Disaster Mitigation and Recovery Planning after Long-term Flood

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This paper examines and evaluates the post-disaster recovery planning strategies and processes in terms of disaster mitigation through case studies of Hurricane Katrina (2005) in the United States, the 2011 Thailand Flood and 2011 Queensland Flood in Australia. In other words, the research question is "To what extent have long-term flooded cities and neighborhoods recovered as resilient cities through disaster mitigation measures in the process of post-disaster recovery planning such as physical structure improvement, land use control and building code for flood?" The common keyword among the three disasters is “long-term flood”.

The authors have been conducting field surveys in New Orleans after Hurricane Katrina (2005) and Ayutthaya after 2011 Thailand Floods. In New Orleans after Hurricane Katrina, National Flood Insurance Program and Hazard Mitigation Grant Program by FEMA are utilized for safer housing recovery strategies, although land use control is not improved to reduce the risk regardless of vulnerable land below sea level, which makes up 80% of the city. In Ayutthaya after the 2011 Thailand Floods, the government developed recovery plans composed of comprehensive measures to mitigate and prepare for floods, however, it is unknown that to which extent these stated strategies could be implemented. The problem is little government funding support which results in minor actions to renovate their housing as flood resistant design. Queensland and the City of Brisbane governments’ leadership for developing a disaster reduction plan is strong, and stands out from the rest in its speed and holistic approach. Especially, building code and land use control which are non-structure measures for disaster reduction is widely planned and implemented since 20th century, and improvement after the 2011 flood.

Key Words: long-term flood, post-disaster planning, land use control, housing recovery, flood resistant housing

1. INTRODUCTION

Why is long-term flood increasing in the global society? It depends on each flood, however, there are two main reasons. The first is global climate change, a natural phenomenon, and the second is urbanization increasing in the areas where vulnerability for flooding is high, which are social phenomenon. What is the characteristics and differences between general flood and long-term flood? It is different in the duration of flooding, and the long-term flood requires government emergency response such as issuing evacuation orders for people to evacuate, draining water and permitting refugees’ re-entrly. In the case of Hurricane Katrina, it took about 43 days to drain floodwaters, and this forced people to evacuate long-distance and long-term.

This paper examines and evaluates the post-disaster recovery planning strategies and process in terms of disaster mitigation through case studies of Hurricane Katrina (2005) in the United States, the 2011 Thailand Flood and 2011 Queensland Flood in Australia. The research question is "To what extent have long-term flooded cities and neighborhoods recovered as resilient cities through land use control, flood resistant housing design and flood insurance for housing?" The authors have conducted field survey in New Orleans after Hurricane Katrina (2005) and Ayutthaya after 2011 Thailand Floods. For Queensland flood, we conducted
literature review by government official report and evaluation report.

Three major metropolitan areas in Japan are vulnerable for flooding because of existence of land below sea level where more than 4 million people live. The urban density is higher and number of population is larger compared to New Orleans which was affected by Hurricane Katrina. We are also expecting the next mega disaster, the Nankai Trough earthquake, and the tsunami submerged area is estimated 1.8 times as large as that of the Great East Japan Earthquake (2011). As happened after the Great East Japan Earthquake, subsidence damage led to region being kept submerged. Japan has to learn from long-term flood experience and lessons in order to develop and prepare efficient strategies and planning measures to reduce the damage for long-term flood.

2. HURRICANE KATRINA (2005)

(1) Disaster Risk

New Orleans is the city that experienced the most severe damage after Hurricane Katrina. The city is a deep water port established in 1718 about 50 miles up the main stem of the Mississippi River. Starting with the original city in the early eighteenth century, the general trend was to spread mostly upriver along the natural levee. After experiencing Hurricane Betsy (1965), the U.S. Congress approved the construction of levees around New Orleans. Levee construction made it possible to develop residential subdivisions. Campanella (2006) shows that most above sea level areas were developed in the nineteenth century or earlier, while most below sea level areas urbanized in the twentieth century. It was obvious that flood risk in New Orleans is very high.

(2) Damage and the situation as long-term flood

Hurricane Katrina’s storm surge washed over the levees and breached the floodwalls of the City of New Orleans, water stood in over 80 percent of the city for nearly two weeks, and 180,000 housing units were severely damaged or destroyed. It took 43 days to drain off the water citywide. This resulted in the largest relocation of citizens in the history of the US; the 100,000 to 120,000 residents who remained in the city were rapidly transformed into a second wave of evacuees, greatly intensifying the need for shelter and housing.

What makes Hurricane Katrina a long-term flood? It is because of the city's geographic characteristics that most of the land is below sea level. New Orleans is situated between the levees along the Mississippi River, and those around Lake Pontchartrain. In addition to this, due to the "bowl" effect, once water gets into the city, it is very difficult to get it out. Due to long-term flooding, the mold exposure and health effect requires housing to be renovated extensively or reconstructed. Based on interviews with homeowners in September 2012 by authors, there are many people who haven’t conducted proper response to mold because of their lack of financial resources. Their health issues is still remain almost 7 years after disaster.

(3) Emergency Response and Evacuation

The Mayor of New Orleans issued a mandatory evacuation for people in the city before hurricane landfall. More than 90% of citizens successfully evacuated before the levee breach, but people who did not evacuate stayed in the Superdome which was used as a "shelter of last resort". Hurricane Katrina forced the largest and
most abrupt displacement in U.S. history. About 1.5 million people evacuated from the Gulf Coast. Katrina survivors were eventually scattered across all fifty states. The New York Times on October 2, 2005 covered "Katrina's Diaspora". It shows the victims have filed for assistance from FEMA from every state. The map shows the distribution and number of the 1.36 million individual assistance applications as of late September, 2005. As of July 2011, 6 years after, the Census Bureau has estimated New Orleans’ population at 360,740, or 74 percent of its 2000 population of 484,674. However, it is unknown where people who left New Orleans live now, and how many live where. When looking at U.S. Census data, it is shown that the share of American-African, low-income, elderly population and family with children has decreased in New Orleans. This means that they are the people who did decide not to come back to the city or couldn't come back to the city yet.

(4) Land use control

Land use control, zoning in the United States, is significant measure to decrease disaster risk, such as not to allow building to be constructed near active faults or on land below sea level. Nonstructural measures can make New Orleans less vulnerable to storm surge and can do so cost-effectively. The national research institute, RAND (2011), points out non structural measures, such as incentives for elevating existing or new structures or for relocation to lower risk areas, revised building codes, and land use restrictions designed to curtail future growth in the floodplain. These measures include incentives for relocation to lower-risk areas and land use restrictions designated to curtail future growth in the floodplain.

It is pointed out in the website of the City Planning Commission that New Orleans’ zoning ordinance dates from the 1970s and is unsuitable for a 21st-century city. In New Orleans, the base flood elevations in many areas of the city were below sea level and hadn't been adjusted in more than 20 years. The draft Comprehensive Zoning Ordinance and Master Plan(2030) is a City Charter-mandated planning framework for the core systems that shape New Orleans’ physical, social, environmental, and economic future. The Ordinance (CZO) is the law that governs land use and it includes lists of permitted land uses for each of the City’s zoning districts, in addition to height limits, setback requirements, urban design standards, operational rules, and other regulations. However, there is no regulation or control that restricts places that can be used to construct buildings. The reason is not clear, but it is assumed that it some influence by the green dot map, approximate areas expected to become green space, by the Mayor's recovery planning committee, strongly criticized by the public. Although the city zoning has not changed as a measure for disaster risk reduction, it is utilized for preserving property values after disaster in middle-high income neighborhood.

(5) Structural Building Codes and Flood Base Map

Prior to 1950, the City of New Orleans had very loose building code regulations. It was not until after Hurricane Katrina that Louisiana adopted a statewide building code. The first form of building codes for the city, requiring slab foundations to be 12 inches (1 foot) above and pier risers to be 24 inches (2 feet) above the natural ground level, was updated during the 1950’s to require foundations to be "18 inches above the highest point of the curb adjacent to the property and the lowest support beams for houses raised above ground level on piers to be 24 inches (2 feet) above the curb".

One of the important government funded program to empower resident to reconstruct their housing higher is Hazard Mitigation Program by FEMA that offers homeowners three types of grants: elevation grants, pilot reconstruction grants, and stormproofing money. Under this program, the lowest floor or lowest mechanical

![Elevated Housing after Hurricane Katrina](Photo by Author in 2010)
equipment of the new or existing structure must be elevated, at a minimum, to the advisory base flood elevation, to the base flood elevation, or to the elevation established in local floodplain ordinance, whichever is higher. It is FEMA's job to determine the base flood elevations - a level of which all new houses must be constructed. Kougan (2011) points out that after Katrina, most people assumed there would be big changes in the elevation rules. Finally, in mid-April 2006, FEMA announced that the base flood elevation would remain unchanged. This is because FEMA concluded that the failure was not with the elevations, but with the levees. In New Orleans, non-structural disaster reduction doesn’t make an improvement.

(6) Post-disaster recovery planning for mitigation

There is little improvement in land use control and building code change, however, there is one promising method for disaster mitigation in New Orleans, "Elevate and Cluster" that is proposed to encourage residents of areas of the city where less than a quarter of the population has returned to rebuild in clusters at higher elevations to help ensure vibrant neighborhoods and more efficient infrastructure costs in the context of a smaller overall population. The expected impact for this program is more than to improve safety but also 1) continuation of prior community, 2) housing rebuilding and restructuring community through flood-resistant designs and 3) restoration of community service coordinated with individual housing reconstruction. The Neighborhood Stabilization Program (NSP), funded by Department of Housing and Urban Development, is one of the strongest initiatives administered by the local government agency, New Orleans Recovery Authority (NORA). The NSP is a national program that was established for the purpose of stabilizing communities that have suffered from foreclosures and abandonment. City-wide NORA works together with 14 consortium members, for-profit housing developer and non-profit community development corporations, to implement the program, utilizing and revitalizing properties that were blighted before and after Hurricane Katrina. If this housing development is conducted by clustering and swapping properties with relocation to safe places such as above sea level, it will be an effective measure to reduce the risk of flood.

(7) Physical Structure Measures: Levee and flood control facilities

Following the flood disaster caused by Hurricane Katrina, Congress allocated $14.5 billion to the Army Corps of Engineers to repair and improve the flood protection system in New Orleans. The goal is that south shore communities were to be enclosed within a 139 mile system of levees, walls and gated designated to protect against the 100-year storm surge, the system known as the Hurricane Storm and Damage Risk Reduction System. Before Hurricane Katrina, the levee protection was designed based on the experience in Hurricane Besty (1965) and intended to protect against a 100-year storm surge, however reevaluated after Hurricane Katrina, its protection defense ability is under that which is needed to protect against a 30 to 40 year storm surge. During hurricanes and tropical storms, three outfall canals drain water from portions of New Orleans northward into Lake Pontchartrain. These outfall canals are critical elements in New Orleans’ flood control system. In addition to repairing and improving canal walls, temporary gated closure structures were built at the mouths of the three outfall canals. Also, the Corps constructed a new pumping station at Pontchartrain Park, and they will manage not only storm surge from the lake but also water level height of drainage canal. When storm surge threatens to exceed the maximum operating water level of a canal, the Corps will close the gates and turn on the pumps. The closed gates prevent storm surge from entering the canals and going back into the city. The FEMA National Flood Insurance Program published revised preliminary flood insurance rate maps for New Orleans in Jan. 2013. The new maps take into account the risk reduction provided by
post-Katrina improvements in the hurricane levee system, which is designed to protect against surges created by a hurricane with a 1 percent chance of occurring, also known as the 100-year storm. About 80 percent of New Orleans will see no flood insurance rate changes.

(8) Insurance
Disaster insurance is a significant measure to “avoid” disaster risk. The National Flood Insurance Program is a Federal government program enabling property owners in participating communities to purchase insurance protection against losses from flooding. Hurricanes Katrina and Rita caused approximately $200 billion in economic losses, of which $21.9 billion was related to insurance claims under NFIP. The number of paid losses was 167,671, amount paid was $16,264,188,476, and the average paid loss was $97,011.7. Based on initial FEMA estimates, premiums through the National Flood Insurance Program for a $250,000 single-family, one-story home in a high-to-moderate risk zone that sits 4 feet below base flood elevations would come to $9,500 a year. If the structure is at the base flood elevation level, it would cost about $1,410 a year, and if it is 3 feet above base flood elevations, it would cost $427 a year (Times Picayune, Dec. 06, 2012). Since Hurricane Katrina, the Flood Insurance Reform Act of 2012 requires FEMA to study the options of privatizing the program and to report to Congress within one year enactment.

3. THAI 2011 FLOOD

(1) Disaster Risk
Thailand is in a tropical zone which is subjected to the influences of monsoons and tropical hurricanes resulting in natural disaster impacts, such as floods, landslides, drought, wildfires etc. Flooding is by far the worst disaster in Thailand which is ranked as the seventh most flood prone country in the world.

The area of the Chao Phraya River watershed is approximately 160,000km², which shares 30% of the total area of Thailand. Flooding occurs every year in the Chao Phraya River Basin. Official statistics from 2002 to 2008 show that the country floods an average of approximately 10 times per year, with an average of 44 provinces affected, 96 deaths and THB 5.88 billion in economic loss (National Disaster Preparedness and Mitigation Plan of Thailand). Thailand also faces earthquake and tsunami risk, as has been experienced in 2004, with a loss of 8,221 lives.

(2) Damage and the situation as long-term flood
The flood caused tremendous damage, including 813 dead and 3 missing nationwide as of Jan. 8, 2012 (Thai Ministry of Interior). Heavy rain combined with multiple tropical storms throughout the extended rainy season played a large part in the extensive flooding. The geographic extent of the floods was enormous, reaching 66 of the country’s 77 provinces. North and eastern residential areas of Bangkok were flooded along with many industrial estates in Ayuthaya and nearby provinces. Table 1 shows how long it took to drain water from the industrial area.

<table>
<thead>
<tr>
<th>Province</th>
<th>Area</th>
<th>Length for flooded</th>
</tr>
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<tbody>
<tr>
<td>Ayutthaya</td>
<td>Saha rattanana korn</td>
<td>Oct 4-Dec 4</td>
</tr>
<tr>
<td>Ayutthaya</td>
<td>Rojana</td>
<td>Oct 10-Dec 2</td>
</tr>
<tr>
<td>Ayutthaya</td>
<td>Hi-tec</td>
<td>Oct 13-Nov 25</td>
</tr>
<tr>
<td>Ayutthaya</td>
<td>Bang-Pa-in</td>
<td>Oct 14-Dec 19</td>
</tr>
<tr>
<td>Pathum thani</td>
<td>Navanakorn</td>
<td>Oct 17-Dec 6</td>
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</tbody>
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Source: Reference 7

Rivers in Thailand are generally gently sloped rivers, with gradients in the aforementioned lower watershed of the Chao Phraya River. The flooding from upstream makes water levels rise downstream, dispersing flooding onto the floodplain. The two main reasons that long-term floods occur in Thailand is characteristics of
the Chao Phraya River, gently sloped rivers and the size of watershed. Historically, Thailand has taken advantage of these characteristics to control flooding of the Chao Phraya River. Flood is controlled by storing water in the dam reservoirs in the upper watershed of the Chao Phraya River, and by expanding the flood area to decrease the floodwater level in the lower watershed.

(3) Emergency Response and Evacuation
In the wake of the floods, the new Flood Relief Operations Center (FROC) was established to provide rapid emergency response and coordinate responsible government bodies. Immediate needs were met largely by appropriate government ministries and the Thai Red Cross. The Ministry of Social Development and Human Security has largely been responsible for the establishment of more than 2,400 shelters nationwide, with the Bangkok Metropolitan Administration establishing another 175 for residents of the capital. Citizens were increasingly frustrated to find that official government flood bulletins and television reporting were constantly changing. The government was limited in gathering urgent flood information and people could not wait for its help.

(4) Post-disaster recovery planning
The Government has set up a National Committee to prepare a comprehensive strategy for the country’s rehabilitation to make Thailand better, safer and stronger. The strategy is separated into three parallel phases, namely, the 3R’s – Rescue, Restore and Rebuild. While the first and second phases of the three-stage national strategy for reconstruction focuses on immediate flood relief and recovery measures, the third phase involves the pursuit of long-term solutions. In the long-term phase which covers actions taken to build confidence, regain trust and restore the country’s prosperity and stability, the Government has set up strategic committees for reconstruction and future development as well as water resources management by inviting respected experts from various fields to formulate a strategy for the country’s rehabilitation so as to provide confidence to investors about Thailand’s water management system and its future economic potential.

(5) Land use control
The significance of land use control is stated in the Prime Minister’s strategy planning, however, it is uncertain how and in which way can government promote and lead this initiatives where local government zoning regulation and land use management is uncommon in urban planning. Except Bangkok, there has been no implementation of land use zoning in most provinces. Communities in big cities like Bangkok and others have been and continue to be vulnerable to disasters. This is in part due to ongoing urbanization without careful planning. The country still lacks sufficient and effective zoning policy or building code that prevents the citizens and land/property developers from building or developing housings and business properties in disaster-risk areas. Poaponsakorn indicates that in a flood-prone Ayutthaya province, several industrial estates and housing development were allowed to locate in the flood prone areas just because the land prices were the cheapest. In Bangkok where there has been land use zoning, the zoning law has been changed by politicians to serve the interests of business and property developers. The most obvious example is the lobby to convert the eastern areas of Bangkok, which were designated as flood ways, to residential areas.

(6) Building structure code
The building code is also not popular in Thailand, mostly outside Bangkok. Ayutthaya City, the former capital of the Kingdom of Siam, Thailand, was one of the many provinces devastated by this event. The city didn’t have building code to reduce the risk for flood, but local and vernacular architecture and housing used to design and build with the floor elevated above ground level. This might be based on people’s experience with flood. However, around Ayutthaya City, after the industrial areas as have developed, new residential areas for industrial workers began to be developed in the city, where local building design does not follow this intention. It is also important to emphasize that government funding support after disaster is not enough to encourage people to renovate and reconstruct their housing in a proper manner for the next flood. The government support for public to rebuild and renovate their housing with flood-resistant design is too small. National government provided disaster relief money in two way.

The first is 10,000 THB provided to all households who are affected by the flood, and the second is based on the actual damage estimate by officials which provide up to 20,000 THB. We got data from Hutra district in...
Ayutthaya city on relief money and its expenditure for 779 household, the fact is the average they spent from relief money is only 4,078 Bath. As Sararit (2013) indicates, the major housing condition improvement were painting the wall or preparing boats to evacuate when flooded.

(7) Physical Structure Measures
After 2011 flood, the government set up two committees to draft the flood management master plan, which is based upon two approaches, structural measures and non-structural measures. The flood recovery plan is composed of immediate response phase and long-term phase. Structure for long-term phase includes the development and construction of dams, reservoirs, irrigation system and water network system in the specific areas to control water flow and respond to water demand. In addition to this, government is planning to accelerate the construction of permanent flood-prevention systems to ensure industrial confidence.

(8) Insurance
The extent of the flooding may lead the international market to reclassify Thailand as a high-risk country. National Economic and Social Development Board developed "Thailand's future development and water management plans". It sets 5 strategies for reconstruction and future development, which are 1) Water Resource Management, 2) Reconstructing the production & service sectors, 3) Development strategy for new economic areas, 4) Infrastructure development and 5) Insurance system development. It states that the focus is on developing the insurance system to be a key mechanism, which provides economic and social security and handles the risk from natural disasters. Disaster Insurance Promotion Fund was established within the Ministry of Finance with the main objective of managing catastrophic risks by means of insurance and reinsurance and providing financial aids to insure, with the starting fund of 50 billion baht. World Bank report (2012) recommended that "it will be critical to restore the confidence of the reinsurance market on the capacity of the government of Thailand not only to manage major floods, but also to have greater domestic capacity to absorb losses when they occur.".

4. QUEENSLAND 2011 FLOOD

(1) Disaster Risk
The city of Brisbane, capital city of Queensland is built on a flood plain. The bayside suburbs are exposed to flood risks from storm tides. There have been many river floods, most notably the large floods in 1893, 1974 and 2011. There has also been flooding in the various creeks, waterways and overland flowpaths due to intense shorter duration rainfall. Between 1852 and 2011, at least 951 people were killed by floods, and the cost of damage reached an estimated AUS$ 4.76 billion dollars. The maximum recorded gauge height on the Brisbane river at the Brisbane City of annual flood peaks were in 1841 and 1893, which represents a depth of approximately 6.5m above the highest tide level.

(2) Damage and the situation as long-term flood
During November 2010 to January 2011, rainfall in the 600 to 1,200 mm range was widespread along most of the Queensland coast. There were two major floods. The first was a severe flash flood exacerbated by a series of intense storms, and the second major flood event occurred when dam releases from Wivenhoe Dam flooded the city of Brisbane and surrounding areas. On 13th January 2011 Brisbane experienced its second highest flood since the beginning of the 20th Century. The flooding caused the loss of 23 lives in the Lockyer Valley and one in Brisbane, and an estimated 18,000 properties were inundated in metropolitan Brisbane and Ipswich. An estimated 28,000 homes would need to be rebuilt, while a vast number of dwellings require extensive repairs. Although smaller in magnitude than the 1974 flood, the impact of the 2011 flood remains the most severe example of urban flooding in Australia. This is because Brisbane's population had grown from 175,000 in 1893 to around 1 million and there was greater exposure afforded by new buildings and infrastructure. The gauge height in 2011 is lower than 1974, however, damage became severe. Figure 10 shows that the extent of 2011 flooding in most areas of Brisbane City was very similar to that observed during the 1974 flood.

(3) Emergency Response and Evacuation
Across Queensland approximately 12,000 people were accommodated in 34 evacuation centers managed by
the Red Cross. Altogether, over 200,000 people were affected. After six more days of contact rain, disaster is declared for the towns of Chinchilla, Theodore and Dalby in southern Queensland, prompting mass evacuation. There were 17 evacuation centres active; more than 1,000 people in those evacuation centres and, thousands more staying with relatives and friends.

(4) Post-disaster recovery planning

Queensland Reconstruction Authority (QldRA) was established after 2011 flood, and charged with the overall coordination of the relief and recovery effort. The state of Queensland focuses on “building back better” in order to reduce the impact of future disasters and create resilient communities.

The Government of Queensland established six lines of reconstruction to facilitate the recovery and reconstruction process. These include: (a) Human and Social, (b) Economic, (c) Environment, (d) Building Recovery, (e) Roads and Transport, and (f) Community Engagement and Communication comprehensively cover the key areas that require attention in the post disaster reconstruction process.

(5) Land use control

Development in the low-lying areas along the lower Brisbane River has occurred despite the city's history of severe flooding and has resulted in large concentrations of properties exposed to flood risk. As a result of previous planning the majority of Brisbane’s dwellings are not located in floodplains. Furthermore, much of the flood-prone land in Brisbane is not developed\(^2\). Brisbane City Council has regulated development in floodable areas since 1965. The 1978 Town Plan introduced two new maps “Areas Subject to Flooding”, designated areas affected by 1974 floods and set minimum habitable floor level for all development. However, it is worth stating that 1,811 development applications for houses, apartments and commercial or industrial developments were approved in the flooded area since 2005\(^3\). Before the 2011 flood, in 2005 the Brisbane City Council established the Lord Mayor's Taskforce on Suburban Flooding which proposed several key priority actions. This included a Voluntary Home Purchase Scheme for identified ‘at risk’ residential properties, as well as reviewing and strengthening land use planning, development and building controls, to ensure future activities have no adverse effect on flooding. One of the eligibility criteria is that the home is predicted to have a 50% chance of creek and local flooding in any year. The property must meet all four eligibility criteria to be considered for purchase.

After the 2011 floods, the Brisbane City Council has decided the future for $35 million worth of flood-affected land once shared between 73 private property owners across Brisbane. More than six hectares has been acquired as part of the buyback scheme introduced by former lord mayor Campbell Newman in 2006, and current Lord Mayor Graham Quirk has confirmed the properties purchased will be transformed into parklands, green space, conservation areas or green links to bikeways\(^4\).

The World Bank (2011) illustrated good practice in town of Grantham. A low-lying part of the town of Grantham is at high risk from flash floods. The authorities seek to discourage affected residents to rebuild in the same area. The State held extensive consultations with the residents on the recovery and reconstruction plans. Affected residents of Grantham will now be offered a land swap: the Local Council bought land outside the affected areas and is offering residents plots of this land in exchange for their flooded land parcels. Over 60 percent of the affected population expressed interest in the land swap idea\(^5\).

(6) Building structure code

Before 2011 flood, city of Brisbane and Queensland State already had building codes. The “Brisbane River Floods – Restriction on Residential Use” Policy was adopted by Council in 1978 introduced the 3.7mAHD Port Office Gauge level requirement for habitable floor levels\(^6\). Queensland government has published a new Queensland Development Code section dealing with construction of buildings in flood hazard areas\(^7\). Property industry representatives today backed a decision by Lord Mayor Campbell Newman to raise the flood level used as the basis for development to 500mm above the 2011 flood high water mark. The Joint Flood Taskforce Report recommended the rise, which will be 1.8 metres higher than the existing level. According to the council’s modelling, the new higher flood level of 4.46 metres at the city gauge would impact an extra 9767 Brisbane properties, including 2685 houses, 5078 units, 12 community properties, 411 industrial and 1581 commercial properties. Under the higher flood level, 30,867 properties would now fall under the flood line, up from 21,100 from the existing level\(^8\).
Brisbane City Council has announced the roll-out of backflow prevention devices to reduce the risk of flooding through water backing up from the river through the drain system. This covers the installation of 39 backflow valves at 11 sites over 4 years, with this investment aimed at preventing 80% of the properties identified as being affected by backflow flooding in January 2011. BCC prepared a discussion paper titled “Engineering solutions for flood mitigation in Brisbane” right after flood in Feb. 2011, and the report explored a number of options for flood mitigation. The final report emphasized the importance of regular maintenance to ensure that drains were not blocked and thus rendered ineffective in a future flood.

Following a natural disaster, the insurance industry plays a vital role in funding the rebuilding, repair or replacement of damaged homes, infrastructure and assets. However, what happened in Australia is that it covers flash flood, as a direct consequence of rainstorm runoff, following high intensity rainfall, but does not cover riverine flood defined as the overflow from rivers and creeks following long duration rainfall over large catchment areas, or water rising up from flooding river, in contrast to water coming down from rain and storm. It is under discussion to issue of a single unified and consistent definition of flood for insurance.

5. CONCLUSION

Long-term flood causes prolonged destruction of peoples’ lives and urban functions. Our society has to learn about the characteristics of this new type of disaster and start to mitigate and prepare to reduce the risk. How did long-term flooded cities recover as resilient cities? This was a research question for this paper.

In New Orleans, the city still relies too much on engineering solutions for flood control, such as levee protection, flood walls, pumping statation, and water gate. The main reason is that federal government agency FEMA concluded that the failure was not with the vulnerabilities of land but with the levees. This might also stem from the failure of post-disaster recovery planning initiative in the early stage by Mayor. If government post-disaster recovery planning doesn’t get enough common consent and understanding, it will fail to implement disaster reduction measures that restrict peoples’ action and choices for housing reconstruction and where to live. The decision to reconstruct housing higher is left to individual level, and relocation to avoid the risk of flooding falls in the hands of neighborhood association and community development corporations by property clustering and swapping.

In Thailand after the 2011 floods, the country’s emergency management system and disaster reduction plan has been greatly improved, however, it is uncertain to which extent national and local actors can implement these strategies. Post-disaster recovery planning is a continuing process of Pre-disaster reduction planning. If
the society has little experience and understanding for government control as public domain for disaster re-
duction, it is difficult to implement it after disaster. The lack of sufficient financial support for individuals to
empower residents to renovate and reconstruct housing is needed.

Queensland and the City of Brisbane governments’ leadership for developing a disaster reduction plan is
strong, and stands out from the rest in its speed and holistic approach. Especially, building code and land use
control which are non-structure measures for disaster reduction is widely planned and implemented since 20th
century, and improoved after the 2011 flood.

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