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Assessment of Water Management in Gapan City Basis for Policy Legislation

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Abstract
Anthropogenic activities had a great possibility of irrigation canal contamination because of the potential number of contaminants that may accumulate. Brgy. San Vicente in Gapan City had determined to have this threat. This study analyzes the NIA-UPRIIS Irrigation Canal via water quality analysis, administers a research questionnaire to identify the most occurring activities, and reviews the City's existing ordinance to find out if there is any Gap when it comes to water quality management. The mean pH (8.52), Ammonia (1.75 mg/L), Nitrate (9.73 mg/L), and Phosphate (5.90 mg/L) were found to violate the set standard of DAO-2016-08 in Class C Water Bodies given by DENR. Among the three observed anthropogenic activities, Urban Activities were found to be the most occurring event in the Canal. This followed by Household Activities and next by Agricultural Activities. Their total weighted mean was 4.34, 4.12, and 3.76 respectively. In reviewing the city's ordinance, lack of specificity, implementing issues and citizen responsibility were found. First, this was because of the broad spectrum of the already laid out ordinance, which does not address the day's observed problem in the canal. Second, even though there is an ordinance related to water quality management implementation and proper monitoring of it were set aside. Lastly, proper awareness of the citizens still needed to avoid irresponsible practices in the canal.

Keywords: Anthropogenic threats, ordinance, water parameters

1. Introduction

Gapan City is an integral part of the Rice Granary of the Philippines because of the city's agricultural landscape and contribution to the farming industry of Nueva Ecija (Wilbeth *et. al.*, 2021). However, the development of growth corridors in Central Luzon (Danilo & Mariqueen 2022) brings the City of Gapan to rapid urbanization. This event leads to anthropogenic threats that primarily affect the water quality of the National Irrigation Administration – Upper Pamapanga River (NIA-UPRIIS) in Gapan City. Conversely, political aspects in terms of sustainable water resources management play a crucial role in addressing this issue (Amanda *et. al.*, 2022). In the Philippines, water policy is complex, fragmented, and multilayered. In which water management was handled by numerous state and non-governmental organizations with varying mandates and coverage areas (Rosalie *et. al.*, 2018). Thus, freshwater governance is losing its effectiveness (Eliman 2017). If the anthropogenic threats and this impending issue continue, this will likely lead to a future crisis in the availability of safe and adequate sources of freshwater. In this context, the study employed water quality analysis in the NIA-UPRIIS canal to determine if it follows the water quality standard set by DAO-2016-08, thoroughly examined the various anthropogenic

activities seen in the canal and revealed the gaps in the existing ordinance within the LGU. This approach ensured that data are cited as the basis for policy legislation. In brief, this study applies a practical application of policy assessment in ensuring water quality in Gapan City. This was considered valuable insight for the next researcher, policymakers, and key stakeholders in Gapan City, thereby emphasizing the role of Public Administration (PA).

2. Materials and Methods

2.1. Research Locale

The study was conducted in Brgy. San Vicente, Gapan City, Nueva Ecija. The population was 9,092, as determined by the 2020 Census, which is 7.39% of the total population of Gapan. It is situated at approximately 15.3088 and 120.9476 on the island of Luzon. Elevations were estimated to be 25 meters or 82 feet above sea level. Moreover, this barangay where the NIA-UPRIIS canal was situated. The canal under the jurisdiction of the barangay has a length of 1,686.29 meters and a width varying from 9-15 meters.

1a 1b

Figure 1. Study Location: 1a (map of brgy. san vicente) & 1b (map of NIA-UPRIIS).

2.2. Sampling Procedure

A preliminary survey for potential water sample sources was conducted on September 8, 2024, fifteen (15) sampling points were identified. Using DA-GeoCamera the coordinates of the samples location were gathered.

Figure 2. Water Sample Source.

2.3. Research Instrument

Water quality analysis was employed via API freshwater test kit. Based on DAO-2016-08, NIA UPRIIS was classified as Class C water body. Hence, the API, freshwater test kit was used. Moreover, it is reliable, commercial portable water test kit generally used for freshwater (Lih-Jiun *et. al.*, 2019). On the other hand, to determine the most common anthropogenic activities in the canal, research questionnaires were used. This was validated by five experts in various field of agricultural, environmental and urban planning sector. Moreover, the questionnaires were also tested for reliability test and undergone for language evaluation.

2.4 Data Gathering and Procedures

2.4.1. Water Collection Methods

The grab method was used in the collection of water samples for water quality assessment. The collected water samples were placed in a clean plastic bottle and were marked according to their designation. All water samples were brought immediately in testing site for water quality analysis to determine its concentration.

3a 3b

Figure 3. Water Collection and Analysis: 3a (grab method) & 3b (water quality analysis).

2.4.2. Survey Administration

Right after the data for water quality were gathered, the self-evaluated questionnaires for observed anthropogenic activities with crobach's alpha of 0.785 were administered. There hundred ninety (390) residents in the vicinity of the canal were the respondents.

Figure 4. Questionnaire Survey Administration

3. Result and Discussion

3.1 Water Quality Data

Table 1: Water Quality Analysis Result at Different Sampling Point

Station	Parameters			
	pH	Ammonia	Nitrate	Phosphate
Sampling Point 1	8.04	0.75	10.00	1.00
Sampling Point 2	8.62	0.90	14.00	1.60
Sampling Point 3	8.65	0.50	8.00	1.30
Sampling Point 4	8.59	1.20	10.00	0.90
Sampling Point 5	8.73	1.55	0.76	8.00
Sampling Point 6	8.69	1.80	9.00	1.60
Sampling Point 7	8.74	1.20	11.00	1.60
Sampling Point 8	7.32	2.80	20.00	2.00
Sampling Point 9	8.70	2.40	8.00	1.70
Sampling Point 10	8.70	2.50	6.20	1.40
Sampling Point 11	8.64	0.90	18.00	1.40
Sampling Point 12	8.72	3.20	18.00	1.80
Sampling Point 13	8.32	3.20	12.00	2.00
Sampling Point 14	8.58	1.40	10.00	1.80
Sampling Point 15	8.79	2.00	1.00	1.40
TOTAL MEAN	8.52	1.75	9.73	5.90
DAO-2016-08	6.5-8.5	0.05 mg/L	7 mg/L	0.05 mg/L

Out of 15 sampling points (SP), three (3) SP were only found to comply with DAO-2016-08. These were SP1, SP8, and SP13 (8.04, 7.32, 7.32). Water pH is a parameter that is crucial in determining its acid-base balance. It can also determine whether water is acidic or alkaline (Yirdaw *et. al.*, 2016). A slight rise in pH makes ammonia more volatile. All of the water samples at each SP do not meet the set standard of DAO-2016-08.

Moreover, since the canal is situated in an open area, it is impossible to completely rule out the possibility that human activity has had a role. Wherein, human urea and crude oil, which might rise in value, may be present in the effluents. Hence, it affects the water quality of the canal as it is discharged. Water quality analysis shows that only three (3) among 15 SP meet the prescribed concentration by DAO-2016-08. These were SP5, SP10, and SP15 (0.76, 6.20, 1).

In the agriculture sector, where the main purpose of the main canal is used, an excessive level of this parameter can create serious water quality issues (Soumya *et. al.*, 2015). The data on the water quality of Phosphate ranges from 0.90-2.00 mg/L. This means all of the water samples do not meet the standard concentration of DAO-2016-08 which is 0.5 mg/L. Furthermore, according to (Devesh *et. al.*, 2017z), elevated phosphate in irrigation water has detrimental effects and become a major environmental issue.

Table 2: Water Quality Analysis When Group According to Sampling Point

Source	Type III SQ	df	MS	F value	P value	Decision
Corrected Model	1368.333a	65.00	21.05	5.98	0.00	
Intercept	1624.95	1.00	1624.95	461.83	0.00	
pH	349.03	29.00	12.04	3.42	0.03	Reject
Ammonia	8.50	4.00	2.13	0.60	0.67	Accept
Nitrate	8.50	3.00	2.83	0.81	0.52	Accept
Phosphate	27.72	3.00	9.24	2.63	0.11	Accept

On the other hand, result of Multiple Comparison procedure for the statistical comparison of various parameters in fifteen (15) selected SPs of the NIA-UPRIIS Irrigation Canal. Results revealed that the p-value of Ammonia (p=0.67), Nitrate (p=0.52), and Phosphate (p=0.11) is greater than ($\alpha = 0.05$).
Therefore, we fail to reject the null hypothesis for these parameters, indicating a statistically significant difference in these values across the sampling points. However, the null hypothesis only for pH (p=0.03) was rejected and concluded that the still overall water quality assessment of the canal with the various parameters has a significant difference at each sampling point.

3.3 Demographic Profile of the Respondents

Table 5: Demographic Profile of the Respondents

Gender	Frequency	Percentage
Male	223	57.18
Female	167	42.82
Total	390	100.00
Highest educational attainment (HEA)	**Frequency**	**Percentage**
No formal education	160	41.03
Elementary	90	23.08
Highschool	62	15.90
Vocational/technical	62	15.90
College graduate	16	4.10
Postgraduate	0	0.00
Total	390	100.00
Marital status (MS)	**Frequency**	**Percentage**
Single	194	49.74
Maried	129	33.08
Widowed	49	12.56
Divorced/separated	18	4.62
Total	390	100.00
Age	**Frequency**	**Percentage**
18 and below	161	41.28
18-25	56	14.36
26-35	53	13.59
36-45	59	15.13

46-45	38	9.74
56-65	14	3.59
66 and above	9	2.31
Total	390	100.00
Monthly income (MI)	**Frequency**	**Percentage**
Below 10,000	180	46.15
10,001-20,000	66	16.92
20,001-30,000	56	14.36
30,001-40,000	40	10.26
40,001 and above	48	12.31
Total	390	100.00
Number of household (NH)	**Frequency**	**Percentage**
1 to 2	71	18.21
3 to 4	76	19.49
5 to 6	85	21.79
7 and above	158	40.51
Total	390	100.00

a.) Gender: The distribution of the respondents according to their sex characteristics that out of 390 respondents, 223 (57.18%) were male, and 167 (42.82%) were female. This means that more males who lived within the vicinity of the canal participated in the study compared to females.

b.) Highest Educational attainment: The distribution of the respondents according to their highest educational attainment revealed that 160 (41.03%) of the respondents have no formal education; 90 (23.08%) were elementary graduates; 62 (15.90%) were high school graduates; 62 (15.90%) were graduate from vocational/technical course, and only 16 (4.10%) were college graduate. The result implied that most of the respondents having turnover intends hold have no formal education and only a few of the respondents hold Bachelor's Degrees.

c.) Marital Status: The distribution of the respondents according to their MS showed that out of 390 respondents, 194 (49.74%) were single being the highest. On the other hand, the lowest respondents to participated in the survey were divorced/separated, followed by widowed, and next were married.

d.) Age: Out of 390 respondents, about 161 (41.28%) belonged within the age of 18 and below, followed by 59 (15.13%) within the 36-45 age bracket, 56 (14.36%) within the age bracket of 18-25 years old, and 53 (13.59%) were in the bracket of 36-45 years old. This means that most of the respondents in the vicinity of the canal were teenagers up to mid-40's, and can be associated that the remaining respondents were 50s and above.

e.) Income: The distribution showed that 180 (46.15%) of respondents were in the range of monthly income below 10,000; 66 (16.92%) were in the range of 10,001-20,000 monthly income; while 56 (14.36%) were in the range of 20,001-30,000 monthly income. This result implied that most of the respondents were below the minimum wage, which means that they were less fortunate respondents confined within the vicinity of the canal.

f.) Family Size: Among the 390 respondents, 158 (40.51%) have a family size of 7 and above being the highest. Where a family size of 1-2 (18.21%) was the lowest, this dictates most of the respondents lived in a larger size of family.

3.4 Common Anthropogenic Activities in the Canal

Table 6. Most Common Activities in the Canal

A. Household Activities (HA)	Mean	SD	Description
I directly wash clothes in the canal.	3.34	1.42	Neutral
I directly discharge bathroom wastewater into the canal	3.95	1.21	Agree
I directly discharge wastewater from washing dishes into the canal	4.16	1.09	Agree
I directly dispose of solid waste (garbage) into the canal	3.61	1.41	Agree
Overall Weighted Mean	3.76	1.03	Agree
B. Urban Activities (UA)	**Mean**	**SD**	**Description**
I see the direct discharge of wastewater from the drainage into the canal.	4.20	0.89	Strongly Agree
I see the direct discharge of urban runoff, such as wastewater from the streets, into the canal.	4.43	0.79	Strongly Agree
I see vehicle pollution due to oil or fuel leaks going into the canal.	4.45	0.74	Strongly Agree
I see the disposal of electronic waste, such as old devices, into the canal.	4.29	0.92	Strongly Agree
Overall Weighted Mean	4.34	0.63	Strongly Agree
C. Agricultural Activities (AA)	**Mean**	**SD**	**Description**
I see the runoff of manure from poultry and piggery operations flowing into the canal.	3.74	1.26	Agree
I see the discharge of agricultural waste, including pesticides, insecticides, and fertilizer packages, into the canal.	4.15	1.12	Agree
I see the disposal of dead animals in the canal	4.36	0.86	Strongly Agree
I see the burning of crop residues near the canal, contributing to pollution	4.22	1.01	Strongly Agree
Overall Weighted Mean	4.12	0.78	Agree

a.) Household Activities: Anthropogenic threats from household activities obtained an overall weighted mean of 3.76, which was verbally described as "Agree." The highest item in this indicator was item "I directly discharge wastewater from washing dishes into the canal.", with a mean of 4.16 verbally described as "Agree," while the lowest was item " I directly wash clothes in the canal." with a mean of 3.34 which was verbally described as "Neutral." This implies that the lack of septage tanks was a common problem in the area. Hence, the respondent has no other choice but to directly discharge their wastewater from their chores in the canal.

b.) Urban Activities: The overall weighted mean was 4.34, which was verbally described as "Strongly Agree". The item's means were ranged from 4.45-4.20. The highest mean in this indicator was item "I see vehicle pollution due to oil or fuel leaks going into the canal.", while the lowest mean was item "I see the direct discharge of wastewater from the drainage into the canal.". Both were verbally described as "Strongly Agree." This result implies that respondents were aware of the threat brought by urban activities in the canal.

c.) Agricultural Activities: These anthropogenic activities got an overall weighted mean of 4.12, which was verbally described as "Agree". The highest mean in this indicator was item "I see the disposal of dead animals in the canal.", with a mean of 4.36. On the other hand, the item "I see the runoff of manure from

poultry and piggery operations flowing into the canal." was the lowest having a mean of 3.74. This implies that the respondents have an awareness of the threats from animal and agricultural waste that is occurring in the canal.

3.5 Water Policy in Gapan City

The current water management ordinance in Gapan City is broad and lacks specific provisions addressing the unique challenges of the NIA canal. First, the lack of specificity was found. The existing ordinance does not adequately address today's problems such as pollution sources affecting the NIA canal, including vehicle pollution due to its leak of oil or fuel going into the canal, disposal of dead animals, and direct discharge of wastewater from dishes. Second, implementation issues were where significant shortcomings in enforcement were happening, including insufficient monitoring, lack of employment resources, and unclear penalties for violations of some ordinances. Lastly, citizen responsibility, the irresponsible practices by citizens still contribute to water quality degradation, indicating a need for increased awareness and accountability not just for the LGU, but also for the people along the vicinity of the canal.

4. Conclusion

Based on the gathered data and results obtained, the following was concluded:

1. Water quality analysis conducted in the NIA UPRIIS Irrigation reveals that the mean of fifteen (15) selected sampling points were found to have a violation of the set standard of DAO-2016-08.
2. The frequency of the demographic profile reveals that most of the residents in the vicinity of the canals were males, in total of 223. Moreover, comparing their educational attainment, it was revealed that most of them have no formal education, with a total of 160. Furthermore, the highest frequency in terms of respondents' marital status, age, and monthly income were 129 (single), 161 (18 and below), and 180 (10,000 below). Also, frequency implies that most of the respondents live in a large number of households, which is seven and above.
3. Among the three observed anthropogenic activities in the canal, Urban Activities were found to be the most common. It has a total weighted mean of 4.34, which has a verbal interpretation of "Strongly Agree." The highest item in this activity was "I see vehicle pollution due to oil or fuel leaks going into the canal," which has a mean of 4.45. This was followed by Agricultural Activities, which has a total weighted mean of 4.12, which is verbally interpreted as "Agree." The item "I see the disposal of dead animals in the canal" was found the be the highest mean at 4.36. Next to this was the Household activities that had a total weighted mean of 3.76, which is interpreted as "Agree." In this part, the item "I directly discharge wastewater from washing dishes into the canal" was found to be the common one which has a mean of 4.16.
4. The four ordinances/executive orders (EO NO. 35 S-2023, CITY ORDINANCE NO. 2 S-2018, CITY ORDINANCE NO. 20 S-2017, and ANTI-POLLUTION ORDINANCE NO. 2 S-1975) in the LGU related in water quality management in the city reveals that there is a Gap. Wherein, even though there is an existing ordinance it does not address the observed problems in the NIA-UPRIIS Irrigation Canal. Moreover, the angle of shortcomings for implementors was significantly high, which resulted in water quality degradation in the canal. Added to this were the irresponsible practices of citizens in the vicinity of the canal.

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