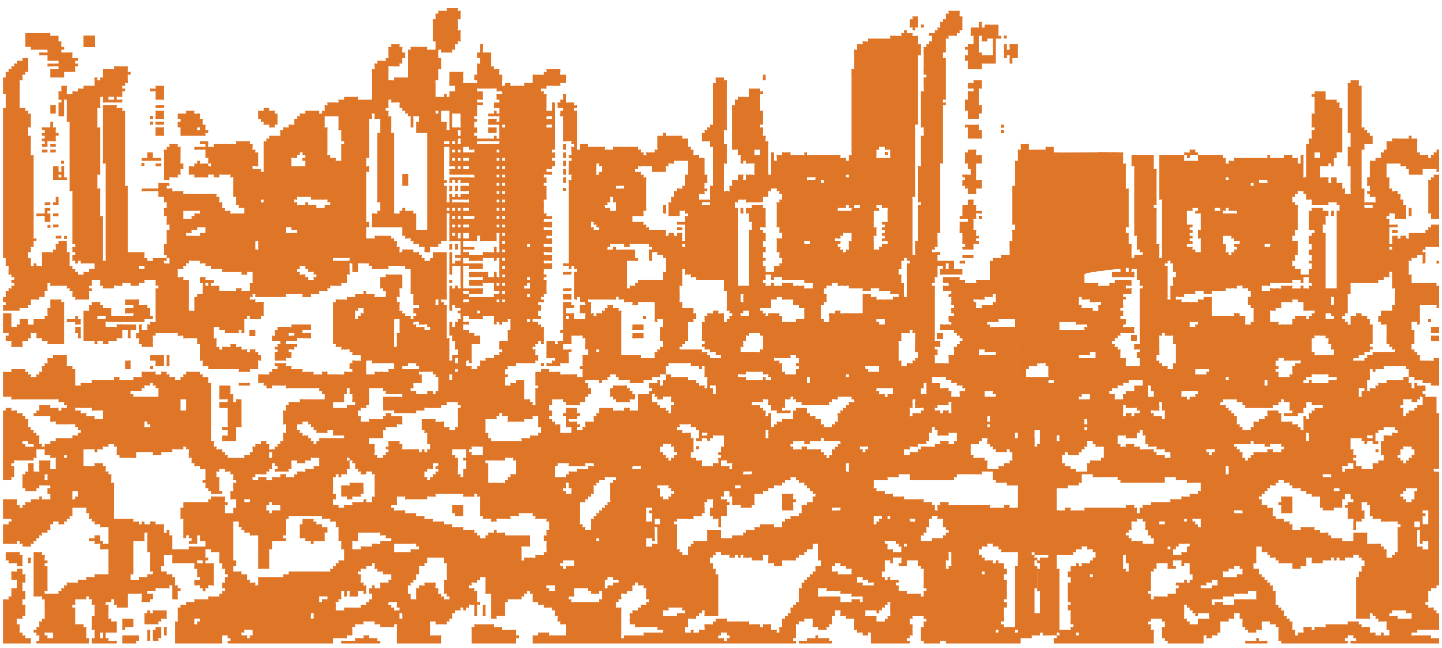
Asian Cities Climate Resilience

WORKING PAPER SERIES 26: 2015

Flood-induced economic loss and damage to the textile industry in Surat City, India

BY CHANDRA SEKHAR BAHINIPATI, UMAMAHESHWARAN RAJASEKAR, AKASH ACHARYA, MEHUL PATEL



Flood-induced economic loss and damage to the textile industry in Surat City, India

Asian Cities Climate Resilience Working Paper Series

This working paper series aims to present research outputs around the common theme of urban climate resilience in Asia. It serves as a forum for dialogue and to encourage strong intellectual debate over concepts relating to urban resilience, results from the ground, and future directions. The series is also intended to encourage the development of local research capacity and to ensure local ownership of outputs.

The series has arisen out of the Asian Cities Climate Change Resilience Network (ACCCRN, www.acccrn.org), an initiative funded by the Rockefeller Foundation.

The series is intended to present research in a preliminary form for feedback and discussion. Readers are encouraged to provide comments to the authors whose contact details are included in each publication.

Published by IIED September, 2015

IIED order no: 10749IIED
http://pubs.iied.org/10749IIED.html

ISBN 978-1-78431-254-1

80-86 Gray's Inn Road, London WC1X 8NH, UK

Tel: +44 (0)20 3463 7399

Fax: +44 (0)20 3514 9055

email: humans@iied.org

www.iied.org

About the authors

Chandra Sekhar Bahinipati is assistant professor at the Gujarat Institute of Development Research (GIDR), Ahmedabad, India. His research interests include climate change economics, risk and vulnerability, loss and damage, environmental economics and development economics.

Umamaheshwaran Rajasekar is director at TARU Leading Edge, New Delhi, India. His interests include hazard-risk modelling, climate variability impact analysis, strategy formulation and developing social systems for transformation. Email: mrajasekar@taru.org

Akash Acharya is associate professor at the Centre for Social Studies (CSS), Surat, India. His current research pertains to health implications of climate change and health systems resilience.

Mehul Patel is a senior associate with TARU Leading Edge, Surat, India. He has considerable experience in researching climate change adaptation and disaster risk reduction for more than five years.

Acknowledgements

We would like thank IIED for their support in conducting this study. In addition, we would also like to thank Surat Municipal Corporation (SMC), Textile Associations, the Southern Gujarat Chamber of Commerce and Industry (SGCCI) for helping us in the data collection, and engaging with us in meaningful discussions during the survey and also during the post-survey workshop for scoping the coping measures. We are also grateful to Dr Diane Archer and Anne Tadgell of IIED for their comments and suggestions.

Contents

List of figures and tables

Acronyms

AAL	Average annual losses
ACCCRN	Asian Cities Climate Change Resilience Network
AMRUT	Atal Mission for Rejuvenation and Urban Transformation (formerly JNNURM)
CoP	UNFCCC Conference of the Parties
CSAG	Climate Systems Analysis Group
CSS	Centre for Social Studies
EM-DAT	Emergency Events Database
GCM	General circulation model (type of climate model)
GDP	Gross domestic product
GIS	Geographic information system
GHCN	Global Historical Climate Network
GoI	Government of India
IIED	International Institute for Environment and Development
IITM	Indian Institute of Tropical Meteorology
IMD	Indian Meteorological Department
INR	Indian rupee
IPCC	Intergovernmental Panel on Climate Change
JNNURM	Jawaharlal Nehru National Urban Renewal Mission (now AMRUT)
L&D	Loss and damage
NIDM	National Institute of Disaster Management, India
OECD	Organisation for Economic Cooperation and Development
SCCT	Surat Climate Change Trust
SGCCI	Southern Gujarat Chamber of Commerce and Industry
SLR	Sea-level rise
SMC	Surat Municipal Corporation
TARU	Taru Leading Edge Private Limited
UHCRC	Urban Health and Climate Resilience Center
UNFCCC	United Nations Framework Convention on Climate Change

Abstract

Indian coastal cities are susceptible to climate-induced rapid and slow-onset disasters, like cyclonic storms, floods and sea-level rise, all while existing urbanisation challenges amplify vulnerability. Enhancing a city's resilience capacity is, therefore, a pertinent issue for policymakers when there are plans to redevelop several of India's cities into 'climate-smart' cities – this needs a comprehensive city-wide loss and damage assessment. For empirical purposes, this study attempts a loss and damage assessment of Surat City in western India to floods. Surat is an industrial hub for both the textile and diamond industries. Interviews with workers from 145 textile-weaving businesses were completed, including focus group discussions and shared learning dialogues.

This study finds five conclusions:

- All the sample businesses were severely affected by floods in 2006, and on an average, each unit required 49 days to return to normal.
- Most of the labourers out-migrated during the post-flood scenario, and hence, a shortage of labour was reported as a major issue.
- The mean loss and damage for each unit was approximately INR1.51 million where, INR 0.98 million was towards direct losses, INR 1 million was towards indirect losses and compensation accounted for INR 0.47 million (at 2013 prices). This reinforces the need for indirect losses to be factored into the disaster's impact cost assessment.
- All of the surveyed businesses are unable to access insurance as insurers are reluctant to provide cover for businesses located in risk-prone areas.
- The textile-weaving businesses' risk perception about potential impacts of future floods is moderate, which may lead to a lack of investment in planned adaptation measures.

1 Introduction

The impacts of climate extremes like floods and cyclonic storms have increased over the years and are likely to be enhanced in the foreseeable future, even without climate change (IPCC, 2012). Climate change could also aggravate the frequency and intensity of such extreme events in the near future (IPCC, 2012). As per Stern (2007), extreme events caused US$ 83 billion in damage globally during the 1970s and increased to US$ 440 billion during 1990s. Between those decades, the frequency of 'great natural catastrophe'[1] events increased from 29 to 74 globally, and the potential impacts from climatic extreme events would cost in the range of 5–20 per cent of global GDP (gross domestic product) now and in the future (Stern, 2007). Further, Bouwer *et al.* (2007) report that the average economic losses (inflation adjusted) globally increased from US$ 8.9 billion during 1977–86 to US$ 45.1 billion between 1997 and 2006.

In terms of spatial impact, developing nations are the worst affected (Mirza, 2003; Botzen and van den Bergh, 2009; IPCC, 2012). For instance, the impacts from climatic extremes were costing 1 per cent of GDP for developing nations in 2001–6, which was 0.3 per cent of GDP for low-income nations and less than 0.1 per cent of GDP for high-income nations (IPCC, 2012). According to Mirza (2003), the cost of damage from natural disasters to developing nations was US$ 35 billion during the 1990s – eight times higher than in the 1960s.

Based on the international Emergency Events Database (EM-DAT) of disasters, the damage costs from a range of natural disasters in India totalled US$55.62 billion between 1964 and 2012[2] (Bahinipati *et al*., 2015). Out of the total damages, floods and cyclonic storms caused an economic loss of US$ 36.05 billion (65 per cent) and US$ 11.43 billion (21 per cent) respectively. This reveals that both types of extreme events are the major causes of disasters in India (Bahinipati *et al.,* 2015). Among the flood-prone states in India, Gujarat state ranks the seventh highest in terms of total people affected and eleventh for total economic damages during 1953–2011. A total of 92.2 million people have been affected and there was an economic loss of INR 56,120.3 million (Bahinipati *et al*., 2015).[3] In fact, the reported impact cost in the state was larger in the last decade than in the previous decades (see Appendix 1).

It is well known that Indian cities are susceptible to climate change-induced rapid- and slow-onset disasters, such as cyclonic storms, flooding and sea-level rise (SLR) (Sharma and Tomar, 2010; Karanth and Archer, 2014) and the present urbanisation challenges make these cities more vulnerable (Revi, 2008; Revi *et al*., 2014). However, less attention has been paid so far to the context of risk reduction and adaptation to climate change, which is imperative in the present context as the Government of India (GoI) recently launched three major urban development initiatives: the Atal Mission for Rejuvenation and Urban Transformation (AMRUT), Smart Cities Mission, and Housing for All.[4] In the meantime, some effort has been made to reduce emissions of greenhouse gases (GHGs) at the city level in India (Sharma and Tomar, 2010).

---

1 *In line with the United Nations, this includes those events that over-stretch the ability of the affected regions. As a rule, this is the case when there are thousands of fatalities, when hundreds of thousands of people are made homeless or when the overall losses and/or insured losses reach exceptional orders of magnitude (Stern, 2007: 100).*

2 *This reported value is not adjusted for inflation, and it is the sum of reported damage costs each year during the reference period.*

3 *INR or Indian Rupee (US$1 = INR61.03 as of July 2015).*

4 *These schemes were launched 25 June 2015. Under these, 500 cities will be developed under the AMRUT scheme, 100 smart cities will be constructed in the next five years, and housing plans for all schemes aim to build 20 million houses in urban areas in the next seven years. The GoI proposes to invest around INR40 trillion in these schemes in the next six years (The Hindu, 2015).*

Based on various scientific studies, it is expected that the average temperature in India could increase between 2–4^{O}C, with a related increase of 7–20 per cent in annual precipitation, riverine flooding, cyclones, storm surges and SLR with increased intensity (Revi, 2008). A study on low elevation coastal zones estimates that about 3 per cent of India's national area is at risk of SLR (McGranahan *et al*., 2007). Further, it is expected that the occurrence of extreme precipitation events like the one in Mumbai in 2005 could be increased over the west coast and in central India (Sharma and Tomar, 2010). Meanwhile, Indian cities are also grappling with problems related to pollution, health, population, infrastructure and services (Revi, 2008; Sidhwani, 2015).

According to the Census of India website (2011), the urban population of India has increased from 285 million in 2001 to 377.1 million in 2011 – representing 31.15 per cent of the country's total population (Karanth and Archer, 2014). In addition, it is also expected that there will be approximately 500 million people living within 7,000–12,000 urban settlements by the 2060s (Revi, 2008; see also Revi *et al*., 2014). Similar to the cities in low- and middle-income nations, Indian cities are already facing inadequate provision of water, sewerage systems, drainage and solid-waste management facilities, and many cities even lack a proper road infrastructure and efficient public transport facilities (Sharma and Tomar, 2010; Sidhwani, 2015; see also Revi *et al*., 2014). Apart from this, around 50 per cent of the people living in slums in cities in India are highly susceptible to various disasters (Karanth and Archer, 2014). Thus, climate change impacts in Indian cities need to be considered along with significant demographic, health and environmental transitions (Revi, 2008), and with an understanding of the potential damage costs.

1.1 History of loss from floods in Surat

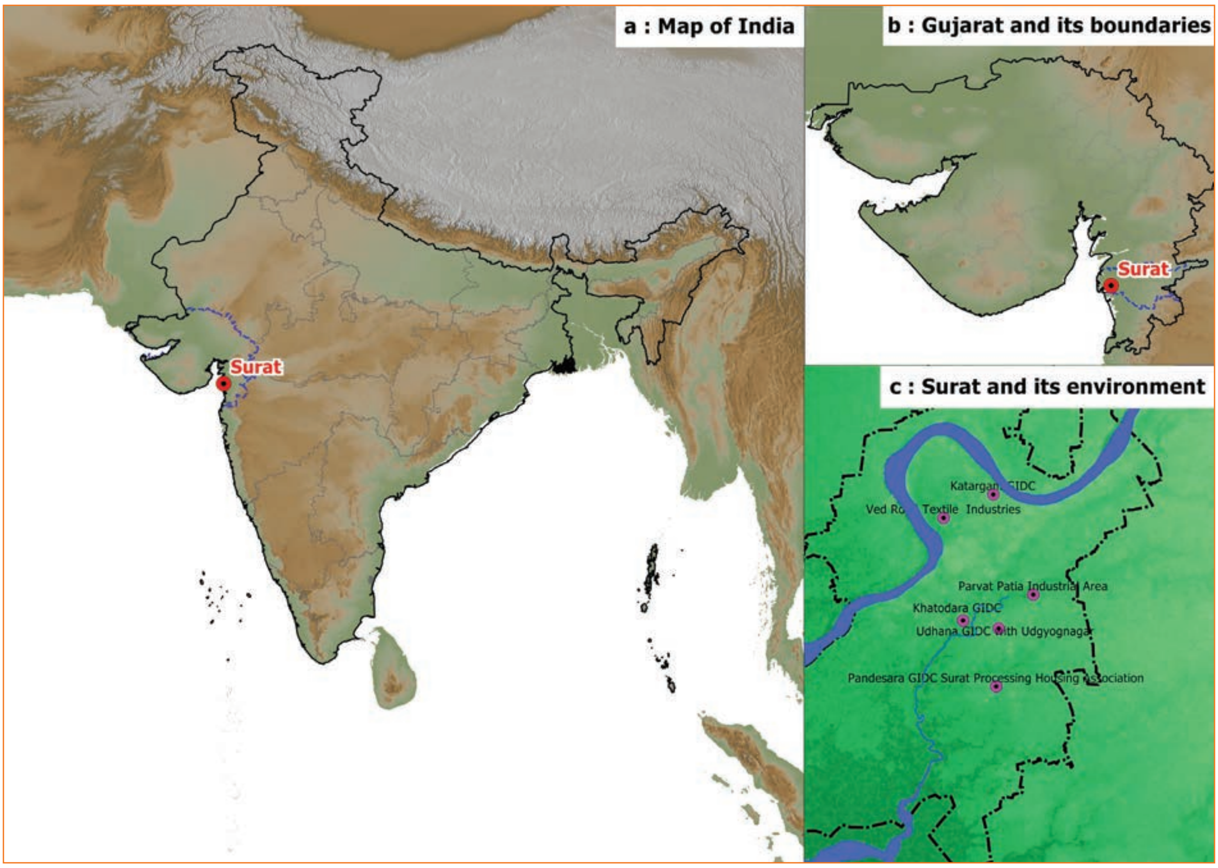
Among the various cities in Gujarat state, Surat is the ninth largest city and geographically situated in western India (see Figure 1). It is a major industrial hub for textiles and diamonds, is extensively vulnerable to floods and other slow-onset disasters like SLR, increasing monsoonal precipitation and related health risks (Revi, 2008; ACCRN, 2011; Bhat *et al*., 2013; Karanth and Archer, 2014). The hazard, risk and vulnerability analysis map carried out in 2005 found that Surat is prone to hydro-meteorological hazard risks: around 90 per cent of Surat's geographical area could be potentially affected by climate-induced events like floods, cyclonic storms or SLR (Bhat *et al*., 2013; Karanth and Archer, 2014).

A recent study by Santha *et al.* (2015) find that households (especially migrant households) in Surat perceived flooding and waterlogging followed by heavy rains and flood-induced displacement as serious threats. The floods in Surat are due to heavy precipitation, either in the city or the upper catchment area of the Tapi river. These floods are also known as 'Ukai floods' as they happen due to the release of water from the upstream Ukai Dam 94km away[5], and can be rapid and severe. Floods can also be caused by seawater intrusion through different creeks which are also known as 'Khadi[6] floods'. These are less devastating, but still significantly affect vulnerable households living around these creeks (Bhat *et al*., 2013; Karanth and Archer, 2014). On the basis of GIS-based vulnerability analysis, Bhat *et al.* (2013) report that around 71,000 households are prone to Khadi floods and approximately 4,50,000 households are susceptible to flooding due to Ukai floods. It is also reported that a one-metre SLR would swamp 40 per cent of the land area in Surat (Karanth and Archer, 2014).

5 *This multi-purpose dam was constructed in 1972 and is 94km upstream of Surat – the objective is to control floods by providing water to irrigate the coastal plains of Gujarat and to generate electricity. One of the major constraints for flood prevention is the inability to manage this dam around competing demands. For instance, the reservoir needs to be filled by the end of the monsoon season for a smooth flow of irrigation water in the other seasons. If there is unexpected heavy rainfall during monsoon season, it becomes difficult to prevent flooding in Surat – this was the major reason for the flood in 2006 (Bhat et al., 2013: 4).*

6 *Khadi in Gujarati means creek.*

Figure 1. Location map of Surat City in the state of Gujarat



Source: Authors' figure

Between 1882 and 2006, Surat experienced flooding in 24 of those years, mostly during the months of August and September (Patel, 2012). Moreover, there were five major floods after 1979 (in 1979, 1990, 1994, 1998 and 2006) (Bhat *et al*., 2013). In fact, floods in the year 1998 and 2006 were due to emergency discharges of water from the Ukai Dam, followed by heavy rainfall in the Tapi River's upper catchment area, in the neighbouring states of Maharashtra and Madhya Pradesh (Bhat *et al*., 2013). In 2006, a severe flood hit the city which inundated around 75 per cent of city's total area, causing a loss of 150 human lives and total economic damages of INR 160 billion (around US$ 3.5 billion). The textile and diamond industries suffered losses of INR 20 billion and INR 26 billion respectively (Bhat *et al*., 2013; Karanth and Archer, 2014; see also Appendix 2). Further, around 77 per cent of the working population lost 15–30 working days (Bhat *et al*., 2013). In 2013, Surat City experienced a Khadi flood, which had less devastating impacts compared to the flood in 2006. Anthropogenic changes, including building of bridges and embankments, have reportedly increased the siltation and reduced the carrying capacity of the river, as evidenced by increasing flood levels for similar amounts of discharge over last few decades (CSS, 2010).

As per Hallegatte *et al.* (2013), the average annual losses (AAL) from floods in Surat are estimated for 2005 at US$ 30 million per year with protection, which amounts to 0.25 per cent of the city's GDP, ranking seventeenth among the 136 coastal cities around the world and third among the coastal cities in India, after Mumbai and Kolkata. With socio-economic change alone (based on Organisation for Economic Cooperation and Development (OECD) and United Nations scenarios), AAL in Surat would be around US$ 905 million per year in 2050 (a 30-fold increase in absolute terms). If additional subsidence (40cm by 2050 in areas of the city prone to subsidence) and SLR scenario (20cm increase) are factored in, as well as loss in investments which were made towards flood adaptation, the AAL would increase to US$928 million per year by 2050, amounting to 0.26 per cent of the city's GDP (Hallegatte *et al*., 2013). Further, Nicholls *et al*. (2008) find that approximately 418,000 people will be exposed to extreme climatic events (ranked twenty-fourth highest in the world) in Surat City by 2070 (100-year return period), and almost US$6.93 billion worth of assets will be at risk if one considers the city's situation as of 2005. In case of any future changes in socio-economic situation, change in current climatic conditions and natural/ human-induced subsidence, approximately 2.02 million people would be exposed in Surat City and US$282.8 billion worth of assets would be at risk.

In addition, the city's industrial base attracts a large number of migrant workers from various parts of India, especially from Odisha, Uttar Pradesh and Bihar, and these people mostly live in under-provisioned slums across the city. There were 406 slums in Surat as of 2006, and most slums are located in the high risk prone regions in Surat (Bhat *et al*., 2013). It is found that around 0.5 million slum dwellers across the city face both flood risk and vector-borne diseases (Anguelovski *et al*., 2014). Because of this, the city experiences various environmental, social, economic and health vulnerabilities, making the city, and the urban poor specifically, more susceptible to challenges posed by climate change (Karanth and Archer, 2014).

Given the susceptibility of various cities in India, including Surat, to climate change risks, it is surprising to find that there is no existing sub-component under JNNURM (Jawaharlal Nehru National Urban Renewal Mission)[7] for climate adaptation, risk mitigation or vulnerability assessment for urban areas (Revi, 2008; Sharma and Tomar, 2010). Moreover, Surat joined the ACCCRN (Asian Cities Climate Change Resilience) Network in 2008 to develop activities related to city resilience (see Anguelovski *et al*., 2014; Karanth and Archer, 2014; Chu *et al*., 2015). Various programmes under ACCCRN, including the end-to-end early warning system for Ukai and Khadi floods, the Surat Climate Change Trust (SCCT) and the Urban Health and Climate Resilience Centre (UHCRC) (see Bhat *et al*., 2013; Karanth and Archer, 2014; Chu *et al*., 2015), could play a major role in reducing potential damages from floods. While the end-to-end early warning system, for instance, assists the textile businesses to take precautionary action, the UHCRC could reduce the post-flood impact on the health of labourers, especially those living in informal settlements. The objective of SCCT is to engage stakeholders to address issues associated with climate change (Chu *et al*., 2015). The ACCCRN process revealed that Surat City does not have enough resources to cope with recent flood impacts, which warrants an estimation of loss and damage (L&D) from floods. Recently, Surat City has also been selected under the Smart Cities Mission recently launched by the GoI, and a large amount of investment is likely to happen in the near future.

7 *JNNURM was initiated in 2005 under Ministry of Urban Development covering 65 cities in India – the main objective was to target urban development and urban renewal, mainly focusing on infrastructure development, urban poverty and urban governance (Sharma and Tomar, 2010).*

1.2 Rationale for the study

In the recent years, few studies (mostly concentrated in South Asia and Africa) have estimated L&D due to natural disasters for different sectors, with predominant focus on agriculture (Rabbani *et al*., 2013; Bauer, 2013; Brida and Owiyo, 2013; Yaffa, 2013; Traore and Owiyo, 2013; see Warner and van der Geest, 2013). Within these studies, some have estimated L&D in terms of people and assets at risk, while none of these studies have estimated the total L&D in monetary terms. Government agencies around the world tend to calculate post-disaster direct L&D to seek financial aid from various donor agencies. A large number of indicators related to direct non-economic and indirect economic/ non-economic L&D are left out by the government in their L&D estimation. The EM-DAT international disaster database also records country-wise L&D indicators from various disasters, which are mostly dominated by direct economic L&D indicators.

Birkmann and Welle (2015) outline that there is still a controversy in the definition and assessment methodology for assessing L&D from various disasters – a comprehensive method for assessing L&D is yet to be developed. Moreover, there is also limited knowledge of how L&D estimation can be undertaken in urban centres, particularly in developing nations, where insurance products are still at their nascent stage and most sectors are informal in nature (Dodman and Archer, 2014). To the best of our knowledge, there is no such study that estimates L&D of Indian cities from various natural disasters, which is also more complicated given the dynamics of urbanisation in India. Most existing L&D assessments concentrate on calculating household level L&D; none of the studies so far are urban-centric or assess L&D from the industry perspective. The L&D assessment initiative could provide inputs for the three ambitious national urban missions, outlined in the previous section, launched recently which aim to transform urban cities and provide better services and infrastructure. Since Surat City is a hub for textile businesses on which a large number of households' livelihoods depend, it is imperative to assess L&D of these industries to enhance their resilience, so that the forward linkage impact on vulnerable households, especially migrant labourers, could be reduced in the near future.

The present study, therefore, aims to answer the following key questions, which will contribute to the understanding of extreme weather event induced L&D to textile-weaving businesses in urban areas. The specific objectives of this study are:

- To estimate the extent of economic and non-economic (direct and indirect) L&D to textile-weaving businesses in Surat due to the 2006 riverine flooding event, and
- To understand what measures were undertaken by weavers and textile associations post-2006 to build their resilience to flooding.

The advantage of this study is that it estimates both direct and indirect economic L&D costs from floods to textile businesses. In addition, it also captures a few non-economic L&D indicators, e.g. labour migration and health impacts. But a large number of other indicators related to non-economic L&D (e.g. social conflict due to loss of wages and remittances, impact on social capital); direct economic L&D (direct impacts of flood on industrial workers, such as damage to homes and property, which could have an indirect economic impact on the industries in terms of availability of labour after the flood); and indirect economic L&D (impact on remittances) are not captured. Further, this study also has not estimated the spill-over impacts of L&D on textile businesses, such as impacts on the livelihoods of industrial workers and on the regional economy. Given these shortcomings, this study makes an attempt to highlight the importance of L&D assessment to building resilient cities – this has larger policy implication in the immediate near future given the GoI's recently launched urban missions.

The next section outlines a review and conceptual framework for L&D assessment, while the third section provides a brief description of Surat City. The fourth section outlines methods, the fifth discusses the empirical results and the final section provides a conclusion with ways forward.

2 Loss and damage: review and conceptual framework

Both the Fourth Assessment Report and the special report on extreme events (SREX) of the IPCC confirm that we are already committed to certain impacts of climate change now and in the foreseeable future, even if we adopt a stringent mitigation policy now (Pielke *et al*., 2007; Roberts and Huq, forthcoming; see Parry *et al*., 2007; IPCC, 2012). These reports also highlight the limits of adaptation where some communities would not be able to adapt beyond a certain threshold level (Dow *et al*., 2013; Roberts and Huq, forthcoming). This reveals the fact that neither mitigation nor adaptation is sufficient to prevent L&D from climate change-induced events (Roberts and Huq, forthcoming), which warrants an urgent need to identify the limits that are likely to occur, to enhance the adaptive capacity of the social actors (Dow *et al*., 2013). As per the Economic Commission for Latin America and the Caribbean (ECLAC), the prime goal of L&D is to assess the impact of disasters on the society, economy and environment of the affected entity (Birkmann and Welle, 2015), though there are limitations to valuing non-monetary losses. As mentioned above, governments have been estimating L&D immediately after disasters, though the indicators vary across countries.

L&D refers to the negative effects of climate variability and climate change that people have not been able to cope with or adapt to, which are the residual impacts (Warner and van der Geest, 2013). Further, the *United Nations Framework Convention on Climate Change* (UNFCCC) defines L&D as the actual and/or potential manifestation of impacts associated with climate change in developing countries that negatively affect human and natural systems (UNFCCC, 2012). 'Loss' means irreversible impacts: negative impacts in relation to which reparation or restoration is impossible, such as loss of ecosystem services. 'Damages' can be recovered, meaning negative impacts for which reparation or restoration is possible, such as damage to houses and coastal mangroves (UNFCCC, 2012). Table 1 reports definitions and indicators of the various types of economic and non-economic L&D.

The notion of L&D in the context of climate change has gained momentum in the UNFCCC arena in recent years, particularly after the Bali action plan at the UNFCCC's Thirteenth Conference of the Parties (CoP 13) in 2007 (UNFCCC, 2012; see Roberts and Huq, forthcoming). It is an important topic for the international community especially in the context of climate change negotiations and disaster-risk reduction. At this meeting, developing nations raised the need for adaptation including the consideration of disaster-risk reduction strategies and means to address L&D associated with the impacts of climate change (Roberts and Huq, forthcoming). At CoP 16 in Cancun in 2010, a work programme on L&D was formally launched to address L&D associated with climate change, especially in developing nations. L&D arrived in the global policy arena at CoP 18 in Doha in 2012, with a relevant policy forum for L&D, the advancement of understanding and expertise on L&D, the acknowledgement of the necessity to enhance support for L&D initiatives, and the decision to establish an institutional arrangement for L&D. At CoP 19 in Warsaw in 2013, L&D was formally institutionalised, through the establishment of the Warsaw International Mechanism for Loss and Damage associated

with climate change impacts (Roberts and Huq, forthcoming). This recognises the fact that climate change has negative impacts on society that will not be avoided by mitigation and adaptation (Roberts and Huq, forthcoming). Two major decisions were taken at this convention: a range of actions were highlighted to (i) assist vulnerable nations to withstand climate change impacts, and (ii) improve the understanding of L&D, including non-economic L&D (Roberts and Huq, forthcoming).

Table 1. Types of economic and non-economic loss and damage

Types of L&D	Definition and example	References
Direct L&D	L&D occurring immediately after a disaster	Hallegatte and Przyluski (2010)
Direct economic/market L&D	L&D of goods and services that are traded in markets e.g. damage to houses, public properties, agricultural crops or loss of livestock	Hallegatte and Przyluski (2010); UNFCCC (2013)
Direct non-economic/ non-market L&D	L&D to goods and services for which a market does not exist e.g. loss of life; people affected; damage to cultural heritage, biodiversity and ecosystem services	Hallegatte and Przyluski (2010); UNFCCC (2013)
Indirect L&D	L&D which is not provoked by the disaster itself, but by its consequences	Hallegatte and Przyluski (2010)
Indirect economic/ market L&D	Includes loss of 'net revenue' by different sectors during recovery period, loss of wages, reduction in tourism revenue, and loss to human capital	Prabhakar *et al.* (2015)
Indirect non-economic/ non-market L&D	Examples include migration; impact on social capital, crime, conflicts and disputes; loss of indigenous knowledge; social welfare loss due to water stress and violence against women	Prabhakar *et al.* (2015)

In the context of India, the state governments generally do a post-disaster impact assessment to seek financial aid from the national government and various donor agencies. This estimation consists of direct economic damage (to various sectors like housing, agriculture, public property or livestock/cattle) as well as non-economic damages (loss of life, people affected) (see Prabhakar *et al*., 2015). From the government side, the Revenue and Disaster Management Department is the nodal agency for the L&D estimation. In addition, a few research studies have also emerged to estimate various L&D indicators, but most of them are location specific (Prabhakar *et al*., 2015). In addition, in recent years the National Institute of Disaster Management (NIDM) has implemented a post-disaster needs assessment study for India to provide an accurate picture of the economic devastation caused by disasters, as a part of the World Bank-assisted National Cyclone Risk Mitigation Project (Kumar, undated). While it is widely known that an L&D assessment is a prerequisite for building smart cities across India, the government's L&D assessment captures direct economic and a few non-economic L&D indicators, which means that the present L&D figures could have been underestimating the actual impact. There is a need to capture various other L&D indicators to develop smart cities. At the same time, because of the underestimated figure, developing countries and less-developed countries (LDCs) are less able to demand adaptation funding in international climate change negotiation processes.

3 Surat: a brief overview

The city of Surat is an industrial hub for textile and diamond industries located in the western Indian state of Gujarat (see Figure 1), with an average elevation of 13 metres. The city is situated on the banks of the River Tapi and the Arabian Sea through its port, so Surat has had well-established international trade links for centuries. The British took control of the city from the Portuguese in the early 1600s, marking the beginning of textile production in India with the expansion of the East India Company.

Today, although Surat is not a metro city[8], it is considered one of the fastest-growing cities of the world with a population of almost five million (Table 2). It also ranks as one of the highest per capita income cities in India (City Mayors, 2008), and its economic base consists of textile manufacturing, trade, diamond-cutting and polishing industries, intricate *zari* embroidery,[9] and chemical industries. Petrochemical and natural gas-based heavy engineering industries at Hazira (near Surat), established by leading industry houses (public, private and multinational companies) such as the Oil and Natural Gas Corporation (ONGC), Reliance, Essar, and Larsen and Toubro-Shell are also a part of Surat's economy (ACCCRN, 2011).

Surat is known as the 'silk city' for its man-made fibre production and as the 'diamond city' for its diamond-cutting and polishing businesses. For both industries, Surat is the biggest national hub. As per the baseline survey of the power-loom sector, conducted by the Ministry of Textiles in 2014, out of 0.49 million power looms in Gujarat, Surat has 0.47 million (i.e. 96 per cent). The annual polyester-yarn consumption by the power-loom businesses in Surat has been pegged at 4,061 million kilograms and annual fabric production is 9,187.1 million metres (Times of India, 2015). In terms of daily production, nearly 30 million metres of raw fabric and 25 million metres of processed fabric are produced in Surat daily. Around 90 per cent of the polyester used in India comes from Surat (ACCCRN, 2011). Apart from the power looms, the textile industry in Surat is also comprised of various dying and printing houses (around 400 in number) and around 50,000 embroidery businesses (SMC, undated). There are 150 multi-storied textile markets and trade is routed through 50,000 merchant manufacturers/traders (ACCCRN, 2011).

8 The government of India classifies Indian cities in three categories (X, Y and Z), on the basis of their population. 'Metro cities' like Mumbai, Delhi, Kolkata, Chennai, Bangalore and Hyderabad are in the X category. Surat is in the Y category. It is important to note that in the urban literature, non-metro cities lie at the lower end of scholarly attention.

9 Zari is a type of embroidery for traditional Indian garments using gold or silver threads.

Table 2. Growth in the city of Surat

	1961	1971	1981	1991	2001	2011
Area (in sq. km)	8.18	33.85	55.56	111.16	112.27	326.5
Population (in millions)	0.29	0.47	0.78	1.50	2.81	4.46
Decadal growth (%)	29.05	63.75	64.65	93	62.4	58.71

Source: Census of India (2011) and SMC (2011)

Surat's industries, being largely manufacturing driven, are labour intensive and attract workers from Gujarat as well as other Indian states like Odisha, Uttar Pradesh and Bihar.[10] The entire textile sector of the city provides employment to more than 0.7 million workers (SMC, undated). The industry still remains traditional and mostly functions from micro-, small- and medium-scale (MSME) enterprises. Power-loom workers live in informal settlements with six to eight people per room, face job insecurity and work long hours (mostly 12 hour shifts) in standing and leaning positions with high decibel noise levels. This could lead to partial or full deafness in the long run. In dyeing and printing businesses the dust, heat, noise, contact with dangerous chemicals and high frequency of accidents are the most common occupational hazards. Dermatological and respiratory problems are also potential health hazards in this industry. Single male migrants in both industries are exposed to sexually transmitted disease including HIV/AIDS and are also found to be consuming tobacco and alcohol to a considerable extent (SMC, undated).

Surat has long been exposed to natural disasters, being in a Seismic Zone 3 (the scale is from 1 to 5, in order of increasing vulnerability to earthquakes). The construction of Surat's castle started in the year 1664 as a flood protection structure with gates that were closed in the event of a flood. From 1869 to 1884, on average, the city was flooded every two and a half years followed by a fall in frequency by 1914. During 1949 to 1979, the average natural flood occurrence was once every four years. The 1968 flood was the biggest flood in Surat's history and had a peak flow of approximately 42,475 cubic metres per second (1.5 million cubic feet per second), while the water level at Hope Bridge in Surat reached 12.01m. The Ukai Dam was completed in 1972. Heavy rainfall in the catchment area upstream of Ukai Dam (mainly in Maharashtra) often results in a heavy discharge of water, causing several floods in Surat in the past 20 years. This is largely caused by the competing objectives of the Ukai Dam, which is designed mainly for irrigation and power generation with partial flood control. To meet the first two objectives, the dam has to be able to hold as much water as possible leaving a limited cushion for flood control, especially during the latter part of the monsoon (SMC,- 2011).

Many of the slums in the city, where migrant labourers live, face a higher risk of flooding because they are located along tidal creeks, the river, other drainage lines, or between embankments. Floods combined with social, health and economic challenges increase their level of vulnerability, especially for migrant labourers. For example, in 1994, a combination of heavy rains and blocked drains led to flooding in the city. Dead animals and public waste were not removed in time and a pneumonic plague epidemic spread through the city. Most of the migrant workers left the city and it took a couple of months before the city's economic activities returned to its normal situation. Such occurrences contribute immensely to indirect economic and non-economic L&D.

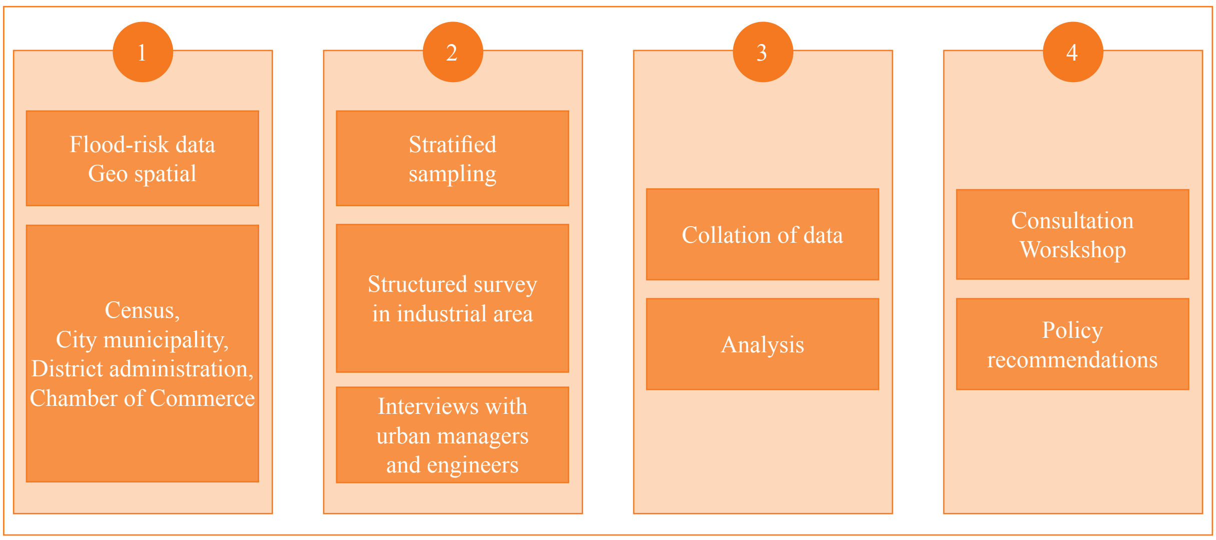
10 In fact, the proportion of migrants in Surat is more than 55 per cent (CRS 2011) making migrants the majority of the population.

4 Methods

As outlined above, this study aims to estimate direct and indirect economic L&D to textile weaving businesses in Surat during the 2006 flood, and to understand the coping measures undertaken by these affected businesses. Due to limited information on the extent of L&D incurred by the small-and medium-scale enterprises in Surat, the framework for this study has been largely based on the city-wide vulnerability assessment in Surat conducted by TARU (see ACCCRN, 2011). The L&D indicators were selected based on- previous studies and stakeholder consultation meetings held before conducting the primary survey; the stakeholders included weaving-unit owners, textile-association presidents, the Surat Municipal Corporation (SMC), and the Southern Gujarat Chamber of Commerce and Industry (SGCCI). An attempt was made to capture the problems faced by the industry, during and after the 2006 flood. Various indicators were selected to quantify the L&D and summarise several adaptation measures which were taken in the aftermath of the event to prevent similar occurrences. Figure 2 highlights the steps followed to conduct this research.

To estimate L&D, data was collected on weaving businesses within the city, along with historical weather data, and information from the businesses on the type and extent of L&D experienced. A detailed stakeholder analysis was conducted through one-to-one interviews to ensure the indicators used and data collected as a part of this research reflected their experiential knowledge and was also of use to improve upon their existing resilience strategies. To verify the findings, a shared learning dialogue was conducted as part of the consultation workshop with the owners of the surveyed businesses where the final findings were also disseminated and 19 weaving-unit owners including the president of the textile association attended this event.[11]

Figure 2. Method adopted for the study



11 *In the survey, respondents were asked about their willingness to participate in the dissemination workshop which was planned to be conducted after the survey. Those people who had shown willingness to participate were invited, and out of which, 19 weaving-unit owners attended.*

Climate data was also used to identify the possibility of similar flood events occurring over the next 30 years. Specifically, data collected included daily rainfall data for the period between 1901 and 2010 from Indian Meteorological Department (IMD); climate data (past and future) from Climate Systems Analysis Group (CSAG), Indian Institute of Tropical Meteorology (IITM), IMD and Global Historical Climate Network (GHCN) for 1970 to 2100 were used for analysis; and the names and locations of weaving businesses were provided by SGCCI. A flood inundation map of 2006 was developed by TARU based on the high flood-level markings which were done by SMC post the event. Since there was no information on the Khadi floods, the area as depicted by SMC and the irrigation department of the state was used for the analysis.

To capture the extent of L&D within textile-weaving businesses due to the floods in Surat, a stratified random sampling approach was adopted to conduct the primary survey. Based on the vulnerability analysis and discussion with the local stakeholders, an industry survey was conducted in three industrial clusters, e.g. Ved Road, Pandol; *Gujarat Industrial Development Corporation* (GIDC), Katargam; and LH Road, Khatodara (see Figure 1). These areas are predominantly comprised of textile weavers and almost all were affected by the 2006 flood. Before the survey began, the total list of weaving businesses in these regions was procured from the SGCCI, which assisted the study in following a stratified random sampling method to cover small-, medium- and large-scale enterprises. A total of 145 weaving businesses were surveyed in these three industrial areas between January and February 2015. In the dense localities, care was taken so that only one in every 3–4 business premises was surveyed to avoid survey bias. The survey was conducted using mobile tablets to record the survey information and other associated information, such as location information, digital images of the businesses and audio recordings of descriptions of various adaptation measures undertaken by the businesses. Once collected, these data sets were verified for erroneous errors before analysis.

A structured questionnaire was designed to collect information related to L&D of the textile businesses in Surat, and it was also revised based on responses received through a pilot survey and stakeholder consultations (see Appendix 4 for the final questionnaire). The final questionnaire includes various sections:

- About the business: this includes information to create a general business profile; production details (raw materials and finished products); number and cost of machines used; employee details (for 2014 and 2006); production and energy consumption details; operational information; and expenses.
- About L&D: this includes the number of times a business has experienced floods in the last 10 years; perceptions of the impact of the 2006 flood; and specific L&D data of 2006 flood, e.g. extent of inundation, direct L&D (damage to buildings, machinery and vehicles; loss of life, raw materials, finished goods and documents; physical injury to people), indirect L&D (number of days businesses were closed, number of days that minimum labour was unavailable, recovery period, time taken to access raw materials), a few non-economic L&D indicators (e.g. impact on health of industrial workers, migration) and any major problems faced by these businesses immediately after the flood event.
- Adaptation: measures undertaken since the 2006 flood and unit owners' perceptions of flood impacts likely to occur in the near future

In this study, the direct economic L&D includes: cost of repairs to buildings and machinery; loss of raw materials, finished goods, furniture and IT equipment; and damage to documents, vehicles and other damage (e.g. repairing electricity connection). The indirect economic loss is estimated based on the number of recovery days for each business multiplied by its net revenue per day – this is the amount of income each business could have earned, if the flood had not occurred. Since these values were reported for the year 2006, a GDP deflator[12] was used to convert these values for the year 2013. Quick-Bird satellite images (resolution 0.6m) of the city and other GIS were used to analyse locational information of the businesses and their proximity to water bodies.

12 *The GDP deflator is a measure of the level of prices of all new, domestically produced, final goods and services in an economy. Since GDP for Surat city is not available, the state GDP values were used to calculate the GDP deflator.*

There are three major limitations to the study:

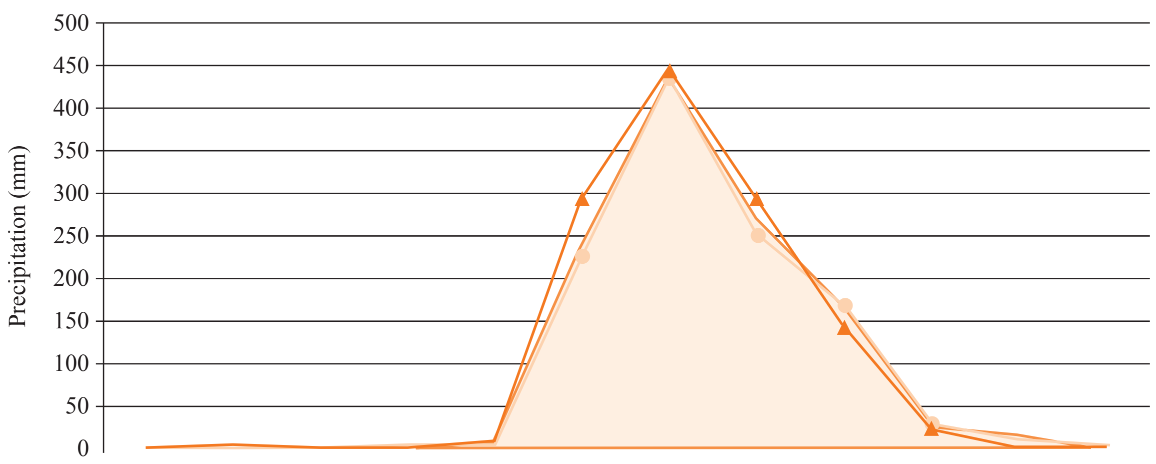
- Intangible losses from the flood were omitted from calculations (such as social impacts, trust between business owners and labourers, social welfare impact on family members of industrial workers due to loss of wages),
- The sample used was small (in relation to the number of weaving businesses in Surat), so there was the possibility of sampling bias, and
- Reporting bias was likely for stating L&D figures from the 2006 flood.

5 Results and discussion

5.1 Impacts of floods in Surat City

Surat has a tropical climate, meaning the rainy season starts in June and extends to September. Even though the mean annual rainfall is over 1,000mm, the variation between the years is high, around ± 40 per cent. Since the 1950s, there are recorded instances (almost once every decade) of total annual rainfall exceeding 2,000mm. Figure 4 shows the total annual precipitation between 1901 and 2008. The results indicate that even though the total annual rainfall has not changed much over the decades the deviation in precipitation has increased considerably, particularly in the last few decades. Figure 3 illustrates this variation in rainfall patterns in different months in 1901–2008, and Figure 4 shows annual rainfall trend in 1901–2008. From 1960 to 1990, the deviation in annual rainfall is found to be over 900mm. This infers that the current level of uncertainty in rainfall is over 90 per cent from the average 40 per cent.

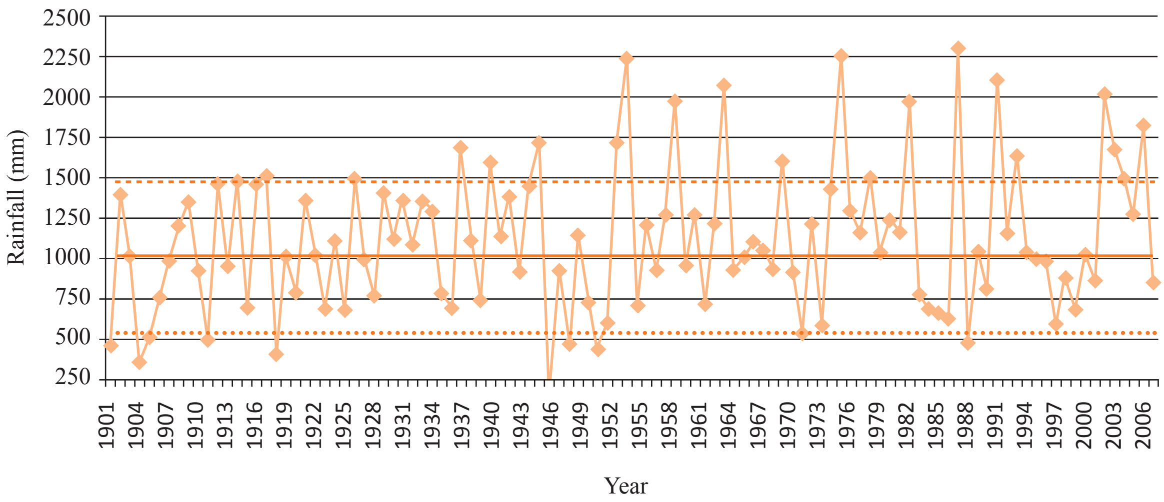
Figure 3. Observed precipitation for different time periods (1901–2008)



Source: CRS (2011)

Figures 5 and 6 illustrate rainfall scenarios for 2021–50 and 2046–65, respectively. A total of 12 models were analysed, of which 9 were from statistically downscaled general circulation models (GCMs)[13] as provided by CSAG, and the others were results from the PRECIS regional climate model (RCM).[14] Most models have a dry bias correlation, and a visual trend analysis was carried out to identify the models that are close to the observed data. Out of the 12 models, three GCM scenarios and three RCM scenarios were selected for further analysis. The future precipitation data indicates a possibility of increased precipitation. While the A1B scenario (2021 to 2050) indicates a possible increase during the second half of the rainy season, other scenarios, namely A1, A2 and B2, indicate that during the latter part of this century (2046–2100) the total amount of precipitation may increase, distributing rainy days across the season.

Figure 4. Annual rainfall trend (1901–2008)



Source: CRS (2011)

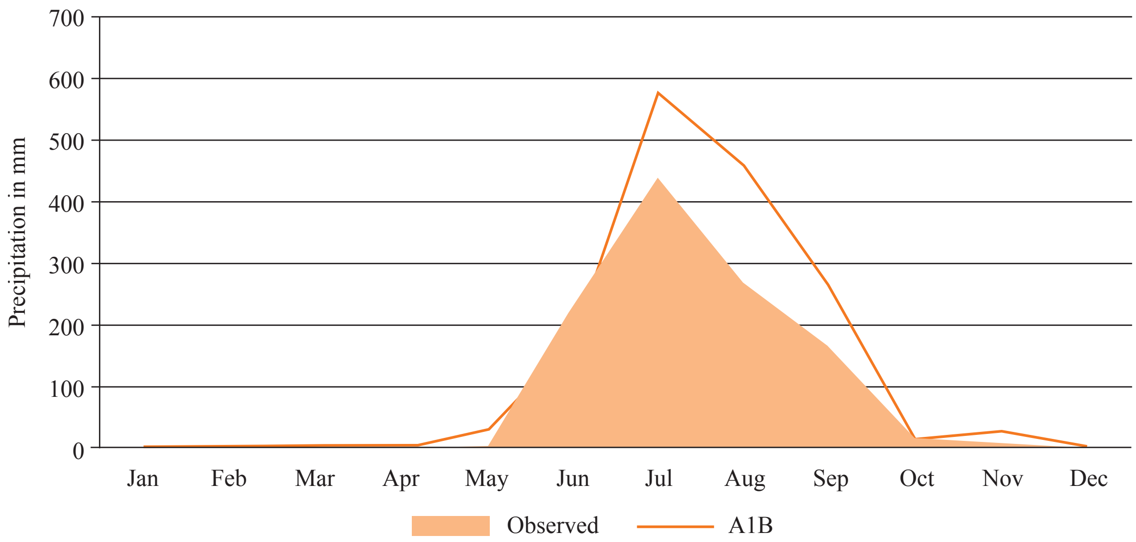
Note: the orange line (solid) in the median and the dotted lines represent the first standard deviations.

Upon analysis of daily precipitation there is evidence of a decrease in the number of rainy days. From this, combined with the increasing rainfall trend, one can infer that the increase in rainfall will be experienced as a single day extreme event of high intensity rainfall. July and August are also months during which the coastal areas of Surat generally experience the highest high tides, so the increase in rainfall during this time, combined with high tides, may increase the chances of Khadi floods in the city. Also, extreme rainfall within the catchment area of Tapi river basin, especially during tail end of the monsoon season (post-August) when the reservoirs have usually reached their carrying capacity, forces the irrigation authorities to release water from dam with limited warning leading to flooding along downstream. In addition, problems of sedimentation in the river channels and encroachment along its embankments increases the risk to people and property.

13 General circulation models (GCMs) are a type of climate model that simulate the response of the global climate system to increasing greenhouse gas concentrations. See: www.ipcc-data.org/guidelines/pages/gcm_guide.html

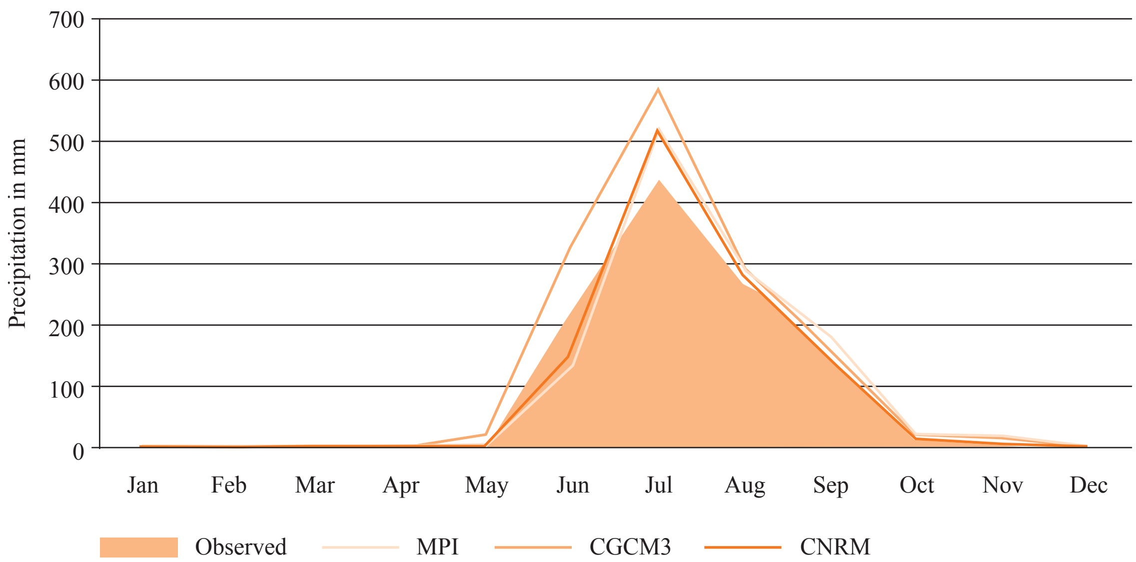
14 PRECIS (providing regional climates for impact studies) was developed by Hadley Centre, UK. PRECIS has been run by Indian Institute of Tropical Meteorology (IITM) for the South Asian domain at 50 km resolution. See: http://www.icimod.org/?q=11138

Figure 5. Rainfall scenario (2021–2050)



Source: CRS (2011)

Figure 6. Rainfall scenario (2046–2065)

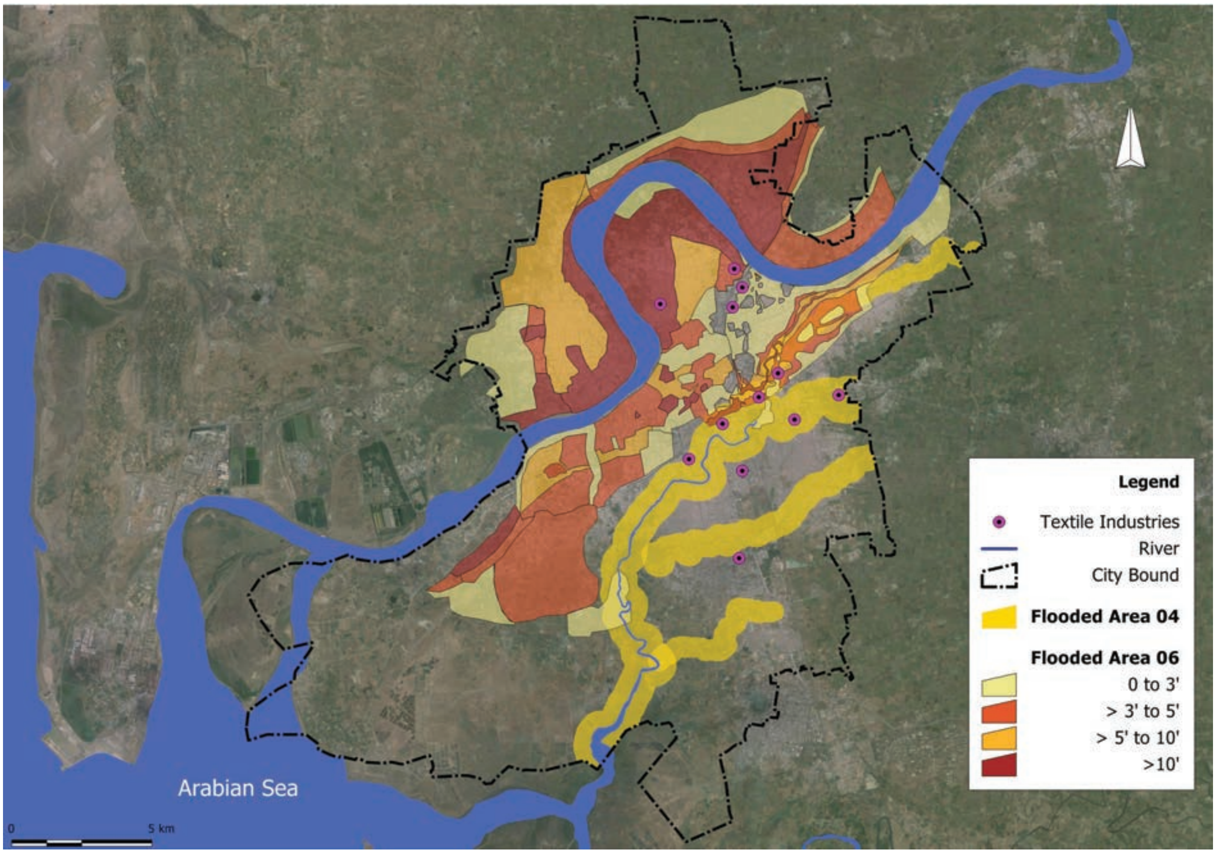


Key to regional climate models: MPI – *Max Planck Institute*. CGCM3 – Canadian Global Climate Model Version 3. CNRM – French National Centre for Meteorological Research (Centre National de Recherches Météorologiques).

Source: CRS (2011)

Figure 7 indicates the extent and magnitude of flooding within the city in 2006. From the results, it can be inferred that the majority of the city was flooded, including eight of the 12 areas that house weaving businesses. The 2006 floods occurred due to the release of excess water from the Ukai Dam and not due to local rainfall. Therefore, there is a strong correlation between the businesses, their proximity to the river (increasing the likelihood of Khadi floods), and the extent and frequency of flooding they experienced.

Figure 7. Riverine flood inundation map, 2006



Source: Authors' figure

5.2 Brief overview of surveyed textile businesses

A typical surveyed weaving unit occupies around 1,600 square feet and has two floors for power looms (see Table 3). Most of the businesses were established during the 1980s and 1990s. For an average weaving unit in business, approximately eight people are required to operate the power-loom machines. The businesses surveyed own an average of 36 power looms, with one typical business unit (locally known as 'Khatu') operates 12 power loom machines managed by two people (one in charge of six power looms) working in 12-hour shifts. On average, weaving businesses operate for 325 days a year. One time investment in machineries (power looms) ranges from INR0.1 million to INR4.14 million; the average investment in the power looms among the businesses surveyed is around INR3 million (see Table 3). The average annual turnover of surveyed businesses is 0.9 million metres of grey cloth and annual average revenue per unit is INR8.62 million. The major input material for power looms is largely yarn, nylon and polyester. Input quantity per weaving unit ranges from 145 to 72,000 metres of yarn per day, and the average is 2,283 metres per day (see Table 3). Since nylon and polyester are the predominant inputs, output is also that of nylon and polyester grey cloth. The daily output ranges from 120 to 10,500 metres and the average is 1,609 metres. The output price per metre ranges from INR4 to INR22 (average INR6.77) per metre (see Table 3).

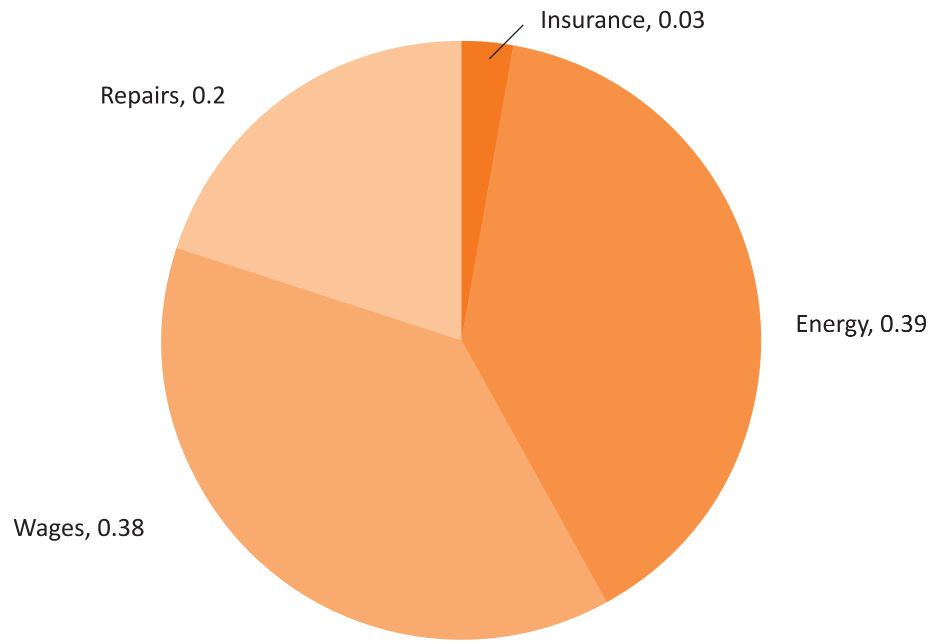
Table 3. Average figures for a typical weaving unit in Surat

Characteristics of businesses	Average value
Space	1,600 square feet over two floors
Number of workers	8
Number of power looms	36
Number of annual business days	325
Daily working hours	12
Investment in machinery (power looms, in million INR)	3
Annual average turnover (in million metres of fabric produced)	0.9
Annual average revenue (in million INR)	8.62

Source: authors' computation based on primary data

The operational cost of running a weaving unit includes components such as energy charges, wages, repair costs, rent and insurance premiums. The average annual energy charges are INR0.62 million, wages INR0.61 million and repairs and maintenance INR0.32 million. Of the 145 businesses surveyed, 114 businesses reported having insurance (approximately 78 per cent; see Table 8) and the average annual premium is INR45,012. Thus the total average annual operational cost of a typical weaving unit is INR1.6 million of which energy charges are 39 per cent, wages 38 per cent, repair and maintenance 20 per cent, and insurance premiums 3 per cent. This is reflected in Figure 8.

Figure 8. Average annual operational breakdown of costs for a typical weaving unit in Surat



Source: survey data

5.3 Perceptions of non-economic loss and damages of textile businesses

This section briefly discusses about the weaving-unit owners' perceptions of past floods (particularly the 2006 flood), and non-economic L&D of the textile businesses from the 2006 flood. In this context, Table 4 shows what percentage of the surveyed businesses experienced floods in the past (in 2006 and 2013) and their perception of the impacts of the 2006 flood. Table 5 outlines the non-economic impacts of the 2006 flood on textile businesses. In fact, all the surveyed businesses are located at an average distance of 0.7km from the Tapi River. The massive 2006 flood affected almost all the surveyed businesses (see Table 4). According to the unit owners, June to November are the peak season months for their businesses, particularly for local Hindu festivals like Dussehra and Diwali which are generally celebrated during October and November, and these businesses receive their highest bulk orders for output during June to September every year. If a flood event, similar to 2006 magnitude, occurs around the months of Dussehra or Diwali is likely to cause greater L&D to textile-weaving businesses in the city. Further, around 78 per cent of the weaving businesses experienced Khadi flooding in 2013; all businesses in the Ved Road area were affected (see Table 4). From the previous section, it is understood that future flood events are more likely to occur between June and September, and therefore, it could be expected that the textile businesses are likely to face a greater loss in the forthcoming decades, particularly the businesses located in the Ved Road area. It is, therefore, imperative to enhance resilience capacity of the textile businesses in Surat to avoid large potential damages in the near future.

As expected, around 6 per cent of sample businesses felt that the impact from the 2006 flood was very high, and 78 per cent of sample businesses felt they were high (see Table 4 and Figure 9). This finding reveals that a majority of textile businesses were affected during flood in the year 2006. The textile businesses located in the Ved Road area experienced higher damages compared to those in other locations; topographically, this area is close to the Tapi River and is also in a low-lying area.

Table 4. Experienced flood risks and respondents' perceptions of 2006 flood impact

	Ved Road		Katargam		Khatodara & LH Road		Total	
	No.	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
Experienced flood risks								
Flood in 2006	99	100	27	100	18	100	144	100
Khadi flood in 2013	99	100	2	7.4	12	66.7	113	78.5
Impact of flood in 2006 (respondents' perceptions)								
Very high	5	5.05	0	0.00	3	16.67	8	5.56
High	91	91.92	18	66.67	3	16.67	112	77.78
Moderate	3	3.03	8	29.63	9	50.00	20	13.89
Low	0	0.00	1	3.70	3	16.67	4	2.77

Source: authors' computation based on primary data

Figure 9. Perceptions of 2006 flood impacts on weaving businesses in Surat (% of respondents)

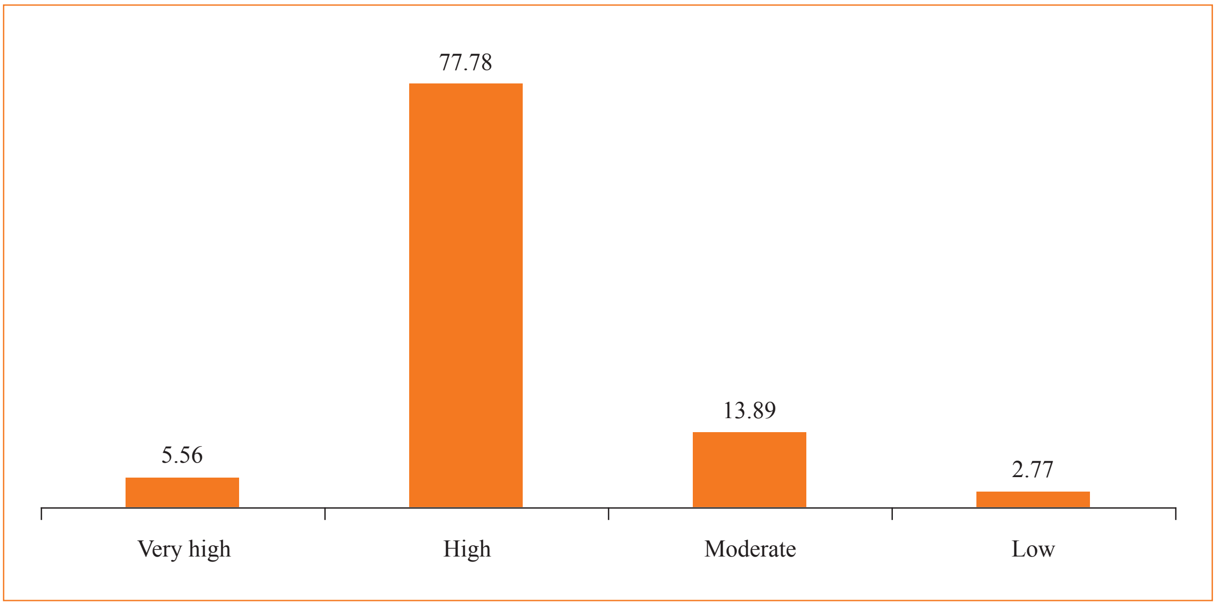


Table 5 shows that the average level of inundation was 14 feet, within a range of 2–22 feet. The impact was so high during the flood in 2006 that it took textile-weaving businesses an average of 49 days to return to normal production – an example of indirect economic L&D. The business owners lost income which they could have earned during the recovery period. This also had economic and non-economic effects on the workers such as loss of wages, migration, impacts on remittances and/or social conflict among the family members. Since there was a relatively higher impact on the businesses located in the Ved Road area, it took longer to recover and resume normal production, as expected, compared to the businesses located in Katargam and Khatodara (see Table 5). In addition, around 12 respondents (8.3 per cent) reported health problems experienced by their employees during or immediately after the flood. The number of sick days ranged from 1 to 12, with an average of 3 days (similar to the findings of the previous studies by Bhat *et al*., 2013), and moreover, around 66 per cent of owners reported that their employees were covered by health insurance.

In fact, there was a huge out-migration of the labour force from Surat after the flood in 2006, and textile businesses faced a large deficiency of labour as a result. For instance, around 95 per cent of weaving businesses reported that a proportion of their employees had migrated from the city of Surat immediately after the flood; some of them could have temporarily out-migrated and returned once the situation had normalised, but others might not have returned to Surat. Similarly, flood-induced displacement is a serious issue in Surat, especially for migrants (Santha *et al*. 2015). This could be the major factor determining how long these businesses took to resume normal production, and this could also have indirectly impacted on the family members of the migrant workers, if remittances were the major source of income. In fact, following the 2006 flood, many small businesses closed down due to financial loss suffered by the owner.

Table 5. Non-economic impacts of flood on textile businesses in 2006

	Ved Road	Katargam	Khatodara & LH Road	Total
Level of inundation (feet)	17	11	6	14
Recovery period (number of days)	54	40	37	49
Flood-related health problems reported (%)	9.09	11.11	0.00	8.33
Migration of labour (%)	98.99	81.48	94.44	95.14

Source: based on primary data

5.4 Perceptions of economic loss and damages of textile businesses

This section reports the major problems faced by the weaving businesses immediately after the 2006 flood event, and calculates average economic L&D (at 2013 prices) to textile businesses in Surat during the 2006 flood. In this context, Table 5 highlights respondents' perceptions of major ex-post problems (from immediately after the flood until normal production was resumed). During the post-flood situation, the textile businesses in Surat encountered problems related to the shortage of labour, transportation and energy, the replacement/repair of machinery and access to raw materials. Except for the replacement/repair of machinery, these problems would have had an indirect economic impact on the textile businesses. When respondents were asked to compare and rank these problems[15], the shortage of labour was cited as the major problem, as around 83 per cent of businesses reported that these were very high post-flood in 2006 (see Table 6). The other major problems were access to raw materials, and the replacement/repair of machinery. While around 53 per cent of respondents answered 'high' in the case of former, the latter was ranked almost as high by 49 per cent of the total surveyed businesses (see Table 6).

Table 6. Respondents' perceptions of major ex-post problems following 2006 flood (%)

Major problems	Very high	High	Moderate	Low	Very low
Shortage of labour	82.64	4.17	10.42	1.39	1.39
Transportation	1.39	10.42	4.86	72.22	11.11
Energy	5.56	9.03	1.39	11.11	72.92
Replacement/repair of machinery	1.39	48.61	49.31	0.69	0.00
Access to raw materials	0.69	52.78	45.14	1.39	0.00

Source: based on primary data

15 *Percentages do not add up to 100 per cent, as each problem was ranked by the respondent separately on a scale of 1 to 5, with 5 being the most important and 1 being the least important.*

Table 7 shows average economic L&D (at 2013 prices) to textile businesses in Surat city during the 2006 flood (see Figures 10 and 11 and Appendix 3 for average impact of individual components of direct economic L&D). Both direct and indirect economic L&D are calculated in Table 7. While the direct economic loss includes costs caused by the loss of raw materials, finished goods, furniture and IT equipment, the direct economic damage cost is the sum of repair costs to buildings, machinery, vehicles, and for other damage (e.g. to energy supply). On the other hand, the indirect economic loss is the loss of net revenue during the recovery period which the businesses could have earned, if flooding had not occurred. The total economic L&D is calculated by deducting compensation received from government and insurance companies from the sum of direct and indirect economic L&D. The advantage is that Table 7 calculates both direct and indirect economic L&D – the latter is, in general, ignored by government agencies while making post-disaster L&D assessments. In doing so, this study has set a methodological framework for the damage assessment agencies in India to evaluate L&D from any future disasters.

On average, weaving businesses lost a total L&D of approximately INR1.51 million, which is even higher in the Ved Road area (INR1.90 million) compared to Katargam (INR0.60 million) and Khatodara (INR0.73 million). The direct L&D was on average INR0.98 million, whereas the mean indirect L&D was INR1 million. It seems that the indirect L&D was marginally higher than the direct L&D, highlighting the importance of including indirect economic L&D in post-disaster assessments; otherwise, the existing L&D estimation significantly underestimates the actual damage costs.

Table 7. Average economic L&D to textile businesses in Surat in 2006 (INR millions, 2013 prices)

		Ved Road	**Katargam**	**Khatodara & LH Road**	**Total**
	Direct L&D				
1	Loss	0.52	0.21	0.18	0.42
2	Damage	0.70	0.31	0.16	0.56
3	Total direct L&D (1+2)	1.22	0.52	0.34	0.98
	Indirect L&D				
4	Total indirect L&D	1.29	0.28	0.45	1.00
	Direct and indirect L&D				
5	Total (excluding insurance compensation) (3+4)	2.51	0.80	0.79	1.98
6	Compensation received from insurance and government	0.61	0.20	0.06	0.47
7	Total L&D (5–6)	1.90	0.60	0.73	1.51

Source: authors' computation based on primary data

While estimating the total L&D, we have deducted the compensation each weaving business received from insurance companies and/or government; this is also not considered by existing agencies while estimating post-disaster L&D. Since both indirect L&D costs and compensation are not calculated by the respective government agencies during post-disaster damage assessments in India, the reported L&D figures are either overestimating or underestimating the actual impact cost. The present reported L&D by government agencies has, therefore, larger policy implications at a different spatial scale. From the business perspective, this has negative implications for business owners in terms of receiving adequate compensation both from government and the insurance industry. At the local and state levels, the respective state government could avail less grant-in-aid from the central government and various donor agencies, since the present L&D estimation underestimates the true economic damage costs. This underestimating of value could also weaken the position

of developing and under-developed nations when demanding adaptation funding during international climate change negotiations under the UNFCCC.

This study, therefore, sets an example for the government agencies on how to estimate actual economic L&D from any disasters.

Figure 10. Loss and damage to weaving businesses in Surat caused by 2006 flood (in INR millions)

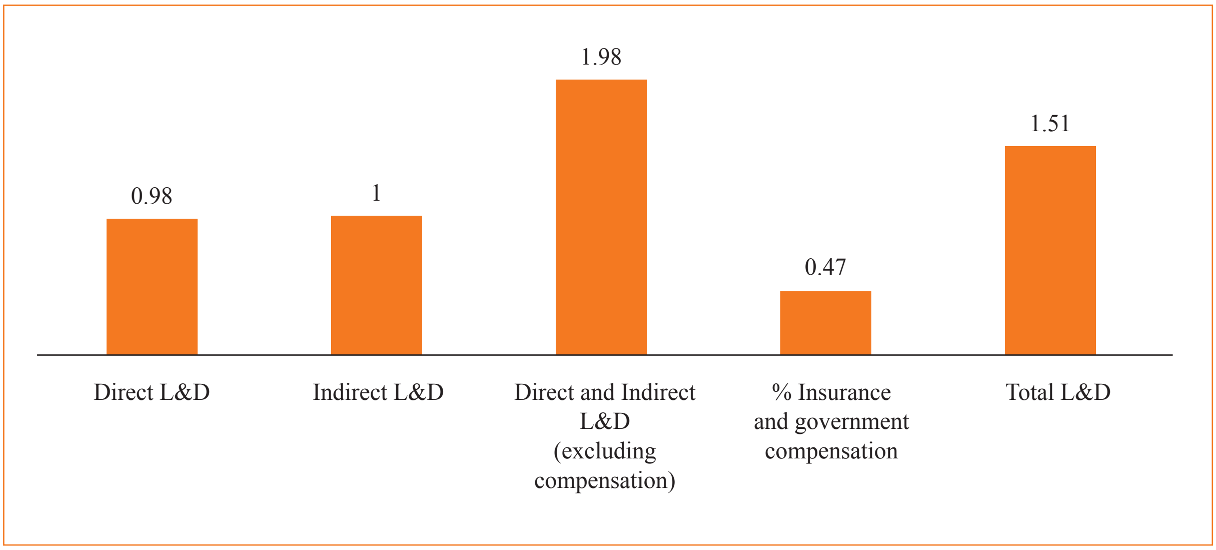
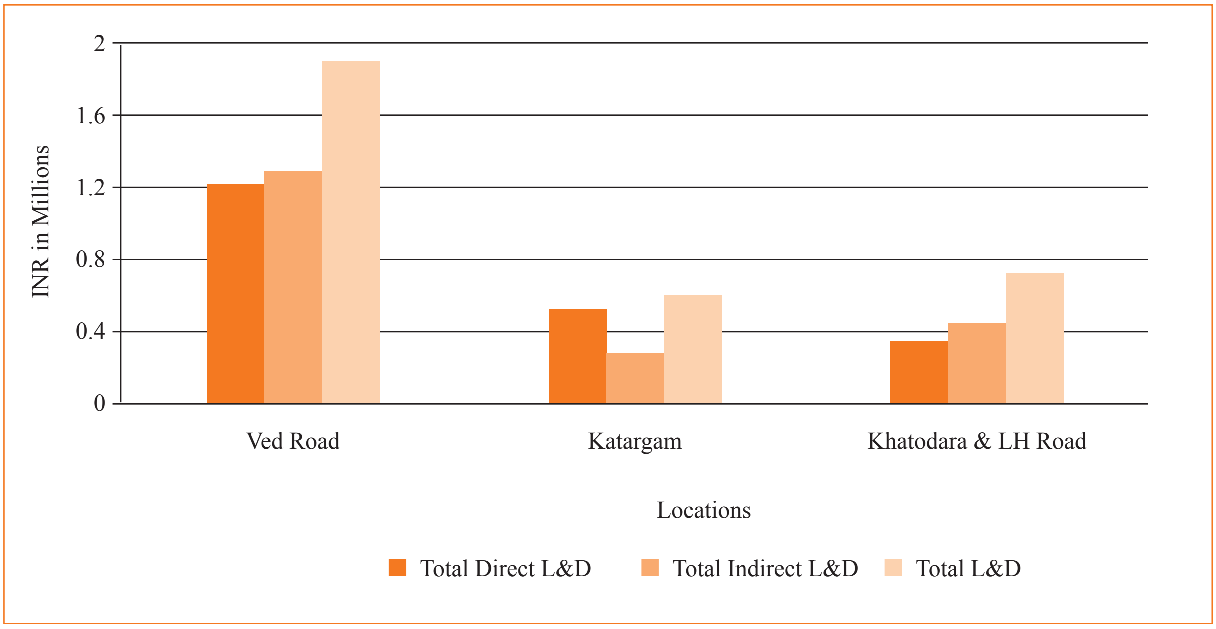


Figure 11. Area-wide loss and damage to weaving businesses in Surat caused by the 2006 flood (in INR millions)



5.5 Coping measures

To withstand past and future floods, the textile businesses in Surat City have adopted various coping mechanisms, which are reported in Table 8. Around 63 per cent of unit owners reported that they had bought insurance prior to the flood in 2006. As of 2014, around 78 per cent of total businesses are covered by insurance; buy although there is an increase in insurance coverage, most of the respondents clarified that the ground floor of their business premises are not covered by insurance. Through the shared learning dialogues, it is understood that all of the weaving businesses are keen to buy insurance to reduce the potential impacts of floods. However, respondents stated that most insurance companies are not willing to insure their businesses, apart from the ground floor, as these businesses are located in a high-risk region. While a smaller percentage of sample businesses have invested in buildings (e.g. shifting machinery and other raw materials to higher floors) and machines to make them more resilient to future floods, a higher proportion of business owners (57 per cent) have invested in other coping mechanisms (see Table 8).

Table 8. Coping mechanisms adopted by textile businesses in Surat City (in %)

	Ved Road	Katargam	Khatodara & LH Road	Total
Coping mechanisms adopted during flood in 2006				
Insurance	67.68	74.07	16.67	62.50
Ex-post loan	22.22	3.70	0.00	15.97
Coping mechanisms adopted after flood in 2006				
Insurance during 2014	86.87	81.48	27.78	78.47
Investment in buildings	13.13	7.41	0.00	10.42
Investment in machinery	2.02	25.93	83.33	16.67
Investment in other infrastructure (e.g. roads)	60.61	70.37	16.67	56.94

Source: based on primary data

5.6 Respondents' risk perceptions of future floods

The respondents were asked about their perception of the impacts of future floods. Surprisingly, a majority of sample businesses (83 per cent) believe that the future flooding risk is moderate (see Table 9). This could be because of the widely held belief that the 2006 floods was a man-made event where the rules for running the dam correctly were not observed (CSS, 2006). Therefore, the perception is that the likelihood of the same mistake being repeated is low, and thus, the city of Surat is safe. Moreover, there is also a belief that Surat City has been undertaking various resilience activities to prevent river water from entering the city. For instance, the irrigation department of Gujarat, in coordination with the Surat Municipal Corporation, has increased both the length and height of the flood-defence embankments. This work was initiated after the 2006 floods, and currently the embankments cover much of the city limits. With the support of the Rockefeller Foundation's ACCCRN initiative, TARU Leading Edge has developed an end-to-end early warning system for the Ukai floods. This warning system provides 24 to 72 hours warning to the dam authorities and the municipal

corporation, allowing them time to slowly release water from the reservoir pending an extreme rainfall event within the catchment area. This system was successfully tested during 2013. The fact that a flood of the intensity of 2006 has not been repeated for at least eight years also strengthens this belief that it will not happen again. Perceptions like this can create a false sense of security, which is problematic and can lead to insufficient investment in pro-active planned adaptation measures.

Table 9. Respondents' perceptions of future floods risks in Surat City

Perceptions of future flood risk	Ved Road		Katargam		Khatodara & LH Road		Total	
	No.	%	No.	%	No.	%	No.	%
Very high	0	0.00	0	0.00	2	11.11	2	1.39
High	6	6.06	5	18.52	12	66.67	23	15.97
Moderate	93	93.94	22	81.48	4	22.22	119	82.64

Source: authors' computation based on primary data

6 Concluding observations and ways forward

The notion of L&D has gained momentum in the international climate policy arena in recent years, particularly after the Bali action plan in 2007 (UNFCCC, 2012) when developing nations demanded climate adaptation funds. Since then, a few research studies have emerged to assess L&D from various disasters across the world (see Warner and van der Geest, 2013). While none of these studies have calculated economic L&D, there is no study so far based on Indian case studies. Moreover, while government agencies in India have been calculating the cost of a disaster to seek financial aid from national government and various donor agencies, they largely focus on direct economic and non-economic L&D indicators (Prabhakar *et al*., 2015). While the definition and assessment methodology of L&D are not properly defined to the research communities so far (Birkmann and Welle, 2015), the challenges of assessment are great, especially for cities in India given the scale of urbanisation. Therefore, this case study is an attempt to address the challenges of calculating economic and non-economic L&D to textile-weaving businesses in Surat from the 2006 flood and identify adaptation measures undertaken at individual, community, civil society and government levels since 2006. This highlights the relevance of inclusion of indirect economic L&D in the post-disaster cost estimation.

All of the sample businesses were severely affected by the 2006 flood, and on an average, these businesses took slightly longer than one and half months to return to normal. This longer recovery period has had an indirect economic impact on the weaving businesses, and has welfare implications for workers in terms of loss of wages, impacts on migration and remittances or potential for social conflict. Because of this, labour shortages were cited as a major problem during the post-flood scenario. This study urges that the forthcoming policies for urban India (e.g. AMRUT, Smart Cities Mission and Housing for All) should consider the possible impacts of extreme events while designing city-wide infrastructure across India.

The mean loss and damage of a textile unit was around INR 1.51 million, and of which, INR 0.98 million was due to direct loss and damage, and average indirect loss and damage and compensation were INR 1 million and INR 0.47 million, respectively. The calculation of indirect economic L&D is equally important but is generally overlooked by the government agencies while doing post-disaster impact cost estimation, and henceforth, this study urges that future damage cost assessment should include it; otherwise the true economic L&D is being underestimated. Though the weaving business owners are aware of insurance, not all insurance companies will provide cover to businesses in risk-prone areas, or will only cover the ground floor. Further, it is surprising that respondents' perceive the threat of impacts from future floods as moderate – this could be detrimental to individual- and community-level investment on pro-active planned adaptation options. Based on the findings, this study has a few policy recommendations:

- During post disaster situation, fear of epidemics lead to migrant workers not returning to work even after the restoration of normalcy. Mechanisms for proper communication are required before, during and after disaster. This will decrease worker absence post normalcy.
- Future calculations of economic L&D figures should include indirect economic L&D.

- Since the impact cost is relatively higher for weaving businesses situated in the Ved Road area, local government should prioritise building climate-resilient infrastructure in this area.
- Government should establish initiatives to provide insurance to all businesses, particularly those situated in the high flood-risk areas.
- Regular awareness-raising meetings about future flood risks in Surat City should be organised, so that business owners can undertake ex-ante adaptation measures voluntarily to avoid potential damage from future floods.
- Government agencies should conduct a citywide L&D assessment to inform efficient investment in services and infrastructure, and hence, facilitate the development of climate-smart cities across India.

During the consultation workshop many of the business owners did cite the availability of good-quality and trustworthy insurance products as a measure to strengthen business continuity. Other measures suggested by them included:

- Installing permanent pumps within the industrial areas to help drain the flood waters,
- Increasing the storm water drainage system (currently many of these areas do not have storm water drainage),
- Improving solid-waste management systems to increase the workers' health, and
- Incorporating tax waivers for businesses post-floods and or during normalcy so that businesses can collectively invest in infrastructure facilities.

A larger policy implication is that the L&D assessment provides an indication of the city's resilience to future disasters, and such an initiative could prompt policymakers to replicate it in other cities across India.

The findings of this study should be read with some caveats. The low number of sample businesses involved in this case study could have led to sample bias while intangible costs, spill-over impacts and impacts on the regional economy have not been captured. These are issues which require further research.

References

ACCCRN (2011) Surat City resilience strategy. Asian Cities Climate Change Resilience Network (ACCCRN) and TARU-Leading Edge, Surat, India.

Anguelovski, I., Chu, E. and Carmin, J. (2014) Variations in approaches to urban climate adaptation: experiences and experimentation from the global south. *Global Environmental Change* 27: 156–167.

Bahinipati, C.S., Patnaik, U. and Viswanathan, P.K. (2015) What causes economics losses from natural disasters in India? In: Dinda, S. (ed.) *Handbook of research on climate change impact on health and environmental sustainability*. IGI Global Publisher.

Bauer, K. (2013) Are preventive and coping measures enough to avoid loss and damage from flooding in Udayapur district, Nepal? *International Journal of Global Warming* 5(4): 433–451.

Bhat, G.K., Karanth, A., Dashora, L. and Rajasekar, U. (2013) Addressing flooding in the city of Surat beyond its boundaries. *Environment and Urbanization* 25(2): 1–13.

Birkmann, J. and Welle, T. (2015) Assessing the risk of loss and damage: exposure, vulnerability and risk to climate related hazards for different country classifications. *International Journal of Global Warming*. See: www.uni-stuttgart.de/ireus/publikationen/Birkmann_Welle_2015.pdf

Botzen, W.J.W. and van den Bergh, J.C.J.M. (2009). Managing natural disaster risks in a changing climate. *Environmental Hazards* 8(3): 209–225.

Bouwer, L.M., Crompton, R.P., Faust, E., Hoppe, P. and Pielke, R.A. Jr (2007) Confronting disaster losses. *Science* 318: 753.

Brida, A.B. and Owiyo, T. (2013) Loss and damage from the double blow of flood and drought in Mozambique. *International Journal of Global Warming* 5(4): 514–531.

Census of India (undated) Census of India website. See: http://censusindia.gov.in. Government of India, Ministry of Home Affairs, Office of the Registrar General and Census Commissioner, India.

Chu, E., Anguelovski, I. and Carmin, J. (2015) Inclusive approaches to urban climate adaptation planning and implementation in the Global south. *Climate Policy*.

City Mayors (2008) ICLEI: local governments for sustainability. *City Mayors* website. See: www.citymayors.com/orgs/iclei.html

CRS (2011)City Resilient Strategy : Prepared by TARU for Surat City

CSS (2006) Surat 2006 floods: a citizens' report. Centre for Social Studies, Surat, India.

CSS (2010) Learning to live with floods at Surat. Centre for Social Studies, Surat, India.

Dodman, D. and Archer, D. (2014) Towards an urban agenda on climate-related loss and damage. Asian Cities Climate Resilience Policy Brief. IIED, London. See: http://pubs.iied.org/10718IIED.

Dow, K., Berkhout, F., Preston, B.L., Klein, R.J.T., Midgley, G. and Shaw, M.R. (2013) Commentary: limits to adaptation. *Nature Climate Change* 3: 305–307.

Hallegatte, S. and V. Przyluski (2010) The economics of natural disasters: concepts and methods. Policy Research Working Paper 5507, World Bank, Washington D.C.

Hallegatte, S., Green, C., Nicholls, R.J. and Corfee-Morlot, J. (2013) Future flood losses in major coastal cities. *Nature Climate Change* 3: 802–806.

IPCC (2012) Summary for policymakers. In: Field, C.B., Barros, V., Stocker, T.F., Qin, D., Dokken, D.J., Ebi, K.L., Mastrandrea, M.D., Mach, K.J., Plattner, G.K., Allen, S.K., Tignor, M. and Midgley, P.M. (eds) *Managing the risks of extreme events and disasters to advance climate change adaptation: a special report of Working Groups I and II of the Intergovernmental Panel on Climate Change.* Cambridge University Press, Cambridge, 3–21. See: http://ipcc-wg2.gov/SREX/

Karanth, A. and Archer, D. (2014) Institutionalising mechanisms for building urban climate resilience: experiences from India. *Development in Practice* 24(4): 514–526.

Kumar, S. (undated) Professor Santosh Kumar of NIDM, New Delhi, personal communication with authors.

McGranahan, G., Balk, D. and Anderson, B. (2007) The rising tide: assessing the risks of climate change and human settlements in low elevation coastal zones. *Environment and Urbanization* 19(1): 17–37. See: http://eau.sagepub.com/content/19/1/17

Mirza, M.M.Q. (2003) Climate change and extreme weather events: can developing countries adapt? *Climate Policy* 3: 233–248.

Nicholls, R.J., Hanson, S., Herweijer, C., Patmore, N., Hallegatte, S., Corfee-Morlot, J., Chateau, J. and Muir-Wood, R. (2008) Ranking port cities with high exposure and vulnerability to climate extremes. OECD Environment Working papers No. 1, OECD. See: http://tinyurl.com/nicholls-et-al-2008

Parry, M.L., Canziani, O.F., Palutikof, J.P., van der Linden, P.J. and Hanson, C.E. (eds) (2007) Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. See: www.ipcc.ch/publications_and_data/ar4/wg2/en/contents.html

Patel D. P. (2012) Flood assessment by integrated hydrological modeling with RS and GIS in water resources

management, Unpublished PhD Thesis, Gujarat University, Ahmedabad, India.

Pielke, R. Jr., Prins, G., Rayner, S. and Sarewitz, D., (2007), "Lifting the Taboo on Adaptation" Nature, 455(8): 597-598.

Prabhakar, S.V.R.K., Chiba, Y., Abamo, A., Bahinipati, C.S. and Shrestha, S. (2015) Addressing non-economic loss and damage associated with climatic events in Asia: experiences, issues and way forward. IGES Research Report, Institute for Global Environmental Strategies.

Rabbani, G., Rahman, A. and Mainuddin, K. (2013) Salinity-induced loss and damage to farming households in coastal Bangladesh. *International Journal of Global Warming* 5(4): 400–415.

Revi, A. (2008) Climate change risk: an adaptation and mitigation agenda for Indian cities. *Environment and Urbanization* 20(1): 207–229. See: http://eau.sagepub.com/content/20/1/207

Revi, A., Satterthwaite, D.E., Aragón-Durand, F., Corfee-Morlot, J., Kiunsi, R.B.R., Pelling, M., Roberts, D.C. and Solecki, W. (2014) Urban areas. In: Field, C.B., Barros, V.R., Dokken, D.J., Mach, K.J., Mastrandrea, M.D., Bilir, T.E., Chatterjee, M., Ebi, K.L., Estrada, Y.O., Genova, R.C., Girma, B., Kissel, E.S., Levy, A.N., MacCracken, S., Mastrandrea, P.R. and White, L.L. (eds.) *Climate change 2014: impacts, adaptation, and vulnerability. Part A: global and sectoral aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.* Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 535–612. See: https://ipcc-wg2.gov/AR5/report/full-report/

Roberts, E. and Huq, S. (forthcoming) Coming full circle: the history of loss and damage under UNFCCC. *International Journal of Global Warming*.

Santha, S.D., Jaswal, S., Sasidevan, D., Datta, K., Khan, A. and Kuruvilla, A. (2015) Climate change, livelihoods and health inequities: the vulnerability of migrant workers in Indian cities. Asian Cities Climate Resilience Working Paper Series 16, IIED, London. See: http://pubs.iied.org/10728IIED

Sharma, D. and Tomar, S. (2010) Mainstreaming climate change adaptation in Indian cities. *Environment and Urbanization* 22: 451–465. See: http://eau.sagepub.com/content/22/2/451

Sidhwani, P. (2015) Spatial inequalities in big Indian cities. Economic and Political Weekly, 50(22): 55–62.

SMC (undated) City development plan (revised) 2008–2013. Surat Municipal Corporation, Surat, India. See: http://tinyurl.com/smc-cdp-revised

Stern, N. (2007) Stern review: the economics of climate change. Cambridge University Press, UK. See: http://tinyurl.com/stern-review-climate-change

The Hindu (25 June 2015) Cities should get chance to plan their growth, says Modi.' *The Hindu* website. See: www.thehindu.com/news/national/prime-minister-narendra-modi-launches-smart-cities-mission/article7353823.ece

Times of India (14 March 2015) Mumbai conclave to assess potential of power loom sector.

Traore, T. and Owiyo, T. (2013) Dirty droughts causing loss and damage in Northern Burkina Faso. *International Journal of Global Warming* 5(4): 498–513.

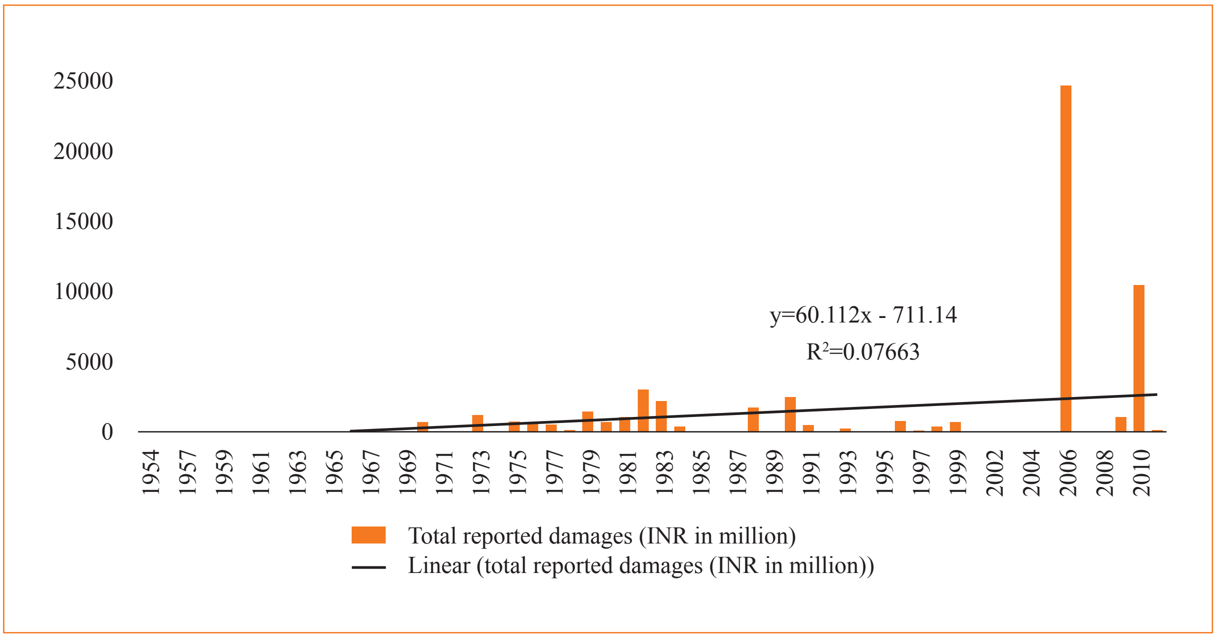
UNFCCC (2012) A literature review on the topics in the context of Thematic Area 2 of the work programme on loss and damage: a range of approaches to address loss and damage associated with the adverse effects of climate change. See: http://unfccc.int/resource/docs/2012/sbi/eng/inf14.pdf

UNFCCC (2013) Non-economic losses in the context of the work programme on loss and damage. Technical Paper, 1–22. See: http://unfccc.int/resource/docs/2013/tp/02.pdf

Warner, K. and van der Geest, K. (2013) Loss and damage from climate change: local-level evidence from nine vulnerable countries. *International Journal of Global Warming* 5(4): 367–386.

Yaffa, S. (2013) Coping measures not enough to avoid loss and damage from drought in the North Bank Region of the Gambia. *International Journal of Global Warming* 5(4): 467–482.

Appendix 1. Total reported economic loss in Gujarat (INR in million)



Source: based on data collected from the Central Water Commission (CWC), Government of India, New Delhi.

Appendix 2. Economic damages caused by 2006 flood in Surat City

Department	Losses (INR million)	% of loss
SMC	1,404.40	0.88
R&B	504.70	0.31
Electricity (GEB & Torrent Power)	1,459.70	0.91
Irrigation (Panchayat)	3.04	0.00
District (Panchayat)	742.50	0.46
Irrigation	3,180.00	1.98
GWSSB	70.00	0.04
Industry Trade & Commerce (asset, output and fiscal)	152,750.00	95.23
Gujarat Maritime Board	13.80	0.01
Drainage (state)	260.00	0.16
Other (state road projects, civil supplies, sales taxes etc.)	5.50	0.00
Total	160,393.64	100.00

Source: data collected from Surat Municipal Corporation (SMC) 2014

Appendix 3. Average direct L&D of various components of textile businesses, Surat (INR million, 2013 prices)

Types of economic loss and damages	Ved Road	Katargam	Khatodara & LH Road	Total
Direct economic loss				
Loss of raw materials	0.44	0.17	0.13	0.35
Loss of finished goods	0.01	0.01	0.05	0.01
Loss of furniture and IT equipment	0.07	0.03	0.01	0.05
Direct economic damages				
Cost of repairs to buildings	0.16	0.11	0.05	0.14
Cost of repairs to machinery	0.51	0.17	0.10	0.39
Cost of repairs to vehicles	0.0008	0.00	0.00	0.0005
Cost of repairs for other damages e.g. energy	0.03	0.03	0.01	0.03

Source: authors’ computation based on primary data

Appendix 4. Structured interview schedule for textile industry

INSTRUCTIONS: Please answer all questions. For multiple choice questions please **TICK** the box that corresponds with your response. For the remaining questions, please **FILL IN** the blanks as indicated. Provide additional information as necessary in the **REMARKS** section.

A. PANEL IDENTIFICATION

Schedule code: _________________ Name of investigator: ______________ Date: ___________

Name of the industrial estate/ location: ________________ City ___________________

Industry class: Large Medium Small (SSI) Micro

B. BUSINESS DETAILS

1. Name of respondent(s): ____
2. Designation of respondent(s): ____
3. Contact details: Mobile: _______________ Landline: ____________________
4. a. Company name: _________________________________

   b. Area: _____________________ sq. yard Number of floors: ______________

   c. Year of commencement of production: ___________

5. Did you suffer from any of the following disasters during the last decade (floods?)

a) 2006 b) 2013

Level of inundation (feet)	Impact			
	Slight impact	Moderate impact	High impact	Very high impact

6. Total number of employees required for production.

A) 2006 :________________

B) 2013:_________________

7. Input materials

Year	Materials type	Quantity per day	Source (city / outside city)	Dependence (%)
2006				
2013				

8. Output materials

Year	Materials type	Intermediary products	Quantity per day/week	Selling sources	Price per unit
2006				City	
2013				Outside city	

9. Seasonality in business

S. No.	Seasonality in business	
	Season	Months (from/to)
1	Peak	
2	Normal	
3	Lean	

10. Working days in a year: ___________

11. Has there been any change to your building between 2006 and 2013? (Y/N)

If yes, please provide information below:

Type	Type in 2006	Cost in 2006	Types in 2013	Cost in 2013
Roof (Tin/RCC)	(Tin/RCC)		(Tin/RCC)	
Walls (Bricks/concrete)	(Bricks/concrete)		(Bricks/concrete)	

12. What are the costs for machinery for your unit? _____________

Types of machine	No. in 2006	Cost in 2006 (in INR)	No. in 2013	Cost in 2013 (in INR)
Power loom				
Water jet loom				
Repair loom				

13. Operational information

	2006	2013
Annual turnover per unit (metres of fabric)		
Energy charges (INRper year)		
Salaries and wages (INRper year)		
Repair and maintenance (INRper year)		
Rent (INRper year)		
Insurance charges (INRper year)		
Minimum employees required for production		

14. Direct and indirect losses should be separated from the previous question

Types of direct loss	Damage/cost of repairs in INR2006	Damage/cost of repairs in INR 2013
Building		
Machinery		
Raw materials		
Finished goods		
Furniture & IT		
Vehicles		
Energy		
Loss of life		
Physical injury to people		
Other		
Total		

15. Indirect loss should have the following elements

Types of indirect loss	2006	2013
Number of days unit was closed (days)		
Number of days labour was not available (days)		
Recovery period (days)		
Time needed to access raw materials (days)		
Loss of documents (INR)		

16. What do you think was the biggest problem you experienced from the list given below? (Please rank 5 as highest and 1 as lowest)

Problem	2006	2013
Labour		
Transportation		
Energy		
Machinery		
Access to markets and resources		

17. Please provide the following information:

	2006	2013
How many long did it take to resume normal productivity? (days)		
Did you or your employees suffer from any diseases? (Y/N)		
If yes, how many people were affected?		
For how many days?		
What percentage of your employees had health insurance? (%)		
Did any of your employees migrate from the city? (Y/N)		
Were you warned about heavy rainfall or floods by the government? (Y/N)		
If yes, what precautionary measures did you take?		
Did you take out any loans after the floods? (Y/N)		
If yes, how much and from where?		
Did you receive any assistance from other agencies/association? (Y/N)		
If yes, from where? (government, private, semi-government, association)		
Type of help (e.g. HR, financial, other, please specify)		
Did you have insurance? (Y/N)		
How much was received against your claim? (In INR)		

18. Do you have insurance now? (Y/N)
19. How much are you insured for? _______________
20. How do you perceive the future flood risk to your unit? (Please select low, medium or high)
21. Have you invested in any coping mechanisms to overcome risks? (Y/N)

If yes, please provide details:

Categories	Capital cost (INR)	Running costs/year (INR)	When was it installed? (year)	Remarks
Buildings				
Machinery				
Function				
Location				
Other				