HURRICANE SANDY IN NEW YORK AND NEW JERSEY: EVACUATION, DISPLACEMENT AND ADAPTATION

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INTRODUCTION

"Maybe things like this happen in New Orleans, places like that. But never here, not in a million years."
V. Baccale, 2012

Vinny Baccale's family had lived on Staten Island for generations, starting with a small holiday bungalow to building a permanent home on the seaside. This area was hit particularly hard by the storm. Like thousands of New Yorkers, Baccale, his wife and two small kids were forced to evacuate when their seaside home was partially destroyed by the storm. Despite their strong roots in the area, they are now considering relocating to a safer neighbourhood (J. Rudolf, 2012).

Hurricane Sandy was a shock for many New Yorkers who had to admit their vulnerability to environmental disasters. Vinny Baccale's remark underscores the persisting perception in many developed countries that such disasters only happen in other places, to other people. Hurricane Sandy, as Hurricane Katrina before it, reversed this idea, showing that developed and relatively wealthy metropolises like New York City are at risk, and that environmental displacement is a concern for all countries, no matter their level of development.

This paper begins by analysing the characteristics of the storm itself, and by evaluating New York City's vulnerabilities to environmental disasters (Part I). It then assesses the evacuation process as well as the forced displacements, with an emphasis on the authorities' management of the crisis both in the short and middle term. A special section is dedicated to the impact of the storm on the elderly and on low-income persons (Part II). Finally, the report addresses the issue of New York's adaptation to environmental disasters, evaluating previous efforts and putting forward proposals for future projects, particularly the option of relocation as an adaptation strategy (Part III).

1. HURRICANE SANDY AND NEW YORK'S VULNERABILITIES

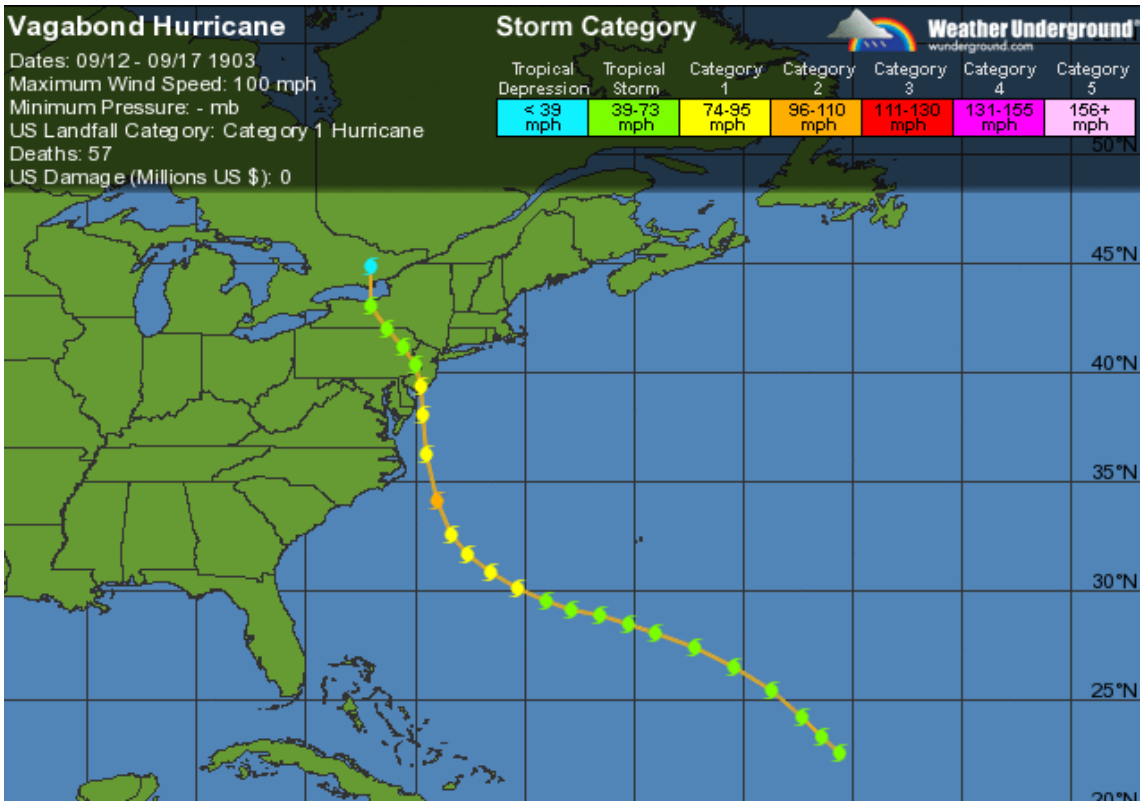
1.1. Hurricane sandy, a record breaker

Hurricane Sandy was a record breaker in many ways. On 29 October 2012, its central pressure reached 940 millibars, the lowest-measured barometric level for an Atlantic hurricane. It also caused a record surge of water for New York City, with a water level of 4.2 meters at Battery Park on October 29th (Drye, 2012). Furthermore, Sandy was much wider than previous storms, with hurricane-force winds spreading over a diameter of 400 hundred kilometres around its eye.

In the afternoon of October 29th, Sandy brought strong winds and rains from Washington D.C. northward. It was downgraded to the post-tropical cyclone category before it hit Southern New Jersey around 8 p.m. EDT, near Atlantic City, with winds of 129km/h (Sharp, 2012). Sandy moved its way up to New York, where its surges topped seawalls at the Battery and flooded Lower Manhattan. The storm's massive size caused flooding, rain and high winds to continue affecting New York and New Jersey throughout the night. On October 30th, Sandy had left New York, although its tail-end was still causing considerable damage on the Northeast. The storm started to weaken in the afternoon of October 30th and dissipated on October 31st over Pennsylvania. Sandy caused the death of 109 people in the United States, including 40 in New York City (Drye, 2012).

The most destructive characteristic of the hurricane was the storm surge, that affected parts of

Map 1. Sandy's track: September 9-17, 2012.



Source: Wunderground (2012)

the Northeast, which is home to 10 per cent of the US population (Murphy, 2012). A combination of several factors magnified the damaging effects of the floods.

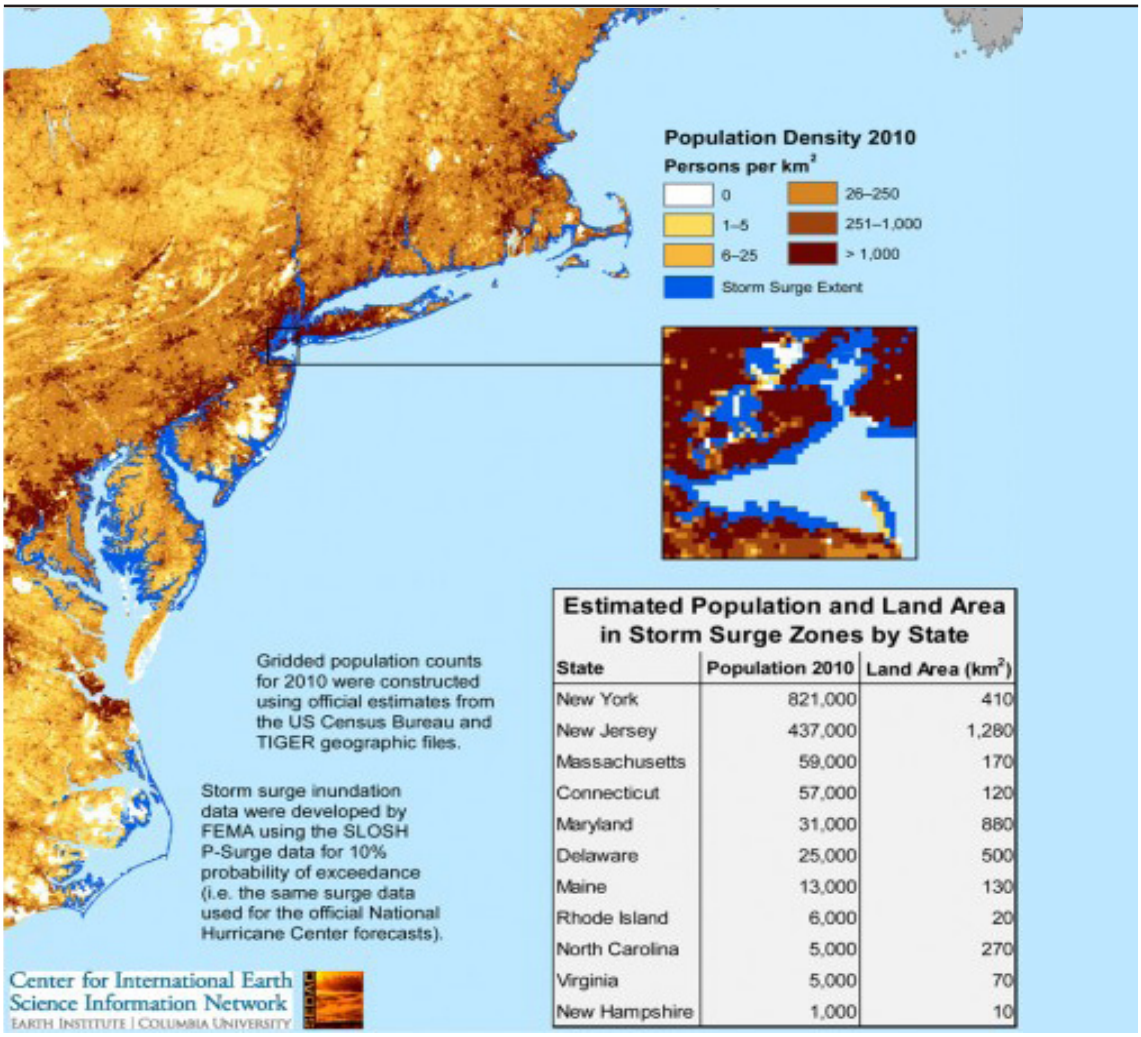
1.2. Short and long term exacerbating factors: the full moon and sea level rise

First, Sandy made landfall during the full moon, while the tide was 20 per cent higher than usual (by about 30 cm) (Khan, 2012). Although the initial waves were not as high as in previous storms, the high tide caused the water levels to flow over sea walls and other protections. Second, the impact of the full moon combined with the longer-term phenomenon of sea-level rise. Although the storm itself might not be directly connected to climate change, the damaging power of the floods partly was. Since 1900, as a consequence of the ocean's thermal expansion and of the melting of ice caps in the Arctic, the sea level in the New York region has risen of about 30c m–twice as fast as water levels of coastal regions in other states (Khan, 2012). New York and New Jersey are particularly vulnerable to the effects of sea-level rise, principally due to natural and man-made forces like erosion that reduce the amount of offshore sand. By 2080, experts have predicted, through the approach of the Intergovernmental Panel on Climate Change, that the sea level will rise in the New York area by 30-58 cm in the best case scenario and 1.0-1.4 meter in a rapid-ice-melt scenario (Khan, 2012). Although the range of these projections remains very broad, they point out that hurricane of the same strength will provoke more intense damage as the surges are worsened by the higher baseline sea level (Avent, 2012).

1.3. The New York Bight

The hurricane's unusual path led its strongest winds –on its front and right-- to hit the angle between New Jersey and Long Island that forms a tip called the New York Bight. This sharp curve on the open coastline significantly magnified the impacts of the hurricane, as the waves composed of ocean water and rain accumulated in the New York harbour. The high surges were boxed in, and pushed onshore into the flood zones (Murphy, 2012). This mechanism was amplified by the relative shallowness of NYC waters that made the surge go even farther onto land.

Map 2. Population density in New York region



Estimated Population and Land Area in Storm Surge Zones by State

State	Population 2010	Land Area (km²)
New York	821,000	410
New Jersey	437,000	1,280
Massachusetts	59,000	170
Connecticut	57,000	120
Maryland	31,000	880
Delaware	25,000	500
Maine	13,000	130
Rhode Island	6,000	20
North Carolina	5,000	270
Virginia	5,000	70
New Hampshire	1,000	10

Source: Centre For International Earth Science Information Network – Earth Institute, Columbia University (2012)

Sandy's destructive power was thus amplified by a combination of short-term climatic phenomena, gradual environmental evolutions and the intrinsic geographical vulnerabilities of the region.

Map 3. New York Bight

Source: Murphy, OEM/City Limits (2012)

1.4. Demographic and infrastructural vulnerabilities

The damage Sandy provoked was further exacerbated by the demographic and infrastructural characteristics of the East Coast. New York City is particularly densely populated on its extensive 930km of coastland (Jones, 2012). According to the New York City Office of Emergency Management, about 2.3 million persons would be in high-risk if a Category 3 hurricane hit the area --three-times the combined potentially vulnerable population in New Orleans and Miami.

In addition to its demographic density, New York's infrastructural characteristics make it especially vulnerable to hurricane damage. The many suspension bridges added to New York's wind vulnerability, forcing authorities to close all bridges to avoid their collapse. These closures reduced the number of evacuation routes (Silverman, 2012).

Third, New York's subway system is quite prone to flooding. When it was designed over a century ago, authorities did not anticipate the impacts of hurricanes causing subway grates to be flooded. City officials/transportation authorities made few changes since the initial construction to provide a better protection of urban subways, mainly due to inadequate funding. As Lower Manhattan was flooded, underground networks were immediately filled with water despite the sealing off procedures that had been developed.

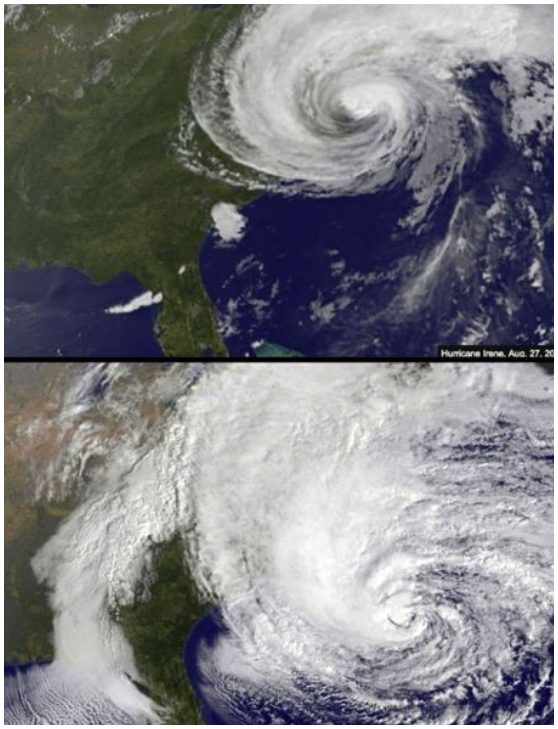
1.5. Winter storm Athena aggravates Sandy's damages

The damage caused by Hurricane Sandy was aggravated by a second storm, which hit the New York area from 7-10 November 2012. This early winter storm brought up to 20 cm of snow and rain across regions that had been significantly affected by Hurricane Sandy (Hydrometeorological Prediction Centre, 2012). The storm also caused high waves of 2.4m, flooding many coastal roads and stalling post-Sandy repairs. An additional 50,000 households lost power in New York and New Jersey, adding to the 640,000 still without power after Sandy (The Associated Press, 2012).

1.6. Hurricane Irene increased new york's vulnerability to hurricane sandy

Before it made landfall, Sandy was widely compared to Hurricane Irene that had hit the same region in late August 2011. Irene was ranked the seventh costliest hurricane in the history of the United States, with an estimated total cost of USD 19 billion, and caused 56 deaths (Fischetti, 2012). However, it did not impact the New York area as authorities and the media had anticipated, because it weakened from a Category 3 storm at sea to a tropical storm at landfall in New Jersey, with 121km/h winds. The highest recorded rainfall measurements in New York barely reached 30 cm, in comparison with the Sandy floods that were measured in meters. The relatively low damage it inflicted compared to the predicted disaster led many to criticize the authorities' "overreaction." Indeed, in its preparedness, the city had evacuated 370,000 people and had shut down subways, airports and buses 18 hours before the storm was expected to hit (Barron, 2011). Although the mayor argued he based his decisions on the side of caution, the criticisms partly led the authorities to adopt a slightly less cautious attitude during Sandy, which proved to be much more devastating (Nye, 2012).

Figure 1. Hurricane Irene (top) and Hurricane Sandy (bottom)



Source: NASA (2012)

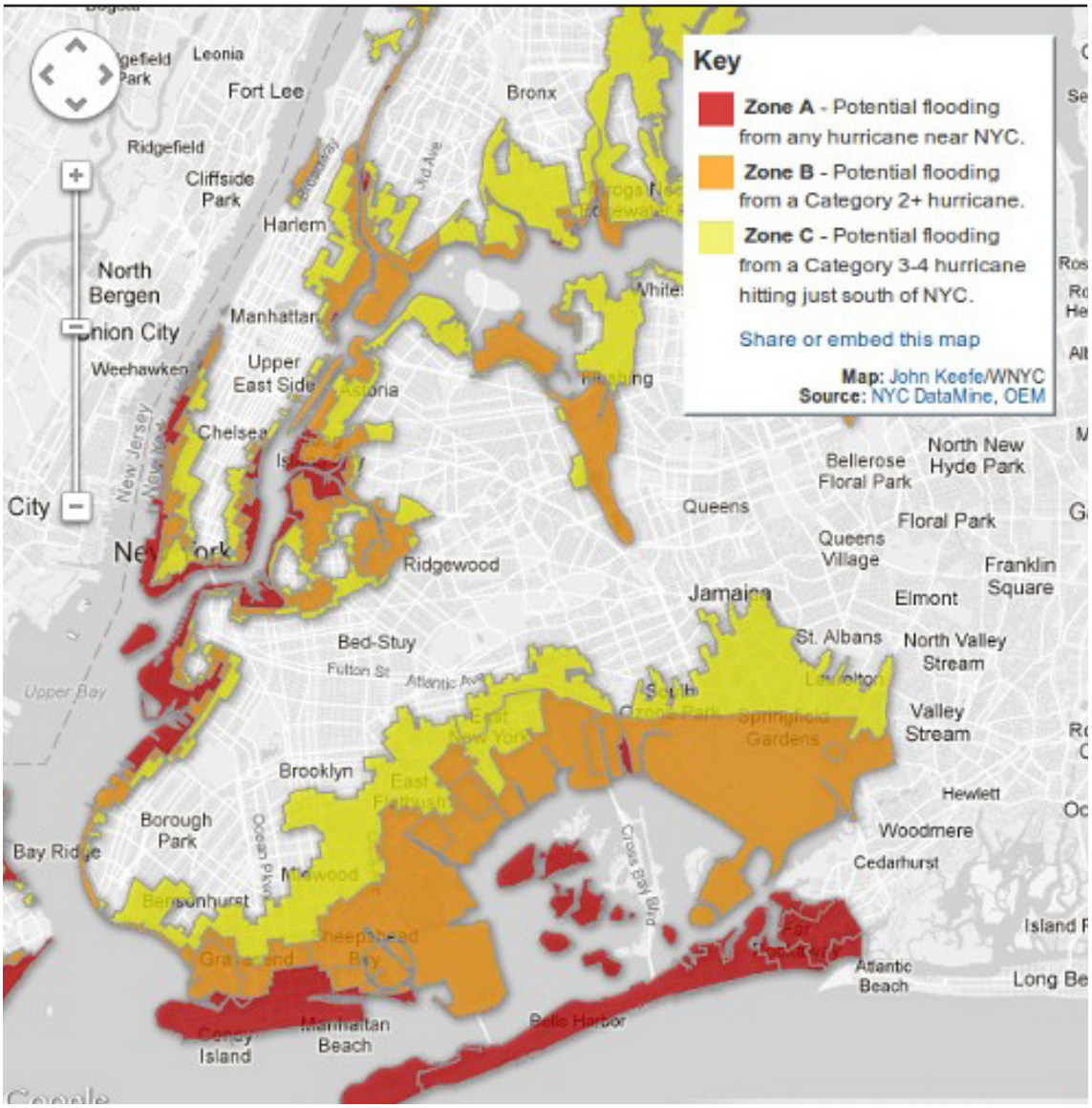
2. EVACUATION AND DISPLACEMENT: WHEN THE UNBELIEVABLE BECOMES REALITY

2.1. The multiple waves of evacuation

Over a week after Hurricane Sandy hit, New York City authorities stated that the number of displaced persons ranged from 10,000 to 40,000. The lowest figure corresponds to the number of people who registered in public shelters, where an official count could be made. Any number above this is a broad approximation, as many people did not go to shelters, and as part of the population in evacuation zones did not evacuate (Jones, 2012). Furthermore, the numerical estimation is complicated by the multiple waves of evacuation.

On Sunday, October 28th, Mayor Bloomberg issued evacuation orders for low lying areas, including sections of lower Manhattan, parts of Staten Island and Brooklyn, Coney Island and the Rockaways in Queens. These areas, populated by 375,000 people, represent the city's evacuation "Zone A" (Gupta, 2012). The first wave of evacuation was therefore mostly composed of the inhabitants of Zone A who followed Mayor Bloomberg's

Map 4. SLOSH Model of evacuation zones



Source: New York City Office of Emergency Management (2012)

order.The three evacuation zones A, B and C[1] had been designed by NYC's Office of Emergency Management in the late 2000s, on the basis of a SLOSH model that showed the areas of the city vulnerable to flooding.

Further evacuations took place after Hurricane Sandy hit New York City on Monday October 29th in the evening, as New Yorkers began to feel Sandy's destructive power. This second wave of evacuations included households in the mandatory evacuation zones that had not yet obeyed the mayor's order, as well as households in other areas who were either forced out of their houses by the unexpected damage of Sandy, or voluntarily left in precaution.

In the following days, evacuations continued as many households were forced to move out of their houses because of the prolonged power outages. A week after the storm, 1.8 million people remained without power, and it was weeks before electricity was restored in some areas, while the already low winter temperatures continued declining (Mazelis, 2012).

From November 7th to November 10th, winter storm Athena prompted further evacuations as snow and rain accumulated in areas that had been

1. Zone A represents the lowest-lying areas of the city, most vulnerable to surges. Zones B and C represent the regions that are expected to be flooded by hurricanes of higher intensity. The order to evacuate Zone A corresponded to the predictions that the hurricane's intensity was decreasing, but might still be Category 1 at landfall.

previously hit by Sandy. The winter storm caused further power outages, forcing individuals out of their houses to find shelters with heating and electricity, and amplified Sandy's damage, as snow accumulated on broken roofs and caused the fall of further trees.

These differences in the time and date of evacuations were partly caused by the lack of obedience to Mayor Bloomberg's evacuation on Sunday 28th. One explanation for this refusal to follow the mayor's orders is the scepticism of the population towards the authorities' warnings after their "overreaction" after Hurricane Irene in 2011 (Preston, 2012). This scepticism was amplified by the National Hurricane Centre's downgrade of the hurricane to a post-tropical storm before it made landfall, decreasing the population's risk perception. Furthermore, the authorities added to the confusion by announcing that nursing homes in evacuation zones would not be evacuated. Many people deduced that the storm would not be much more severe than Hurricane Irene, and decided to ride it out (MacDonald, 2012). The dispersion in the dates of evacuation was also caused by the authorities' two-fold response. Mayor Bloomberg first declared that evacuation would not be necessary, as the authorities were expecting a slow accumulation of water rather than a sudden surge, as they were comparing Sandy to Irene. However, on Sunday 28th, the day before Sandy hit New York, the tone completely changed as he ordered a mandatory evacuation of Zone A, the low-lying areas of the city (Preston, 2012). The late order left little time for people to evacuate, causing many New Yorkers to ignore the order, both because they were not psychologically and physically prepared to evacuate, and because they considered that such a late order must be an overreaction. Those who did follow the order had so little time that they often took few personal belongings with them (assuming they would be back after a few days) whereas they were actually often displaced for extended periods of time (Barron, 2012).

Another interesting reason for the refusal to evacuate is that most New Yorkers had too little experience responding to hurricanes to have built a response culture. This human factor plays an important role during evacuation processes, as people often measure the risks against similar past experiences (Monitz, 2013). As the situation was new for most New Yorkers, many made misjudgements on the ways to respond, for instance, by disregarding evacuation orders. In addition to this psychological element, a great obstruction to the efficiency of evacuations turned out to be the lack of knowledge on the evacuation zones. Although Hurricane Irene had strengthened the familiarity with the zones' boundaries, many residents were still unsure which zone they lived in, revealing a lack of awareness of the risks posed by hurricanes. The city's evacuation and early warning procedures should be improved, particularly by enhancing the dissemination of information about the endured risks.

2.2. From short-term evacuation to displacement

The shelter challenge

The various evacuations waves can therefore be distinguished according to their time of occurrence, but also, and most importantly, according to their length. While some evacuees were able to return to their homes just a few days after the hurricane hit, other households were still displaced in May 2013. The length of displacement is largely to be correlated to the damage to the evacuee's home. Whereas some buildings were only lightly damaged, many structures were either severely affected or completely destroyed. In such cases, evacuees turned into displaced persons, as they were unable to return home. It is estimated that about 40,000 persons became homeless because of Sandy, in New York City alone (Mazelis, 2012).

In the first few days after Sandy's landfall, officials provided emergency shelters for evacuees, usually in public schools (Bernstein N., 2012). While a few successful examples can be highlighted, such as the opening of recently closed Fort Monmouth for 600 displaced families (Bonamo, 2012), provisions for shelters and transitional housing were not adequate. In the weeks following Sandy, the evacuees had to be relocated several times, as schools were reopened or as they decided to move to another shelter in the hope that it would be less overcrowded. Many were moved to drill floors and armouries, but the conditions were often precarious (Bernstein N., 2012). Sandy highlighted the lack of space in New York City, in comparison to its dense population, as well as the lack of emergency preparedness of local authorities. The shelters were usually filled to twice their capacity, and the city struggled to find additional spaces to welcome new comers. In response to this situation, the Federal Emergency Management Agency (FEMA) –in coordination with NYC officials- reserved hotel rooms, sometimes luxury ones, across Manhattan, Brooklyn and Queens, as a transitional solution. However, as evacuation centres were progressively closed to rely only on hotels, officials faced the new wave of displaced people from houses lacking heat and hot water, in the cold winter, forcing them to re-open some shelters and book additional hotel rooms (Bernstein N., 2012).

When evacuation turns into displacement

After the urge to find temporary shelter, authorities were faced with the necessity to provide longer-term structures for households whose homes were destroyed or inhabitable, and to launch a recovery programme for damaged houses. In early November, over 45,000 households were approved for housing assistance to help them seek a temporary living place, or repair their houses, for a total cost of over USD 203 million (Barron, 2012). However, the management of longer-term displacements was as debatable as the city's emergency preparedness. Once power was re-established, and individuals who could return to their homes had left shelters, the authorities started relying almost exclusively on FEMA hotel room system as a transitional solution for displaced families. However, if this option was adequate for transitional lodging, it was not designed as a long-term option. As weeks and months went by, the authorities discovered that the 'transitional' situation turned out to be 'quasi-permanent.' Three months after hurricane Sandy hit New York and New Jersey, at least 3,500 families remained displaced in hotels, often having to change rooms or hotels as reservations for conferences and parties came up (Zezima, 2013). Hotels close to affected areas were taken over, such as the Clarion Hotel in Toms River, where about 80 per cent of the guests were part of the FEMA programme in January. The expected cost for FEMA has amounted to tens of millions of dollars, with an estimated rate of USD 250 per room per night on average.

A positive aspect of the hotel programme is that it enabled most households to remain close to their former living places, thus preventing the need to change schools for children, and long commutes to the workplace for adults. However, the families lived in constant fear regarding their future, as the hotel stays expired every two weeks (Zezima, 2013). This lack of guaranteed stability was a great source of worry, as the FEMA's decision to renew the hotel stays was made on a case-by-case basis (Piore, 2012). Households constantly feared they would lose their right to hotel assistance, for instance if the FEMA decided that their homes were safe to come back to, that they had a sound insurance settlement or had received assistance to rent another place (Zezima, 2013). Although such reasons for the removal of hotel assistance seem reasonable, they added to the psychological plight of displaced households, and were occasionally applied in an arbitral manner, without taking some households' characteristics into account. This was sometimes the case for low- and middle-income households, who were shut out of the hotel assistance programme after receiving FEMA household assistance, but actually used that money to pay for gas to drive their children to school in their previous neighbourhoods, to drive to their jobs, to pay the mortgage on their damaged house, and to buy food. They, therefore, did not have any funds left to find proper lodging or to repair their homes, and had lower hopes to return to a stable existence in the short term. Furthermore, hotel stays were also very costly for the displaced families, as they did not have kitchens to cook in and had to order take-out or go to restaurants every day (Associated Press, 2013).

The number of displaced people gradually decreased from December to March as many households were able to return to their homes after they were repaired, or as they decided to leave FEMA hotels for a more stable situation, such as a rented apartment (FEMA, 2013). A small number of families whose houses were damaged but had land available opted for FEMA's "temporary housing units," which soon became negatively referred to as "FEMA trailers" (Barron, 2012).[2] The fact that some individuals preferred to move to trailers rather than remain in hotels underscores how inadequate FEMA's hotel housing programme was in the long term. It should also be mentioned that while some households left for other lodging options, many persons that had not previously applied for FEMA financial or lodging assistance were forced to request help as their personal circumstances evolved. Indeed, in many cases, individuals received help from relatives and friends for some time, but realized after a few months that this situation could not last any longer (Jones, 2012). In January, FEMA received about 60 new applications every day for financial and/or lodging assistance (FEMA, 2013). This point underlines that the situation was constantly evolving, as displaced people that had not been accounted for yet stepped out to ask for assistance. Overall, FEMA has registered over 250,000 households, and given over USD 370 million in assistance (FEMA, 2012). However, it is important to highlight that although the displaced households in hotels were the most visible, the majority of displaced individuals were "invisible," staying with relatives or friends, renting apartments, or remaining homeless. As such individuals have not been officially registered, it is difficult to evaluate the number of persons included in each category (Jones, 2012).

2. FEMA trailers are widely associated with New Orleans' Katrina victims, as over 230,000 FEMA trailers and mobile homes were used after the hurricane hit the city in August 2005, becoming part of the city's landscape. The last FEMA trailer was removed in 2012, over 6 years after the disaster. (Burdeau, 2012)

2.3. Sandy's long-term displaced

Five months after Sandy made landfall, over 500 people remained displaced and living in hotels in New York, through FEMA's temporary housing programme. Most of the remaining displaced households in hotels were either too poor to pay for their home repairs or were renters whose landlords had not dedicated the necessary funds to repair their apartments (O'Connor, 2012). In order to provide for this group, on March 29th, FEMA launched a "Disaster Housing Assistance Programme," in cooperation with the Federal Department of Housing and Urban Development, modelled on the one that was launched after Hurricane Katrina. This programme was designed to help displaced people who were still living in motels find long-term solutions, by temporarily paying their rent. It aimed at introducing more stability to their lives, by acting as "a bridge from displacement to a permanent relocation in their former houses" as Senator Chuck Schumer of New York declared. It was particularly designed for displaced families in hotel rooms who could not afford to rent an apartment. Indeed, after Sandy hit, many real estate firms such as Ashore helped by finding families homes in winter rentals. In December, some landlords accepted to prioritize displaced people for the rental of apartments at market price. Since these rentals were managed privately, it is not possible to evaluate how many of those displaced found acceptable housing. However, few people (or families) displaced by Sandy could afford rents at market price. Estimates show that 75 per cent of the households that applied had annual income inferior to the estimated USD 25,800 needed to qualify (FEMA, 2013). Although FEMA's Disaster Housing Assistance Programme represents a considerable improvement for the life of displaced households, families (or people) still live in the fear of leases ending, particularly with the beginning of the tourist season, when rent prices usually peak. Indeed, although FEMA will provide financial support by paying rent temporarily, landlords usually want to be assured that they will be able to keep paying once the assistance is removed (McKelvey, 2013). As this programme was only set in motion five months after the hurricane, the conditions of displacement were often precarious both in physical, financial and psychological terms for a developed city such as New York (Dawsey, 2013).

2.4. Displacement and social inequality - the diverse outcomes of Hurricane Sandy

Low-income people constituted a particularly vulnerable group to Sandy's impact. Before Hurricane Sandy, New York City had the largest population of homeless people, 47,000, and 4.9 per cent of the city's overall population lived in public housing structures (Huang, 2012). These buildings were usually quite old and badly maintained, with pre-existing mould problems that were aggravated by the floods. Evacuation orders were often ignored by the people with the least means, because of the high price associated with it. Sandy would have required evacuating relatively far away, and sometimes moving from shelter to shelter. These factors led many low-income people to try and ride out the storm.[3] Public transportation had been stopped on the 29th in the morning, before the hurricane hit, removing this cheaper option (Mathis, 2012). As the subway and train systems remained closed or with running with reduced frequency after Sandy, many households were unable to evacuate from their disaster-struck homes, and had to survive without power or basic food and health facilities. Another reason that led lower-income persons to stay in their homes is that the jobs they occupy are usually quite unstable. Missing a work day meant missing a day's salary, which is something that most public housing residents cannot afford (O'Connor, 2012). The number of people who filed for first-time unemployment insurance benefits after Sandy highlights the disastrous impact that Sandy had on the poorer groups: 120,000 applications were made in the period between November 10th and November 27th only (some of those applications may also have been filed as businesses closed due to damage). Furthermore, although the most publicized media reports after the storm showed the destroyed houses in coastal neighbourhood, we have to think about the losses proportionally to the person's assets. Homeowners who lost their house surely suffered, but usually had savings or resources to draw upon, in contrast with poorer renters who sometimes lost everything they owned (O'Connor, 2012). Almost half of all FEMA registrants indicated their annual income was below USD 30,000 (Enterprise Community Partners, 2012). Almost 45 per cent of them were renters, who usually did not have insurance for their possessions. Furthermore, in cases when the renter's home was damaged but not completely destroyed, they depended on their landlords' will and financial capacity for repairs. As landowners often lost other large assets during Sandy, these necessary repairs were not their priority, forcing many poorer households to live in precarious conditions in terms of health, with increasing mould, among other issues (O'Connor, 2012).

3. As gasoline is expensive, and many of them did not have cars (access to cars in New York is lower than in any other city in the United States).

THE ELDERLY IN THE FACE OF SANDY: A TALE OF DISPROPORTIONATE VULNERABILITIES

The intrinsic vulnerabilities of the elderly to environmental disasters

A specific social group, the elderly, was particularly affected by the hurricane's damage. Approximately 37 per cent of those who died in New York City because of Hurricane Sandy were 60 or older, whereas only 17.2 per cent of the city's population belongs to this age group (Synergy Home Care, 2012). Many elderly people drowned within their houses, while others suffered from fatal storm related injuries and hypothermia (Parry, 2013).

The elderly are extremely vulnerable to the effects of storms for two main reasons. First, elderly people are often socially isolated, making them more vulnerable in the case of a natural disaster. Although this isolation is sometimes unwelcomed, it most of the time stems from a choice: elderly people are more reluctant to ask for services or seek their family's help, because of a will to maintain their independence, and out of concern that they will bother others (Parry, 2013). This was often the case during Hurricane Sandy, when many elderly decided to "ride out" the storm instead of calling their families or rescue teams for help. Second, most of the disaster preparedness procedures are designed for healthy individuals, sometimes requiring a walk of a mile to the closest evacuation centre, or to take crowded buses. Elderly people have a small capacity of adaptation because of their limited physical capability to leave their home independently (Solecki, 2012). Most elderly cannot drive anymore, and find it physically or psychologically difficult to take public transports (Parry, 2013). This left them no choice but to stay home or call for help. Many were also living on the highest floors of buildings. When the power was cut off, the elevators often stopped working for days, sometimes weeks, forcing elderly people to stay home in often precarious conditions.

Evacuating nursing homes in the face of Sandy: a tale of mismanagement and lack of emergency preparedness

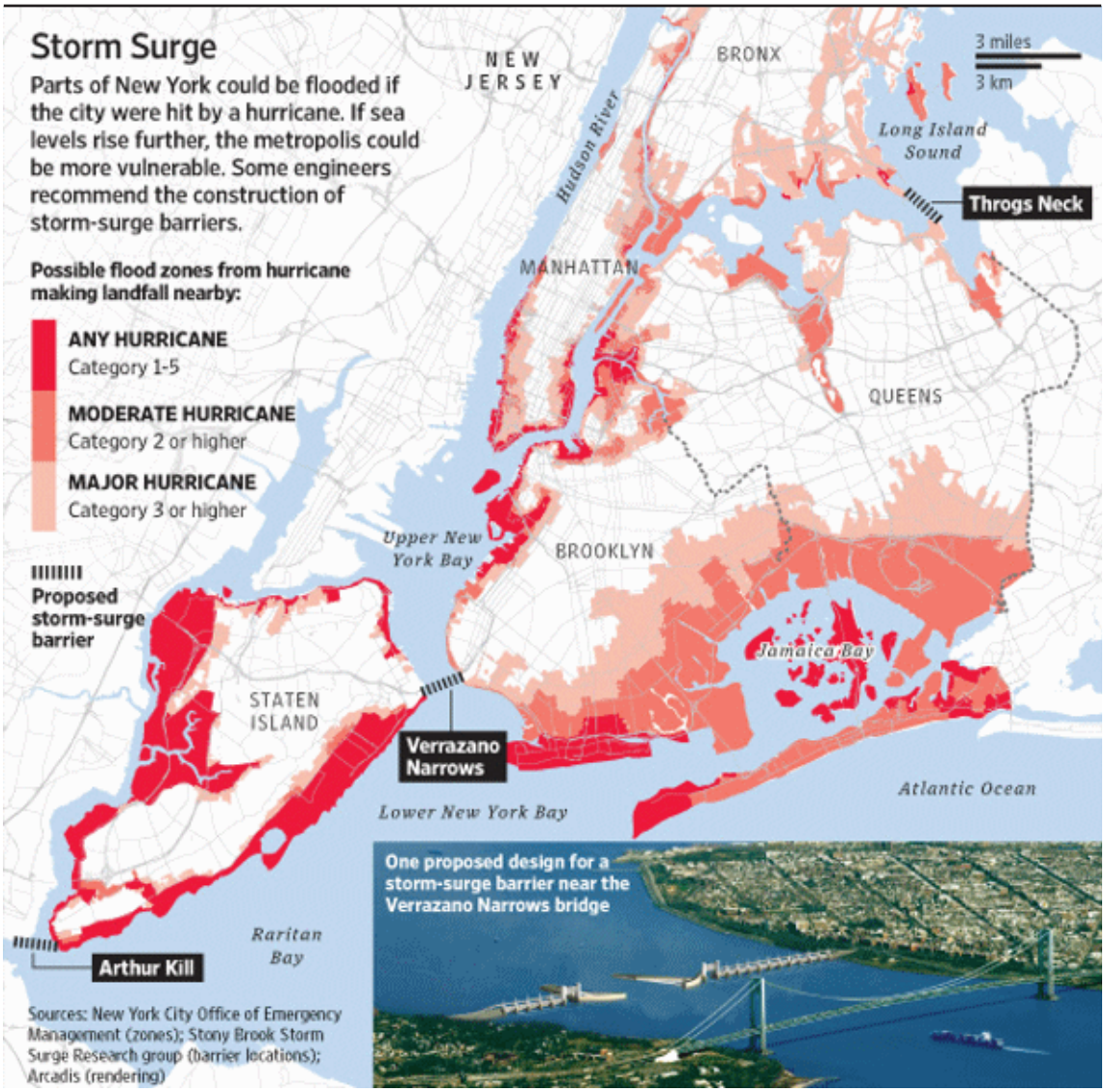
Elderly people living in nursing and care facilities were not spared from the hurricane's damage. A few days before hurricane Sandy made landfall, Mayor Bloomberg advised 40 nursing homes located in the mandatory evacuation areas to cancel plans to move their 3,000 residents to safety (Preston, 2012). This decision was influenced by the past experience of Hurricane Irene in 2011. At that time, officials had ordered evacuation of nursing and adult homes in specific zones. While the hurricane finally caused minor damage, the cost of evacuation in terms of transportation, health care, and housing amounted to millions of dollars, leading to broad criticism. Some nursing homes had still not been reimbursed for Irene's evacuations at the time of Sandy's landfall. Furthermore, the evacuation of nursing and care homes had proved difficult and dangerous to the physical and psychological health of the residents. However, this time around, the decision not to evacuate had disastrous consequences. By the time the intensity of the storm became clear, and the surge projection rose from 1.8 to 3.4 meters (Wunderground, 2012), it was too late to evacuate elderly people, which is a 48-hour process. Nursing homes were then ordered to increase staffing and to transfer the residents who required ventilators to hospitals.

In addition to this lack of caution by NYC authorities, the effects of the hurricane on nursing home residents were worsened by the default in emergency preparedness in the facilities. First, emergency backup generators are not legally required to be able to withstand flooding, as health inspectors only check that they are functional, but not whether they are protected against flooding. When Sandy hit, the waters rose so quickly that the workers in the facilities did not have time to elevate them. In Queens and Brooklyn alone, over 23 nursing homes were severely flooded, leading to heat and power to go outin many cases (Preston, 2012). Elderly people therefore had to ride out the storm within the nursing homes, and were later on forced to evacuate after the surge, due to the absence of electricity. In the days following the storm, 6,300 patients were evacuated from 47 facilities according to the New York State Health Department (Durkin, 2013). These examples highlight the importance of emergency preparedness of nursing homes themselves, as facilities where generators were protected from surges, like Ocean Promenade in Queens, did not have to evacuate after the storm. Evacuees were taken to other facilities, but also to high schools converted to shelters, often quite far away--even as far as Albany. They were sometimes sent without their medical records or medications, to places that were not specialized for nursing home care. Furthermore, the evacuation flows caused residents from facilities dealing with specific illnesses to be mixed with residents from "normal" nursing homes, causing a great deal of confusion and psychological damage for many (Preston, 2012). Some of the 160 residents evacuated from Bell Harbor in Queens had, for instance, been diagnosed with only slight psychiatric illnesses, but during the evacuation they were mixed with residents who had more severe disorders, and were brought to the Milestone Residence where they were obliged to adopt a much more institutional lifestyle (The Associated Press, 2012). In December, two months later, hundreds of nursing home patients were still displaced, living in temporary, overcrowded quarters, sometimes without a regular change of clothes. The Bishop Henry B. Hucles Nursing Centre in Brooklyn was for instance full at nearly twice its licensed capacity (The Associated Press, 2012).

The confusion was magnified by the fact that the floods cut off phone lines, disabling facilities from fulfilling a major requirement: notifying relatives. Communication continued to be chaotic up to a week after Sandy hit New York, as many families still were not aware of where their elderly family members had been evacuated, or of their health status. No clear indications had been given as to which phone number should be called to obtain information, and many relatives were directed to the wrong shelters (Hallman, 2012).

The disproportionate impact of the storm on the elderly was caused by this group's intrinsic vulnerabilities, but also by the insufficient preparedness at the state, local and facility level. The fact that structures designed for this particularly vulnerable group were allowed to be located in low lying areas illustrate a sense of invulnerability of New Yorkers and authorities to environmental disasters.

Figure 2. Surge barrier projects



Sources: New York City Office of Emergency Management (2012)

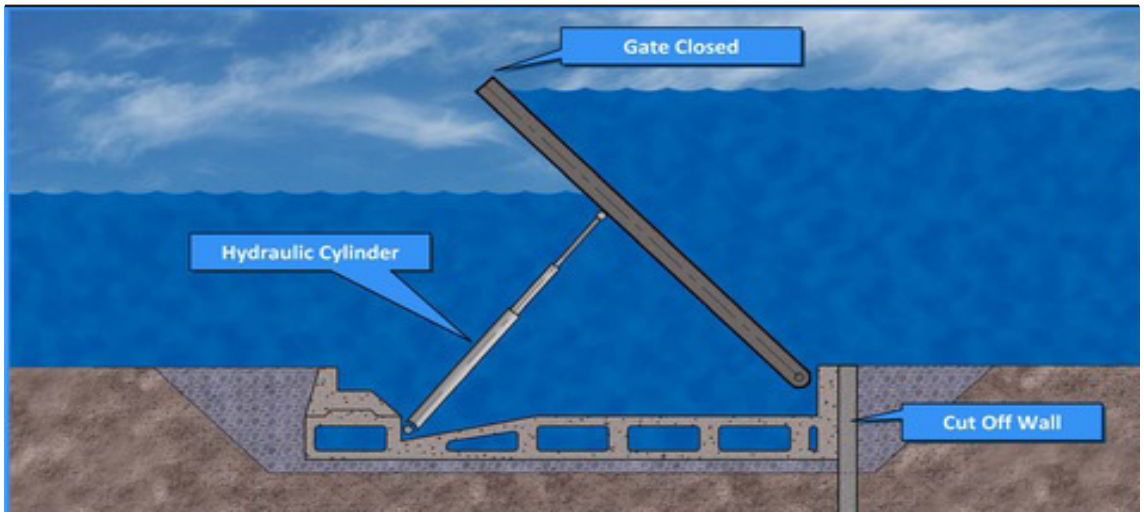
The authority's reliance on hotels highlights that the emergency disaster management and recovery mechanisms did not take into account the radical impact of income differences on displacement. New York authorities failed to immediately differentiate the needs of the displaced according to their income level, causing a "tale of two Sandys", with lower-income displaced people remaining in precarious living conditions for a much longer length of time than households of higher means.

3. REBUILDING AND ADAPTING: A POLICY PATH FOR SANDY'S AFTERMATH

3.1. Action at various levels

Climate change adaptation needs to happen at different scales. At the household level, it could mean thinking in a vertical manner, a certain flood requirement level and flood-proofing all the lower floors, with all essential utilities at higher floors (Solecki, 2013). Building defensive systems is building resilience into public structures. For nearly 100 years, officials have tried to compensate the erosion of shorelines due to natural causes by building hard structures such as seawalls and

Figure 3. Flap-type barrier model



Source: Parsons Brinckerhoff, PBS Newshour (2012).

bulkheads. Experts use the term "New Jerseyzation" to refer to such structures now present on 80 per cent of the shoreline of New Jersey (Rudolf, 2012). Although sea walls are particularly well-known for their use in the Netherlands, they can actually be found much closer to New York: in Stamford, a city of 124,000 on the East Coast (Navarro, 2012). A five-meter high barrier was built in 1969, protecting an area of about 2.4 square kilometres. The Army Corps of Engineers estimated that it helped prevent USD 25 million in damage to houses and businesses (Navarro, 2012). Such successful examples have attracted the attention of engineers and authorities, which have considered applying similar systems to protect New York. Three main projects were presented in 2009 at the American Society of Civil Engineers conference, to protect New York against Category 3 hurricanes. One of the designs represented a rolling gates system, north of the Verrazano-Narrows Bridge connecting Long Island and New Jersey. The USD 6.5 billion project envisaged a complex system of various gates which could be closed during a storm to prevent flood surges to affect the City and parts of New Jersey, and could sustain a surge of nine meters –twice as high as Sandy- (Jacobson, 2012). In normal situations, it would still allow the water to pass, in order to limit the disturbance on the ocean's tides and on the heavy commercial boat traffic.

A second design proposed, in addition to the previously mentioned sea wall, the creation of a flap-type barrier at the upper East River. The sea-wall would include a number of panels that would rest flat on the ground below the water, and could be raised in the case of a surge. This would limit the disturbance for boat traffic as well as to the local marine life, while being high enough to act as a buffer against storm surges of a Category 3 hurricane (Jacobson, 2012). An advantage of this design is that it could be built off site before being laid down in the river, thereby reducing the costs and economic and wildlife disruptions. However, such plans would force local areas to build draining systems to deal with water flooding over the banks on the sides of the gates (Jacobson, 2012), amounting to an added cost of around USD 10 billion to USD 12 billion to shore up the areas on the sides of the barriers (Navarro, 2012).

In addition to being quite costly, such sea wall plans also reflect a somewhat short-term adaptation view. Indeed, even after the debate is won and politicians line up behind the project –Congressional approval will be needed--funding, acquiring permits and conducting environmental studies would be a lengthy process. The construction would very likely not begin in the next two decades, leaving New York vulnerable in the meantime (Peltz, 2012). Furthermore, it would only provide protection for 50 to 100 years, as sea levels continue rising (Parry, 2013). Sea wall construction projects also assume that current climate change, sea-level rise and hurricane size predictions are accurate. These models are debatable because of the global scale and complexity of climate change. Indeed, meteorological estimations of Sandy's development as it moved towards the East coast have proved to be very hesitant at best, highlighting that there is still much to improve in this area. One can thereby wonder whether sea walls built on current projections will still be able to withstand floods and hurricanes that will have evolved in size and scope in the coming decades.

The barriers' limitations are also evident in the shorter term: an important question is whether they would be socially fair, as they would cause water levels on the other side to rise approximately one foot (30 cm), possibly worsening flooding in these areas –the water level could be around 20 per cent higher on the other side of the barrier (Navarro, 2012). Furthermore, barrier plans are likely to raise objections from industries arguing against the large disruption in the city's waterways, as well as from residents objecting to the destruction of the natural landscapes. Barriers would also reduce the exchanges of New York's estuarine waters with the sea, worsening water quality and modifying temperatures and salinity, with potentially negative impacts on rebounding ecosystems and local fisheries (Jonkman, 2012) that benefit the area both economically and in terms of recreation. Such policies could create a false sense of security that blinds New Yorkers from the increasing risk, and thereby prevent authorities from searching for smaller, more flexible and more efficient solutions (Gessner, 2012).

3.2. Learning from the past while preparing for the future

It can be argued that a series of minor interventions will lead, over time, to efficient and more natural systems to deal with climate change and sea-level rise (Peltz, 2012). In recent years, the armouring of the coast against erosion has for instance been supplemented by beach replenishment systems (Wald, 2013). An obvious policy would be to disaster-proof infrastructure, to increase their resiliency against natural disasters. A large part of Sandy's damage could have been avoided by adaptive measures such as burying power lines in the suburbs and designing closing doors for subways (Lind, 2012). This point highlights that recovering after Sandy is not enough, the city needs to rebuild in a way that decreases the risks of future damage. Populations need to return to a new normalcy, where they are actually in a better situation than before. Authorities cannot only learn from the past anymore, they have to take into account climate change related projections, including those of sea-level rise (Solecki, 2013). Although efforts to increase resilience have been launched in the past, they were usually conducted with a short-term view. The National Flood Insurance Programme Community Rating System, for instance, was introduced in 1990 to encourage local authorities to upgrade buildings' structures to decrease the risk from floods, in exchange for deductions on residents' flood insurance premiums. The large majority of the 1,211 communities that voluntarily participated in the programme received minimal ratings from federal agents, which means that local authorities had implemented the lowest level of adaptation measures to prevent flood damage (Rudolf, 2012). Floods due to hurricanes like Sandy are not just "natural disasters," they are failures to adopt and implement adequate land use and building code requirements.

Flood-proofing subway and road tunnel systems in coastal areas (Jonkman, 2012), while adopting more nature-friendly barrier systems such as rebuilding the harbour's salt marshes and oyster beds, that once acted as softener against storms (Jacobson, 2012 and Jonkman, 2012) could go a long way to increase the city's resilience. As Mayor Bloomberg declared after hurricane Sandy: "What we have to do is learn, and it would be great if you didn't put your generators in the basement… The fact that we live close to the water shouldn't be a surprise to everybody." (Chaban, 2012).

3.3. Relocation, the key to adaptation?

A longer-term adaptation method would be to encourage the relocation from low lying areas, to higher regions in Queens and Staten Island that are currently scarcely populated. In addition to mitigating the impacts of future storms, such measures would be more cost efficient than to repair structures after every storm. This could be achieved through economic incentives, with higher taxes for businesses and residences in vulnerable areas, and tax incentives for those who move elsewhere (Young, 2013). In the past, many coastal towns such as Long Branch in New Jersey actually granted tax abatements for real estate developers to relocate there. Hurricane Sandy has sent the clear message that this type of policy needs to be reversed. Many residents in Staten Island for instance have been seeking government buyouts to be able to relocate to higher areas. People whose homes were destroyed or badly damaged in flood-prone areas are not inclined to stay and rebuild, either out of fear that the increasingly frequent storms will take their houses every time or because they have been too emotionally affected (The Associated Press, 2013). This is the case in Oakwood Beach, an area that has been rapidly developed in the last century, and was particularly hit by the storm. In February, Governor Mario Cuomo launched a programme through which homeowners in the area could sell their houses at their pre-Sandy market value. To date, In the Fox Beach section of Oakwood Beach, 133 of 165 households have signed up to take a buyout if one becomes available (Kaplan, 2013). Nevertheless, as the focus has been on rebuilding

rather than retreating, residents will have to pressure authorities to obtain additional funding for buy-outs, for instance, through the Federal Emergency Management Agency's Hazard Mitigation Grant Programme, that was used after Hurricane Irene. It remains to be seen whether the will to relocate permanently is reflected in the majority of coastal populations, or if it was solely a short-term post-storm reaction from a small share of coastal residents.

Another method to induce relocation from low-lying areas would be to increase insurance costs. Before Sandy, coastal areas benefitted from low insurance costs, which gave homeowners a false sense of security. Increasing the individual costs of living in low-lying areas would enable to transfer more of the risk burden to property owners, improving popular risk perception. In 2010, an official report by the city's Panel on Climate Change highlighted that New York authorities should "reduce incentives that increase or perpetuate development in high-risk locations." (Rudolf, 2012). However, this proposal was not adopted by the city, that feared that in would lead to a policy of disinvestment and would encourage relocation away from current urban regions, resulting in disastrous impacts on the economy. Authorities underlined that the FEMA's zone with 1 per cent risk of flooding in NYC was populated with over 210,000 persons, and provided for almost 190,000 jobs (Rudolf, 2012).

The example of Ocean Country is quite revealing. It was one of New Jersey's most rapidly developing areas in terms of population density, with a total population growth of over 69 per cent between 1980 and 2010 (J. Rudolf, 2012). Landscapes that used to act as natural buffers against storms were destroyed and populated. This county, which issued the highest number of coastal residential building permits in 2010, was also one of the most devastated by the flood. Real estate representatives have a large influence in the politics of New Jersey and New York, as they have been major donors to governors and local leaders, ranking among the top contributors to New Jersey Governor Christie (Rudolf, 2012). Before Sandy, there was no provision in these states laws requiring in-depth review of developments on coastlines, nor for buildings to meet reasonable storm and flood resistance standards. Small developments of fewer than 25 units in vulnerable areas did not require any form of state approval, leaving the decision to local officials. This was specifically the type of projects that were designed throughout the 1970s, 1980s and 1990s, as local officials were more eager to develop their localities in the short term than to adopt a sustainable long-term view (Bernstein, 2012). Officials in localities that lacked funds have tended to prioritize short-term economic benefits, especially since many are elected for two-years terms. This lack of action on the part of authorities highlights the tension between the objectives of development and environmental protection for many localities (Bernstein, 2012).

CONCLUSION

Hurricane Sandy was a partly political disaster, caused by the lack of adaptation and mitigation measures. Authorities had received many warnings about the high risks of hurricanes, as early as 1992 when environmentalist Suzanne Mattei analysed the worst-case scenario of a "combined sea-level rise/storm surge event" (Rudolf, 2012). However, the federal government, the State of New York as well as the City generally did not conduct proper adaptation programmes.

Hurricane Sandy has shown that economic development and environmental protection are not at odds and can be improved together. Political will needs to be stirred up now, so New Yorkers do not have to live through multiple Sandys before officials act. Taking projects beyond the research/development phase would allow them to be fully funded and implemented through cooperation between federal, state and local authorities, as well as the private sector. The environment cannot be considered a stable variable in New York's urban planning anymore (Funkhouser, 2012), and migration from low-lying areas would be a particularly efficient adaptation strategy to increasing climate risks in New York. Resilience, mitigation and adaptation can be combined to protect New Yorkers from the impact of future natural disasters. In some cases, the cost of staying in low lying areas surpasses the cost of relocating, as households face higher insurance premiums (Holborn, 2012), and have to raise their houses higher above sea-level, at an approximate cost of USD 10,000 to USD 100,000 for the entire house (Harris, 2013). Although there is no legal obligation to lift houses in New York City, it is recommended to elevate them as a protection from future storms. Hurricane Sandy has changed cost-benefit calculations, and this should be an opportunity for authorities as well as communities to adapt in a sustainable way.

Although resilience and adaptation are important objectives, New York authorities and inhabitants could also improve their preparedness to natural disasters. Responses to all phases of evacuation and displacement can be enhanced, in order to avoid the confusion and lack of organization that followed Sandy. The authorities'

preparedness and emergency response system was not efficient enough to deal with the immediate human displacement consequences of Sandy, as shown by the low level of pre-storm evacuations, as well as the precariousness of the shelter system, highlighting the dire lack of space for New York City to welcome displaced persons. As hurricanes become stronger and more frequent, authorities could also improve their policies targeted at particularly vulnerable groups such as the elderly and the low-income households. Services such as special phone lines for the elderly would be useful, to enable them to call for help if they do not have any family or friends help them to safety. Past censuses could be particularly used to identify the areas where many vulnerable people live, enabling authorities to increase their activity and presence in such places in the case of a natural disaster – particularly before the disaster strikes.

Responses to long-term displacements have yet to be created to deal with displaced families whose houses have been destroyed. Many programs were created after Sandy hit without proper coordination or prior reflexion, leading to uneven and often poor responses. The FEMA's hotel program is a perfect illustration.

Finally, the efficiency of preparedness, resilience and adaptation measures relies on the authorities' communication strategy. In terms of preparedness, enhancing the communication with communities and households would allow for easier and more efficient management of evacuations, through a better awareness of evacuation zones, of the risks involved, and of available means of transportation. Working with local associations, NGOs and religious groups, among others, could prove extremely useful –many households are more likely to be persuaded by their local pastors than by official messages on T.V. Improved communication with local communities is also fundamental in the adaptation process, for three main reasons. First, locals can prove very useful to develop efficient adaptation measures, as they usually know their locality and its geographical and demographical characteristics very well. Second, involving communities in the process and taking their concerns into consideration increases the chances that they will support the final decision. Everyone having a say in the debate makes improves stakeholder sense of ownership Third, promoting conversations and debates on the issue increases the population's awareness of the risks, making them more likely to make sound, long-term decisions rather than short-term ones based on pre-conceived notions or political inclinations.

Migration——and more precisely displacements and relocations—has been one of the main, and yet least-reported, consequence of Hurricane Sandy. It has been essential to the short-term response and remains crucial to the long-term adaptation process. Technology, high income levels and stable institutions are likely to mitigate the consequences of disasters. However, the centrality of migration during and after Hurricane Sandy highlights that environmentally-induced displacements are not restricted to developing countries or to lower-income cities like New Orleans, as natural disasters strike regardless of the level of development. The impacts of Hurricane Sandy furthermore underscore that relocation is not necessarily a consequence of disasters, but should also be considered as an opportunity to adapt to a changing world, through relocation to safer, less vulnerable areas.

Picture 1. After hurricane Sandy

Source: Coastal America, 2013.

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