ETH zürich

CDRP – Climate Disaster Recovery Process in Chennai

Summary Report

Zurich, Switzerland, December 2017

University of Madras

About the Initiative

The Climate Disaster Recovery Process Initiative for Chennai is an umbrella project of the Climate Policy group of ETH Zurich. This initiative builds on earlier work conducted between 2009 and 2012 as part of the Climate Disaster Resilience Initiative. This current research project was developed in cooperation with the University of Madras and with support from the Greater Chennai Corporation, the Revenue Administration of the Government of Tamil Nadu, MLA offices of Mylapore and Velachery constituencies. A full master thesis of this research project is available upon request.

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Executive Summary

After an unusual period of prolonged intensive rainfall caused by a coincidence of the northeast monsoon (October-December) and the El Niño, Chennai was badly affected by the 2015 South Indian floods. As Chennai is built around a former lagoon andis thus located at the end of a series of water bodies, it is vulnerable to excessive periods of rainfall. Since the catchment areas in Kanchipuram District were already filled-up by the end of November 2015, the relentless downpour of rainfallon December 1, 2015, triggered the floods and forced the city to stand still. On this day in average and citywide 286mm of rain fell within 24 hours[1] and the catchment areas of Adyar and Cooum received about 490 mm of rain. The amount of rain recorded on December 1 was the highest in 100 years[2]. Damages were estimated at USD 3 billion and 301 casualties were recorded in Chennai.

In response to this disaster, we assessed the recovery process 10 months after through a household survey in two equally exposed (coastal) constituencies, Mylapore and Velachery. The objective was to understand how the physical, social and economic conditions of the city recovered following this disaster event. Furthermore, we looked at the interplay between communities and authorities in the recovery process. Following the household survey, survey validation meetings were held with residents of Velachery (June 29, 2017) and Mylapore (June 30, 2017).

Key findings from this study include:

- Residents living in low-land (marshland) and newly built areas in Velachery were more affected by damages (houses, household assets, health) compared to residents living in the older part of Chennai (Mylapore). The median damages per household wereINR 30,000 in Mylapore and INR 50,000 in Velachery.

- The recovery time (average) for basic services (electricity, water, sanitation, solid waste management, roads and communication) took about seven days in Mylapore and around 14 to 21 days in Velachery. Housing took in average 22 days in Mylapore and 33 days in Velachery to be rebuilt.

- The recovery time for socio-economic factors (physical health, mental health, employment, household income, education, household assets, etc.) took longer to be restored compared to the physical items. For example, mental health took in average up to four months to be recovered and household income losses more than three months in both areas.

- While physical items took longer to be recovered in the more affected area (Velachery), socio-economic factors took equally long to be restored in Mylapore and Velachery.

- The level of satisfaction about the recovery process did not differ between residents living in Mylapore compared to Velachery. Therefore, the recovery time does not correlate with the level of disaster affectedness.

- Residents in the more affected area (Velachery) became more active to be better prepared (stock emergency supply, make their home flood proof, get informed about flood mitigation options, etc.) for a future flood disaster compared to residents in the less affected area (Mylapore).

- Residents in the more affected area (Velachery) also become more solidary compared to residents in the less affected area (Mylapore). For example, more residents participate in a volunteer group, talk to other members of their community and request assistance from neighbours.

- Residents in both areas showed equally high willingness (around 90%) to become part of the recovery planning process.

- The absence of a needs assessment and limited involvement of residents in the recovery planning process are key areas where the interplay between residents and authorities needs to be improved in the future.

- Overall, this study summarises that the efforts by the various governmental agencies were effective in restoring physical, social and economic items.

Foreword message

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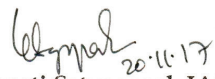   94450 00444

FOREWORD MESSAGE

Tamil Nadu is vulnerable to a number of natural & Man-made hazards of varying intensities. Droughts, Floods and Cyclones have been affecting the State frequently and have become complex to deal with, and more so in the context of the Climate Change. The Floods of December 2015 was an extreme weather event of epic proportions. In the month of November 2015, Chennai has reported 1,024 mm (40.31 inches) of rain, more than 300 percent of the normal rainfall that is expected for the entire month, according to the Indian Meteorological Department (IMD). December 2015 also continued this wet pattern as more than 300 mm (12 inches) of rain fell in Chennai on the first day of the month. This is the wettest December day in more than 100 years of records in Chennai. The unprecedented devastation was managed through the efforts of Government Machinery, Central forces, NGOs and the Community.

I appreciate the efforts of Research Teams led by Prof.R.R.Krishnamurthy of the University of Madras and Dr.Jonas Joerin of ETH Zurich, Switzerland, to study the "Climate Disaster Recovery Process in Chennai". The focus of this study is to compare the recovery process of Velachery (more affected) and Mylapore (less affected) through house hold assessments. The study attempts to assess the Community Perspectives and their level of participation in the recovery process. Velachery's problems are compounded because of its locational disadvantage. Being in the lower end of a series of water bodies, the accumulated surplus flows from the upper catchment areas towards Velachery. Location of Velachery adjoining the flood bowl of Pallikaranai Marshland makes it even more vulnerable.

The Report highlights how the Community became very responsive and co-operative in dealing with various operations of rescue, evacuation and demonstrated its solidarity with fellow citizens and Government. This element of community's willingness in responding on occasions of emergencies has to be nurtured and harnessed during non - disaster periods also by the Government departments, Greater Chennai Corporation and Local Bodies as well as NGOs. Proper Land Use, Solid Waste management, Waste Water Recycling are issues that will increase the resilience of the City.

I am sure, the outcome of the study will help all of us to minimise and mitigate risks of disasters and prepare communities to handle the future disasters with much more resilience.

Chennai – 600 005
20.11.2017

Dr. Korlapati Satyagopal, IAS.,
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Introduction

After an unusual period of prolonged intensive rainfall caused by the coincidence of the north-east monsoon (October-December) and the El Niño, Chennai was badly affected by the 2015 South Indian floods. A relentless downpour of rainfall forced the city to stand still on December 1, 2015 after in average and citywide 286mm of rain fell within 24 hours [1]. Damages were estimated at USD 3 billion and 301 casualties were recorded in Chennai. The airport and basic services stopped functioning, e.g. communication lines and electricity were interrupted. Figure 1 highlights how the 2015 South Indian floods unfolded and affected Chennai.
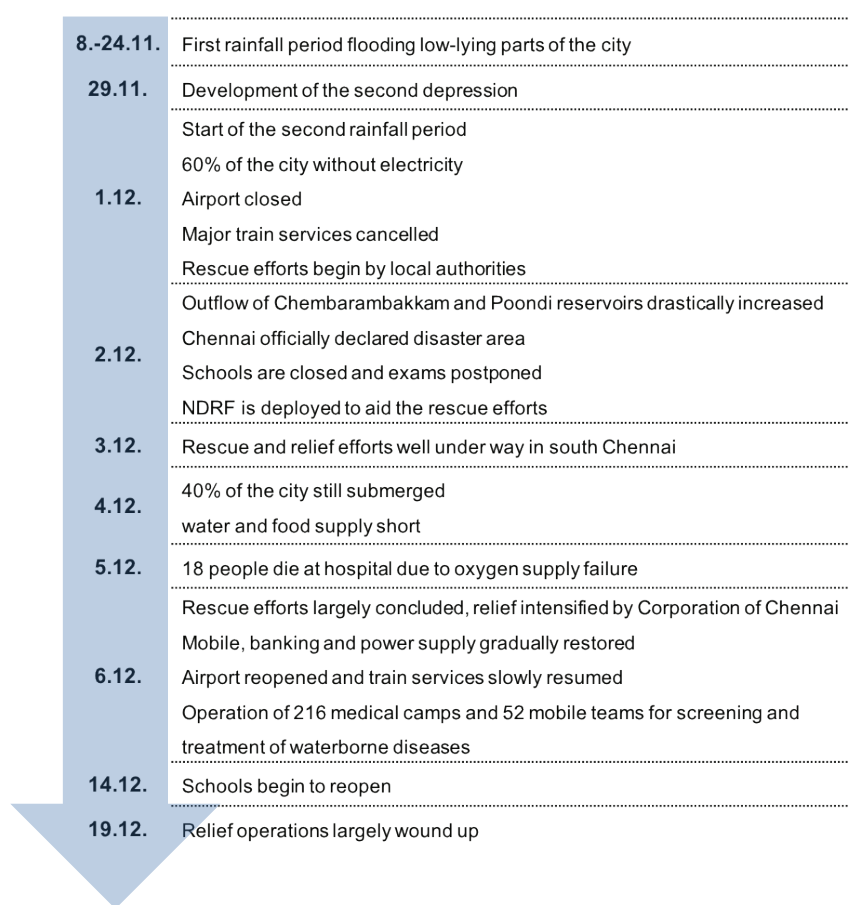
The 2015 South Indian Floods in Chennai

8.-24.11.	First rainfall period flooding low-lying parts of the city
29.11.	Development of the second depression
1.12.	Start of the second rainfall period
	60% of the city without electricity
	Airport closed
	Major train services cancelled
	Rescue efforts begin by local authorities
2.12.	Outflow of Chembarambakkam and Poondi reservoirs drastically increased
	Chennai officially declared disaster area
	Schools are closed and exams postponed
	NDRF is deployed to aid the rescue efforts
3.12.	Rescue and relief efforts well under way in south Chennai
4.12.	40% of the city still submerged
	water and food supply short
5.12.	18 people die at hospital due to oxygen supply failure
6.12.	Rescue efforts largely concluded, relief intensified by Corporation of Chennai
	Mobile, banking and power supply gradually restored
	Airport reopened and train services slowly resumed
	Operation of 216 medical camps and 52 mobile teams for screening and treatment of waterborne diseases
14.12.	Schools begin to reopen
19.12.	Relief operations largely wound up

Figure 1
Timeline of the 2015 South Indian floods in Chennai

The severity and unprecedentedness of such an extreme flood event in Chennai, called for a thorough assessment to understand to what extent the city could recover from this disaster. Hence, the key objective was to better understand the physical, social and economic drivers of recovery following a flood disaster event. Furthermore, we looked at the interplay between communities and authorities in the recovery process.

Goals of study

Methodology

Few studies exist that quantitatively assess disaster recovery processes [3, 4]. Hence, this study aims to contribute to the understanding of the factors driving recovery processes. For this purpose, we selected two adjacent constituencies (Figure 2) with equal coastal exposure and inclusion of water bodies (e.g. Adyar river, canals in Mylapore and basins/lakes in Velachery). However, Mylapore forms part of the old town of Chennai whereas Velachery was just developed during the last two decades and contains marshlands. The population of Mylapore is about 300,000 and 600,000 in Velachery.

We identified households in both areas through a stratified random sampling process. In total, 257 households in Mylapore and 264 households in Velachery were surveyed during October and November 2016. The content of the survey included questions that are typical to a post-disaster needs assessment, such as the provision of basic services (e.g. electricity, water, sanitation, housing, etc.) and socio-economic factors, such as household income, employment, household assets, education, health, nutrition, etc. For all these factors, we asked households how long they needed to recover and whether the services/factors were better, the same, or worse than before. Additionally, we asked residents whether they became more active, solidary and engaged in their communities following this disaster.
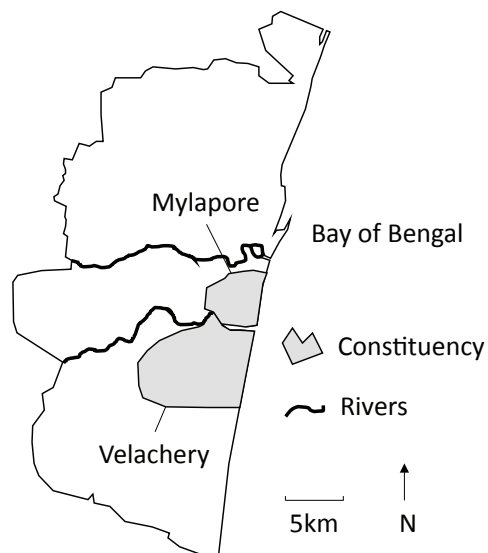

Figure 2
Study area: Mylapore and Velachery

The analysis of the survey focused on comparing the responses between the two constituencies through statistical tests, including Mann-Whitney-Wilcoxon tests. Descriptive analysis, including boxplot analysis, complemented the tools on how to extract relevant information from the survey data. Validation meetings with residents from the affected constituencies served to verify the analysed results.

Results

Among the surveyed households, the median of the total recorded damages (damages on house, household assets and health) was INR 30,000 in Mylapore and INR 50,000 in Velachery. As Figure 3 shows, around 75% of the households in Mylapore recorded damages below INR 60,000. In contrast, the same proportion (75% of the survey respondents) of households in Velachery recorded damages up to INR 100,000. This highlights that households in Velachery were considerably more affected by the 2015 South Indian floods compared to Mylapore.
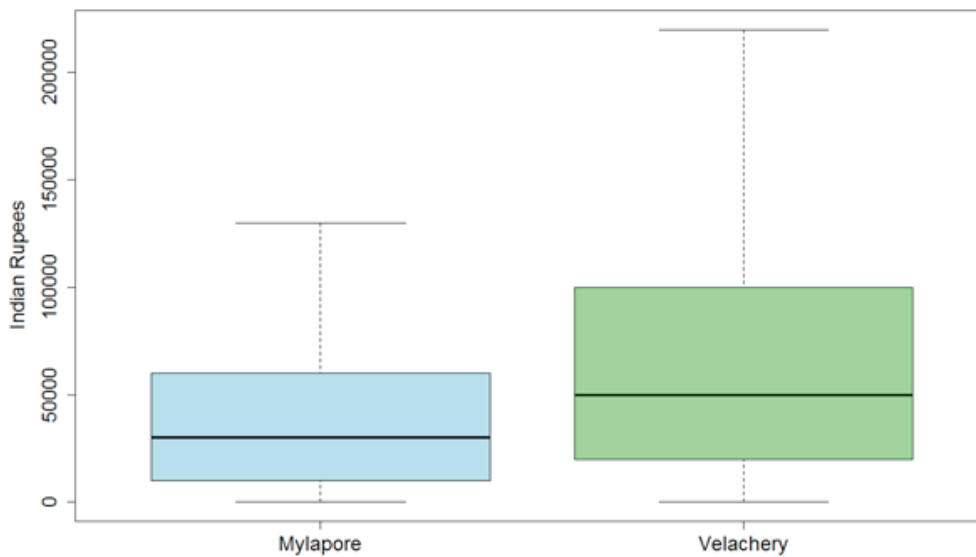
Damages on households

Figure 3
Total median damages in Mylapore and Velachery

The reason for this is largely because the floods were higher in Velachery (as high as 3m above the ground) compared to Mylapore. A lack of effective drainage systems, particularly in Velachery, is one of the key reasons why the water could not run off. Furthermore, Velachery is located in a low-lying area with marshlands. The damage structure (Figure 4) shows that a majority of the damages was attributed to damages on houses and a slightly smaller fraction was recorded on destroyed household assets.

A somewhat weak correlation was found with the Pearson's product-moment correlation for the variables 'annual income' and 'total damage costs' (p = 0.006, r = 0.136), indicating that households with higher annual income also suffered from higher damages. Moreover, Kendall's tau correlation between the variables 'education' and 'annual income' (p = <2.42e-14, tau = 0.298) show (weak correlation) that households with higher annual income also tend to have higher education. A significant correlation between the lev-

el of 'education' and 'total damage costs' could however not be found. This highlights that the level of education is not decisive in whether households are affected (household damage-wise) by a natural hazard, such as a flood. Mylapore – compared to Velachery - has a higher proportion of non-educated people (32.27% in Mylapore and 16.87% in Velachery) and also a lower proportion of college-educated people (24.30% in Mylapore and 40.16% in Velachery). This shows that the level of education did not prevent households from being affected by the floods.
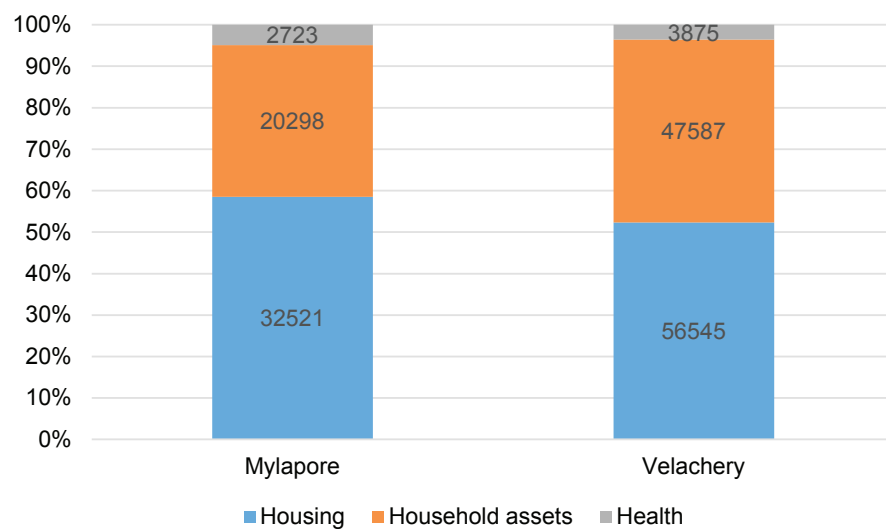

Figure 4
Damage structure (median values in INR) in Mylapore and Velachery

Therefore, the main reason for why households were affected must be attributed to their actual exposure to the floods. The fact that the damage structure (Figure 4) does not vary between the two constituencies confirms that the level of education cannot serve as an explanation for why households suffered from damages on their house, household assets and health.

The offer by the Tamil Nadu State government for damage compensation was collected by 75% of the surveyed households. Among the 25% who did not receive damage compensation, half responded that they did not need it and the other half said that they did not receive it.

In this study, the primary objective was to better understand the flood recovery process. Table 1 shows that for physical items the recovery time differed between Mylapore and Velachery. It took less time for Mylapore (less affected) to recover the provision of electricity, water, communication, sanitation, roads, solid waste management and housing.

Regarding the quality of the physical items, households in both constituencies overwhelmingly perceived that the physical items were in a better condition (recovery outcomes) after the recovery compared to before the floods. We interpret this in two ways: either households were genuinely satisfied with the recovery process, or they were already happy if somehow the physical items functioned again and were not worse than before. During the validation meetings, residents urged for greater investments into basic services and the infrastructure. This confirms the second interpretation that households were already satisfied if the previous level of functionality got achieved. Thus, both constituencies still need to invest in making their neighbourhoods further flood proof against future similar events.

Recovery process – Physical dimension

Table 1
Physical recovery of Mylapore and Velachery [5]

Item	Mylapore	Velachery
Electricity (affected in %)	99.61% (n=256)	99.62% (n=263)
Recovery outcomes (0 no recovery – 3 better): Days of recovery: median; mean; stand. dev	2.59 7; 7.16; 5.77	2.72 7; 12.75; 16.08
Water (affected in %)	98.44% (n=253)	92.80% (n=245)
Recovery outcomes (0 no recovery – 3 better): Days of recovery: median; mean; stand. dev.	2.60 7; 6.89; 6.35	2.71 7; 16.74; 31.08
Roads (affected in %)	99.61% (n=256)	96.97% (n=259)
Recovery outcomes (0 no recovery – 3 better): Days of recovery: median; mean; stand. dev.	2.56 7; 12.23; 32.69	2.58 10; 20.22; 39.21
Sanitation (affected in %)	99.61% (n=256)	90.53% (n=239)
Recovery outcomes (0 no recovery – 3 better): Days of recovery: median; mean; stand. dev.	2.55 7; 7.74; 6.19	2.60 7; 18.08; 33.11
Solid waste management (affected in %)	98.44% (n=253)	93.93% (n=248)
Recovery outcomes (0 no recovery – 3 better): Days of recovery: median; mean; stand. dev.	2.59 7; 7.84; 6.42	2.57 7; 21.25; 44.55
Communication (affected in %)	99.61% (n=256)	98.48% (n=260)
Recovery outcomes (0 no recovery – 3 better): Days of recovery: median; mean; stand. dev.	2.57 7; 7.46; 5.79	2.69 7; 12.57; 16.12
Housing (affected in %)	80.93% (n=208)	82.95% (n=219)
Recovery outcomes (0 no recovery – 3 better): Days of recovery: median; mean; stand. dev.	2.38 7; 22.44; 49.84	2.56 14; 33; 59.28

Unlike the physical dimension, socio-economic aspects (Tables 2 and 3) show a different pattern in terms of recovery time. While the provision of nutrition and the recovery of household assets took longer in Velachery, education, physical health and access to cultural activities took almost equally long.

Recovery process – Socio-economic dimension

Table 2
Social recovery of Mylapore and Velachery [5]

Item	Mylapore	Velachery
Physical health (affected in %)	28.40% (n=73)	42.04% (n=111)
Recovery outcomes (0 no recovery – 3 better): Days of recovery: median; mean; stand. dev	2.51 7; 24.79; 61.26	2.56 7; 25.43; 32.62
Mental health (affected in %)	1.17% (n=3)	10.60% (n=28)
Recovery outcomes (0 no recovery – 3 better): Days of recovery: median; mean; stand. dev.	2.33 10; 106.70; 167.43	1.67 30; 111.40; 132.33
Nutrition (affected in %)	60.31% (n=155)	59.47% (n=157)
Recovery outcomes (0 no recovery – 3 better): Days of recovery: median; mean; stand. dev.	2.53 5; 5.74; 5.01	2.61 7; 14.73; 24.95
Education (affected in %)	41.25% (n=106)	57.56% (n=152)
Recovery outcomes (0 no recovery – 3 better): Days of recovery: median; mean; stand. dev.	2.34 30; 28..74; 5.74	2.44 30; 29.09; 15.81
Culture (affected in %)	14.01% (n=36)	26.89% (n=71)
Recovery outcomes (0 no recovery – 3 better): Days of recovery: median; mean; stand. dev.	2.06 30; 30.28; 6.17	2.23 30; 36.55; 53.46

Table 3
Economic recovery of Mylapore and Velachery [5]

Item	Mylapore	Velachery
Income (affected in %)	12.06% (n=31)	30.68% (n=81)
Recovery outcomes (0 no recovery – 3 better): Days of recovery: median; mean; stand. dev	2.29 30; 107.60; 132.9	2.14 30; 89.12; 113.55
Employment (affected in %)	0.78% (n=2)	10.60% (n=28)
Recovery outcomes (0 no recovery – 3 better): Days of recovery: median; mean; stand. dev.	2.86 93.5; 93.5; 122.33	2.71 22.5; 29.89; 32.82
Credits (affected in %)	0%	3.03% (n=8)
Recovery outcomes (0 no recovery – 3 better): Days of recovery: median; mean; stand. dev.	NA NA; NA; NA	1.5 165; 159.90; 149.88
Household assets (affected in %)	89.11% (n=229)	77.27% (n=204)
Recovery outcomes (0 no recovery – 3 better): Days of recovery: median; mean; stand. dev.	2.12 30; 38.03; 64.87	2.13 30; 68.44; 90.68

For getting back at previous household income levels, Mylapore took even longer than Velachery. In addition, more households in Mylapore were affected by losses of household assets. This highlights several points: firstly, the recovery time for socio-economic factors was not connected to the magnitude of the floods; and secondly, it took longer (one to three months) to recover socio-economic items compared to physical items.

Similar to the physical dimension, households in both constituencies were satisfied with the recovery process in the socio-economic dimension and felt that the various items were in better condition than before the floods. This confirms again the disconnection between the recovery time and the recovery outcome. This also proves that households differentiated between speed and quality of recovery. Thus, a faster recovery time for a particular item did not translate into greater satisfaction about its recovery outcome

Action

The above findings about recovery time and recovery outcome require the examination of some of the underlying factors of recovery processes. Figure 5 shows that households became more 'active' in response to the disaster. In both constituencies, households increased their preparedness by stocking up emergency supply, making their homes flood proof, insure household assets and getting informed about flood mitigation options.

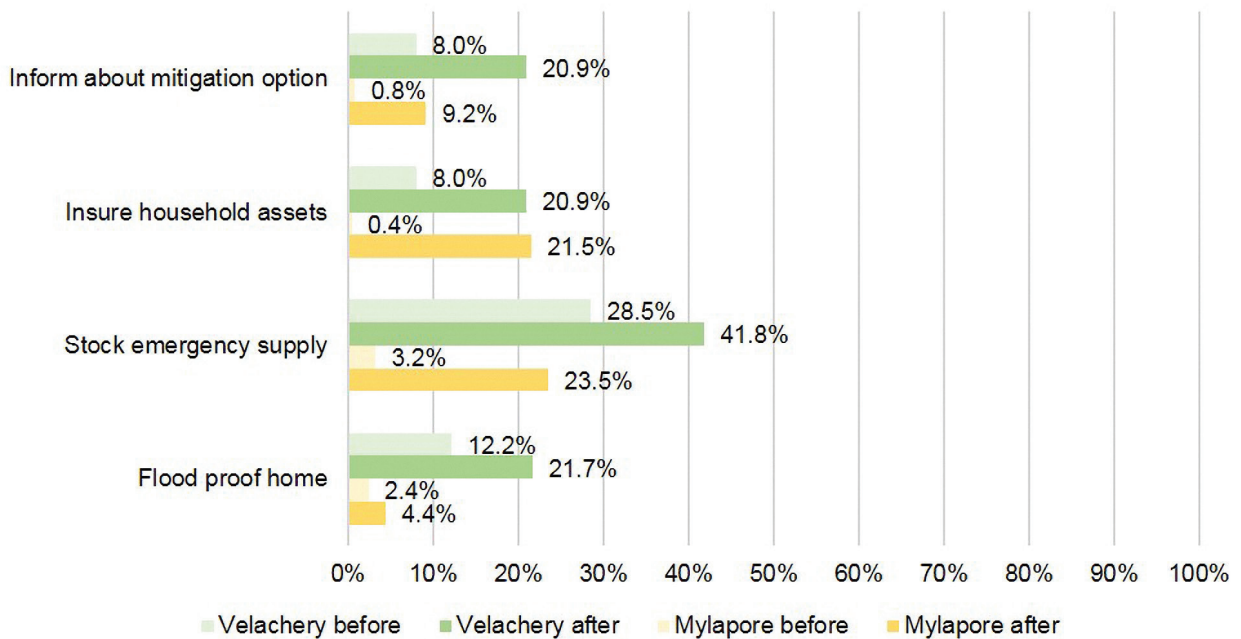**Underlying factors of recovery processes**

Figure 5
'Action' triggered among households in Mylapore and Velachery [5]

Interestingly, households in both constituencies became active, but all the above values are lower in Mylapore compared to Velachery. Although, Velachery is more flood-prone due to its topographic exposure, households in Mylapore continue to be at risk from future flood hazards. The fact that all parts of the city were affected by the floods, although with varying severity, does not require less preparedness against future flood hazards.

Solidarity

Households became as well more solidary (Figure 6) in response to this flood disaster. People increased their willingness to provide help and support to their community members and neighbours. In line with earlier studies [4, 5], more people joined voluntary groups, increased their social cohesion by talking more to each other, and got interlinked. These are signs indicating that this disaster had a positive effect on communities in terms of increasing their social capital.
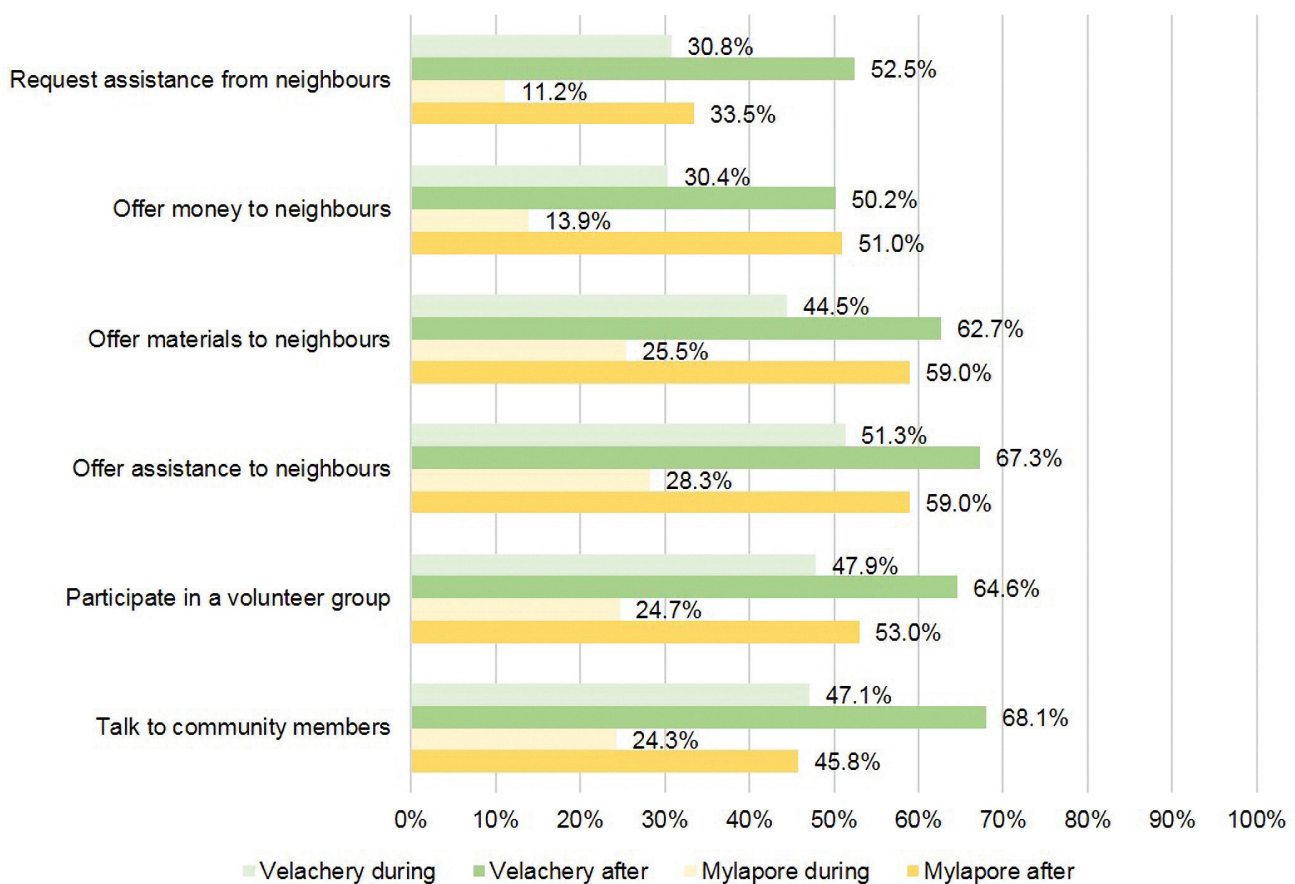

Figure 6
'Solidarity' triggered among households in Mylapore and Velachery [5]

Satisfaction

Although the recovery process in both constituencies was exclusively led by the local and state authorities with no needs assessment conducted and involvement of residents, people were equally satisfied overall with the recovery outcomes – similar to the detailed findings above for the physical and socio-economic items. Figure 7 highlights that the magnitude of the floods did not have an impact on how people evaluated the recovery process. Thus, people differentiated between being affected by the disaster and how their neighbourhood (constituency) recovered ten to eleven months after.
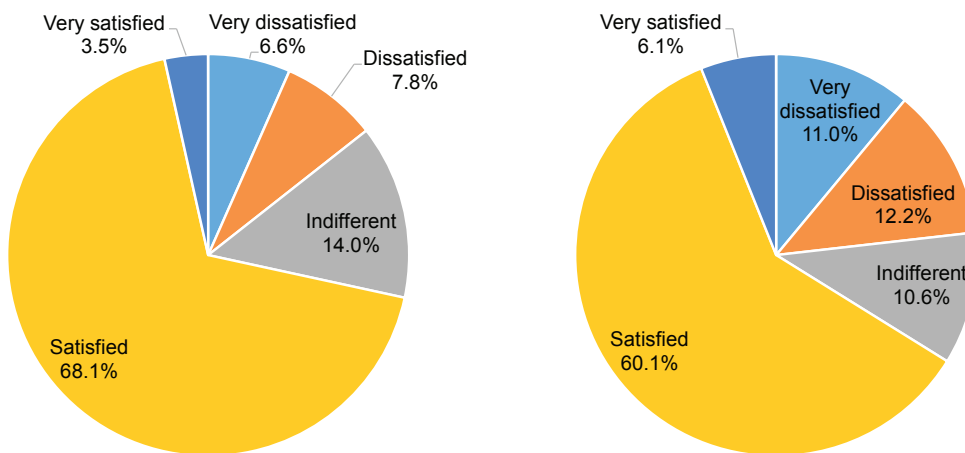

Figure 7
Satisfaction of recovery processes in Mylapore (left) and Velachery (right)

During the survey data collection process, residents in both constituencies complained that they were not involved in the recovery process and also, they were not trained before the disaster. Residents in both constituencies were only informed through voluntary groups (e.g. residents welfare associations), personal contacts, newspaper and TV about the recovery process (Figure 8).

During the survey, households were also asked about topics that should be discussed in stakeholder meetings. Figure 9 shows that solid waste management, sanitation, physical health, water, roads and electricity are among those that bother people most in both constituencies. Not surprisingly, residents perceive that infrastructure improvements are among the key areas of future interventions. Blocked waterways, insufficient waste management systems, unstable electricity provision are prioritised compared to 'soft' intervention measures, such as increasing people's preparedness and ability to respond to heavy rainfall events.
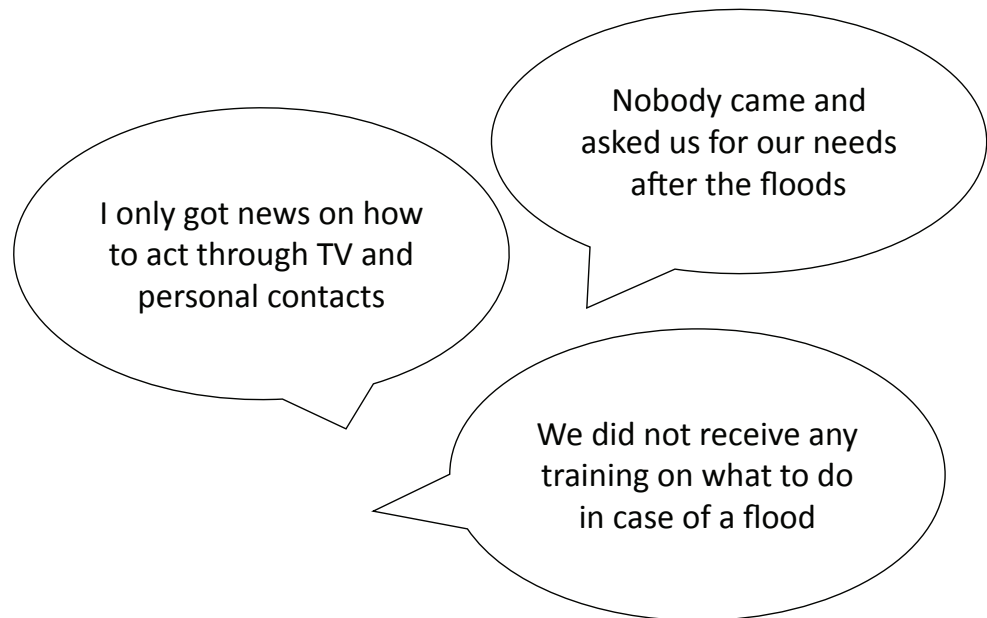
Voices from people

Figure 8
Voices from households during survey data collection

Figure 9
Word cloud about topics to be discussed in stakeholder meetings

On June 29 (Velachery) and June 30 (Mylapore), 2017, we conducted validation meetings in both constituencies. With the support from the local Members of Legislative Assembly (MLA's), residents were invited to hear about the survey results and provide stories and feedbacks. Around 100 residents participated in Velachery and around 30 in Mylapore. In addition to participating residents, representatives from the Greater Chennai Corporation, local NGOs and media were present at these meetings.

The participating audience approved the results and urged for rapid improvements of the urban infrastructure. Although, improvements are being carried-out, people stressed the need to speed-up the process before the next monsoon period starts.

Key recommendations by the stakeholders for Velachery are as follows:

- Entire waterways network has to be properly maintained
- Create interconnections to the Buckingham Canal
- Desilting of waterways: so far only conducted manually → require professional help
- Conservation of Pallikaranai Wetland: maintain the influx of sea water
- keep waterbodies intact
- SRB tools: sewerage pipes and construction have to be regulated
- Reworking of storm water drainage systems
- Lifting of ground floor level of houses
- Building of emergency relief groups

Key recommendations by the stakeholders for Velachery are as follows:

Stakeholder validation meetings – recommendations

Meeting in Velachery

Meeting in Velachery

Meeting in Mylapore

Meeting in Mylapore

- Rivers and canals should flow freely (remove garbage)

- Government should focus on all preventive measures: e.g. effective storm water drainage system

- Continuous desilting of canals throughout the year: MLA funds should be used for desilting canals → request Corporation for support

- Financial and planning approval support for lifting houses → provide proper guidelines

- Water harvesting measures should be supported → awareness and strict implementation

- Unplanned housing constructions should be avoided → conservation of waterbodies

- Strict implementation of construction regulations

- Interest of conducting awareness raising programmes, e.g schools → academia-authorities interaction

- Discuss with Director of Fire Services and take appropriate measures for flood prevention

- Create a website for Chennai → dedicated for disaster management purposes and run by academia; run webinars; informal information networks during recovery processes should be expanded; websites can be funded through local sponsors

Way forward

This study has shown that Chennai is vulnerable to flood hazards. Residents, authorities, scientists and NGOs are united in the understanding that the affected constituencies require credible interventions to ensure they can provide security to people and the built environment.

The next steps, based on the above recommendations, require communities and authorities to work hand-in-hand. This interplay has a great potential considering the fact that 88% of the households in the survey showed willingness to become active in the recovery process.

The results from this study can also serve other parts (constituencies) of Chennai and thus, it is expected that some of the results are likely to be of relevance as well to other neighbourhoods of the city.

Finally, this study improved the understanding of disaster recovery processes and extract areas of where interventions can help to increase the resilience of Chennai. Future flood hazards are likely to occur, but it is also residents' responsibility to reduce their exposure and increase their ability to face harmful events.

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