Reinsurance // Property CAT

Disaster Recovery Case Studies
US Storms 2012: Superstorm Sandy

XL CATLIN

In partnership with

Centre for
Risk Studies

UNIVERSITY OF
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Introductory Commentary

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The important role of (re)insurance in the speed of physical and economic recovery after a major disaster, especially when there is little to no coverage due to unavailability, insufficient capacity or lack of take up (predominantly because of economic reasons), has not really been studied in detail. The (re)insurance industry tends to focus on the potential for future events and events in the immediate past but we at XL Catlin saw the need for a deeper understanding of the aftermath of disasters over a longer time frame, as well as an understanding of the impact that insurance penetration has on the pace of economic recovery.

Working with Cambridge Centre for Risk Studies at the University of Cambridge Judge Business School (CCRS) we have identified 13 catastrophes across the world from 1998 to 2014 to be studied over a three-year timeline to compare and contrast outcomes and establish some conclusions and recommendations. Our original plan was to have one consolidated report released in 2020 but the Case Studies (this one covers Hurricane Katrina) produced by CCRS were so interesting and of such quality we thought it would be beneficial to share these as they became available. CCRS will still issue a consolidated report in April 2020.

Our aim is for this work to be used as a tool by policymakers and governments worldwide when evaluating disaster preparedness and seeking to fully understand, from the lessons learned by others, the impact of displacement of populations; increasing personal debt levels; change in economic mix of industry; political upheaval and overall time to recover, among other things.

We also want to explain the marginal increased cost in relation to the value of rebuilding with resilience – what we call "building back better" – over and above the cost of replacement. The (re)insurance industry needs to provide extra limit and contractual stipulations for "building back better" to minimize the impact of future disasters.

Intuitively, we know the speed and scale of protection the (re)insurance industry provides dramatically reduces the recovery time for communities which have suffered through extreme catastrophes. However, we believe that it is imperative that this be demonstrated in more detail with evidence and placed in front of the right people to effect change.

Almost every event we're focusing on in the 2020 report and associated Case Studies originates from the world's oceans. For the past three decades, XL Catlin has played a leading role in pushing for greater understanding of our oceans, for example, supporting the Bermuda Institute of Ocean Sciences. We have also sponsored independent scientific research into key ocean indicators including extensive work on coral reefs, Arctic sea ice loss and raising awareness of increasing Ocean Risk, i.e., rising sea levels and sea surface temperatures, over-fishing, ocean deoxygenation, pollution and ocean acidity. This work has accelerated in 2018 with the inaugural Ocean Risk Summit held in Bermuda. The Summit, sponsored by XL Catlin and other scientific and Bermuda-based partners, aimed to deepen understanding of Ocean Risk and bring together participants to try to tackle some of these broad ranging consequences.

We are tying increased understanding and awareness of Ocean Risk together with the work by CCRS, making a case for the societal benefit of increased (re)insurance penetration and, in September 2018, will be issuing a special report detailing our own thoughts on the role governments could play in providing cover over and above the (re)insurance industry.

The views, findings and opinions in this Case Study are those of the researchers at CCRS and not necessarily those of XL Catlin. Notwithstanding this, we are proud to be associated with this project and are sure that by gaining a greater level of understanding, we will ultimately develop more catastrophe business and, more importantly, show the world the true value and social benefit of (re)insurance.

Abstract

On 29th October, 2012, Superstorm Sandy made landfall in New Jersey, producing a record storm surge and widespread flooding which devastated the densely-populated and highly vulnerable northern US East Coast. This case study examines the impacts of Sandy in the US – a high-income economy with relatively high non-life insurance penetration – and the subsequent socioeconomic recovery.

Sandy resulted in direct and indirect losses totalling up to an estimated $97 billion. Nevertheless, Sandy had a negligible impact on the national and regional economies. Nearly half of the total loss was insured, at a total cost of nearly $30 billion, making Sandy the US insurance industry's second costliest natural disaster. High-value, commercial properties, public infrastructure, and business losses comprised a large proportion of the insured total, while the federal National Flood Insurance Program (NFIP) – the dominant provider of flood insurance in the US for households – paid nearly $9 billion to policyholders. However, the NFIP was financially inviable, while local NFIP insurance uptake rates rarely exceeded 30%, representing a considerable residential protection gap.

The FEMA-led disaster response was generally commended, and normal social and economic functions recovered within weeks in most areas. However, the antecedent socioeconomic inequality across the region, and a lack of resilient planning and impeded aid delivery resulted in a spatially-disparate recovery. While wealthy, elite organisations experienced an acute interruption, the worst affected, most vulnerable, and often un(der)insured areas experienced prolonged (and in certain cases ongoing) displacement and socioeconomic disruption. Consequently, Sandy has prompted various significant legislative changes to improve the federal governance of disasters. Encouragingly, policy has shifted to include resilient design in the rebuilding process.

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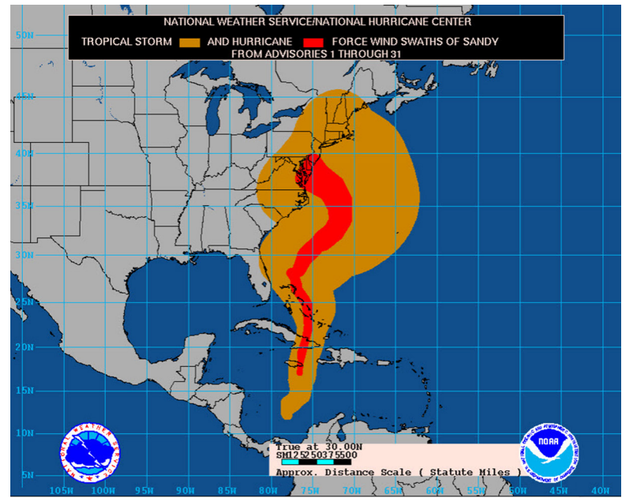
Introduction

This report focusses on the US east coast region impacted by Superstorm Sandy ('Sandy') in 2012, as a case study of a high-income economy with relatively high GDP per capita and non-life insurance penetration. It outlines the characteristics of the immediate and long-term recovery of the region affected by Sandy, and discusses controls on recovery, such as the influence of the socioeconomic and political climates at both the regional and national levels. Further, it addresses the speed and effectiveness of disaster recovery in relation to the disaster governance and funding.

Meteorological overview

Hurricane Sandy was the 10th and final hurricane of 2012, forming in the southwestern Caribbean Sea in late-October. Sandy made two initial landfalls in the Caribbean – in Jamaica on 24th October as a category 1 hurricane, and in eastern Cuba on 25th October as a category 3 hurricane (reaching peak intensity with wind speeds of 115 mph) – before weakening to a tropical storm while tracking through the Bahamas (Blake et al., 2013). At this time, Sandy experienced a complex transformation with its wind field expanding to over 1,600 km in diameter, making it the largest tropical storm on record (Blake et al., 2013) (Figure 1). Subsequently, the system re-strengthened into a hurricane as it tracked north-eastward, parallel to the US east coast. As it turned north-westward towards the mid-Atlantic states, it again weakened and lost its tropicalcharacteristics, interacting with various atmospheric and oceanic elements to produce a hybrid 'superstorm'. Sandy was de-classified by the National Hurricane Center (NHC) to a post-tropical cyclone before making landfall in the US near Brigantine, New Jersey on 29th October (Halverson and Rabenhorst, 2013). The New Jersey and New York coastlines experienced 80 mph sustained winds, and a catastrophic storm surge 4.3 m (14.1 ft) above mean low tide height (MWL) that was exacerbated by a coincident astronomical spring tide (Blake et al., 2013). Following landfall, Sandy steadily weakened, though its broad size caused widespread impacts to the eastern and mid-western US and south-eastern Canada (Aon Benfield, 2014).

Figure 1. Tropical storm (orange) and hurricane (red) force wind swaths of Sandy (Source: NOAA)



Impacts

Sandy hit a region that has rarely been affected by hurricanes. Sandy was the third hurricane to make landfall in New Jersey, a densely populated and highly vulnerable area to such an event (Kunz et al., 2013). The storm made landfall on the New Jersey coastline with a track angle closer to perpendicular than any previous hurricane in the historic record, which contributed to the record inundation depths in coastal New Jersey and New York (Hall and Sobel, 2013). Hall & Sobel (2013) calculated a return period of one-in-714 years for a hurricane of at least the observed intensity making landfall in New Jersey at such an angle.

However, while Sandy was exceptional in a meteorological sense, it was not a particularly intense storm and lacked the high winds and rainfall associated with most major North Atlantic hurricanes. Therefore, this multi-century return period is misleading, and the probability of a hurricane event in the north-east causing economic damages equal to or greater than those of Sandy is relatively high (approximately one-in-50 years) (Swiss Re, 2014). Current FEMA flood hazard maps at the time of Sandy were outdated, significantly underestimating the level of risk, and the storm surge caused flooding that exceeded the 100-year flood boundaries by 53% in New York City (PlaNYC, 2013). The FEMA 100-year flood plain has since been drastically revised to represent a much greater area at risk, and the number of New Yorkers living in the 100-year floodplain went from approximately 218,000 to almost 4000 (PlaNYC, 2013).

Prediction and planning

Certain weather prediction models provided accurate forecasts of the storm track and intensity more than one week in advance (Rosenzweig and Solecki, 2014). However, Sandy posed a significant challenge to the National Hurricane Center (NHC) and National Weather Service (NWS) because of the complexity in its evolution from a hurricane to a post-tropical cyclone (Aon Benfield, 2014). Given this anticipated transition, the NHC followed regular protocol in not issuing tropical-based watches and warnings – a decision that proved controversial. However, later NHC advisories did include the anticipated impacts of Sandy, giving adequate time for immediate preparations. Effective near-term measures included issuance of warnings, advisories, and evacuation orders (the latter on 28th October, one day before landfall). However, the public's acceptance of advisories and evacuation mandates was hindered by ineffective and/or inappropriate communication, for instance to non-English speaking residents and those living in high-rise buildings (Rosenzweig and Solecki, 2014), while many residents underestimated the strength of the storm (Baker et al., 2012). Nevertheless, these preparations significantly alleviated the total damages and fatalities caused by Sandy.

In the long term, hazard exposure has been exacerbated through decades of unsustainable policy and planning, with waterfront development infringing on coastal wetlands (Rosenzweig and Solecki, 2014). In a process termed by Greenberg (2014) as 'crisis-driven urbanisation', New York City in particular has experienced short-sighted, market-oriented, and unequal post-9/11 redevelopment. Billions in federal rebuilding dollars fuelled the rapid construction of luxury residential and commercial developments on the southern tip of Lower Manhattan – with proximity to low-lying waterfronts actually boosting real estate values (Greenberg, 2014). The affected region had not sufficiently incorporated climate risk into development, and while efforts had been made to prepare for high-risk coastal flooding events in various impacted regions, adaption or mitigation measures had not been made at the required scale. It is therefore probable that insufficient coastal risk management contributed to the magnitude of observed damages (Rosenzweig and Solecki, 2014).

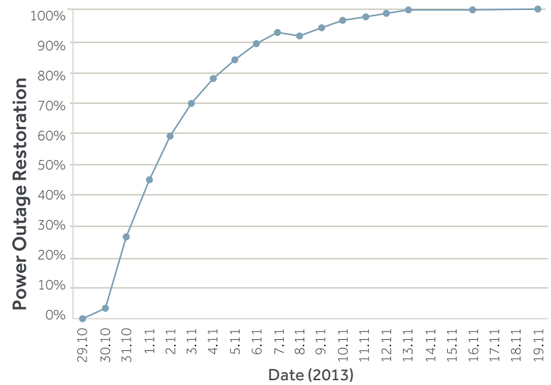
Impacts on life and livelihood

In the US, over 60 million people were directly affected across 24 states, experiencing a range of storm effects – including wind, rain, blizzards, storm surge, and flooding – at varying intensities (Neria and Shultz, 2012). 159 fatalities occurred in the US, of which 71, 43, and 15 occurred in New York, New Jersey, and Pennsylvania, respectively (Diakakis et al., 2015). Nearly half of this total were recorded within <2 km from the coastline (Diakakis et al., 2015). Physical damage was particularly severe in New York and New Jersey – the most densely populated region in the US (U.S. Census Bureau, 2010) – where over 300,000 and 350,000 homes, respectively, were damaged or destroyed (Aon Benfield, 2014). At least 300,000 business properties and 250,500 insured vehicles were damaged or destroyed (Aon Benfield, 2014). Most of this damaged occurred as a result of the storm surge and/or large wave heights.

Impacts on infrastructure

Utility services were not sufficiently prepared, resulting in widespread power outages and various other unforeseen and cascading impacts. Approximately 21.3 million people (8.7 million customers) across 21 states were without power during peak outages on 29th and 30th October (U.S. Department of Energy, 2012). One week after landfall, 84% of the energy system had been restored (Figure 2), although 3.37 million people (mostly in New York and New Jersey) remained without power (Kunz et al., 2013). 95% of customer power supplies had been restored within 13 days – not an unusually long period relative to other major US hurricanes (Kunz et al., 2013).

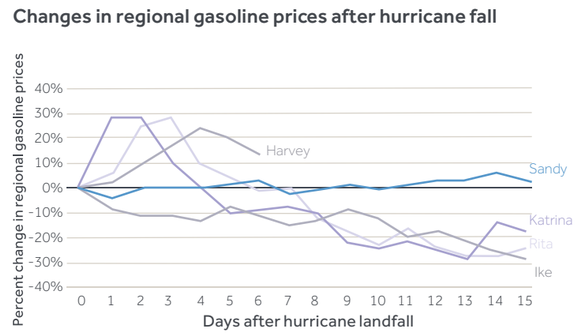
Figure 2. Restoration of power outage for affected customers in the US. Source: Kunz et al. (2013). Data from U.S. Department of Energy, Office of Electricity Delivery and Energy Reliability



The northeast region affected by Sandy is a major consumer of gasoline and not a major producer. Prior to the event, the region endured a steady decline in gas inventories as reliance on imports from the US Gulf Coast increased, and so became vulnerable to shortages. Localised gas shortages and rationing, due to truncated supply and distribution, resulted in small regional retail price increases, as well as more extreme localised price gouging and the emergence of an online black market for gas (Kahn, 2012; Tuttle, 2012). Nonetheless, Sandy hit at a time when national gas prices were falling dramatically, and Sandy reduced demand for gas in the affected region as cars were damaged in the storm and fewer people commuted to work. Therefore, notwithstanding localised price hikes, gas retail prices in the effected region remained relatively low in contrast to the soaring prices associated with past major hurricanes (Tuttle, 2012). Further, regional spot prices remained stable in the weeks following Sandy contrary to trends following other recent hurricane events (Figure 3).

The New York City's Metropolitan Transit Authority (MTA) endured the most destructive storm in the 108-year history of the subway system, with total damages of over $5 billion. The MTA held $1.7 billion of maximum insurance coverage from global reinsurance markets for infrastructure damage, and FEMA reimbursed about 75% of the uninsured loss through Public Assistance, leaving the MTA with a near-$1 billion loss. More severe damages were alleviated by acting on issued early warnings. The MTA implemented a system-wide shutdown of services, including subways, tunnels, bridges, and highways; and moved the rolling train stock to outside of flood zones (Roberts, McNeill and Respaut, 2012; Rosenzweig and Solecki, 2014).

Figure 3. Changes in regional spot gasoline prices after hurricane landfall. Source: Energy Information Administration (2017)



This action resulted in the restoration of partial services less than three days after landfall, and the subway was nearly fully operating within a week. In contrast, New Jersey Transit ignored flood forecasts, and their lack of preparation to mitigate damages resulted in major losses of equipment and prolonged periods of service outages, hindering the resumption of economic activity in the region (Haraguchi and Kim, 2016).

Impacts on employment

Liberty Street Economics (Abel et al., 2013) examined new claims for unemployment insurance in New Jersey and New York in the months before and after the storm. Prior to Sandy, new claims for unemployment insurance between New York and New Jersey averaged 35,000 per week. In the first full week of November, 2012 (following storm landfall on 28th October) unemployment insurance claims increased to over 100,000 and remained elevated for two to three weeks (Figure 4). After four weeks, claims had returned to pre-storm level. In total, 160,000 initial unemployment claims filed in the two states were attributed to Sandy, of which the majority were in the New York City metropolitan area (including the devastated areas in Long Island and northern New Jersey).

A payroll employment survey (in the second week of November) showed a loss of 32,000 jobs in the NYC metropolitan area – considerably lower than the surge in unemployment insurance claims might suggest, indicating that many people filing for unemployment insurance at the beginning of the month may have been back to work within weeks (Abel et al., 2013). It is also likely that, while many people lost jobs because of Sandy, others found work created as a consequence of the event, offsetting this value. Figure 5 highlights the change in employment by sector. Leisure and hospitality experienced the sharpest decline in jobs (14,000), with education and health services, government, and construction sectors also sustaining significant job losses. By the end of the year, payroll employment figures showed a strong rebound in New York and New Jersey to above pre-event levels, with a strong gain of over 53,000 jobs in December. The construction, education and health, and finance and real estate sectors each recovered sharply in this period (Figure 5).

Figure 4. Weekly initial unemployment claims in New York and New Jersey. Source: Abel et al. (2013). Data from U.S. Department of Labor; DLX Haver

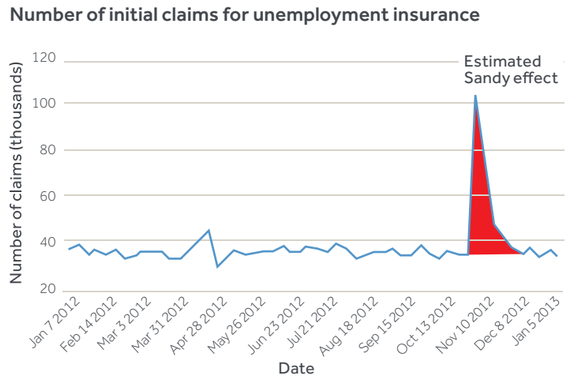
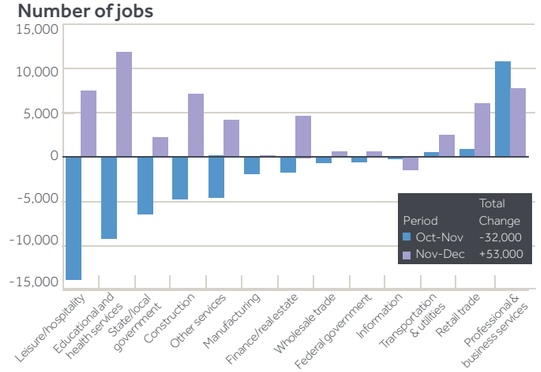


Figure 5. Change in Total Employment in the NYC Metro Region, by Sector. October-November and November-December 2012. Source: Abel et al. (2013). Data from Bureau of Labor Statistics; Moody's Economy.com

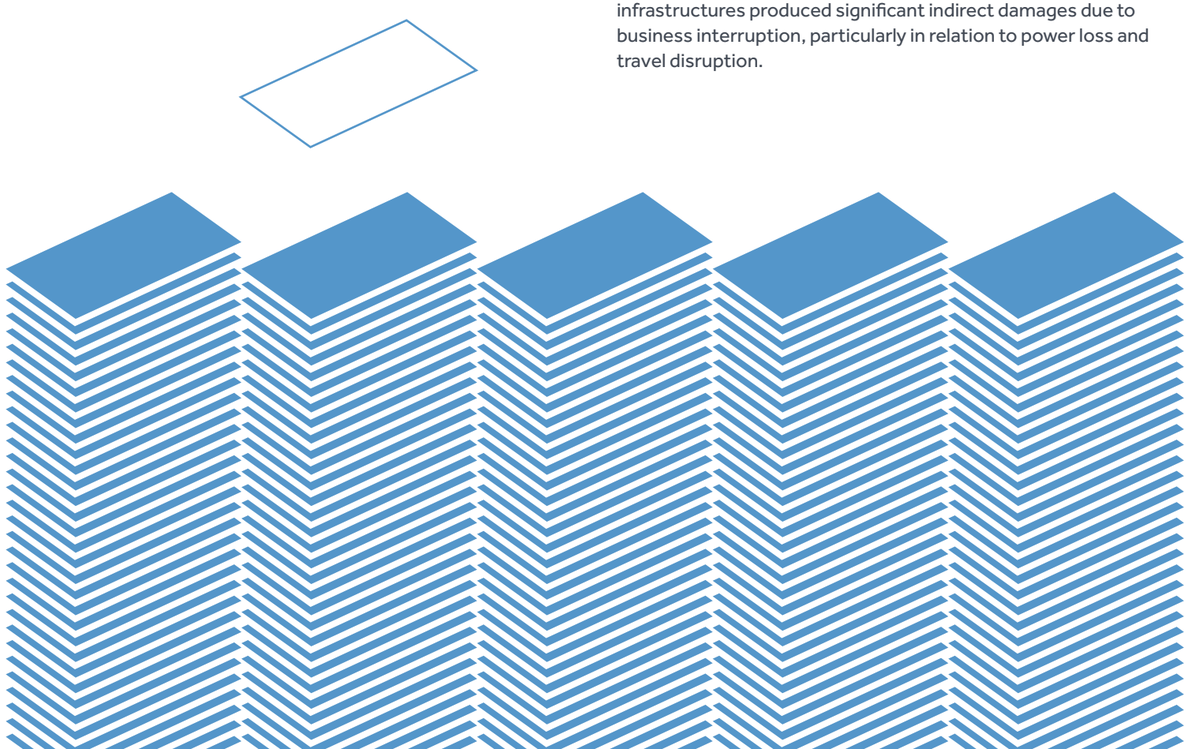


Sectoral impacts

The US Dept. of Commerce (Henry, Ambargis and Mead, 2013) highlighted a number of sectors impacted by Sandy, and assumed that most businesses faced only short-term disruptions. Economic activity almost fully resumed within a couple of months after Sandy. Longer term industry disruptions primarily occurred within the travel and tourism industry in New Jersey, while manufacturing represented a sizeable portion of the overall number of business closures due to Sandy. The New Jersey construction industry saw relatively steady growth in the months after Sandy, adding 4,500 jobs and growing 3.8% between November 2012 and June 2013. Similarly, New York construction employment grew by 4.7% in this period (state-wide, including those areas not affected) adding 14,100 jobs. Based on the experience of Hurricane Katrina, the economic boost from housing construction "would take place over several years" (Henry, Ambargis and Mead, 2013). (Feria-Domínguez, Paneque and Gil-Hurtado, 2017)

Business and finance impacts

The brunt of Sandy's impact was felt in NYC's Lower Manhattan – the primary financial centre in the US and the source of most of New York and New Jersey's GDP. Consequently, the New York Stock Exchange (NYSE) experienced its first two-day closure since 1988, and telecom disruptions impacted electronic trading at the NYSE and NASDAQ. Some trading firms sustained significant damage to their data centres which hampered their operations upon Wall Street's re-opening (Aon Benfield, 2014). Feria-Domínguez, Paneque and Gil-Hurtado's (2017) study of the financial impacts of recent hurricanes to US P&C insurance companies, listed on the NYSE, found that firms were insensitive to Sandy in terms of cumulative average abnormal returns from 10 days before to 10 days after landfall. Hurricane Katrina gave the same result, in contrast to each of the other hurricanes analysed (Rita (2005), Felix (2007), Ike (2008), Igor (2010), Ophelia (2012)). This highlights that the short-term economic impact was small, and the market's resilience in the days following the storm indicates that investors did not panic or overreact to short-term developments (Feria-Domínguez, Paneque and Gil-Hurtado, 2017). Further, the accurate storm forecast provided more than a week in advance gave adequate time for immediate preparations. However, the interconnected risks within critical infrastructures produced significant indirect damages due to business interruption, particularly in relation to power loss and travel disruption.



Macroeconomic impacts and insurance

The total direct economic damage caused by Sandy is estimated to be between $54.7 billion (2018 US$) (ICAT Damage Estimator, 2018) and $78-97 billion (Kunz et al., 2013). A breakdown of losses by state is detailed in Table 1, along with further indirect damages which may have driven the total loss in excess of $100 billion (Kunz et al., 2013). Therefore, Sandy was the second most costliest tropical storm in the history of the US (Kunz et al., 2013). Nevertheless, Mantell et al. (2013) predicted that Sandy would have modest net impacts on the macroeconomic performance of the state's economy, dependent on having the required resources to repair the storm's extensive damages.

Table 1. Summary of Sandy-related losses to US states, New York City, and indirect losses to the total affected region. Note: Values are in 2012 US$.

Loss Value	Comments	Source
New York State		
$32.8 Bn	Total direct economic losses	Cuomo, 2012
$9.7 Bn	Estimated cost of damage to 305,000 houses	Cuomo, 2012
$7.3 Bn	Direct losses to transit, roads, and bridges	Cuomo, 2012
$6 Bn	Direct loses due to business impact	Cuomo, 2012
New Jersey State		
$29.4 Bn	Losses to housing, transit systems, tourism, and coastlines	Kunz et al., 2013
Pennsylvania State		
$19 Bn	Estimated direct economic losses	Kunz et al., 2013
Other States		
$15 Bn	Estimated direct economic losses	Kunz et al., 2013
New York City		
$13.3 Bn	Direct losses in New York City	DeStefano, 2012
$5.7 Bn	Indirect losses in New York City	DeStefano, 2012
Indirect losses to affected region		
$16.3 Bn	(Direct and indirect) value of power outage disruption in affected region, calculated by comparison with similar past events	Kunz et al., 2013
$10.8-15.5 Bn	Total losses due to business interruption calculated using input-output modelling of sector-specific dependencies	Kunz et al., 2013

Sandy triggered $18.75 billion (2012 US$) in insurance pay-outs, excluding flood insurance claims covered by the federal National Flood Insurance Program (NFIP), making Sandy the third most costly US natural catastrophe for the insurance industry (behind Katrina, 2005 and Andrew, 1992) (Insurance Information Institute, 2014). Of this total, insured commercial losses comprised $8.93 billion, personal losses made up $7.11 billion, and Auto losses totalled $2.72. Assuming a total damage estimate of $54.7 billion (ICAT Damage Estimator, 2018), approximately 50% of the total loss caused by Sandy was insured, although the insured proportion of loss is lower when higher loss estimates (that include indirect damages are considered. Some 1.58 million claims were filed in relation to Sandy, most of which were by homeowners. At $9.65 billion and $6.3 billion, respectively, New Jersey and New York suffered the vast proportion of the total insured loss (Insurance Information Institute, 2014).

Following a relatively strong growth rate (3.1%) in the third quarter of 2012, US GDP increased at a sluggish 0.4% annual rate in the final quarter. However, Superstorm Sandy had a negligible impact on the fourth-quarter growth rate, and any effect Sandy had on aggregate economic activity was well within the range of 'noise' in quarterly GDP growth rates (Linder, Peach and Stein, 2013). In terms of state GDP, New York GDP experienced continued growth in the fourth quarter of 2012, but a notable decrease in the first quarter of 2013 (similarly within the range of quarterly GDP 'noise'), before pre-event growth rates resumed. The volatile GDP of the finance and insurance sector showed a similar trend, while other economic sectors in New York were unaffected by Sandy according to their GDP (Figure 6). New Jersey GDP exhibited an even more negligible impact following Sandy, and although the real estate sector – the most productive sector in the state – experienced a loss of GDP in the first quarter of 2013, the long-term growth rate was unaffected (Figure 7).

Figure 6. Gross domestic product GDP) of significant industrial sectors in New York, and total state GDP (secondary axis). Source: Bureau of Economic Analysis (2018)

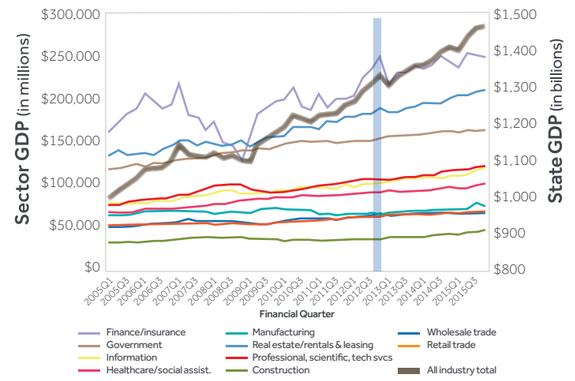
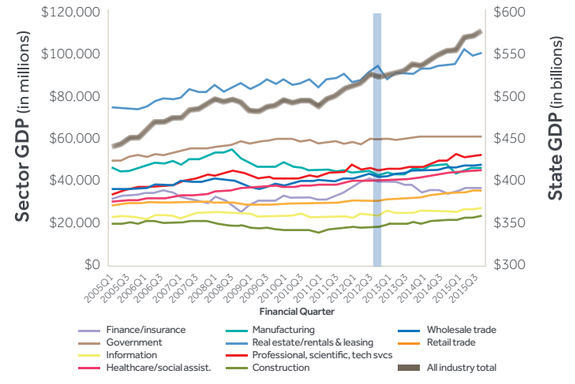


Figure 7. Gross domestic product (GDP) of significant industrial sectors in New Jersey, and total state GDP (secondary axis). Source: Bureau of Economic Analysis (2018)



Disaster management and funding

Immediate disaster funding and response

Under the 1988 Stafford Act, state and local governments may receive FEMA resources following a presidential declaration of a state of emergency. This can incentivise state governments to seek federal disaster declarations rather than shoulder the cost themselves, as "if FEMA will pick up the tab, why should governors not spend their tax funds elsewhere" (Mayer and Meese, 2009). Indeed, neither the states of New Jersey nor New York had a disaster relief fund, representing a moral hazard on a national scale. Prior to Sandy's landfall, New Jersey and New York each instituted a state of emergency. Each county in New Jersey was declared eligible for federal disaster relief by FEMA, as were 13 eastern New York counties (Federal Emergency Management Agency, 2017b). Following a declaration, Individual and Public Assistance were made available to the impacted regions.

FEMA's mandate to provide public assistance funding allowed for a coordinated federal, state, and local response in order to rapidly restore power, critical infrastructure, and public transport and services (Federal Emergency Management Agency, 2017a). Emergency officials moved rapidly to expedite the removal of debris that littered the landscape, disrupted transport, and threatened public safety (Federal Emergency Management Agency, 2017a). Within seven days, 17,000 federal responders were on the ground, including a range of other federal partners, representing one of the largest personnel deployments in FEMA's history (Federal Emergency Management Agency, 2017a). As a result, public services and critical infrastructure recovered quickly within the weeks following Sandy's landfall.

Individual assistance was also provided to homeowners and renters for housing and other needs, including grants for temporary housing and home repairs, low-cost loans to cover uninsured property losses, and other programs to help individuals and business owners to recover from Sandy (Fugate, 2012). As of 3rd December, 2012, FEMA had received 241,318 individual assistance registrations in New York and had provided over $732.9 million in disaster aid. Similarly, in New Jersey, more than 238,353 residents had applied for aid and FEMA provided over $272 million in disaster aid. For all Sandy declarations, FEMA provided over $1 billion in disaster aid to over 490,000 applicants (Fugate, 2012). However, the speed of delivery and inclusivity of subsequent federal aid provided to many affected individuals and homeowners was widely criticised in the long term after the disaster.

Concerns were raised that the recovery from Sandy would be plagued by similarly perceived delays and bureaucratic burdens that inhibited the recovery following Hurricane Katrina (Brown, Mccarthy and Liu, 2013). It took almost three months for US Congress to enact legislation in response to these concerns, creating huge uncertainty for victims, communities, and regional economies in the meantime. In January, 2013, legislation was passed in the form of the Disaster Relief Appropriations Act, which provided a $50.7 billion package for disaster relief agencies. FEMA received $5.4 billion of the appropriations bill towards the Disaster Relief Fund, the most immediate source of relief and recovery funds for Individual and Public Assistance. Major appropriations were also made to the Department of Transportation ($5.4 billion), the Department of Housing and Urban Development ($5.4 billion), and the Army Corps of Engineers ($1.35 billion) (U.S. Government Publishing Office, 2013). Additionally, Congress increased FEMA's borrowing authority by $9.7 billion (from $20.73 to $30.43 billion) to keep the NFIP solvent and able to pay the hundreds of thousands of incoming homeowner claims (Federal Emergency Management Agency, 2013). Recognising problems with previous recovery assistance, Congress also passed the Sandy Recovery Improvement Act of 2013. This Act represented a significant legislative change to the way FEMA may deliver federal disaster assistance, with a stated goal of streamlining administrate procedures to improve the efficiency and quality of disaster assistance, namely Individual and Public Assistance, and the Hazard Mitigation Grant Programmes (Brown, Mccarthy and Liu, 2013).

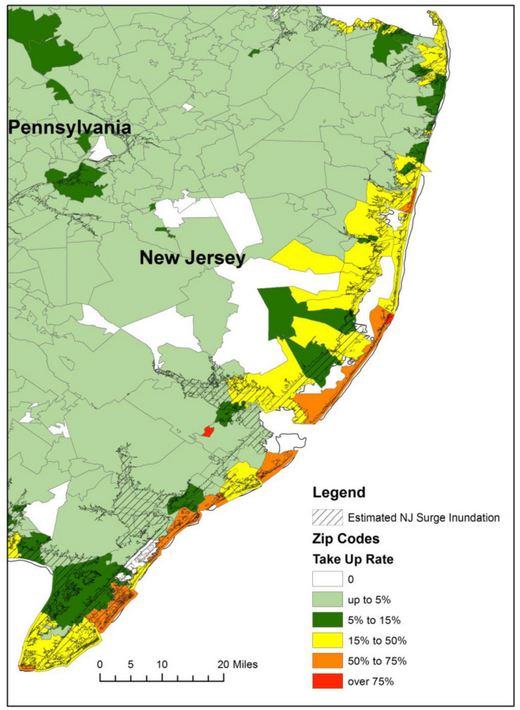
Further, the scale of the Sandy disaster motivated the federal government to examine how it might include and increase preparedness for existing and future threats in the recovery process. A notable step in the disaster response was President Obama's Executive Order in December, 2012 to create the Hurricane Sandy Rebuilding Task Force to coordinate the federal government's rebuilding efforts, ensuring key resilience principles were incorporated (Olshansky and Johnson, 2014). The task force was charged with "working to remove obstacles to resilient rebuilding while taking into account existing and future risks and promoting the long-term sustainability of communities and ecosystems in the Sandy-affected region" (Hurricane Sandy Rebuild Task Force, 2013). The task force set out to establish guidelines for managing the flow of federal recovery funds in a coordinated and accountable manner to achieve long-term goals, and sought to cut red tape and reduce regulatory burdens in delivering disaster assistance (Olshansky and Johnson, 2014).

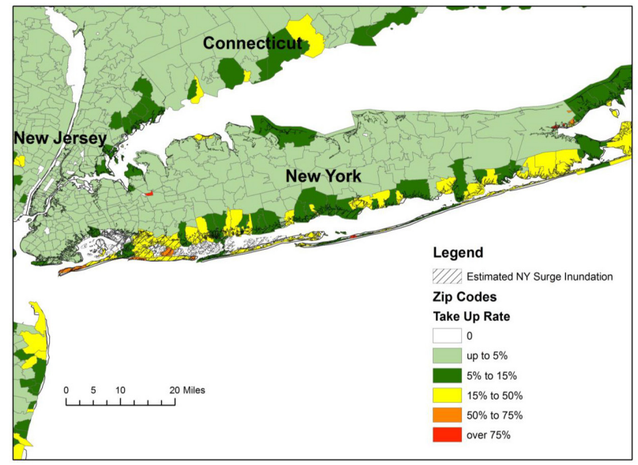
Nevertheless, FEMA's subsequent execution of the relief effort on receipt of funds received much scrutiny and criticism. One year after the event, only 23% of the funding appropriated by Congress had been obligated, and only 11% dispersed, mostly by FEMA (National Center for Disaster Preparedness, 2013b). At this time, HUD had disbursed less than 1% of the more than $14 billion it received for housing and community development purposes (National Center for Disaster Preparedness, 2013b). Very little information was readily available about the number of people who received various kinds of monetary assistance, or on the scope and magnitude of the remaining need. As of August 2014, two years after the event, just over $11 billion had been awarded to government agencies under the Disaster Relief Appropriations Act, representing less than a quarter of the $50.7 billion allocated, and indicative of the continually laboured and inefficient recovery (National Center for Disaster Preparedness, 2013a). This significantly impeded the recovery of the most heavily-impacted and vulnerable individuals and households, many of whom experienced damages and losses that were not insured. To exacerbate these problems, federal aid is suggested to have discouraged households from insurance where people consider federal aid as a substitute for, rather than a compliment to, insurance (Kousky, 2017). This is despite the intended purpose of Individual Assistance to finance items not covered in a standard NFIP policy. In the US, between 2005-2014 the average individual assistance grant for housing repairs associated with flood-related disasters was only $5,508 (2015 US$), indicative that alone, federal aid is insufficient to aid an efficient recovery (Kousky, 2017).

Insurance and the National Flood Insurance Program

The NFIP represents the vast proportion of flood insurance coverage in the US, and a key objective of the NFIP program is to

Figure 8. Residential NFIP flood insurance uptake rate by zip code in New York (left) and New Jersey (right) with Sandy storm surge estimates. Source: Kousky & Michel-Kerjan (2012). Data from the Federal Emergency Management Agency





Recovery

reduce the need for and reliance on federal disaster assistance (Hayes and Neal, 2011). The private flood insurance market comprises only a small portion of the overall residential market, focused on high-value residences and large commercial clients (Kousky and Michel-Kerjan, 2015). NFIP policies insure up to $250,000 for home coverage and $100,000 for contents within a home (Kousky, 2017). The NFIP is only available to homeowners within participating communities, and although community participation is voluntary, homeowners with federal mortgages living in Special Flood Hazard Areas (SFHAs – high-risk, 100-year floodplains) must purchase flood insurance with FEMA (Kousky and Michel-Kerjan, 2015).

Immediately prior to Sandy, in New Jersey 236,000 NFIP policies were in force, while New York had about 169,000 policies, representing $55 billion and $42 billion in coverage, respectively (Kousky and Michel-Kerjan, 2012). An estimate of flood insurance uptake rates in census tracts along the New Jersey and New York coasts immediately preceding Sandy suggests market penetration was generally in the range of 5-50%, with very few postcodes exceeding 30% (Kousky and Michel-Kerjan, 2012) (Figure 8). A report by the NYC Mayor's Office revealed that 80% of residents living in inundated areas had no flood insurance (Cuomo, 2012). However, vast areas were inundated beyond SFHA boundaries where flood risk is perceived to be low, and a higher proportion (55%) of properties within SFHAs in New York City were insured. This provided evidence that FEMA's flood insurance rate maps were based on outdated models and analysis. The nationwide flood insurance penetration rate outside SFHAs is only about 1%, despite 40% of properties that are exposed to storm surge in coastal states falling outside FEMA SFHAs (Fugate, 2015). This large gap in coverage represents a significant exposure to individuals, financial markets, and taxpayers, since un(der)insured catastrophe risk increased the fiscal strain on the federal government (Fugate, 2015).

Although FEMA operates the NFIP, private insurance companies are contracted to manage and oversee policies. Following Sandy, NFIP policyholders filed flood insurance claims and engineers and adjusters of the private insurance companies valued the damage to a home and the resulting pay-out (Kousky, 2017). However, allegations of falsified engineering reports which undervalued damages resulted in extensive litigation (Kearney, 2015). In response, FEMA permitted the review of 18,643 policyholders' claims (as of January, 2017) (Federal Emergency Management Agency, 2017b). This process was extensive, resulting in 81% of closed claims receiving additional payments, and revealing that most Sandy victims were underpaid (by an average of nearly $16,000) (Ryan, 2015). Despite this, many policyholders refrained from participating in the claims review process, fearful of having existing payments rescinded or "beaten down" after nearly three years of battling with bureaucratic agencies (Ryan, 2015). The underpayment of flood insurance claims impeded recovery and prevented the repair of damaged homes for over five years after the event.

Sandy made 2012 the second-most costly flood insurance pay-out event in the history of the NFIP, with nearly $9 billion claims (Kousky and Michel-Kerjan, 2015). Nearly 1.2 million NFIP claims were made (for single-family homes nationwide – the largest portion of NFIP policies), of which the mean claim value was $34,376, and the median was $12,555 (in 2012 US$) (Fugate, 2015). Prior to the arrival of Sandy in 2012, the NFIP was in significant debt, mostly as a result of the $19 billion borrowed from the federal government in 2005 to pay claims following Hurricanes Katrina, Rita, and Wilma, necessitating the aforementioned increase in the NFIP's borrowing authority. As Sandy-related claims continued to close in the months after the event, NFIP debt rose to a record $24 billion (Kousky and Michel-Kerjan, 2015). While a considerable proportion of NFIP policyholders' premiums target consumer affordability and are not commensurate with the underlying risk, the program remains fiscally unprepared for catastrophes of Sandy's magnitude. Since the NFIP has gone into debt, the US government has sought diversification of flood risk through private insurance and reinsurance markets (Michel-Kerjan, Czajkowski and Kunreuther, 2015)

Socioeconomic recovery

The long-term state of recovery following Sandy was disparate across socioeconomic strata, and has been dubbed "a tale of two Sandys" by Bergren et al. (2013). On the one hand, Sandy was an "acute, disruptive event damaging physical infrastructure and interrupting normal city functions, temporarily moving New York City away from its status quo" (Bergren et al., 2013). The 'new' Lower Manhattan – wealthy, comprehensively insured, and with superior infrastructure – was able to withstand the storm's initial impact, and then repair and rebuild with rapid speed (Greenberg, 2014). The downtown area received essential services (including electricity, heat, and hot water) within days, and 99% of its commercial, residential, hotel, and retail inventory "back to business" within weeks (Downtown Alliance, 2013; Greenberg, 2014).

In contrast, Sandy "sharpened and exacerbated systematic crises of social and economic inequality which existed before the storm (Bergren et al., 2013; Cohen and Liboiron, 2014). While wealthy, predominantly white neighbourhoods and high-end industries were privileged in receiving government aid and were economically resilient, funding to low income homeowners was very slow to materialise. Equally inundated parts of the Lower East Side and Chinatown, Red Hook, Coney Island, Far Rockaway, and parts of the South Bronx, Queens, and the north shore of Staten Island experienced a "woefully inadequate" response (Greenberg, 2014). These low-income, racially diverse neighbourhoods remained flooded, and businesses and public services closed for business, for weeks and often months (Greenberg, 2014).

Six months after the event, the majority of the affected region reported high levels of recovery after the storm – 55% of surveyed residents in the affected region say their neighbourhoods completely recovered– but many individuals and neighbourhoods continued to struggle (Tompson et al., 2013). 17% of those living in the affected region reported that their neighbourhoods had recovered only halfway or less. For those who report living in the "hardest hit areas", this proportion increased to nearly 40%, while over 22% believed that their neighbourhood would never fully recover (Tompson et al., 2013). Whether affected residents reached out for support or assistance varied considerably by how affected their neighbourhood was by the storm. Higher rates of requests were made in areas that were reported to be extremely affected versus those reported to be moderately or little affected (Tompson et al., 2013). For those extremely affected, 47% turned to nearby friends and family (53% for friends and family who live over a mile away); 21% sought help from their church or religious community; 16% reached out to relief organisations; 17% say they reached out to their state government; and 43% report reaching out to federal agencies, including FEMA, for assistance. Not everyone sought help, and some residents benefited from multiple sources of assistance. In this survey, both the state and federal governments rated poorly among those individuals in the affected region who asked them for help. Instead, friends, family, and neighbours were cited as among the most helpful sources of assistance and support (Tompson et al., 2013).

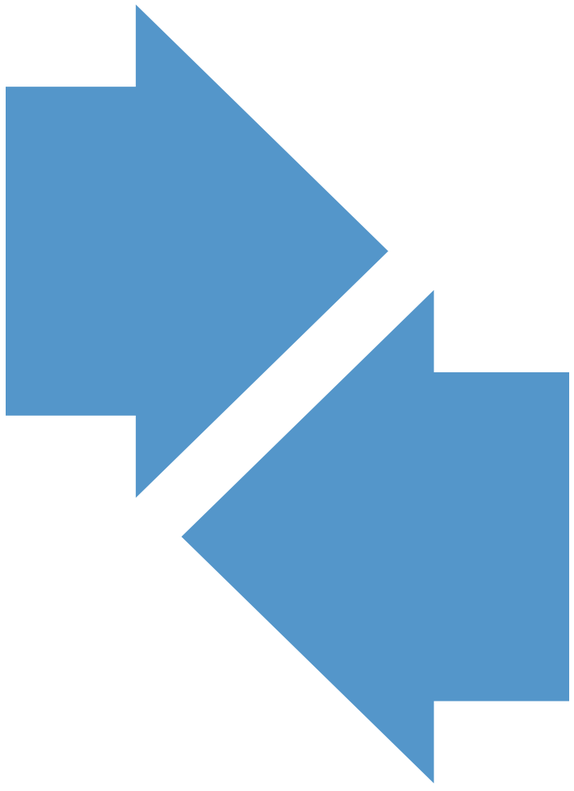
Housing and displacement

In October, 2012, New Jersey experienced a 140% increase in foreclosure activity (compared to the previous year), and New York saw a similar increase, in stark contrast to decreasing national trends (Christie, 2012). While problems with the recovery and rebuild effort persisted, foreclosure remained an issue as victims incurred substantial costs to repair their homes, pay their mortgages on damaged homes, and/or rent temporary housing (Sugarman, 2016). In an attempt to minimise the injustice of foreclosure proceedings due the government's ineffective response, HUD provided a six-month moratorium on foreclosures (U.S. Department of Housing and Urban Development, 2013). Despite further forbearance relief, government efforts to address foreclosures was inadequate, making recovery after Sandy unattainable for individuals with modest economic means (Sugarman, 2016). Thousands of people became newly homeless after Sandy, and advocacy groups estimated that 22,000 households remained displaced one year later (Doran et al., 2016).

The Disaster Relief Appropriations Act made $16 billion available for HUD's Community Development Block Grants (CDBGs), which aimed to help Sandy victims return to their homes (Sugarman, 2016). New York City received $4 billion for recovery activities which manifested through the 'Build It Back' (New York City Moyor's Office of Housing Recovery Operations, 2017). This program has been described as a 'categorical failure' by its creator (Rizzi, 2016), and indeed, in the first 18 months after Sandy, "absolutely nothing was built back" (Nonko, 2017). Other initiatives in New York and New Jersey with similar well-intentioned aims also proved largely unsuccessful, due to convoluted design and poor execution (Sugarman, 2016). Residents were unable to rebuild or return to their homes for several years after Sandy, while facing a greater likelihood of foreclosure in the interim. In addition, when contractors were hired to repair homes, many were guilty of breach of contracts or fraud, either by working at an unacceptably slow pace, or failing to complete projects while pocketing homeowners' money (Zimmer, 2013; Di Ianno, 2016). Thus, fraudulent contractors were yet another impediment to recovery.

When Sandy damaged buildings, shortages in critical tax revenues followed, and as federal aid has dried up in the years since local governments have endured the deficit. For example, in the severely-impacted Ocean County, towns were a total of $7.8 billion (8%) short of their pre-storm tax base at the start of 2017, as a result of slow rebuilding, abandoned lots, emigrated families and businesses, and property reassessment (Corasaniti, 2017). These towns had previously been propped up by hundreds of millions of dollars of state aid and subsidies, which HUD ceased in 2017, leaving many areas scrambling to find money to provide services during the busy summer season. As a result, in Ocean County and elsewhere, towns were forced to adjust their budgets and spending, and many municipalities saw their property taxes rise (Corasaniti, 2017).

A 2015 report on Sandy-related displacement in New Jersey found that an estimated 14,650 homeowners in Sandy-affected areas were "still in need of housing assistance and longer-term solutions", based on applications made for government reconstruction assistance. In 2017, despite making landfall five years previously, Sandy continued to affect homeowners in New York and New Jersey, and many are yet to rebuild or return to their homes (Di Ianno, 2017). Rebuilding continued to be stalled by the underpayment of flood insurance claims, contractor fraud, and ineffective state rebuild programs (Sugarman, 2016). As of 2017, New Jersey's foreclosure rate was 2½ times the national average; a crisis which experts agreed Sandy "definitely play[ed] a part" in (Zimmer, 2015; RealityTrac, 2017). Lower income residents remain particularly vulnerable to housing instability, and are yet to recover to their pre-Sandy 'norm' (The Fund for New Jersey, 2017). The most recent legislation, signed in February, 2017, will help Sandy victims through a stay on foreclosure proceedings and mortgage forbearance (Christie, 2017). Today, over five years after Sandy, the success of this bill in aiding recovery remains to be seen.



Conclusions

The US East Coast, particularly New York and New Jersey, experienced a record storm surge and resultant widespread flooding, producing resultant damage that was unprecedented in recent history. In macroeconomic terms, the event produced catastrophic damages totalling between approximately $54.7 billion (ICAT Damage Estimator, 2018) and $97 billion (ICAT Damage Estimator, 2018), but had a negligible impact on the national and state economies in the time following according to GDP growth. Unemployment effects were short-lived and rebounded quickly, and critical infrastructure and public services were mostly restored within days-to-weeks, allowing normal social and economic functions to recuperate quickly for most affected people. Prior to 2017, Sandy was the second costliest natural disaster to the US insurance industry, with nearly half of the total loss insured. However, while high-value and large commercial properties had a high level of private flood insurance uptake, the level of insurance penetration was relatively low for affected households and small businesses. When Sandy hit, the NFIP constituted a vast proportion of the US flood insurance market and the private sector had a limited appetite for flood risk. This was in part due to subsidised NFIP premiums (that under-priced the risk) with which the private sector could not compete. Few of the Sandy-impacted postcodes had NFIP insurance uptake rates exceeding 30%, representing a considerable protection gap. Nevertheless, approximately 1.2 million NFIP claims cost FEMA nearly $9 billion, exacerbating its debt to the federal government. The resultant delays and underpayment of claims engendered criticism and harsh scrutiny of the program, prompting significant changes by FEMA to improve the NFIP's sustainability.

Although FEMA did receive criticism for the timing and inclusivity of its response, it's actions in the months following Sandy were significantly more efficient and effective than its response after Hurricane Katrina, where "the recovery efforts were the disaster inside the disaster" (Greenberg, 2014). This demonstrated lessons learned from Katrina, through well-coordinated decision-making and improved communication throughout levels of government. However, despite specific legislation aimed at removing bureaucratic red tape in disaster management, the $50.7 billion Sandy relief package was slow to materialise, and over three quarters of this money had yet to be distributed two years after the event.

The speed and efficacy of recovery were varied and unequal across areas and socioeconomic strata, and Sandy exacerbated pre-existing systematic inequalities and vulnerabilities in the region. While Sandy represented an acute, disruptive event for elite organisations (especially in wealthy Lower Manhattan), the worst affected, most vulnerable, and often un(der)insured areas experienced prolonged disruption of and difficulties in recovery. For many of the victims most reliant on disaster relief and assistance, federal aid was slow to materialise and insufficient to enable an effective recovery. This was evidenced by the slow and ineffective rebuilding of housing in certain areas of New York and New Jersey, resulting in prolonged displacement and attrition of local economies for years following. Legislation to address such issues has been enacted as recently as 2017, concerning a stay on foreclosure proceedings and mortgage forbearance, evidencing that the recovery process remains incomplete.

Despite the damage and disruption to victim's lives and livelihoods, Superstorm Sandy provided an opportunity to "build back better'" – a phrase that became synonymous with the recovery. This intention was driven by initiatives such as the Hurricane Sandy Rebuilding Task Force's "Rebuild by Design", an ongoing interdisciplinary, design-based approach to achieve resilience (Rebuild by Design, 2018). Rosenzweig & Solecki (2014) found that Sandy served as a "tipping point" in New York City, leading to transformative adaptation due to the explicit inclusion of increasing climate change risks in the rebuilding effort.

As outlined in this report, Sandy has prompted significant legislative changes to the federal governance of disasters, with FEMA continuing to promote private sector participation in flood risk management to improve the resilience of the NFIP, including the purchase of reinsurance in 2017 (Federal Emergency Management Agency, 2018). The experience of Superstorm Sandy has had a major effect on coastal storm resilience not only in New York City, but in the entire effected region and nationally. The challenge, however, is to implement and sustain this transformative trajectory (Rosenzweig and Solecki, 2014).

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