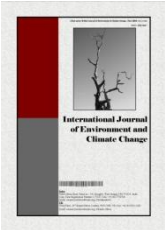

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Assessment of Drainage Conditions in the Poblacion Barangays of Catarman, Northern Samar: A Pilot Study

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A technical survey was conducted in the 16 Poblacion barangays of Catarman, Northern Samar to gather technical data on the existing length of drainage canals, the land area of the barangay, and the average slope of the existing drainage canal. Using a survey questionnaire, the reasons for flooding and perceived remedial measures were gathered from the barangay residents. The existing lengths of the drainage canal in the barangays range from 0.52 – 2.263 km. The average slope of the drainage canal in the barangays ranges from 0.012 – 1.572 %. The average depth of maximum flooding ranges 0 (no flooding) – 1.3 m. The computed drainage density for the different barangays ranges 2.92 – 32.46 km/km^2 while the computed additional lengths of drainage needed in the barangays ranges 0 (sufficient length of existing drainage canal) – 4,954 m. On the other hand, the most common reasons for flooding are small drainage canals, clogged drainage canals, no drainage canal, water coming from other puroks, and flooding from Catarman River or a nearby creek. The most common remedial measures perceived by the barangay residents are construct a drainage canal, drainage canal maintenance, construct river control, and repair of the existing drainage canal. The researchers concluded that the barangays with high drainage density has no

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or minimal flooding, many of the barangays still need a considerable length of drainage canals to eliminate in the area, most of the barangay respondents claimed that the problem is that the drainage canals are not sufficient and some existing drainage canals need repair and so there is a need to construct additional drainage canals and repair existing ones and a significant number of barangay residents asserted there is a need to construct a river control structure to avoid river water coming into their barangay.

Keywords: Flooding; drainage; drainage density.

1. INTRODUCTION

Climate change is being experienced globally. One of its effect, as observed is the intensified rainfall causing some places to be flooded frequently. Even progressive countries like in UK [1] and Britain [2] is being challenge by flooding.

Philippines has a rainy season thus flooding is a great challenge both to the government and constituents. It is being experienced by some provinces of the country and one of them is the province of Northern Samar and Catarman is its capital town. Catarman, officially the Municipality of Catarman, is a first class municipality and capital of the province of Northern Samar, Philippines. According to the 2015 census, it has a population of 94,037 people. It is the commercial, educational, financial, political and government center of the province. The Municipality of Catarman is politically subdivided into 55 barangays, 17 of them in the poblacion.

Every year, flooding, due to the occurrence of the Cold Front, the La Niña phenomena and tropical depressions is becoming serious in the different poblacion barangays of Catarman with so much destruction to properties as well as human lives and activities. Millions of government funds are allocated annually to the construction and repairs of drainage and flood control projects. In 2018, Gabieta et al. [3] reported that 282 families in 12 villages in Catarman, Northern Samar, were displaced by floods brought about by Tropical Depression "Usman". These barangays are Yakal, Narra, Ipil-ipil, Bangkerohan, Dalakit, Talisay, Baybay, Molave, Macagtas, Abad Santos, Casoy and Mabolo. Usman dumped 300 mm of rain in Catarman, the highest water level recorded by PAGASA in 20 years. In 2019, Meniano [4] reported that widespread flooding, landslide, damaged houses and infrastructure, power outages, fuel shortage, and weak communication signal have prompted the Catarman LGU to issue a state of calamity brought about by Typhoon Tisoy in Catarman, Northern Samar.

But is the flooding problem being addressed – that is flooding has already stopped, is now becoming less intense or less frequent. Drainage conditions in the area can be assessed by looking into the total length, slope and cross-sectional area of the drainage canals and the drainage density. Drainage density, defined as the total length of stream channels per unit area, may be used as the best available index to describe a particular drainage network [5]. It is a measurement of the sum of the channel lengths per unit area.

Drainage densities in semi-arid to humid landscapes range from 2 to 12 km/km^2 [6]. Values may range from about 5 km of channel per sq km (8 mi per sq mi) on erosion-resistant, permeable sandstones, to 500 km per sq km (810 mi per sq mi) on highly erodible, impermeable clays.

Aside from the technical problems on drainage, there could be human related problems which should be addressed to improve the drainage conditions in an area and prevent flooding.

It is the purpose of this study to investigate the drainage and flood conditions and the reasons for flooding in Catarman, Northern Samar. Specifically, this study aims to:

1. determine the technical profile of the barangays of the respondents of the study in terms of:
   a. Area of barangay;
   b. Existing length of drainage canals in the barangay; and
   c. Average slope of drainage canals.
2. estimate the density of drainage canals in the barangay;
3. determine the average depth of maximum flooding in the barangay from the respondents;
4. estimate the total required and additional lengths of drainage canals needed in the barangay;

5. determine the reasons for flooding as observed by the respondents in the barangay; and
6. determine the perceived remedial measures by the respondents to minimize, if not solve, the flooding problem.

2. METHODOLOGY

This research study started with a Courtesy Visit to the Mayor's Office of Catarman, Northern Samar, to ask permission from his office for the conduct of this activity in his municipality. A Coordination Meeting with the Barangay Chairmen to ask permission to conduct survey on flooding was also conducted. A research assistant was hired and oriented about the study.

A simple questionnaire has been developed to gather the respondents' data on barangay of residence, the reasons for flooding as observed by the respondents, and their perceived remedial measures to stop flooding during typhoons and rainy days. The sample respondents per barangay are tabulated below:

List 1. The sample respondents per barangay

Barangay	Number of sample respondents
Acacia	155
Airport Village	327
Baybay	361
Calachuchi	317
Casoy	283
Ipil-ipil	327
Jose Abad Santos	327
J. P. Rizal	208
Lapu-lapu	197
Mabolo	197
Molave	317
Narra	343
Sampaguita	234
Santol	197
Talisay	307
Yakal	337

Using a Global Positioning System and a distance measuring wheel, a technical survey was conducted in all the barangays to gather data on the length and end-to-end elevations of drainage canals. The area of the barangays included in the study were obtained from appropriate internet website.

The end-to-end elevations were used in the computation of the average slope of canals. The drainage density per barangay was computed by dividing the total existing length of canals by the area of the barangay. The total length of required canals was computed using the data on average depth of flooding, the cross-sectional area of the canal and the average slope.

The data gathered and computed were tabulated, summarized and analyzed. From the results of the study, conclusions and recommendations were formulated.

3. RESULTS AND DISCUSSION

3.1 TECHNICAL profile of the Barangays

Table 1 presents the area of the barangay, the existing length of drainage canals and the average slope of the drainage canals in the barangay. The table shows that Barangay Baybay has the largest area of 0.297 sq. km while Barangay Sampaguita has the smallest area of 0.024 sq. km. All of the barangays has less than 1 sq. km land area which means that they are small barangays. It is also shown in the table that Barangay Narra has the longest drainage canals of 2.189 km while Barangay Sampaguita has the shortest drainage canal of 0.507 km. As to the slope of drainage canals, the table shows that Barangay Talisay has the steepest slope of 1.572% followed by the slopes of drainage canals in Barangays Baybay and Sampaguita of 0.677% and 0.52%, respectively. The rest have slopes less than 0.5% which could be the reason for slow drainage.

3.2 Drainage Density in the Barangays

Table 2 shows the computed drainage density in the different poblacion barangays of Catarman, Northern Samar. Barangay Santol has the highest drainage density of 32.46. This is followed by Barangay Mabolo (26.62), Barangay Acacia (25.22), Barangay Sampaguita (21.12), Barangay JP Rizal (20.83), and Barangay Lapu-lapu (19.19). The rest of the barangays have drainage density of less than 15.00 with the lowest drainage density of 2.92 for Barangay Molave.

3.3 Average Depth of Maximum Flooding in the Barangay

Table 3 exhibits the average depth of maximum flooding in the barangay as revealed by the respondents. Barangay Ipil-ipil has the deepest average maximum flooding of 1.3 m, followed by

Barangays Molave and Yakal with 1.0 m, Barangay Casoy with 0.9 m, and Barangay Narra with 0.7 m, average depth of maximum flooding. Barangays Airport Village and Calachuchi have 0.5 m average depth of maximum flooding, barangays Jose Abad Santos and Talisay have 0.35 m average depth of maximum flooding and barangays Baybay and Sampaguita have 0.25 m average depth of maximum flooding. Four barangays, namely JP Rizal, Lapu-lapu, Mabolo, and Santol did not experience any flooding at all.

Relating to the drainage density, it can be seen that these four barangays which did not experience flooding have very high drainage densities as compared to those barangays which experienced a flooding of 1.0 m or more (Barangays Ipil-ipil, Molave and Yakal). Infact, Barangay Molave has the lowest drainage density of 2.92 only. This could mean the inadequacy of drainage canals in the area.

3.4 The Total Required and Additional Lengths of Drainage Canals Needed in the Barangay

Table 4 shows the computed total required length of drainage canal in the barangay, the existing length of canals in the barangay, and the additional length of drainage canal needed in the barangay. It can be gleaned in the table that Barangays Acacia, J.P. Rizal, Mabolo, Sampaguita, and Santol have longer existing drainage canals than what is needed in those barangays. This could be the reason why there is no more or very shallow flooding in these barangays.

This table also shows that ten (10) of the barangays still needs additional lengths of drainage canals. Barangays Airport Village, Baybay and Molave are the ones needing very long additional drainage canals which can be attributed to their bigger land areas.

Fig. 1 shows the map of the Canal System reflecting the existing drainage canals (yellow) and the required additional canal (blue).

3.5 The Reasons for Flooding as Observed by the Respondents in the Barangay

Table 5 exhibits the reasons of the respondents in the different barangays why flooding occurred.

It can be gleaned in Table 5 that there has been no flooding in Barangays Acacia, J.P. Rizal, Lapu-lapu, Mabolo, and Santol while there is minimal flooding in Barangay Baybay and Sampaguita. All of these barangays have drainage densities greater than 15. On the other hand, Barangay Ipil-ipil experienced the deepest flooding of 1.3 meters due to flooding from the Catarman River. Barangays Molave and Yakal experienced flooding of 1 m due to the flood waters from a nearby creek.

Table 1. The technical profile of the poblacion barangays of Catarman, Northern Samar

Barangay	Land area (km^2)	Existing length of drainage canals (km)	Average slope (%)
Acacia	0.073	1.841	0.300
Airport Village	0.204	0.971	0.012
Baybay	0.297	1.058	0.677
Calachuchi	0.128	1.186	0.032
Casoy	0.091	0.831	0.232
Ipil-ipil	0.087	0.737	0.175
Jose Abad Santos	0.066	0.520	0.396
J. P. Rizal	0.041	0.854	0.073
Lapu-lapu	0.031	0.595	0.106
Mabolo	0.085	2.263	0.208
Molave	0.290	0.846	0.182
Narra	0.162	2.189	0.169
Sampaguita	0.024	0.507	0.523
Santol	0.050	1.623	0.067
Talisay	0.084	0.528	1.572
Yakal	0.127	1.436	0.122

Table 2. The drainage density (km/sq. km) of the poblacion barangays in Catarman, Northern Samar

Barangay	Existing length of drainage canals (km)	Land area (km^2)	Drainage density (km/km^2)
Acacia	1.841	0.073	25.22
Airport Village	0.971	0.204	4.76
Baybay	1.058	0.297	3.56
Calachuchi	1.186	0.128	9.27
Casoy	0.831	0.091	9.13
Ipil-ipil	0.737	0.087	8.47
Jose Abad Santos	0.520	0.066	7.88
J. P. Rizal	0.854	0.041	20.83
Lapu-lapu	0.595	0.031	19.19
Mabolo	2.263	0.085	26.62
Molave	0.846	0.290	2.92
Narra	2.189	0.162	13.51
Sampaguita	0.507	0.024	21.12
Santol	1.623	0.050	32.46
Talisay	0.528	0.084	6.29
Yakal	1.436	0.127	11.31

Table 3. The average depth of maximum flooding in the poblacion barangays in Catarman, Northern Samar

Barangay	Average depth of maximum flooding, M
Acacia	0
Airport Village	0.50
Baybay	0.25
Calachuchi	0.50
Casoy	0.90
Ipil-ipil	1.30
Jose Abad Santos	0.35
J. P. Rizal	0
Lapu-lapu	0
Mabolo	0
Molave	1.00
Narra	0.70
Sampaguita	0.25
Santol	0
Talisay	0.35
Yakal	1.00

Table 4. The computed total required length of drainage canal, the existing length of canals, and the additional length of drainage canal needed in the barangay

Barangay	Existing length of drainage canal (m)	Computed total required drainage canal	Additional length of drainage canal
Acacia	1,841	1,460	-
Airport Village	971	4,080	3,109
Baybay	1,058	5,940	4,882
Calachuchi	1,186	2,560	1,374
Casoy	831	1,820	989
Ipil-ipil	737	1,740	1,003
Jose Abad Santos	520	1,320	800
J. P. Rizal	854	820	-
Lapu-lapu	595	620	25

Barangay	Existing length of drainage canal (m)	Computed total required drainage canal	Additional length of drainage canal
Mabolo	2,263	1,700	-
Molave	846	5,800	4,954
Narra	2,189	3,240	1,051
Sampaguita	507	400	-
Santol	1,623	1,000	-
Talisay	528	1,680	1,152
Yakal	1,436	2,540	1,104

Fig. 1. Catarman, Northern Samar Drainage Canal System Map

Note: Yellow colored Lines are the existing drainage canals; Blue colored lines are the required additional canal

Table 5. The reasons for flooding in the barangays according to the respondents

Barangay	Reasons	Number	Percentage
Acacia	No flooding		
Airport Village	Small drainage canal	52	33.33
	Clogged drainage canal	7	4.76
	No drainage canal	66	42.86
	Low elevation of area	15	9.52
	Drainage canal has no hole	15	9.53
	Total	155	100.00
Baybay	Small drainage canal	30	8.31
	Clogged drainage canal	70	19.39
	No drainage canal	200	55.40
	Low elevation of area	50	13.85
	Drainage canal has no hole	11	3.05
	Total	361	100.00

Barangay	Reasons	Number	Percentage
Calachuchi	Small drainage canal	113	35.65
	Clogged drainage canal	113	35.65
	Drainage canal has no hole	91	28.70
	Total	317	100.00
Casoy	Clogged drainage canal	61	21.43
	No drainage canal	81	28.57
	Low elevation of area	141	50.00
	Total	283	100.00
Ipil-ipil	Small drainage canal	41	12.50
	Clogged drainage canal	41	12.50
	No drainage canal	27	8.33
	Water coming from other puroks	68	20.83
	Flooding from Catarman River	150	45.84
	Total	327	100.00
Jose Abad Santos	No drainage canal	11	100.00
J. P. Rizal	No Flooding		
Lapu-lapu	No Flooding		
Mabolo	No Flooding		
Molave	Drainage canal has no hole	35	11.11
	Flooding from the creek	282	88.89
	Total	317	100.00
Narra	Small drainage canal	57	16.67
	Clogged drainage canal	86	25.00
	No drainage canal	28	8.33
	Drainage canal has no hole	43	12.50
	Flooding from the creek	129	37.50
	Total	343	100.00
Sampaguita	Water coming from other puroks	175	75.00
	Flooding from Catarman River	59	25.00
	Total	234	100.00
Santol	No Flooding		
Talisay	Clogged drainage canal	184	60.00
	No drainage canal	123	40.00
	Total	307	100.00
Yakal	No drainage canal	46	13.64
	Drainage canal has no hole	15	4.55
	Flooding from the creek	276	81.81
	Total	337	100.00

Generally, most of the drainage canals have no holes for the water to enter the canal, many were clogged and many were smaller than what is needed to pass out the drainage waters at faster rate.

3.6 The Perceived Remedial Measures by the Respondents to Minimize, if not solve, the Flooding Problem

Table 6 exhibits the perceived remedial measures by the respondents to minimize, if not solve, the flooding problem.

It can be seen from Table 6 that most of the respondents in Barangays Airport Village, Baybay, Casoy, Ipil-ipil, Jose Abad Santos, Molave, Narra, Sampaguita, Talisay and Yakal perceived that, to improve the drainage conditions in their barangay, the government should construct additional lengths of drainage canal and repair existing drainage canals. In Barangays Casoy, Ipil-ipil, Molave, Narra, Sampaguita, and Yakal, the respondents suggested the construction of a river control structure to control flood waters from the Catarman River or a nearby creek. Many respondents from Barangays Airport Village, Baybay, Calachuchi, Casoy, Ipil-ipil, Narra, Sampaguita, Talisay and Yakal believed that there should be maintenance of the cleanliness in the drainage canals. This interview has been made to get the views of the residents on the

ground that public participation was encouraged in the township to help both stakeholders and engineers outline the principles of flood management [7].

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Table 6. The perceived remedial measures by the respondents to minimize, if not solve, the flooding problem

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Barangay	Remedial measure	Number	Percentage
Acacia	None		
Airport Village	Enlargement of drainage canal	66	42.86
	Drainage canal maintenance	23	14.28
	Construction of drainage canal	66	42.86
	Total	155	100.00
Baybay	Enlargement of drainage canal	16	4.48
	Drainage canal maintenance	102	28.36
	Construction of drainage canal	243	67.16
	Total	361	100.00
Calachuchi	Enlargement of drainage canal	113	35.71
	Drainage canal maintenance	113	35.71
	Repair of drainage canal	91	28.58
	Total	317	100.00
Casoy	Construct a drainage canal	94	33.33
	Drainage canal maintenance	151	53.33
	Construct river control	38	13.34
		283	100.00
Ipil-ipil	Construct a drainage canal	48	14.81
	Drainage canal maintenance	48	14.81
	Construct river control	96	29.63
	Repair of drainage canal	135	40.75
		327	100.00
Jose Abad Santos	Construct a drainage canal	11	100.00
J. P. Rizal	None		
Lapu-lapu	None		
Mabolo	None		

Barangay	Reasons	Number	Percentage
Molave	Construct river control	282	88.89
	Repair of drainage canal	35	11.11
		317	100.00
Narra	Construct a drainage canal	43	12.50
	Drainage canal maintenance	86	25.00
	Construct river control	114	33.33
	Repair of drainage canal	100	29.17
		343	100.00
Sampaguita	Drainage canal maintenance	26	11.11
	Construct river control	26	11.11
	Repair of drainage canal	182	77.78
		234	100.00
Santol	None		
Talisay	Drainage canal maintenance	97	31.58
	Repair of drainage canal	210	68.42
		307	100.00
Yakal	Construct a drainage canal	112	33.33
	Drainage canal maintenance	14	4.17
	Construct river control	140	41.67
	Repair of drainage canal	71	20.83
		337	100.00

4. CONCLUSIONS

Based on the findings of this study, the researchers concluded that:

1. The barangays with high drainage density has no or minimal flooding.
2. The average maximum flooding in the 16 barangays is 1.3 meters.
3. Many of the barangays still need a considerable length of drainage canals to eliminate in the area.
4. Most of the barangay respondents claimed that the problem is that the drainage canals are not sufficient and some existing drainage canals need repair and so there is a need to construct additional drainage canals and repair existing ones.
5. A significant number of barangay residents asserted there is a need to construct a river control structure to avoid river water coming into their barangay.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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