

# Flood Prevention and Mitigation Initiatives towards a Flood-Free City

Engr. Joefil C. Jocson Ph.D.<sup>a</sup>, Engr. Noel T. Florencondia Ph.D.<sup>b</sup>, Engr. Gener  
S. Subia Ph.D.<sup>c\*</sup>

<sup>a</sup>President / CEO, Dyas Construction and Management Consultants, Cabanatuan City, 3100, Philippines

<sup>b</sup>Dean, College of Engineering, Nueva Ecija University of Science and Technology, Cabanatuan City

<sup>c</sup>OIC Dean, Graduate School, Wesleyan University Philippines, Cabanatuan City

<sup>c</sup>Email: [subiagener@yahoo.com](mailto:subiagener@yahoo.com)

## Abstract

This study aimed to investigate the flood prevention and mitigation initiatives of Cabanatuan to gain information that served as the basis for the development and integration of flood prevention and mitigation initiatives in the City. The researcher used the descriptive research design with questionnaire as the main tool to gather information from the 110 barangay residents and officials, Local Government Units (LGU) and Cabanatuan City Disaster Risk Reduction and Management Office officers (CCDRRMO) of the City. The study found out that: a. Cabanatuan City is vulnerable to floodings; barangays in Cabanatuan that are more flood physical vulnerable are Aduas Centro, Aduas Norte, Aduas Sur, Bagong Sikat, Bakero, Bakod Bayan, Bantug Bulalo, Barlis, Barrera and Balite; b. Heavy and prolonged rainfall, clogged river, canals, creeks and streams, lack of preventive infrastructure and facilities and poor implementation of waste management system were the possible leading causes of flooding in Cabanatuan City; c. The flood prevention and mitigation initiatives as to control over the river and control over the land were moderately implemented while other mitigation measures that had been done by the City Government were properly implemented; d. There is no significant difference in the responses of the three groups of respondents regarding the flood prevention and mitigation initiatives done by the Cabanatuan City government; e. Monthly seminars regarding floods for proper awareness and readiness, strict implementation of the law, appropriate coordination with community and government authorities and better flood prevention and mitigation plan were the suggestions of the respondents towards a flood-free city.

**Keywords:** Building Codes; Control Over the River; Disaster Risk Reduction; Engineering; Flood Prevention; Mitigation Initiatives.

-----  
\* Corresponding author.

## **1. Introduction**

Floods can occur in every single nation in the world. “It causes more than \$40 billion in damage worldwide annually, according to the Organization for Economic Cooperation and Development” [1]. People who live in low-lying areas – near water or behind a river or a dam are at even at a greater risk of the danger caused by flooding. During a flood, people try to move themselves and their most precious belongings to higher ground quickly. Flood is also a serious concern in the Philippines, especially in Metro Manila, today because the country is prone to about 18 - 21 typhoons per year. According to the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA), flooding is characterized as an “abnormal progressive rise in the water level of a stream that may result in the overflowing by the water of the normal confines of the stream with the subsequent inundation of areas which are not normally submerged [2].” Aside from Metro Manila, Central Luzon was also regularly flooded because of frequent typhoons particularly all of the low-lying areas of its provinces namely: Aurora, Bataan, Bulacan, Nueva Ecija, Pampanga, Tarlac, and Zambales. Among the provinces, Nueva Ecija is largest in Central Luzon, and it is not spared from the devastating effects of extreme weather events that brought flooding to its cities and municipalities including its first-class city and the most populous, “the Cabanatuan City”[3]. The Worst Flood in Cabanatuan City happened in the morning of Monday of October 19, 2015, due to Typhoon Lando. According to Engr. Domingo of National Irrigation Administration (NIA), one of the reasons why the flood happened was the overflowing of the river in barangay Cabu. There had been floods in some parts of the city before, but this was the first time in its history that most of its parts were submerged with a flood. Rescue operations which began at night amidst heavy downpour continued until the next day. The rescue teams were still rushing to heed requests for help in various villages that were submerged. According to the City Mayor, the volume of water hitting Cabanatuan was unusual. For several days, transportation and communication were disrupted as there was a lack of power due to damaged electrical post and cut electrical wires in most parts of the city. It even took more than one month for certain villages in the city to regain electricity. Business operations were suspended for a while due to rehabilitation that ensued. Indeed the damages were so massive, proving only the vulnerability of the city [4]. After this calamity, the city government tried to improve the drainage systems and implemented flood mitigation initiatives such as enhancement of flood ways and floodwalls, dredging of rivers and flood forecasting. However, up to this point of time, there seems to be no significant change observed as the streets of the city easily submerge in waters when there is medium and heavy rainfall proving only the vulnerability of the city. These annual scenarios of flooding that have contributed to a loss of life and millions of peso worth of damages to properties and crops in Cabanatuan City have inspired the researcher, as an engineer and a resident of the city, to conduct this study. Since Cabanatuan is vulnerable to flooding, it is about time that research and development actions be conducted to prevent or lessen the possibility of another worst flood that may further devastate the city. Hence, this study finds meaning and relevance.

## **2. Materials and Methods**

The study utilized the descriptive research design. According to [5], as cited by the authors in [6] and [7], “descriptive research systematically describes a situation, problem, phenomenon, service or program, attitude toward an issue or simply, it provides information on a subject”. This study described the possible causes of

flooding in Cabanatuan City, the flood prevention and mitigation initiatives implemented by the government as to control over the river, control over the land, and other additional mitigation measures. Also, this study shared the suggestions of the respondents for better implementation of the flood prevention and mitigation initiatives to have a flood-free City. The sample respondents of the study who were purposively were 110 residents and barangay officials of Cabanatuan City. The purposive sampling technique, also called judgment sampling, is a non-random technique that only requires the researcher to decide what needs to be known and sets out to find people who can and are willing to provide the information by knowledge or experience and certain criteria [8]. The sample barangay respondents were chosen purposively based on the following criteria [9]: A resident of Cabanatuan City for more than ten years; have experienced 2 or more flooding in the city; at least college graduate; and currently residing at the identified vulnerable areas. For the Government representatives, the researcher had picked 10 Local Government Units (LGU) officers and 10 CCDRRMO (Cabanatuan City Disaster Risk Reduction and Management Office) officers. The researcher utilized a researcher-made questionnaire and an adopted questionnaire to collect the necessary data. The instrument is a structured questionnaire and is composed of close-ended and open-ended questions to gather relevant information from the respondents regarding the flood prevention and mitigation initiatives of the Government of Cabanatuan City. Part 1 of the instrument dealt with the possible causes of flooding in the City. This is a close-ended part of the questionnaire where the respondents have chosen from the following scale to establish their level of conformity regarding the items in the questionnaire: 1-Disagree, 2-Slightly Agree, 3-Moderately Agree, 4-Agree. Part 2 is another closed-ended questionnaire which was lifted from the Flood Prevention and Mitigation Manual of CDEMA-Caribbean Disaster Emergency Management Agency [10]. This is about the description of initiatives employed by the City of Cabanatuan as to control over the river, control over the land, and other mitigation activities. The scales utilized in this were the following: 1-Disagree (The flood prevention and mitigation initiatives are not implemented), 2-Slightly Agree (The flood prevention and mitigation initiatives are not implemented properly), 3-Moderately Agree (The flood prevention and mitigation initiatives are implemented to moderate level), 4-Agree (The flood prevention and mitigation initiatives are properly implemented). Part 3 was open-ended questions answered by barangay residents and officials regarding their suggestions of the respondents for better implementation of the flood prevention and mitigation initiatives to have a flood-free City. Appropriate statistical tools, such as mean and weighted mean and ANOVA formulae, were utilized to compute for the numerical pieces of information that were collected in this study. Data analysis of Microsoft Excel 2010 was utilized for computations of the gathered information of the questionnaire from the respondents. As to the data that were gathered from the open-ended, or non-numerical data, they were presented in narrative forms.

### **3. Results and Discussion**

#### ***3.1. The vulnerability of Cabanatuan to Flooding***

The flooding in Cabanatuan City resides for about 3 - 5 days in the farms bringing millions worth of damages, especially in agricultural villages, proving that the city is vulnerable to flood. Flood physical vulnerability deals with the level of damage or loss that elements at risk or built environments suffer from the occurrence of flooding. Those barangays that are more flood physical vulnerable are those that were highlighted with color orange: These are barangays: Aduas Centro, Aduas Norte, Aduas Sur, Bagong Sikat, Bakero, Bakod Bayan,

Bantug Bulalo, Barlis, Barrera and Balite.

**3.2. Possible Causes of Flooding in Cabanatuan City**

**Table 2:** Causes of Flooding According to the Respondents

Possible Causes of Flooding in Cabanatuan City	Residents	Barangay Officials	Government Representatives (LGU, CCDRMO)	Average	Verbal Description
1.Heavy and prolonged rainfall	3.56	3.86	3.67	3.70	Agree
2.Clogged river, canals, creeks and streams	3.50	3.58	3.42	3.50	Agree
3.Inadequate drainage capacity and networks	3.26	3.23	3.20	3.23	Moderately Agree
4.Lack of Vegetation.	2.67	3.19	2.92	2.93	Moderately Agree
5.Poor implementation of a waste management system.	3.29	3.31	3.22	3.27	Agree
6.Siltation of river basins and streams	3.23	3.22	3.20	3.22	Moderately Agree
7.Lack of preventive infrastructure and facilities	3.49	3.46	3.20	3.38	Agree

*Legend: 1.00 to 1.74 Disagree; 1.75 to 2.49 Slightly Agree; 2.50 to 3.24 Moderately Agree; 3.25 to 4.00 Agree*

The respondents conformed that heavy and prolonged rainfall (WM= 3.70), clogged river, canals, creeks and streams (WM=3.50), lack of preventive infrastructure and facilities (WM=3.38) and poor implementation of the waste management system (WM=3.27) were the possible leading causes of flooding in Cabanatuan City as experienced by the respondents. This means that the respondents observed that unexpected substantial rainfall, blocked body of water and obstructed artificial waterways, inadequate flood prevention structures and improper enactment of waste management techniques were their main reasons why they suffered flooding in Cabanatuan. The finding of the recent study is similar to the most common causes of flooding identified by [11]. Bair stated that heavy rains and overflowing rivers were two of the eight reasons why there were floods. He added that those who live along a river and areas upstream that experience heavy rains could lead to a serious overflow, especially if the body of waters and waterways are clogged. Improper waste disposal was also mentioned of the Office of Disaster Preparedness Management (2013) of the Government of the Republic of Trinidad and Tobago

as one of the leading causes of flood which is also what was discovered by the researchers of this current study [12]. Oftentimes, garbage that is not properly disposed enters into drainage systems and clogs drains. This obstructs the free flow of the water that enters into these drains causing water to back up during rainfall flooding the surrounding area. A build-up of garbage can also obstruct the natural flow of water in rivers and streams.

**3.3. Flood prevention and mitigation initiatives had been done so far by the City Government to improve the situation as to**

**3.3.1. Control over the River**

**Table 3:** Control over the River

<b>A. Control over the River</b>	<b>Residents</b>	<b>Barangay Officials</b>	<b>Government Representatives (LGU, CCDRMO)</b>	<b>Average</b>	<b>Verbal Description</b>
1. Dams or retention basins or reservoirs on mainstreams or tributaries are constructed in the City to store excessive water and release it gradually after the threat has passed;	3.30	3.36	2.75	3.14	Moderately Agree
2. Floodwalls are constructed to confine flood waters to a floodway, thereby reducing flood damage;	3.27	3.44	3.42	3.38	Agree
3. Channel improvements are implemented such as straightening to eliminate unwanted bends, excavating and broadening to escalate the size of waterways; clearing to remove brush, trees and other obstructions; lining with concrete to increase efficiency;	3.40	3.33	3.42	3.38	Agree
4. Watershed treatment is employed to help the soil on slopes to become more absorbent of rainfall until flood heights have receded.	3.12	3.22	2.83	3.06	Moderately Agree
Overall Weighted Mean	3.27	3.34	3.10	3.24	Moderately Agree

*Legend: 1.00 to 1.74 Disagree; 1.75 to 2.49 Slightly Agree; 2.50 to 3.24 Moderately Agree; 3.25 to 4.00 Agree*

The respondents agreed that two of the flood prevention and mitigation initiatives that the city government did to control over the river were “Floodwalls are constructed to confine flood waters to a floodway, thereby reducing flood damage (WM=3.38)” and “Channel improvements were implemented, which include, straightening to remove undesirable bends, deepening and widening to increase size of waterways; clearing to remove brush, trees and other obstructions; lining with concrete to increase efficiency (WM=3.38)”. The areas that need enhancement to toughen the initiatives were in “Dams or retention basins or reservoirs on mainstreams or tributaries are constructed in the City to store excessive water and release it gradually after the threat has passed (WM=3.14)” and “Watershed treatment is employed to help the soil on slopes to become more absorbent of rainfall until flood heights have receded (WM=3.06)”. Watershed treatment and management was significant due to its benefits, such as reduced flood mitigation costs. It minimizes the area and impacts of floods, reduces the burden on public drainage infrastructure, and increase groundwater recharge [13].

**3.3.2. Control over the Land**

**Table 4:** Control over the Land

<b>B. Control over the Land (Our city has...)</b>	<b>Residents</b>	<b>Barangay Officials</b>	<b>Government Representatives (LGU, CCDRMO)</b>	<b>Average</b>	<b>Verbal Description</b>
<b>1.Designated floodways and encroachment lines</b>	3.25	3.14	3.00	3.13	Moderately Agree
<b>2.Zoning</b>	3.18	3.06	3.08	3.11	Moderately Agree
<b>3.Subdivision Regulations</b>	3.18	3.25	3.08	3.17	Moderately Agree
<b>4.Building Codes</b>	3.35	3.36	3.25	3.32	Agree
Overall Weighted Mean	3.24	3.20	3.10	3.18	Moderately Agree

*Legend: 1.00 to 1.74 Disagree; 1.75 to 2.49 Slightly Agree; 2.50 to 3.24 Moderately Agree; 3.25 to 4.00 Agree*

The city government of Cabanatuan City was observant on their building codes as revealed in the descriptions made by the three groups of respondents. The respondents agreed that the city government follows quality for the erection of buildings and other structures since it can diminish damages to buildings in flood-prone areas. There were the establishment of basement elevations and first flood elevations consistent with potential flood levels and also ensure that buildings have adequate structural strength which would likely withstand water pressure or the high velocity of flowing water [10]. However, the city government should strengthen their flood prevention initiatives in their subdivision regulations and zoning and in designating floodways and encroachment lines. This finding is related to the concern of the author in [14] about her article “How long will we drown in the Philippines’ flood problems?” She mentioned that “Flooding is caused and/or affected by a combination of several natural, geographical, and human factors. Improper land use or faulty zoning make certain areas susceptible to flooding. The presence of informal settlers along major rivers and improper waste

management also contribute to flooding.”

**3.3.3. Additional Mitigation Measures**

**Table 5:** Additional Mitigation Measures

<b>C. Additional Mitigation Measures (Our City employs...)</b>	<b>Residents</b>	<b>Barangay Officials</b>	<b>Government Representatives (LGU, CCDRRMO)</b>	<b>Average</b>	<b>Verbal Description</b>
<b>1.Flood Proofing</b>	2.95	3.00	3.17	3.04	Moderately Agree
<b>2.Flood Forecasting</b>	3.47	3.56	3.67	3.56	Agree
<b>3.Temporary Evacuation</b>	3.38	3.47	3.67	3.51	Agree
<b>4.Permanent Evacuation</b>	3.52	3.67	3.58	3.59	Agree
<b>5.Flood Insurance</b>	3.28	2.97	2.92	3.06	Moderately Agree
Overall Weighted Mean	3.32	3.33	3.40	3.35	Agree

*Legend: 1.00 to 1.74 Disagree; 1.75 to 2.49 Slightly Agree; 2.50 to 3.24 Moderately Agree; 3.25 to 4.00 Agree*

The respondents agreed that the city government of Cabanatuan City employed flood forecasting (WM=3.56), temporary (WM=3.51) and permanent evacuation (WM=3.59). This means that the city was employing reliable, accurate and timely forecasting of floods, coupled with timely evacuation to save lives and reduce property losses and they also remove persons and property from the path of flood waters and acquired lands can be used for agriculture, parks or other purposes that would not interfere with flood flows or result in material damage [10]. On the other hand, flood proofing (WM=3.04) and flood insurance (WM=3.06) were the areas of mitigation that the city needs to augment. The city needs to assist by compensating for flood damage.

**3.4. The difference in the Responses of the Three Groups of Respondents Regarding the Flood Prevention and Mitigation Initiatives done by the City Government**

It can be noted on the table that barangay officials (WM=3.33) have higher mean responses compared to residents (WM=3.29) and government representatives (WM=3.27).

Testing the difference of means among the responses, the result revealed that there is no significant difference and the null hypothesis was accepted. This implies that barangay officials, residents and government representatives have similar views regarding the flood prevention and mitigation initiatives done by the Cabanatuan City government.

**Table 6:** The difference in the Responses of the Three Groups of Representatives

ANOVA	Residents	Barangay Officials	Government Representatives
Mean	3.29	3.33	3.27
Variance	0.0523	0.0630	0.0677
F	0.3168 Ns		
P-value	0.7301		

Ns = No significant difference since the P-value > 0.05

### 3.5. Suggestions of the Respondents for Effective Implementation of the Flood Prevention and Mitigation Initiatives

The proposed measures of the respondents for better implementation of the flood prevention and mitigation initiatives were monthly seminars regarding floods for proper awareness and readiness, strict implementation of the law for good waste management practices of the residents, hire people who will clean clogged waterways or tap the 4p's beneficiaries, correct allotment of funds and appropriate coordination with government authorities and better flood prevention and mitigation plan. The proper collaboration was also demanded by the respondents to be able to make accurate decisions given available information [15] between the government and the communities since both are affected by the negative effect and impact of a flood.

## 4. Conclusions and Recommendations

This research revealed that: Cabanatuan city is vulnerable to flooding especially barangays Aduas Centro, Aduas Norte, Aduas Sur, Bagong Sikat, Bakero, Bakod Bayan, Bantug Bulalo, Barlis, Barrera and Balite. Heavy and prolonged rainfall, clogged river, canals, creeks and streams, lack of preventive infrastructure and facilities and poor implementation of the waste management system were the possible leading causes of flooding in Cabanatuan City. The flood prevention and mitigation initiatives to control over the river and control over the land were moderately implemented while other mitigation measures that had been done by the City Government were properly implemented. There is no significant difference in the responses of the three groups of respondents regarding the flood prevention and mitigation initiatives done by the Cabanatuan City government. Monthly seminars regarding floods for proper awareness and readiness, strict implementation of the law, appropriate coordination with community and government authorities and better flood prevention and mitigation plan were the suggestions of the respondents towards a flood-free city. Based from the findings and conclusions, the following are offered: The vulnerable barangays of Cabanatuan City should be closely monitored by the city engineering office and CCDRRMO to determine the needed assistance and facilities to prevent them from experiencing worst floods. Barangay residents and officials may voluntary clean clogged river, canals, creeks and streams. Barangay officials and the city government officers should strictly implement the regulations of Republic Act (RA) 9003 or the Ecological Solid Waste Management Act of 2000. The CCDRRMO should conduct monthly seminars regarding floods for proper awareness and readiness. The city



officials may pass an ordinance requiring every subdivision and mall owner to have water rain harvesters in their establishments. The city officials should allot huge fund allocated to constructions and rehabilitations of dams, improvement of flood prevention facilities and equipment, and to study and explore [16] the increasing flood-carrying capacity of rivers through modification and dredging. Higher Educational Institutions thru their research and extension office should collaborate with the City Government to help reinforce the flood prevention and mitigation initiatives of Cabanatuan. Further research regarding the feasibility and design of infrastructures and facilities to prevent flood could be done by future researchers.

## References

- [1] Silvestri, Manuel . Impacts of Flooding. National Geographic Magazine.2018
- [2] Philippine Atmospheric, Geophysical and Astronomical Services Administration. Definition and Nature of Flood. Retrieved September 18, 2012, from [http://kidlat.pagasa.dost.gov.ph/genmet/floods/def\\_natur.html](http://kidlat.pagasa.dost.gov.ph/genmet/floods/def_natur.html).
- [3] Paz-Alberto, A.M., de Dios, M.J.J., Alberto, R.P. and De Guzman, C.H.E.A. Climate Change Impacts and Vulnerability Assessment of Selected Municipalities and Agro-ecosystems to Support Development of Resilient Communities and Livelihoods in Nueva Ecija, Philippines. American Journal of Climate Change, 2018, 7, 295-335
- [4] Inquirer.Net. Cabanatuan City starts cleaning up mud after worst flood in years. 2015. [Newsinfi.inquirer.net](http://Newsinfi.inquirer.net)
- [5] Kumar, R. Research Methodology: A step-by-step guide for beginners (4<sup>th</sup>.ed.) SAGE,CA: Thousand Oaks.2014.
- [6] Pagandian, Joni L. and Eduardo, Jesster P. Restorative Justice in Cordillera Administrative Regio: tradition and Praxis towards a Peace Process Model. International Journal of Social Science Studies. Vol.7, No.1; January 2019. Doi:10.11114/ijsss.v7i1.3748.
- [7] Subia, G.S., Trinidad, C.L., Pascual, R.R., Medrano, H.B. & Manuzon, E.P. Learning Styles and Preferred Teaching Styles of Master of Arts in Teaching (MAT), major in Vocational Technological Education (VTE) Generarion Y Learners. International Journal of English Literature and Social Sciences (IJELS) .Vol-4, Issue 2, Mar-Apr, 2019. <https://dx.doi.org/10.22161/ijels.4.2.35>.
- [8] Bernard, H.R. Research Methods in Anthropology: Qualitative and quantitative methods. 3rd edition. AltaMira Press ,Walnut Creek, California.2002.
- [9] Subia, G.S. Comprehensible Technique in Solving Consecutive Number Problems in Algebra. Journal of Applied Mathematics and Physics, 6, 447-457. <https://doi.org/10.4236/jamp.2018.63041>

- [10] Caribbean Disaster Emergency Management Agency (CDEMA). Flood Preparedness (Flood Prevention and Mitigation Manual). Acute Vision Inc, 2010. European Union.
- [11] Bair .What Causes Floods? Top 8 common causes of Flooding. info@b-air.com. Azusa, California. 2018.
- [12] Office of Disaster Preparedness and Management –ODPM. Flooding. 2013. <http://www.odpm.gov.tt/node/16>
- [13] Postel, S. and Richter, B.D. Rivers for Life: Managing Water for People and Nature. Island Press, Washington DC.2003.
- [14] Jimeno, Karen V.(2017). How long will we drown in the Philippines' flood problems? The Philippine Star. philstar Global.
- [15] Subia, Gener S. Think Like My Teacher (TLMT): A New Method in Assessing Millennial Learners. International Journal of Arts, Humanities and Social Sciences. Volume 3. Issue 1.2018. 57-61. [www.ijahss.com](http://www.ijahss.com)
- [16] Subia, G. , Amaranto, J. , Amaranto, J. , Bustamante, J. and Damaso, I. Chess and Mathematics Performance of College Players: An Exploratory Analysis. Open Access Library Journal, 2019, 6, 1-7. doi: 10.4236/oalib.1105195