Flood Control Projects in the Philippines: A Historical Overview

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Abstract

Floods have been a natural occurrence in the Philippines since the pre-Hispanic time because most settlements are in very close proximity to bodies of water. These floods often result in calamities that are aggravated by the uncontrolled urbanization which brings about even bigger problems. In order to mitigate the effects of flooding, especially in highly urbanized areas, different flood control projects have been undertaken by the Philippine government. But, despite these efforts, the problem persists and continues to threaten the growing population especially with climate change. This paper looked into different projects in combating flooding from the Hispanic period to the present. This is done by looking into flood control projects through the archives of the Bureau of Public Works (Department of Public Works and Highways) and other literature and categorizing them as risk reduction strategy or risk avoidance strategy. As a result, it can be noted that in the past, the placement of towns and villages and even the design of houses and buildings took into consideration flooding and other natural phenomena in their location and design, an effective risk avoidance strategy as in the case of the relocation of San Juan in Batangas. However, with the establishment of the Bureau of Public Works flood control projects focused mainly on costly structural solutions or risk reduction strategies as in the case of the Manggahan Floodway. Failure to finish and/or maintain these projects render them ineffective just like what happened during Typhoon Ondoy. Therefore, the most effective solutions in mitigating the effects of flooding are mostly non-structural in nature, however, there are situations where structural solutions are inevitable and therefore a combination of strategies with focus more on risk avoidance strategies should be considered.

Keywords: disaster, disaster preparedness, risk avoidance, flood control, risk reduction

I. Introduction

The Philippines is an archipelagic nation situated along the Pacific Ring of Fire. It is composed of more than seven thousand islands and islets which are divided into three geographical regions called Luzon, Visayas and Mindanao. These groups of islands extend from the Balintang Channel on the north to the Sulu and Celebes Seas on the south and South China Sea on the west and the Pacific Ocean on the east. Due to its location, the Philippines is vulnerable to hazards such as tropical cyclones that usually form in the Pacific Ocean aside from earthquakes, volcanic eruptions and others. These tropical cyclones are characterized by heavy rains which are influenced mainly by the monsoons coming from the northeast (Amihan) and southwest (Habagat). An average of twenty tropical cyclones visit the country each year of which seven or eight make a landfall and inflict considerable damages to lives and properties. These cyclones are also characterized by strong wind forces that bring about storm surges and heavy rainfall resulting in inundation of river basins and low-lying areas. They also cause erosion and slope failures both in rural and urban areas. These floods are worsened by population growth, in-migration, urbanization and economic development that have an adverse impact on the environment (Pante, 2015). Aside from the obvious devastation, floods also increase runoff, reduce water quality and damage water supply infrastructure according to the United States Agency for International Development (USAID). However, it is argued also that these floods are not merely natural phenomena but mostly political, demographic and socioeconomic according to Piers Blaikie (1994) and Mark Pelling (2003) as cited by Pante (2015). If the causes of flooding are not merely natural, then it is believed that human interventions can alleviate its effects. And that brings out the question of "what must be the best practices in mitigating floods?" which is the aim of this paper. In September 2009, the country was hit by typhoon Ketsana, local name Ondoy, which brought 150-year return flood water over Metro Manila and nearby municipalities in the downstream with a rainfall which lasted for 12 hours. This brought changes to the way the Philippines look at disasters particularly at flood disasters. As a result, the National Disaster Coordinating Council (NDCC) which was reactionary was changed to a more proactive approach in dealing with disasters as the National Disaster Risk Reduction and Management Council (NDRRMC) known as Republic Act 10121.

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In the Philippines, flooding is one of the major problems affecting all sectors of society, especially the poorest and most vulnerable; specifically, those who live in low-lying areas and informal settlements near or on bodies of water in major cities like Metro Manila. This situation has not only become a problem on flooding but a problem in drainage and sanitation as well. There have been 169 flood events recorded since 1968 to 2019 that affected almost 35M people (EM-DAT, 2019). With the threat of the changing climate, it is expected to be happening more frequently and gravely in the years to come.

Typhoon Ketsana (local name Ondoy) in 2009 was a wake-up call among Manileños and the rest of the country that flood is still a reality which brought about the re-examination of non-structural flood mitigation measures such as flood forecasting and disaster preparedness and response; investigation on the extreme flooding events to land use and water resources; impact assessment of extreme floods to the urban ecological environment; and performance evaluation of existing flood control structures, all as part of an integrated water resources management program (Gilbuena, 2013).

There were flood control projects undertaken by the government and there are still projects to be implemented under the Department of Public Works and Highways since its establishment during the American Era. This paper argues that it is important to take a look at these projects in order to determine different approaches and find out which ones are effective and/or appropriate in the Philippine setting. And therefore, a look at flood protection strategies is very important to weigh for a better approach to mitigate flooding.

II. Related Literature

Flood research in the Philippines has been done but no research chronicles the flood control projects from pre-colonial up to the present. However, the following research have contributed to build up this paper's importance and contributed to the data needed to support the goal of the research. Bankoff (Bankoff, 2007) traced the occurrence of disasters in the Philippines to the lack of mutuality between the environment and human activities over time. His research focused mainly in Metro Manila and chronicled the history of flooding from 1691 to 1911 as recorded in the archives of the Manila Observatory. This work proves that flooding is not just a recent phenomenon in the Philippines. Chias (Chias & Abad, 2012) studied old maps and other archival literary materials to trace how the cities in the Philippines developed from small native communities during the Spanish colonization. She concluded that Spain colonized and controlled the territories by establishing the foundation of sites and the creation of a road network to link each. While Ocampo (Ocampo, 1992) recorded the growth of cities in the Philippines particularly that of Manila from the start of the Spanish period, Commonwealth and Post-war period. His study showed how the esteros have been part of the Spanish and American plans to be improved and used for transportation and recreation, however, in the next generations they were neglected and became the eyesores in the city that needed the quick fix solutions as the informal settlers who live in them. This shows that a change of mindset among decision makers need to occur for this to be controlled. Gilbuena's (Gilbuena, 2013) study found that existing flood control structures in Metro Manila failed during Typhoon Ketsana (Ondoy) due to inappropriate designation of land use particularly the encroachment of informal settlements causing drainage problems and the lack of maintenance. His conclusion, however, focused on disaster preparedness and mitigation via structural flood mitigation measures such as proper maintenance of existing flood control structures and early warning systems and did not reiterate the importance of land use as a more sustainable solution and as a major factor for flood control structures to function during disasters; an important point that was implied in his findings and is the focus of this paper.

III. Research Methods

Archival research was done from the records of the Department of Public Works and Highways, formerly known as the Bureau of Public Works through its publication from 1912 (Quarterly Bulletin) to the present (Annual Report). Other records were gathered from different literatures to cover the period before the abovementioned publications existed. The flood control strategies recorded in literary works and the official publication of the bureau were tabulated and categorized into two: risk reduction and risk avoidance of which only some projects will be mentioned in the presentation of the findings for the sake of brevity. The generally accepted definition of risk avoidance and risk reduction was used as follows; risk avoidance deals with eliminating any exposure to risk that poses a potential loss and risk reduction deals with reducing the likelihood and severity of a possible loss. Two major projects deemed to best represent the type of each approach were further identified and compared in terms of effectiveness. From the data gathered, conclusions and recommendations were drawn in order to guide decision makers to formulate a better strategy for flood control. The illustration below explains the research framework.

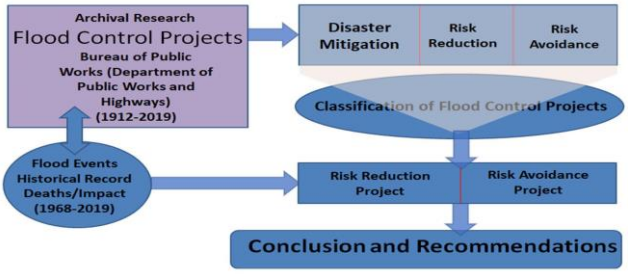

Figure 1. Research Framework.

IV. Findings

Flooding in the Philippines has been chronicled by Bankoff (Bankoff, 2000) showing that flooding is a regular occurrence in the Philippines due to its location, topography, climate, the global crisis of climatic change and rising sea level and other human induced factors. A record of flood events from 1691 to 1900 have been gathered by Bankoff from the archives of the Manila Observatory (Bankoff, 2007) and this was continued with the available data from EM-DAT from 1960 to 2019 accessed in May 2019 (Figure 3). It is noticeable that the occurrence of flood is continuously increasing which is partly attributable to the more accurate recording of events. As a response, the government in all the forms it has taken throughout history responded accordingly with the given technology and resources of the time.

For ease of presentation of the findings, major events in Philippine history were divided into four periods namely: Hispanic Period (1521-1898), American Era (1898-1946), World War 2 to Marcos Regime (1946-1986), and Post-Marcos to Present (1986-2019).

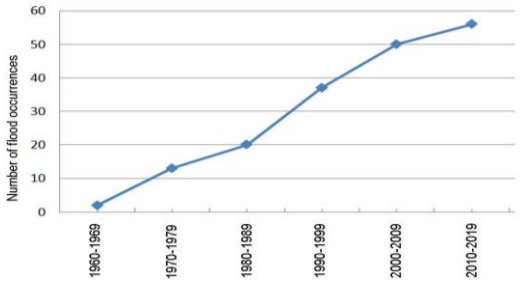

Figure 2. Flooding Record from 1960-2019 EM-DAT, May 2019

A. Hispanic Period

"It was no marvel that they left it, because the few Indians who dwelt there, about seven hundred inhabitants in all, were scattered in thirty villages situated at the foot of some mountains toward the sea – in a land subject to overflow, with many creeks or little rivers to cross which the Indians did not take the trouble to build bridges. There was no open road from one village to another." (Aduarte, 1640)

The Philippine archipelago was under Spanish rule beginning in 1521. The first Spanish settlement was built in Cebu Island and then expanded into more than two hundred new cities following the traditional grid structure according to the provisions of Leyes de Indias (Indies Legislation) enacted in 1573 by King Philip II of Spain to whom the archipelago was also named after. The most important was Manila (1571), which was founded over an existing native commercial settlement. The cities were established mainly on the coast which later became port cities. They then moved inland which were soon connected through a network of roads, railroads and navigational routes. The establishment of new cities was guided by simple principles according to their function and to urban type to which flood and earthquake protection has been a consideration as evident in the urban development as well as the height of the housing and main buildings and even the bell towers. However, early settlements have been decided on where they were carried by the ocean current or where they took shelter from storms (Chias, 2012). This is an example of how nature and its limitations have been a major consideration for development. A very good example of such consideration is the old town (Pinagbayanan) of San Juan in Batangas which was established along the coast of Tayabas Bay in the 1840s during the late Spanish Colonial Period. Popular history recounts its relocation seven kilometers inland to its current location from 1869 until the new town was established in 1890 because of seasonal flooding. Geoarchaeological landscape data from two stone houses and the old church complex are used alongside ethnohistorical accounts to explore this period further. Archival documents recorded the conflict between the priest and the residents in transferring the town. By integrating these data, it shows the power of the church and resilience of the townspeople. This argument analyzes how two prominent groups responded to the same flooding event in the context of local resilience and resistance to Spanish demands. The results are tied to the larger context of Spanish colonial occupation of the Philippines (Tesoro, 2017).

From 1780 to 1893, the hacienda administrators built forty-five irrigation dams with tunnels, waterways, and irrigation canals in order to channel available water sources to excellent use, that way securing rice paddies during extended drought periods. They appropriated considerable sums of money for breaking up untilled lands, putting up mangrove embankments, draining swamps, and building vital road arteries and streets. One of the evident irrigation projects that still exist today is Prinza Dam which was "built in the 18th century to irrigate the surrounding rice fields of Las Piñas & Bacoor. It is a gravity dam on the Zapote River found on the border between Barangay Talon Dos, Las Piñas and Barangay San Nicolas, Bacoor. This is a man-made irrigation dam with its walls made out of adobe (height ranging from 25-30 stacks) and some parts of the flooring made out of cobblestones. Series of buttresses support its perimeter walls and balete trees and bamboo grasses contribute to the enhanced structural integrity of the dam. This dam and its attached water distribution system is an outstanding feat of hydrological engineering. The dam serves as a passageway for commuters from Bacoor and Las Piñas respectively" (City Government of Bacoor, 2017).

Figure 3. Remains of the houses in Pinagbayanan (San Juan, Batangas).

Source: Philippine Daily Inquirer, August 21, 2011

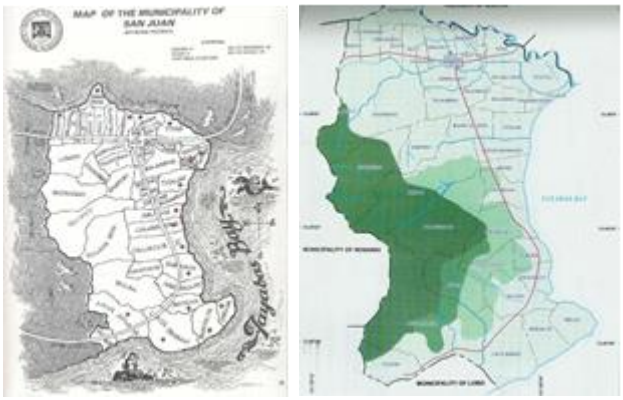

Figure 4. Location Map of the old town Pinagbayanan.
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According to Huez de Lemps as cited by Bankoff, as early as 1882, the refurbishment of the drainage system in Manila based on the network of esteros was drawn as the most practical solution given the financial resources at that time. This was only partially realized until the eve of the 1896-98 Philippine revolution (Bankoff, 2000).

B. American Era

In 1898, the Spaniards ceded the Philippines to the Americans through the Treaty of Paris alongside Puerto Rico and Guam. The Americans immediately recognized social and environmental problems in the Philippines including poor quality housing, polluted waterways, widespread poverty and lack of a national education system to name a few (Morley, 2011). As part of the response to these problems, the Americans created big plans for the cities in the image of the idealized City Beautiful with Burnham's Plan of Manila as a start. This plan was meant to improve the physical city by means of constructing new road systems, using waterways for transportation, beautification of the city's waterfront, and construction of parks, parkways and buildings with Pasig River as the key design driver (Zaide, 2018). Although there was no explicit flood control plan under the Burnham plan, a citywide drainage system was built in Manila for the first time in 1909 (Pante, 2015). This plan also included the reclamation of portions of Manila Bay as reported by John D. Fitzgerald of Australia (Vernon, 2011). The plan recognized the balance between living, working and recreation, however, the formalism of the City Beautiful Movement failed to consider the socio-economic concerns of the working class of Manila (Zaide, 2018). Aside from the city of Manila, Burnham also made the plan for the city of Baguio on the north, the summer capital of the Philippines. Baguio's undulating terrain posed a challenge to Burnham's "controlling principle" and decided to make his plans "obedient to nature" and therefore cannot be a formal layout of the City Beautiful street plan but rather adaptive to the "terrain's warp and weft" (Vernon, 2011).

Figure 5. Frinza Dam.

Source: http://bacoor.gov.ph/tourism/prinza-dam

Figure 6. Flooded Santa Ana, Manila circa 1914.

Source: Eduardo de Leon (Pinterest)

Although the Bureau of Public Works was already in existence in 1867 under the Spanish Civil Government whose function was to encourage insular trades and transportations, it was only formally established in 1905 to take charge in constructing roads, bridges and buildings in the country. As part of the Division of Irrigation is the "Flood Control and Drainage Section responsible for investigation, survey, planning, design, construction and repair of river and flood control and drainage projects, both communal and regional in scope, and the dredging of river for flood control" (Bureau of Public Works, 1958).

Several projects have been undertaken during the American Era in Manila and other parts of the country focusing on dredging operations along the Pasig River, and several esteros such as Binondo, Reina Regente, Escolta, Magdalena, Paco (Bureau of Public Works) and others from 1915 continuing onwards until the Second World War. The table below from the Quarterly Bulletin of the bureau shows some of these projects in 1919 although these activities as well as river walls have been built as early as 1912 when the bureau built "Angat River Protection Wall to Protect the city of Baliuag against further encroachments of the Angat River" in Bulacan (Bureau of Public Works, 1912).

There were also technologies employed such as the one done for "Tanhay, on Kilometer 33 of the Dumaguete North Road, where the district engineer started a river-control project to prevent the Roman Catholic Church and other valuable property from being destroyed by undermining from the Tanhay River flood waters. This project consists of anchoring bamboo mattresses loaded with rock and sunk in place, at approximately a right angle from the line of embankment, which will tend to divert the stream flow from being destroyed" (Bureau of Public Works, 1912). Such examples of indigenous ways combined with engineering technology were successful in preventing floods at that time. Flood control projects during the American Era covers the entire country from Northern Luzon to Mindanao. One of the biggest dams in the Philippines, the La Mesa Dam which supplies most of the water demands in Metro Manila at the present, was also built in 1929 as well.

Dredging operations, 1919.

Location.	Total from 1902-1918.	Fiscal year 1919.	Total.
	Cubic meter.	*Cubic meter.*	*Cubic meter.*
Lower Pasig River	6,008,596	386,804	6,395,400
Outer Harbor	2,459,348		2,459,348
Upper Pasig River	675,045	19,206	694,251
Inner Basin	408,953		408,953
Binondo Estero	52,816		52,816
Estero da la Reyna	232,922		232,922
Paco Estero	26,965.40	1,107	28,072.40
San Miguel Estero	56,796	769	57,565
Provisor Estero	27,744		27,744
Marine R. R. Engineer Island	30,865	2,444	33,309
Talim Island (City)	1,071		1,071
Outer Bar	760,931	277,220	1,038,151
San Sebastian Estero	3,556	4,193	7,749
Magdalena Estero	16,580		16,580
Engineer's Island Canal	30,180		30,180
Vitas Estero	296,150	29,516	325,666
Quiapo Estero	12,507		12,507
Cegado Estero	35,509		35,509
Pandacan Estero	172		172
Estero de San Lazaro	22,975		22,975
Corregidor Bay Q. M	54,956		54,956
Iloilo River	1,594,399.50	313,250	1,907,649.50
Cebu Harbor	212,684	36,967.50	249,651.50
Mariquina River	7,290		7,290
Balete Estero	21,646		21,646
District of Cavite	20,876.25		20,876.25
Tondo Beach	9,013		9,013
Santibañez Estero	19,762		19,762
Tanque Estero	10,500	12,780	23,280
Tacloban Wharf	34,105.50	400	34,505.50
Zamboanga	29,880		29,880
Cotabato River	11,350	38,112	49,462
Earnshaw's Slipways		2,208	2,208
Total	13,186,143.65	1,124,976.50	14,311,120.15

Figure 7. Sample Table of Flood Control Projects.
Source: Bureau of Public Works

Figure 8. Temporary Bank Revetment, Magat River Control, Bayombong Nueva Ecija.
Source: Bureau of Public Works

Figure 9. The "Sausage" A Novel method for preventing river overflow on the Tumaga River.
Source: Bureau of Public Works

C. WWII to Marcos Regime

The era after World War Two is of great importance when it comes to flood control because it was at this time that rebuilding after the war began. According to the report of the Bureau of Public Works secretary Prospero C. Sanidad, from 1948 to 1949, works were undertaken for ports and harbors and sea protection walls, irrigation systems, waterworks and river control works. River and flood control priorities included the Pampanga River control and the Agno River control as well as the Manila Flood Control Program, during which time a master storm drainage plan was completed. Three major flood control projects were built during the presidency of Elpidio Quirino, Agno River control, Pampanga River control and Manila flood control and drainage project. And in 1958, a plan for the reclamation of a portion of Manila Bay was proposed along Dewey Boulevard and broadened by Manuel L. Quezon. Three major dams were built including Ambuklao Dam in 1950–56, Agusan Dam in 1956–57 and Angat Dam in 1961–67. Many authors wrote how they see the efforts done by the government through very critical eyes saying that the Marcos regime focused on infrastructure as a means to build up its power. "The state efforts to control floods pursued two aims: to tame nature and to discipline human nature." The first aim considered flooding as not just part of a natural order and therefore can be resolved through technical measures. The second aim is to discipline the people to eradicate "bad" attitudes deemed to contribute to

flooding and to nurture socially responsible behavior. Of course, the first aim failed due to the difficulty of implementing the second. The goal to make the waterways free of obstructions is hampered by the existence of informal settlements along riverbanks who were often "blamed for floods." Therefore, they also became the primary targets of the state's flood control efforts (Pante, 2015). The government focused on beautifying the city of Manila but forgot to include "the nameless and faceless urban poor, who lived in their thousands in squatter communities along the esteros" (Warren, 2013). Mrs. Marcos, who was the governor of Manila, sees the squatters as an eyesore. The typhoons and floods that occurred in the Marcos years were labeled 'natural disasters' by the authorities in Manila. But in fact, it would have been more appropriate to label them un-natural or man-made disasters because of the nature of politics in those unsettling years" (Warren, 2013). The typhoons experienced during the 70s and 80s made the real problems very obvious, particularly in highly urbanized parts of the Philippines like Manila. There was an exponential growth of the population and rural-urban migration and the government failed to address the needs for housing of the growing squatter communities who dwelled out of sight of the path of the capital's crushing progress. These communities thrived in low lying and vulnerable areas that are directly in the path of typhoons and prone to flooding. Instead of solving these problems, the government focused on building world-class hotels, convention and cultural centers, chain drug stores, schools, hospitals and clinics, and shopping centers. The government fell into what can be called a national "quick-fix" relief aid syndrome. "The Marcos regime, from a purely political standpoint, could only think about short term effects, rather than thinking and operating on longer-term environmental scales in dealing with urban flooding as a serious and growing development challenge for Manila. The proclamations of a state of calamity benefitted the Marcos administration. The manipulation of disaster relief funds by the Marcos politicians and their ability to reap political and social capital from their risk management of floods" has been manipulated by the media. The Marcos administration was the prime beneficiary both economically and politically (Warren, 2013). Despite these points of view, it is only toward the end of the Marcos regime that the biggest Flood Control Project materialized is the Manggahan Floodway which was finished in 1986 after Marcos was ousted from power. The second phase which is the Paranaque Spillway, however, was not built by the next administrations up to the writing of this paper and is not in the priority projects even of the present administration of Duterte although comprehensive studies and plans have already been laid out by the Japan International Cooperation Agency (JICA) in 2018 patterned from the original concept drawn by the office of Ar. Felino Palafox Jr. shown in figure 13. This spillway was supposed to draw off floodwater from Laguna Lake into the ocean, preventing the flood disasters that now affect Metro Manila according to Ar. Felino Palafox (Palafox, 2017 as confirmed in an interview with him in 2019). Without the spillway, the construction of the Manggahan Floodway only created risk transference as the floodwater from Metro Manila is directed toward the Laguna Lake which floods the towns along the lake as shown in the study of Saguin (Saguin, 2017).

Figure 10. Manggahan Floodway.
Source: Bureau of Public Works

several edifices that still stand today but he also undertook major projects for flood control. The Magat Dam in Isabela was constructed in 1975 and finished in 1982 for irrigation and power generation. In 1978, flood control programs were given substantial budgets for a total of 3.5 billion pesos due to flood damage which was estimated at 30 million pesos. The proposed projects were the Manggahan Floodway, Napindan Hydraulic Control System, Parañaque Spillway, and Marikina Dam. However, the last two were not built or even started during his 20-year regime.

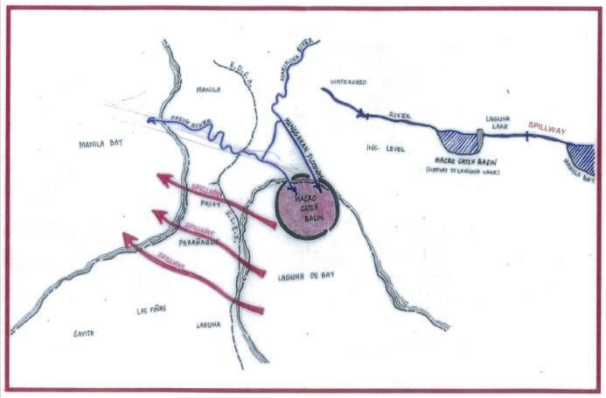

Figure 11. Paranaque Spillway Original Concept Diagram by the office of Ar. Palafox.

D. Post Marcos to the Present

After the Marcos regime, Corazon Aquino halted all projects with the name Marcos stamped to it including the flood control projects. Thus, according to some reports, only the first three parts of the Manggahan Floodway were completed in 1983, 1984 and in 1996; the Marcoses were ousted from power in 1986. The second phase which was supposed to be the construction of a spillway from Laguna de Bay to Manila Bay in case the lake overflowed in a

massive flood was one of those projects that was scrapped by the Cory administration (Billington, 2009).

Figure 12. Napindan Hydraulic Control.
Source: Bureau of Public Works

Figure 13. Manggahan Floodway.
Source: Flicker.com

programs for the urban poor are evident as the Manggahan Floodway is not spared from the encroachment of informal settlements as shown in figure 15. This scenario puts more people in vulnerable situations.

Figure 14. Estero de Paco before and after the clean-up and relocation of the Informal Settlers.

Major flood control projects have been accomplished by the next administrations like the continuation of projects already started during the former regimes and immediate relief to respond to a disaster; such as the construction of the protective dikes in Pampanga to prevent further destruction by lahar after the Mount Pinatubo eruption in 1991; the rehabilitation of Ormoc City after the flash flood that devastated the city, also in 1991. Most of the projects as well remain to be either on the drawing board or partly built due to lack of funding. Therefore, although the plans are supposed to mitigate flooding, partly built projects become a false security and create more damage to lives and properties. An example of these projects includes the proposals for major rivers such as the Cagayan River Basin of which the plans laid out by Nippon Koei International Consulting Engineers still remains partly constructed and the continuing sedimentation of the river causes flooding and obsolescence of the Magat Dam, and therefore needs special attention.

After Typhoon Ketsana (Ondoy), rehabilitation of the Pasig River and its tributaries was one of the successful projects undertaken under the Pasig River Rehabilitation Commission (PRRC) in Manila. The effects on flooding of this project are yet to be seen but the project received international recognition in 2018 when the effort was awarded as the Asia River Prize Award. Along with it was the relocation of informal settlers along the rivers and esteros; clearing them from garbage that blocks the waterways. This also includes the in-city relocation of informal settlements along Manggahan Floodway. But like other projects, these are only part and parcel of the bigger project proposal.

With the administration under Rodrigo Duterte, the government's effort in nation-building is focused on infrastructure with its Build Build Build program. This includes the prioritization of Flood Control as one of the key projects. "The master plan proposed a set of measures to effectively manage major flood events, which include reducing flooding from river systems that run through the metropolis, by building a dam in the upper Marikina River catchment area in order to reduce the peak river flows entering Metro Manila during typhoons and other extreme rainfall events. Also included are the elimination of long-term flooding in the floodplain of Laguna de Bay, to protect the population living along the shore against high water in the lake; improvement of urban drainage, including modernization of Metro Manila's pumping stations; and improvement of flood forecasting, early warning systems, and community-based flood risk management (Finance, 2018). One of the biggest undertakings of this government is the continuation of the spillway project which has been undertaken by JICA in 2018 (JICA, 2018). However, this project is still on the boards.

E. Analysis

It can be noted that flood control strategies employed since the inception of the Bureau of Public Works (Department of Public Works and Highways) are focused on Risk Reduction with a few exceptions of Risk Avoidance strategies. The summary of these projects is shown in figure 18.

Major projects that employ risk avoidance strategies involve mostly relocation of vulnerable populations to less

hazardous locations. The project which best represents this strategy is the relocation of San Juan town proper in Batangas. From then, flooding was never a problem in this town from Hispanic times until today. While major projects that employ risk reduction strategies create a false security scenario or risk transfer if left unfinished or poorly maintained. However, the two strategies need to be combined and a more innovative, efficient, cost effective and most of all, suitable for the local situation (local knowledge) must be employed.

Summary of Projects (Simplified Table)				
	Pre-Hispanic-Hispanic (1521-1898)	American (1898-1946)	WWII- Marcos (1946-1986)	Post-Marcos-Present (1986-2019)
Risk Avoidance	Relocation of town to higher ground; design of houses and buildings (primary considerations in locating cities)	Raising of driveways "well above high water", relocation of roads.	Eviction of informal settlers from waterways and dikes – Policy.	Relocation of informal settlements from esteros/waterways – Policy)
Risk Reduction	Irrigation canals used mainly to irrigate fields but also function as flood control. The use of plants for bank protection.	"Sausage", irrigation canals, riverbank erosion control (dikes, bamboo mats, walls, revetment), dams, dredging of rivers, channel diversion (pile hurdles, cut-off channels), channel improvement, flood canals, levees	Irrigation canals, riverbank, erosion control (dikes, walls, revetment), dams, dredging of rivers, channel diversion (cut-off channels), channel improvement, levees, flood canal, flood gates, flood reservoir, drainage, pumping stations, small water impounding management (SWIM), retarding lagoons	Irrigation canals, riverbank, erosion control (dikes, walls, revetment), dams, dredging of rivers, channel diversion (cut-off channels), channel improvement, levees, flood canal, flood gates, flood reservoir, drainage, pumping stations, small water impounding management (SWIM), retarding lagoons, mega dikes

Figure 15. Flood Control Strategies Summary Table.

V. Conclusion and Recommendation

Based on the records of flood control strategies from pre-Hispanic to the present, we can see that the focus since the creation of the bureau is mainly on risk reduction and not on risk avoidance as shown in figure 18. Most of the projects are engineering in nature and very few dealt with land use, thus neglecting the more important issues on housing, job creation, and others. Esteros and other natural drains are neglected and become breeding grounds of garbage, literally and figuratively. And even major engineering solutions such as the Manggahan Floodway just transferred the risk especially if the entirety of the proposal is not built. It is understandable that the application of available technology has been employed but the main reason for project implementation is the availability of funds and therefore very dependent on the priorities of the incumbent administration. The government has been trying to implement something that is not grounded in culture and local situations particularly in terms of economics. A number of proposals have been done but most projects have not been completely implemented thus providing false security and eventually neglected due to high maintenance cost as in the case of the failure of several pumping stations during Typhoon Ketsana (Ondoy). There are strategies that worked like the relocation of San Juan town proper to avoid flooding and the strategies employed by the Spaniards in selecting the location of the city. This only shows that the failure to consider land use planning in dealing with flooding brought the Philippines to the never-ending loop of flooding and recovery. The table below shows that there are very few risk avoidance strategies employed throughout history compared to the risk reduction strategies.

There must be some intervention. It is recommended that risk avoidance strategies should be given priority without losing the risk reduction strategies as both need to be working together. Risk reduction strategies should be combined with local or indigenous knowledge in order to be able to create strategies that are feasible and not very much dependent on borrowed engineering technologies. Figure 19 shows the illustration of the recommendation for a better way to build back better.

Further research must be done in order to make a more detailed analysis of the projects undertaken by the government in terms of their effectiveness.

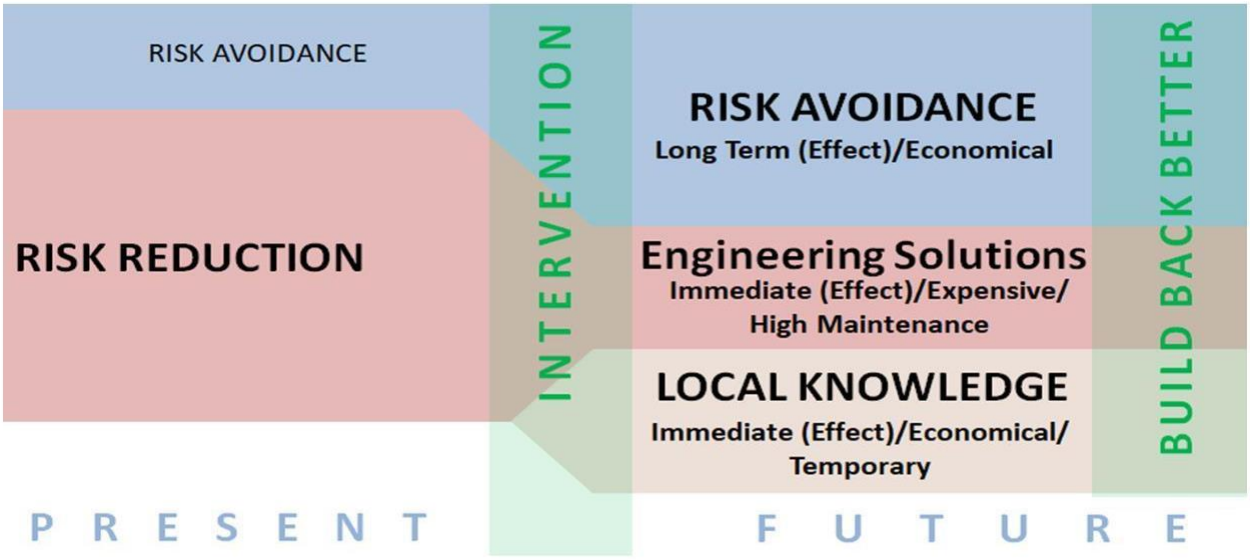

Figure 16. Recommendation.

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