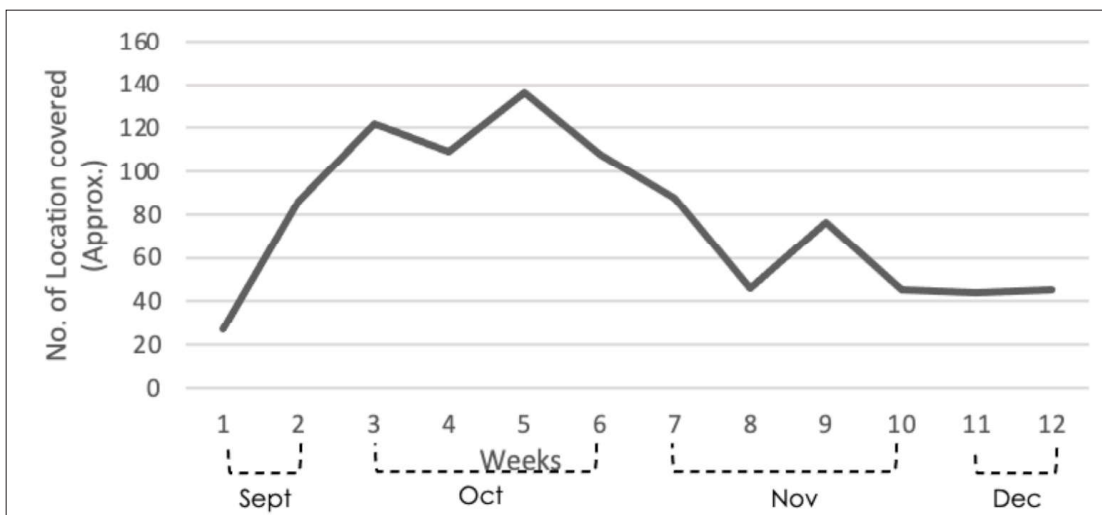


Figure 18 Weekly progresses in spraying of disinfectants during Sept-Dec 2014

Source: SMC, 2014

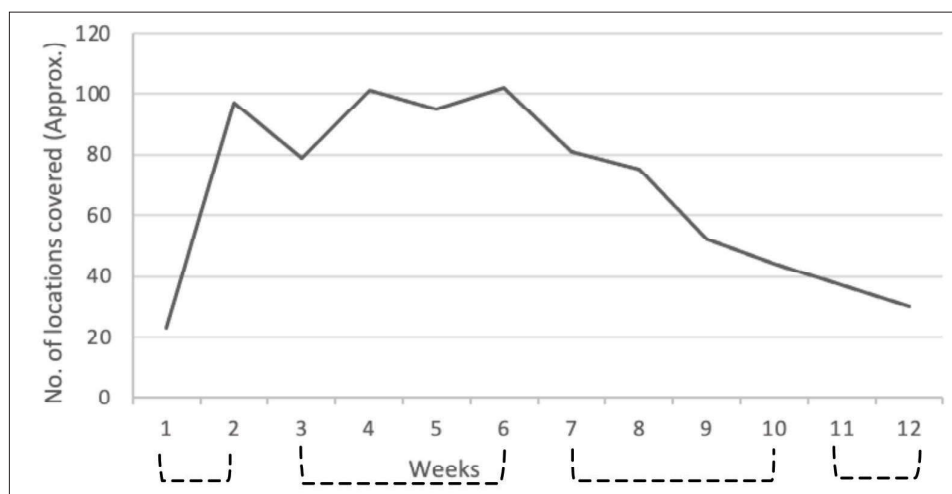


Figure 19 Weekly progresses in fogging the areas during Sept-Dec 2014

Source: SMC, 2014

Above graphs (Refer Figure 18, 19) show that most parts of Srinagar city were covered with fogging and spraying disinfectant in the month of October (Refer figure 20). Daily basis spraying of disinfectant and fogging in flood affected areas started picking up by the first week of October. For safe drinking water, State Health Department further distributed Chlorine tablets from their central offices to the workers and the public.



Figure 20.

Source: SMC, 2014

As cleaning and sanitisation progressed, SMC team worked round-the-clock without any pause and in a short span of time, getting the city life back to normalcy, an effort that was highly appreciated by the public. Figure 21 shows the graph of Garbage collected and daily truck trips to the landfill site. Table 2 enlists the achievements of SMC during sanitation drive.

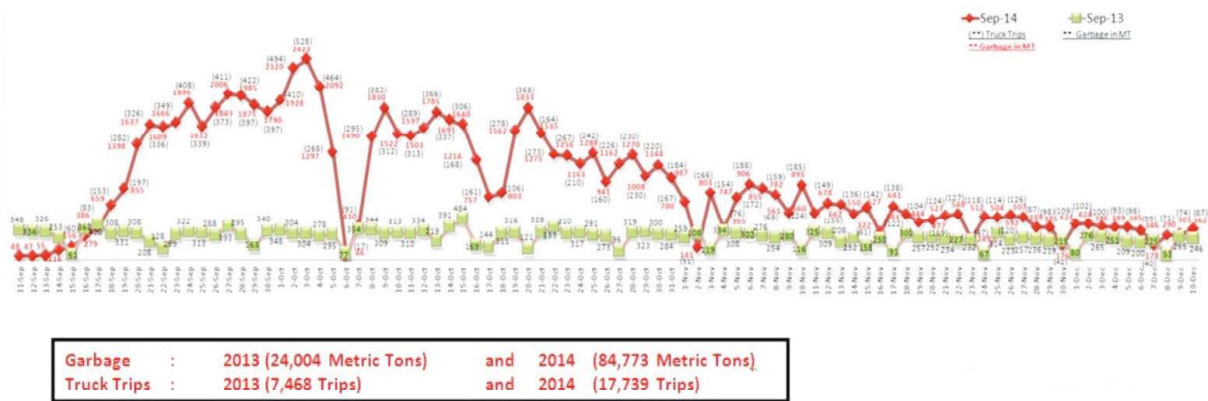


Figure 21 Garbage collected and Truck trips

Source: SMC, 2014

Post Flood Waste Management initiatives from 11 September- 12 th September- 10 th December 2014	
Garbage collected and Disposed off	84773 Metric Tons
Truck trips to land fill site (Achan)	17739

Disinfectants and other chemicals used	59540 liters
Anti-Odour Formulation (Sanitreat) used	29500 kgs
Animal Carcasses disposed	1686 (Small- 687, large 999)
Source: SMC, 2014	

Table 2 Achievements of SMC sanitation drive during September 2014, Srinagar flood

f) Outcome of the Operation- a Full stop to Epidemic Outbreak

The biggest outcome of the operation “Clean Srinagar” was the prevention of disease and epidemic. No case related to chest infection or water borne disease was recorded, as reported by the Director of Sher-e-Kashmir Institute of Medical Science, Soura. The director appreciated the commendable work done by the SMC and stated that the efficient removal and disposal of garbage and dead animals helped in achieving this. The process was so quick and efficient that senior military officers, notable citizens of society and tourism operators from flood affected areas acknowledged and praised these efforts. The operation “Clean Srinagar” was thus the biggest ever sanitation and cleanliness drive in Srinagar city.

The India Today report published on December 1st, 2014, ranked Srinagar city at ninth spot for cleanliness. Efficient post-flood management practice enabled the city to secure its place in the list of top 10 cleanest cities in the country.

5. CONCLUSION

Despite limited resources, the success of the “Operation Clean Srinagar” can be accounted to the following factors

- **Strategic location of landfill site:** A well-constructed Scientific Landfill Site, strategically located at Achan, Saidpora, Srinagar was away from any risk of inundation due to flood. It is equipped with a computerised weighing bridge, keeping a full record of waste and movements of the garbage trucks. It comfortably accommodated over 85,000 kg of post flood waste in less than two months.
- **Availability of Right Equipment:** As the flooding had caused heavy damage to the infrastructure, the heavy capacity dewatering pumps, fogging machines and disinfectants /anti-odour formulations were organised by the state Government Authorities from Delhi and in support from other states and Industrial houses.

- **Community engagement through social media:** Immediately after the mobile telephones and internet was restored, use of Facebook (social media) was encouraged and SMC kept the public and outside world updated about the progress on handling the sanitation and cleanliness crisis. An interactive exchange was taking place on Facebook where people were posting alerts, grievances and suggestions on SMC Commissioner's Facebook page and steps to tackle individual problems were also being suggested.
- **Leadership and management:** The team SMC was well trained and motivated. The team worked under the leadership of experienced persons and efficiently handled the post flood crisis of sanitation and cleanliness operations.
- **Liberal use of Chemicals:** Liberal use of Baygon, phenyl (including black phenyl) and an anti-odour/deodorising formulation Sanitreet - were used to fight the odour and to disinfect the affected areas.
- **Proactive Planning:** As part of the planning strategy, 15,000 litres of diesel was already stored to prepare for this calamity. It was because of this that initial rescue, relief and SMC operations were facilitated.

Acknowledgement

The operation "Mission Clean Srinagar" was made possible by the efforts of the selfless staff of the SMC, who contributed immensely beyond call of duty, particularly the officers, officials, Engineers, Technicians, drivers, and Fieldworkers. The success story of this mission shall be elaborated further in the voluminous body of written work to come. We extend our sincere thanks to Dr. Jyoti K Parikh, Executive Director, IRADe and Dr. Kirit Parikh, Chairman, IRADe, their guidance and support throughout the course of this study.

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