Perceptions on the water quality of Marikina River of selected riverbank residents of Barangays Manggahan and Santolan, Pasig City, Philippines

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ABSTRACT

Marikina River is in the state of water deterioration and monitoring its water quality is necessary and timely. This paper generally determined the perceptions on the river quality of selected residents of Barangays Manggahan and Santolan, Pasig City, Philippines. Survey questionnaires using Likert scale were utilized in the study. Data gathered from a total of 96 participants revealed that they generally agreed that the water quality of Marikina River has changed over the past years as based on the number and variety of trees near and in the river, its ability to support wildlife, its cleanliness and safety for swimming and drinking, its trash and sewage composition, its turbidity, and its smell. These descriptions were in addition to the changes in various activities they generally were performing before. These findings suggest that the poor water quality of the river could be addressed through various conservation and restoration efforts to bring Marikina River back to its natural conditions.

Introduction

Rapid urbanization can help in the development of the national economy, but the continuously growing population, together with the increased construction activities, may result to serious water contamination threatening the ability of the local aquatic ecosystem to retain its structure and function over time (Costanza & Mageau, 1999; Luo *et al.,* 2018). One of the known natural waters in the Philippines is the Marikina River. Some time ago, it was recognized for its clean water and bank, and rich plant composition which provided its local people a ground for picnics and fiesta celebrations. But due to the rise of industrialization about four decades ago, this 31-km long waterway (Abon et al., 2011;

Iglesias & Yu, 2008; Yu & Sajor, 2008) was adversely affected, and both its biodiversity and water system started to deteriorate until today's generation (Iglesias & Yu, 2008; Yu & Sajor, 2008.). This then negatively impacts some other water bodies as it serves as a common tributary of Laguna Lake and Manila Bay (Tachikawa et al, 2004).

Assessment of the Marikina river suggested that it already fell under the Class D water quality classification after it exceeded its Class C requirement (Magabo, 2012). A freshwater system categorized with Class C quality can offer both fisheries and recreational uses, while a Class D water system is primarily for irrigational use (DENR Administrative Order No. 34, 1990). This deterioration in water quality was principally caused by the rapid population increase, which entailed agricultural-to-residential land conversion, illegal settling, and indiscriminate waste disposal by both households and industries (Iglesias & Yu, 2008; Yu & Sajor, 2008), then serving as a potential source of water-borne diseases (Burgess, 2008), and ecological damages such as reduction in lifeforms and promotion of pollution in most of its stretches (Nallathiga, 2010).

In this regard, it is important to monitor and analyze the water quality of Marikina River, like any other natural waters, to determine its status and make appropriate managing actions. This monitoring and analysis system generally encompasses a standardized measurement and observation (Bartram & Balance, 1996) of several components of the aquatic environment including hydrology, physico-chemistry, and biology (Chapman, 1996) that are then compared over time (Florescu *et al*., 2011). However, not all reported water quality would agree with what the local community perceives; hence, this study was conducted.

Purpose of the Research

This study was conducted to determine the perceptions of local residents of Marikina riverbank on the water quality of this river. Specifically, it aimed to describe the water quality of Marikina River then and now as perceived by its local residents, assess their practices relating to river use, and determine their perceived causes of water pollution.

The results of this study may provide an understanding about the status of Marikina River in respect to urbanization and to encourage the Local Government to apply extra efforts for the restoration and conservation of this precious ecosystem. This would also provide the residents with a sense of ownership, insight into the local culture, and a context for how they value the river. Furthermore, this study could help the local government in making policies and activities that are appropriate to bring Marikina River back to its natural state.

Methodology

Research Design

This study followed a descriptive type of research design. This sought to obtain information on the current status of the water quality of Marikina River based on the perceptions of its residents.

Participants and Sampling Site

The study was conducted in Barangay Manggahan and Barangay Santolan, Pasig City (Figure 1). These two barangays were selected as these were the nearest areas to the sampling station (*i.e.,* Manggahan Floodway) of the Laguna Lake Development Authority (LLDA) in assessing the water quality of Marikina River.

A total of 96 randomly selected local residents of Barangay Manggahan and

Figure 1. Map showing Marikina River and Barangays Manggahan (14° 36'5"N 121°5'51"E) and Santolan, (14°36'53"N 121° 5'7"E) Pasig City. ▲, Marikina River; ★, sampling sites; ●, Manggahan Floodway (The UP NOAH, 2019)

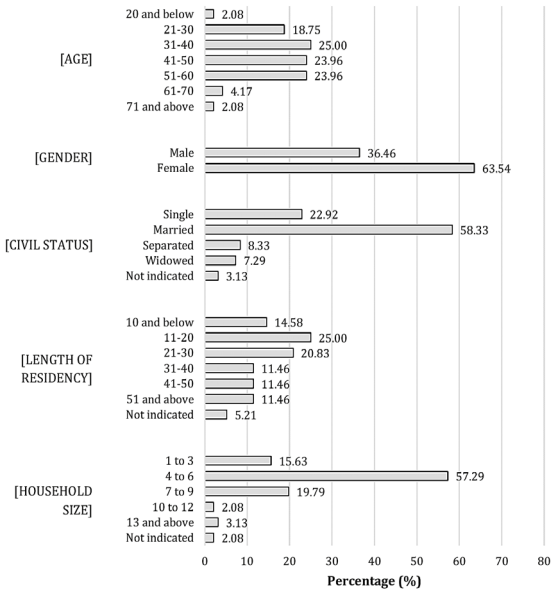

Figure 2. A graph showing the demographic profiles of participants from Brgys. Manggahan and Santolan, Pasig City based on age, gender, civil status, length of residency and household size

Barangay Santolan, Pasig City served as participants of the study. Majority of them were between 31 to 40 years old (25.00%), married (58.33%) and females (63.54%) (Figure 2). Senior citizens, comprising ages 60 and above, were represented by more than 6.00% of the group. This result agrees with the report of the National Statistics Office (NSO) (2012) that senior citizens of Pasig City accounted for 5.80% of its total household population. The greater number of female participants, on the other hand, was an expected outcome due to the reason that majority of the population in Pasig City prior to the inclusive period were females (National Statistics Office, 2012).

In addition, a quarter of these participants (25.00%) were residents of their respective barangays for 11 to 20 years, with an overall average length of residency of 27.80 years. Furthermore, the most common household size was four to six (57.29%), with 5.72 as the calculated average size. This then reflected the average household size of the city in 2010 which was 4.3 persons per household.

Research Instruments

The questionnaire that was used in this study and was patterned from the report of Day and Mourato (1998) consisted of three parts: (1) a 9-item section for the perception of participants on the water quality of Marikina River then and now, (2) a 12-item section providing a checklist of indicators to measure how the participants make use of the Marikina River, and (3) a 5-item section providing a checklist of the possible causes of pollution in the river. Likert scale was used by the participants in their assessment in Parts 2, 3 and 4 of the questionnaire.

Data Collection Procedure

For the perception on the water quality of the river, a communication letter was

given to the Barangay Captains of Barangays Manggahan and Santolan, Pasig City prior to the conduct of survey in February 2015. Participants were also provided with a brief background of the research, the procedure to be done, and the information to be gathered. The confidentiality of their identity and their responses was also emphasized. Participants were then personally handed with questionnaires and were given enough time, usually 5 to 10 minutes, to accomplish them. Any unclear items were clarified to them by the researchers. A 96% retrieval rate for the distributed questionnaires was recorded.

Data Analyses

Data gathered were analyzed using the descriptive statistics (frequency, percentage, mode) utilizing a statistical software, SPSS version 16.0.

Results and Discussion

This part is sectioned into three, which discuss the participants' perceptions on the past and present water quality of, human activities and practices in, and perceived sources of pollution in the Marikina River.

Perceptions on the Past and Present Water Quality of Marikina River

From its good water quality before, Marikina River underwent deterioration (Iglesias & Yu, 2008; Yu & Sajor, 2008). It was suggested by Magabo (2012) that the water quality of the river could already be classified as Class D after it exceeded its Class C requirement. This means that the river adversely changed its value as contributed by its poor water quality—a quality caused by various changes in the environment. This section discusses how the locals perceive the river quality then and now based on a number of indicator statements.

All participants were asked for their perception on the water quality of Marikina River (Table 1). Data revealed that, in general, participants perceived the water quality of the river as *'Good'* (33.33%) and *'Poor'* (51.04%) then and now, respectively. This difference in the perception of the locals on the past and present status of the river was supported by the claim of 86.46% of them that the water quality of Marikina River significantly changed over the past years.

In addition, with respect to the past condition of the river, participants *'Agree'* that the water quality of the river was important to them (31.25%), and that there were a large number and variety of trees near and in the Marikina River (42.71%). Moreover, they were *'Undecided'* that it was a good habitat for wildlife (34.38%), it was clean and safe for swimming (23.96%) and drinking (38.54%), it had much trash and sewage (34.38%), and that it was turbid (26.04%), and had a foul smell (38.54%).

On the other hand, with respect to the present status of the river, participants *'Strongly Agree'* that the water quality of the river is important to them (33.33%), it had much trash and sewage (42.71%), it is turbid (51.04%), and it smells bad (40.63%). In addition, they were *'Undecided'* that there are a large number and variety of trees near and in the Marikina River (37.50%). Furthermore, they *'Strongly Disagree'* that it is a good habitat for wildlife (37.50%), and that it is clean and safe for swimming (60.42%) and drinking (76.04%).

Participants stated that the significant change in the vegetation composition near the river was caused by the industrial development of the area to address flooding, which involved uprooting and cutting down of trees in the riverbank. Additionally, though some wildlife can still be seen at present, some participants observe a significant variation in this biodiversity aspect of the river over the past

Table 1

Perceptions of participants on the water quality of Marikina River using a 5-point Likert scale

			PERCENTAGE*					*p*-VALUE
INDICATOR STATEMENTS	**A**	**PERIOD**	**5**	**4**	**3**	**2**	**1**	**(SIG.)**
The Marikina River has a good water quality.	P	Past	13.54	23.96	33.33	20.83	8.33	<0.00001
		Present	3.13	4.17	14.58	27.08	51.04	(S)
The water quality of Marikina River is important to me.	P	Past	22.92	31.25	29.17	8.33	8.33	.213062
		Present	33.33	10.42	20.83	21.88	13.54	(NS)
There are a large number and variety of trees near and in the Marikina River.	P	Past	9.38	42.71	27.08	12.50	8.33	.000016
		Present	8.33	9.38	37.50	23.96	20.83	(S)
It is a good habitat for wildlife, e.g. fish, ducks, other birds.	P	Past	16.67	26.04	34.38	10.42	12.50	< .00001
		Present	3.13	8.33	22.92	28.13	37.50	(S)
It is clean and safe for humans to swim in.	P	Past	21.88	16.67	23.96	16.67	20.83	< .00001
		Present	4.17	1.04	12.50	21.88	60.42	(S)
It is clean and safe for humans to drink.	P	Past	4.17	10.42	38.54	9.38	37.50	< .00001
		Present	3.13	1.04	4.17	15.63	76.04	(S)
It does have much trash and sewage.	N	Past	18.75	15.63	34.38	18.75	12.50	.009103
		Present	42.71	19.79	11.46	9.38	16.67	(S)
It is turbid.	N	Past	17.71	20.83	26.04	20.83	14.58	< .00001
		Present	51.04	20.83	15.63	1.04	11.46	(S)
It has a foul odor.	N	Past	16.67	11.46	38.54	21.88	11.46	.000039
		Present	40.63	21.88	21.88	5.21	10.42	(S)

-Column A: P, positive statement; N, negative statement

**5, Strongly Agree; 4, Agree; 3, Undecided; 2, Disagree; 1, Strongly Disagree*

Note: Highlighted cells represent the highest percentage per row.

** significant @ .05*

years. For instance, frogs were so populous before especially during the wet season. But at present, there was a decline in their population causing an alarming increase in the number of mosquitoes, which used to serve as food for frogs.

As aforementioned, the river falls under Class C to D based on its water quality (Magabo, 2012). Class C water bodies are intended primarily for fishing, recreation, and supplying manufacturing processes. Class D, on the other hand, are mainly for agriculture, irrigation and livestock watering (Greenpeace, 2007). This then indicates that the water of the river is not safe for humans to drink. In addition, despite the effort of the local government in regularly collecting household wastes, participants strongly agree that the river at present has much trash and sewage. They found it to be contributed by households living in regions upstream the river, whose wastes thrown into the river just flow down into their area. Furthermore, as affirmed specifically by the older participants, the river was significantly more turbid that they were able to compare this with the clarity of the river before. They said that during their time, the river was so clear that its floor could still be seen above-water.

Table 2.

Frequencies of doing river-related activities then and now in Marikina River measured using a 5-point Likert scale

		PERCENTAGE*					*p*-VALUE
RIVER ACTIVITIES	**PERIOD**	**5**	**4**	**3**	**2**	**1**	**(SIG.)**
Walking	Past	26.04	18.75	31.25	8.33	15.63	.000012
	Present	11.46	6.25	21.88	38.54	21.88	(S)
Relaxing and enjoying scenery	Past	19.79	26.04	34.38	6.25	13.54	< .00001
	Present	8.33	6.25	30.21	20.83	34.38	(S)
Transportation	Past	11.46	10.42	40.63	14.58	22.92	.019795
	Present	9.38	6.25	23.96	26.04	34.38	(S)
Playing in or around river	Past	15.63	29.17	35.42	2.08	17.71	< .00001
	Present	8.33	1.04	26.04	25.00	39.58	(S)
Swimming	Past	6.25	16.67	29.17	20.83	27.08	< .00001
	Present	1.04	3.13	11.46	23.96	60.42	(S)
Fishing	Past	9.38	15.63	39.58	15.63	19.79	< .00001
	Present	3.13	4.17	26.04	18.75	47.92	(S)
Boating	Past	10.42	12.50	42.71	15.63	18.75	< .00001
	Present	7.29	1.04	17.71	30.21	43.75	(S)
Watching wildlife	Past	9.38	6.25	32.29	30.21	21.88	< .00001
	Present	3.13	4.17	14.58	13.54	64.58	(S)
Picnicking	Past	15.63	13.54	26.04	19.79	25.00	< .00001
	Present	1.04	7.29	19.79	20.83	51.04	(S)
Bathing	Past	7.29	8.33	18.75	13.54	52.08	< .00001
	Present	0.00	0.00	9.38	9.38	81.25	(S)
Washing clothes	Past	1.04	2.08	15.63	21.88	59.38	.000507
	Present	0.00	0.00	7.29	10.42	82.29	(S)
Throwing garbage	Past	11.46	5.21	15.63	14.58	53.13	.087545
	Present	3.13	7.29	11.46	18.75	59.38	(NS)

**5, Every Time; 4, Almost Every Time; 3, Sometimes; 2, Almost Never; 1, Never*

Note: Highlighted cells represent the highest percentage per row.

** significant @ .05*

Changes in the Past and Present Human Activities and Practices in Marikina River

The changes in the water quality of the river entail the differences in the way locals make use of it. This section discusses the past and present river activities or practices of the participants and how often they do them (Table 2).

Gathered data showed that, on the average, participants before *'Sometimes'* walked along the river bank (31.25%), relaxing and enjoying the river scenery (34.48%), use the river for transportation (40.63%), observe children playing in or near the river (35.42%), swam (29.17%), fish (39.58%), boat (42.71%), watch wildlife (32.29%), and have picnics (26.04%). Moreover, most of them *'Never'* bathed and washed their bodies (52.08%), washed

Table 3.

Perceived sources of pollution in Marikina River

	PERCENTAGE*				
INDICATOR STATEMENTS	**5**	**4**	**3**	**2**	**1**
Discharge from industrial sources	48.96	33.33	10.42	1.04	6.25
Sewage from villages and towns	42.71	30.21	17.71	2.08	7.29
Dumping of trash	46.88	19.79	17.71	3.13	12.50
Dumping of factory waste	48.96	26.04	8.33	8.33	8.33
Seepage from agriculture	26.04	26.04	25.00	7.29	15.63

**5, Strongly Agree; 4, Agree; 3, Undecided; 2, Disagree; 1, Strongly Disagree*

Note: Highlighted cells represent the highest percentage per row.

their clothes (59.38%), and threw garbage (53.13%) in the river.

Considering the present river status, participants *'Almost Never'* walks along the bank (38.54%). Additionally, they *'Never'* practice relaxing and enjoying river scenery (34.38%), use the river for transportation (34.38%), observe children playing in or near the river (39.58%), swim (60.42%), fish (47.92%), boat (43.75%), watch wildlife (64.58%), picnic (51.04%), bathe and wash their bodies (81.25%), wash their clothes (82.29%), and throw garbage (59.38%) in the river.

The significant changes in the frequency of performing most of the activities (i.e. walking, relaxing and enjoying scenery, river transport, playing of children, swimming, fishing, boating, watching wildlife and picnicking) then and now, could be attributed to the foul smell of the river and the reduction in its number of wildlife and trees. Specifically, the use of the river for transport to nearby areas was reduced after the establishment of highway systems. The change in the frequency of use for playing and swimming, on the other hand, could also be associated with the belief that the river takes human lives. The finding that people were consistently *'Never'* throwing garbage into the river then and now was in relation to the policy of the local government which prohibited them from doing so. Garbage was collected regularly in the area, and they believed that the trashes seen in the river were mostly coming from upstream areas.

Perceived Sources of Pollution in Marikina River

The poor water quality of Marikina River is said to be caused by the rapid population increase, which entailed agricultural-to-residential land conversion, illegal settling, and indiscriminate waste disposal by both households and industries (Iglesias & Yu, 2008; Yu & Sajor, 2008). This section discusses the perception of participants on the possible contributions of discharge from industrial sources, sewage from villages and towns, dumping of trash, dumping of factory waste, and seepage from agriculture in the water pollution of Marikina River (Table 3).

Participants generally *'Strongly Agree'* that discharge from industrial sources (48.96%), sewage from villages and towns (42.71%), dumping of trashes (46.88%), and factory wastes (48.96%), and seepage from agriculture (26.04%) were all contributors to the pollution of the river.

Several factors which greatly affect water quality and put in peril the habitat of aquatic organisms are industrialization, anthropogenic activities, urbanization, and land use development (Maglangit et al., 2014). This usually involves the release into the freshwater of effluents starting with metropolitan sewage, animal wastewater, industries and agricultural activities that then result to considerable changes in the water quality (Al-Badaii et al., 2013).

Changes in water quality have detrimental effects on both of the aquatic environment and human health (Naiman & Dudgeon, 2011; O'Toole et al., 2009). This adversely affects the productivity, efficiency, biodiversity, and complexity of the aquatic systems (Labajo-Villantes & Nuñeza, 2014; Martinez and Galera, 2011). Furthermore, polluting water systems can increase the morbidity and mortality of humans as pathogenic microorganisms are introduced into the environment (Odeyemi et al., 2011; Tarkan, 2010; Emeka et al., 2009; Govender et al., 2011; Martinez and Galera, 2011).

Conclusion and Recommendations

This study determined that the 96 participants who were mostly between the ages 31 to 40, married, females, and who were residents of the area for 27.80 years with an average household size of 5.72, generally perceived the water quality of Marikina River as *'Good'* and *'Poor'* then and now, respectively. This difference in the perception of the locals on the past and present status of the river was supported by the claim that the water quality of Marikina River has changed over the past years, in a way that, at present, it already does not serve as a good habitat for wildlife, good area for swimming, and good source of water for drinking, and that it also became more turbid releasing foul odor.

In addition, the activities of the participants with respect to the river have also changed over the past years except for bathing, washing clothes and throwing garbage which they have not performed since then. At present, residents rarely do walking, relaxing, transporting, playing, swimming, fishing, boating, and picnicking within the river area—an observation that is attributed to the poor water quality of the Marikina River.

Furthermore, they typically perceived that discharge from industrial sources, sewage from villages and towns, dumping of trashes and factory wastes, and seepage from agriculture were all high contributors to pollution in the river.

These perceptions on the water quality of the river then agree with the report of Laguna Lake Development Authority (LLDA), the institution responsible for scientifically monitoring the water quality of Marikina River, that it is of poor quality. It is then suggested to continuously monitor and analyze the quality of the river to come up with a more reliable basis of policies or programs to bring the river back to its natural conditions. The perceived contributors of river pollution could then serve as the initial targets to minimize the entry of unwanted pollutants into the river.

Like many other descriptive studies, this research has its limitations. First, this only focused on the residents of two selected barangays which are nearest to the sampling area of the LLDA for its monitoring of the River. To further strengthen the results of this study, it is recommended to extend the survey participants to other barangays along the Marikina riverbanks. Second, the perceived water quality of the Marikina River was used to compare it with its annual scientifically measured quality. However, this research was not able to provide links between the indicators used here, and the indicators being used by the LLDA. It would be better to

assess the relationship between parameters (physico-chemical, microbiological) used by the LLDA, and the anthropogenic activities which were reported in this study as significant contributors to poor water quality of the Marikina River. Lastly, this was only performed once. In line with this, an annual conduct of this study is recommended to come up with a more reliable basis of policies or programs to bring the river back to its natural conditions.

This research is heading towards performing follow-up surveys every five years that will look into the development in the local perceptions of the water quality of Marikina River.

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