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Research Article

Green Infrastructure: Flood Control and Water Management

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ABSTRACT

Water scarcity is a pressing issue in many parts of the world. One innovative solution to this problem is rainwater harvesting, which involves collecting and storing rainwater for later use. The study aims to install a rainwater harvesting and treatment system to :1. Reduce water loss by its running-off.2 Meeting the demands of increasing water. 3. Reducing groundwater contamination.4. Increase available water during dry season.5. Reduce flooding and potentially prevent flooding of roads. This is a descriptive research method and is purely qualitative. It used Focus Group Discussion (FGD), Interview, and secondary data to get the necessary information from three Consultants, three Executives, and four Professors who are experts in the field. The study found that the rainwater harvesting and treatment facility would be a feasible project. It would minimize water consumption costs and reduce flooding in the city, with potential for replication by other universities, governments, and private entities.

Keywords: *Eco-friendly architecture, Green infrastructure, Renewable resources, Water management*

Introduction

The Philippines is vulnerable to natural calamities like typhoons, storm surges, tsunamis, and earthquakes because it is located in a part of the Pacific Ring of fire. Approximately 20 typhoons per year, the highest frequency in the world. Due to its destructive results that put lives in danger and property destruction in the affected areas, flooding is one of the most significant and common natural disasters. The phenomena frequently lead to flooding, limited river channel capacity, human habitation in low-lying locations, and a rapid increase in habitation without enhancing the drainage systems. (Cabrera et al, 2020). Flooding is a serious threat to human life, with the United Nations estimating that it killed 157,000 people between 1995 and 2015 and affected 2.3 billion

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others. Economic and social development are both negatively impacted by flooding. Globally, the cost of flood damage and related losses is projected to be over $104 billion annually. The risk of urban flooding is rising as more impermeable surfaces are built at the expense of porous green spaces. (Li et al., 2020).

Plans for green infrastructure can set the stage for future development while preserving significant natural and cultural resources for future generations (McMahon, Edward, 2000). Green Infrastructure is a strategically planned network of high-quality natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services and protect biodiversity in rural and urban settings. More specifically, GI, a spatial structure providing natural benefits to people, aims to enhance nature's ability to deliver multiple valuable ecosystem goods and services, such as clean air or water." European Union (2013). Countries must give wastewater treatment greater attention and increase efficiency using green technology to achieve the harmonious development of economic growth and the environment. (Kumar et al, 2022).

All natural, semi-natural, and artificial networks of multifunctional ecological systems within, around, and between urban areas at all geographical scales have been referred to as green infrastructure (GI). This definition covers various ecosystem types that offer various Ecosystem Service (ES) bundles. Some of these regulating services, such as climate, air quality, water flow, and water purity, are essential in urban settings. (Maragno et al, 2018).

Green industrial design may enhance environmental quality, encourage sustainable economic growth, and translate technological innovation into green technology innovation. Chengchao, et al, 2021). Green technology innovation achieves economic benefits via traditional technological innovation, while on the other hand, it realizes the internalization of external environmental pollution (Dai et al., 2021). Governments at local levels are increasingly considering passing legislation to support green infrastructure. By exploiting and imitating natural systems to collect, treat, and infiltrate rain where it falls, stormwater management and green infrastructure are intended to reduce the production of urban stormwater runoff and related pollution. Zellner, M,et al, 2016). Green architecture, commonly called sustainable architecture or "green building," is the philosophy, science, and design aesthetic for structures developed and built in compliance with green building practices. In addition to reducing the number of resources used in the building's construction, usage, and operation, green architecture aims to lessen the damage that its constituent parts cause to the environment through emissions, pollution, and waste. (Ragheb et al, 2016).

Urban flooding is becoming more frequent and intense, a global issue. Residents of industrialized cities with outdated combined sewer systems and towns with less centralized stormwater, fecal sludge, and wastewater management infrastructure are directly impacted by flooding. Green infrastructure is becoming increasingly well-liked as a sustainable approach to flood management. (Venkataramanan, 2019). This study modeled green innovation, which is the creation and application of green innovation, the developing of novel goods and procedures to fulfill environmental goals, and the ecological impact of the entire production process and the product life cycle. (Lin et al., 2014).

The objectives of the study are:1. Reducing Loss of Water by its running-off. 2. Meeting the demands of increasing water. 3. Reducing groundwater contamination. 4. Increasing available water during dry season. 5. Reduce flooding and potentially preventing flooding of roads. To propose the installation of a rainwater harvesting and treatment system. We proposed a rainwater harvesting system that collects rainwater from the roof of a building and stores it in a cistern tank. The collected rainwater is then filtered using another cistern and pumped to a 3-story high tower for flushing and lavatory water use. The system can be powered using a booster pump and connected to a solar panel for more sustainable and eco-friendly operation.

This system will reduce the water consumption of an increasing number of building occupants and provide an alternative to retained water from the rain, which can often cause flooding outside the campus. If the study succeeds, this system can be applied to all buildings, contributing to the United Nation's sustainability developmental goal. This study addresses United Nations (UN) Clean Water and Sanitation (SDG6), Affordable and Clean Energy (SDG7), and Industry, Innovation, and Infrastructure (SDG8). To promote sustainable development, the government should logically create environmental regulations based on regional differences, promote inter-regional communication and collaboration, and foster regional green technology innovation more effectively. (Liu et al., 2022).

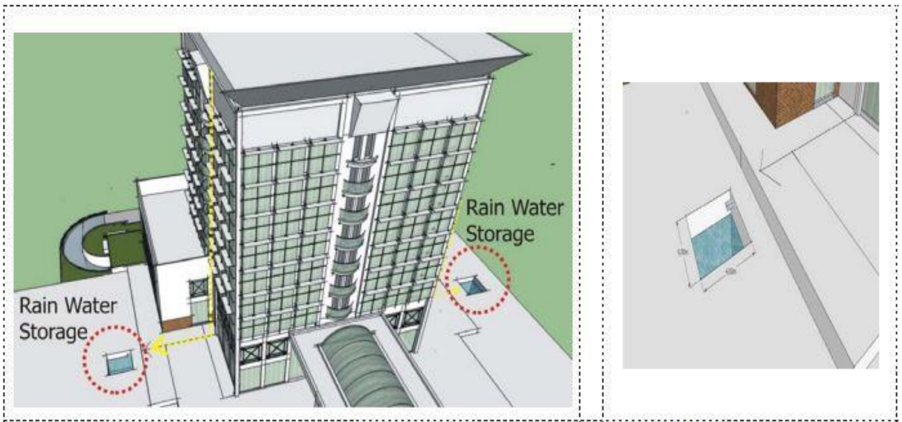
Sample of Rainwater Harvesting in Australia

The picture depicts an instance of Exposed Rainwater Harvesting Polypropylene (PP) employed in industrial buildings. This technique utilizes a filter to gather and treat rainwater for various purposes like irrigation, toilet flushing, and drinking. Polypropylene, a commonly used plastic material, is intended for use in Rainwater Harvesting Systems. These systems comprise pipes and fittings that collect rainwater from open areas and store it in tanks.

Source: Cleanawater. (n.d.). Above Ground vs. Below Ground Rainwater Harvesting. Retrieved March 30, 2023, from https://cleanawater.com.au/information-centre/above-ground-vs-below-ground-rainwater-harvesting

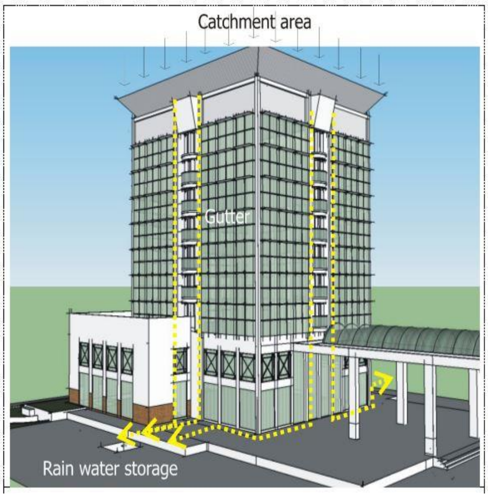
Sample of Rainwater Harvesting in Indonesia

This illustrates collecting rainwater through a technique commonly known as rainwater storage or harvesting. The process involves channeling rainwater from the roof of a building through a pipe into a storage tank at the bottom of the building. Collecting the runoff water is conserved and can be utilized for various human needs.



Rain Water Storage

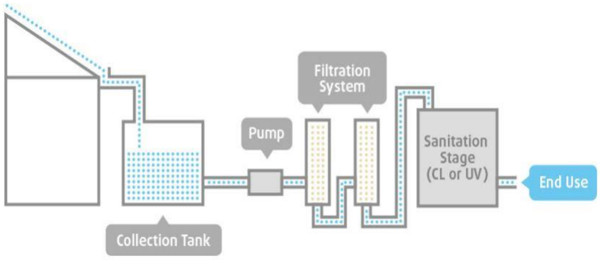
Rainwater storage tanks harvested in this design are based on 10-year rainy volume periods. It is to anticipate if there is a rainfall period of 10 years, storage can accommodate the rain volume. The rainwater storage is made underground by utilizing the existing gutter pipe and creating an additional channel to flow rainwater from the existing gutter to the reservoir.



Source: Endah Lestari et al 2020 IOP Conf. Ser.: Mater. Sci. Eng. 852 012054

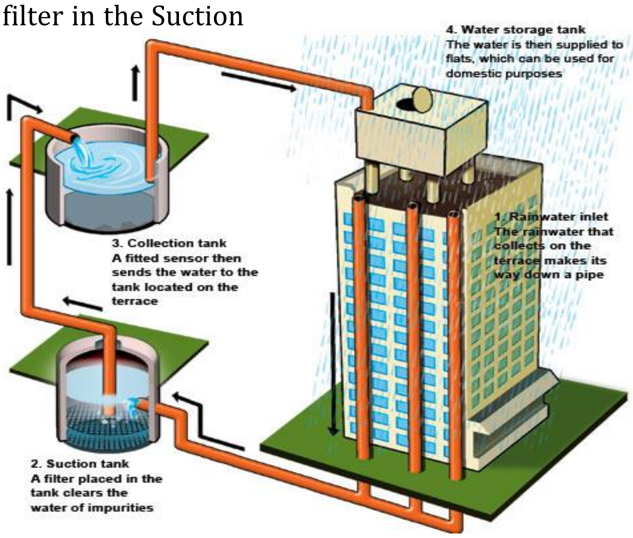
Rainwater Harvesting System

It describes the rainwater harvesting system, in which rainwater from the roof is collected in a tank specifically designed for rainwater. The water is then pumped to increase its pressure and sent through a filtration system to treat it. After that, it is stored in a cistern tank for future use in human needs.



Source: Cleanawater. (n.d.). Guide to rainwater harvesting and treatment. Retrieved March 30, 2023, from https://cleanawater.com.au/information-centre/guide-to-rainwater-harvesting-and-treatment

The image illustrates how the Rainwater Harvesting System functions. In this case, rainwater is gathered on the terrace, flows down a pipe, and passes through a filter in the Suction Tank to remove impurities. The filtered water is then stored in the Collection Tank for later use and distribution throughout the area.



Source: Penguin Polyfoam. (n.d.). Start Rain Water Harvesting Today. Retrieved March 30, 2023, from http://penguinpolyfoam.com/start-rain-water-harvesting-today/

Methods

It is a descriptive research study and purely qualitative. It used Focus Group Discussion (FGD), Interviews, and secondary data to get the needed information from three Consultants, four Executives, and three Professors who are experts in the field. The FGD is a very effective tool for getting reactions, comments, and suggestions from the chosen experts in the area.

Research Respondents

Ten participants in the study were three Consultants, three Executives, and four Professors. Purposive Sampling was used to get the data and information from the experts in the field. Their comments and suggestions help a lot in the planning, process, development, and implementation of the rainwater harvesting system of the university.

Results and Discussion

Mean = Total Water Consumption Bill of CTU-Main Campus/number of months

Mean = 8,316,525/12

= ₱693,043.75

[Average Costing of CTU-Main Campus/month (Water Consumption)]

There are 7 active buildings in CTU-Main Campus:

1.) Engineering
2.) Sci-Tech
3.) Centennial
4.) 7-storey
5.) Education
6.) COT
7.) ICT

Ratio and proportion:

1:7

Average Costing of CTU-Main Campus/month (Water Consumption)/number of active buildings

= 693,043.75/7

= 99,006.25/2 (since we're only using 3 floors of Sci-Tech which has 6 floors)

= 49,503.125

(Assumed individual costings of each building)

Given that the estimated average monthly demand at Sci-Tech from ground floor to third floor is 25.738 m^3/day:

CLASSIFICATION	SIZE	MINIMUM CHARGE	COMMODITY CHARGE			
			11-20 m3	21-30 m3	31-40 m3	41 m3 up
Residential/ Government	½"	280.00	30.80	34.30	38.50	43.40

Solution:

Minimum charge + (11-20m3) x (estimated average monthly demand at Sci-Tech) + (21-30m3) x (estimated average monthly demand at Sci-Tech)

280 + (30.80 x 10) = 588

(34.30 x 5) = 171.5

171.5 + 588 = 759.5 (daily charge per person)

759.5 x 30 = **₱22,785.00**

(Average monthly costing of water bills at Sci-Tech building from ground floor to third floor)

Assumed individual costings of each building - Average monthly costing of water bills at Sci-Tech building from ground floor to third floor
₱49,503.125 - ₱22,785.00
= **₱26,718.125**
[Monthly cost left to pay (Sci-Tech)]

To determine the monthly water consumption, we multiplied the daily water consumption of 25.738 m^3 by 30 to get 772.14 cu.m (monthly water consumption). Then, we subtracted the volume of rainwater tanks (220 cu.m.) from the monthly water consumption (772.14 cu.m.) resulting in 552.14 cu.m.

Given that the estimated average monthly demand at Sci-Tech from ground floor to third floor is 220 m^3:

CLASSIFICATION	SIZE	MINIMUM CHARGE	COMMODITY CHARGE			
			11-20 m3	21-30 m3	31-40 m3	41 m3 up
Residential/ Government	½"	280.00	30.80	34.30	38.50	43.40

Solution:

Minimum charge + (11-20m3) x (estimated average monthly demand at Sci-Tech) + (21-30m3) x (estimated average monthly demand at Sci-Tech) + (31-40m3) x (estimated average monthly demand at Sci-Tech) + (41m3 up) x (estimated average monthly demand at Sci-Tech)
280 + (30.80 x 10) + (34.30 x 10) + (38.50 x 10) = 1,316
(43.50 x 10) x 18 (to get the 220 cu.m.) = 7,830
1,316 + 7,830 = ₱9,146.00
[Average costing water bills that could be saved by the use of rainwater tanks (Sci-Tech bldg.)]

Average monthly costing of water bills at Sci-Tech building from ground floor to third floor – Average costing water bills that could be saved by the use of rainwater tanks (Sci-Tech bldg.)
₱22,785.00 - ₱9,146.00 **= ₱**13,639.00
[Monthly cost left to pay (Sci-Tech) with the help of rainwater tanks]

Monthly cost left to pay (Sci-Tech) with the help of rainwater tanks/Average monthly costing of water bills at Sci-Tech building from ground floor to third floor
₱13,639.00/₱22,785.00 = 0.59 x 100%
= 59.86%
(Percentage of the average costing water bills that could be saved by Sci-Tech bldg. through the usage of rainwater tanks)

The Science and Technology Building has a roof area of 654 square meters, and the Average Annual Rainfall in Cebu City, Philippines, is 1,340 millimeters, according to PAGASA's Rainfall Data. By using the Monthly Rainfall, Roof Area, and Runoff Coefficient 85% (Refer to Figure 2), we calculated the Available Rainwater per month to be 744,906 liters, with an Average Monthly Supply of 62,075.50 liters or 62.08 cubic meters (Refer to Figure 2). Although seven buildings are currently in use on the campus, including Engineering, Science and Technology, Centennial, 7-story, Education, COT, and ICT, we will specifically focus on the Science and Technology building for this discussion. According to Table B-3 from the Revised Plumbing Code of the Philippines, the total water consumption of every person in a School building, including staff and office workers, as well as intermediate and college level students, is 75.7 liters per day.

CTU-Main Campus Rainwater Harvesting System

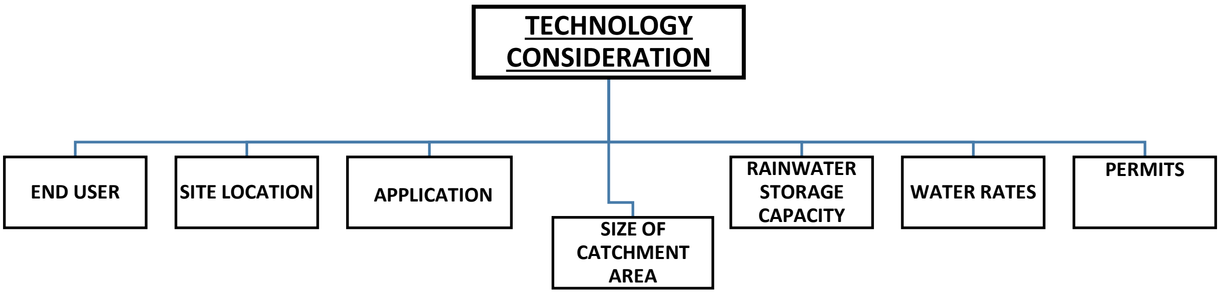


Figure 1-Technology Consideration

The university is the end user and the Science and Technology Building is the site location. It aims to minimize water loss due to run-off, meet the increasing water demand, reduce groundwater contamination, provide more available water during the dry season, and lessen flooding by using a Rainwater Harvesting System. The Catchment Area (Settling Tank) measures 1.8m x 8m x 15.3m and the Rainwater Storage Capacity is 220 cu.m. Rainwater harvesting systems (RWHS) substantially impact both urban and rural sustainability. These systems offer various advantages, such as improved stormwater management and their more obvious ones (such as the ability to supply water in a decentralized manner and enhance local water security) (de Sá Silva et al., 2022).

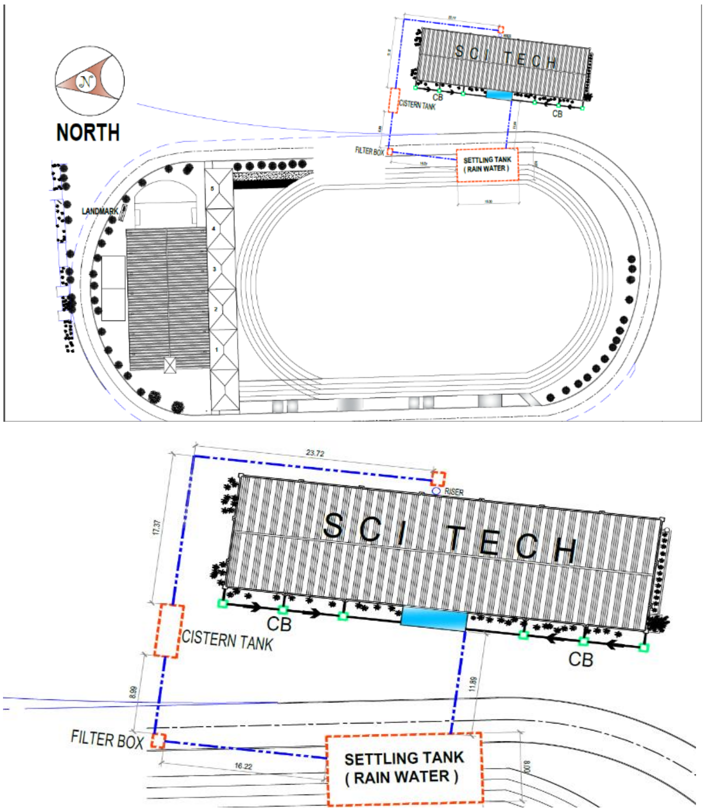


Figure 2. Plan for the Sci-Tech Building where the Proposed Rainwater Harvesting System will be installed.

It is a plan for developing the rainwater system in the Sci-Tech building. We plan to use this site to model our proposed rainwater harvesting system. The system will collect rainwater from the roof of the building and direct it to a downspout, which will lead to a settling tank. The settling Tank will have three chambers to reduce the number of particles in the rainwater. From there, the water will be sent to a filter box, which will be treated using natural methods such as pea gravel, pool filter sand, drain rock, zeolite chemical, etc. The treated water will then be stored in a cistern tank, which is the final stage of water treatment. To supply water to the higher floors of the building, a water pump will be used to increase the water pressure. The water pump will be generated by a photovoltaic solar pane.

Proposed Rainwater Harvesting Maintenance System

Table 1 shows the rainwater harvesting maintenance system, which guides the entire process from collection system, storage tank, overflow, controls, treatment system, pump, flow meter, power supply, water level indicator, and potable water connection. The detailed maintenance of each component and its corresponding frequency needed to maintain the water's quality, safety, cleanliness, and portability are clearly described and explained—proper administration, operations, and maintenance training to enhance and sustain water services. (Osumanu,et al, 2022).

Table 1-Proposed Rainwater Harvesting Maintenance System

COMPONENTS	MAINTENANCE	FREQUENCY
1. Collection System	Keep clean and clear of excessive debris, especially after prolonged dry periods or after storms.	Weekly
2. Storage Tank	Inspect the Tank for cracks or leakage.	Annually
3. Overflow	Visually inspect the overflow spout to ensure it is clear of debris.	Monthly
4. Controls	Check that wiring is in good condition.	Monthly
5. Treatment System	Clean and replace filters at manufacturer-specified intervals.	Manufacturer-specified intervals
6. Pump	Check motor condition. Investigate excessive vibration, noise, or temperature.	Monthly; Manufacturer-specified intervals
7. Flow Meter	Ensure the meter is calibrated per meter manufacturer instructions.	Monthly
8. Power Supply	Check power supply and equipment after power outages and ensure no damage to components.	As needed, Manufacturer-specified intervals
9. Water Level Indicator	Ensure the indicator is functioning as intended.	Monthly
10. Potable Water Connection	Comply with any regulations for testing required by local ordinances.	Annually

Table 2, shows that the ground floor of the building contains classrooms that accommodate 340 people (Refer to Figure 6), while the second and third floors have offices and laboratories that accommodate only a few individuals, totaling 240 people. Using this information, we multiply 75.7 (Refer to 5) by 340 (Refer to Figure 6) to get 25,738 liters daily. We then convert this to cubic meters, which equals 25.738 m^3 per day (estimated average monthly demand at Sci-tech ground floor to third floor).

Table 2 - Building Accommodation

TABLE B-3

Estimated Waste/Sewage Flow Rates

Because of the many variables encountered, it is not possible to set absolute values for waste/sewage flow rates for all situations. The designer should evaluate each situation and, if figures in this table need modification, they should be made with the concurrence of the Administrative Authority.

	Type of Occupancy	Liters Per Day
1.	Airports	56.8 per employee 18.9 per passenger
2.	Auto washers	Check with equipment manufacturer
3.	Bowling alleys (snack bar only)	283.9 per lane
4.	Camps:	
	Campground with central comfort station	132.5 per person
	With flush toilets, no showers	94.6 per person
	Day camps (no meals served)	56.8 per person
	Summer and seasonal	189.3 per person
5.	Churches (Sanctuary)	18.9 per seat
	With kitchen waste	26.5 per seat
6.	Dance halls	18.9 per person
7.	Factories	
	No showers	94.6 per employee
	With showers	132.5 per employee
	Cafeteria, add	18.9 per employee
8.	Hospitals	946.3 per bed
	Kitchen waste only	94.6 per bed
	Laundry waste only	151.4 per bed
9	Hotels (no kitchen waste)	227.1 per bed (2 person)
10.	Institutions (Residents,	283.9 per person
	Nursing home	473.1 per person
	Rest home	473.1 per person
11.	Laundries, self-service	
	(minimum 10 hours per day)	189.3 per wash cycle
	Commercial	Per manufacturer's specifications
12.	Motel	189.3 per bed space
	With kitchen	227.1 per bed space
13.	Offices	75.7 per employee
14.	Parks, mobile homes	946.3 per space
	Picnic parks (toilets only)	75.7 per parking space
	recreational vehicles –	
	without hook-up	283.9 per space
	with water and sewer hook-up	378.5 per space
15.	Restaurants – cafeterias	75.7 per employee
	Toilet	26.5 per customer
	Kitchen waste	22.7 per meal
	Add for garbage disposal	3.8 per meal
	Add for cocktail lounge	7.6 per customer
	Kitchen waste –	
	Disposable service	7.6 per meal
16	Schools - Staff and office	75.7 per person
	Elementary students	56.8 per person
	Intermediate and high	75.7 per student
	With gym and showers, add	18.9 per student
	With cafeteria, add	11.4 per student
	Boarding, total waste	378.5 per person
17.	Service station, toilets	3785 for 1st bay 1892.5 for each additional bay
18.	Stores	75.7 per employee
	Public restrooms, add	4 per sq. m. of floor space
19		
20	Swimming pools, public	37.9 per person
	Theaters, auditoriums	18.9 per seat
	Drive-in	37.9 per space

(a) Recommended Design Criteria. Sewage disposal systems sized using the estimated waste/sewage flow rates should be calculated as follows:

(1) Waste/sewage flow, up to 5677.5 L/day
Flow x 1.5 = septic tank size.

(2) Waste/sewage flow, over 5677.5 L/day
Flow x 0.75 + 1125 = septic tank size

(3) Secondary system shall be sized for total flow per 24 hours

(b) Also see Section B 2 of this Appendix.

Schools – For staff use All schools	Male 1: 1-15, 2: 16-35, 3: 36-55; Female 1: 1-15, 3: 16-35, 4: 36-55 Over 55, ad 1 fixture for each additional 40 persons	1 per 50	Male 1 per 40; Female 1 per 40		

50

Revised National Plumbing Code of the Philippines

Schools – For student use Nursery	Male 1: 1-20, 2: 21-50; Female 1: 1-20, 2: 21-50 Over 50, add 1 fixture for each additional 50 Persons		Male 1: 1-150, 2: 26-50; Female 1: 1-25, 2: 26-50 Over 50, add 1 fixture for each additional 50 persons		1 per 75[12]
Elementary		1 per 75			1 per 75[12]
Secondary	Male 1 per 30; Female 1 per 25	1 per 35	Male 1 per 35; Female 1 per 35		1 per 75[12]
Others (Colleges, Universities, Adult Centers, etc.)	Male 1 per 40; Female 1 per 30 Male 1 per 40; Female 1 per 30	1 per 35	Male 1 per 40; Female 1 per 30 Male 1 per 40; Female 1 per 30		1 per 75[12]
Worship Places Educational and Activities Unit	Male 1 per 25, 2: 126-250; Female[14] 1 per 75, 2: 76-125, 3: 126-250	1 per 25	1 per 2 water closets		1 per 75[12]
Worship Places Principal	Male 1 per 150; Female[14] 1 per 75	1 per 150	1 per 2 water closets		1 per 75[12]

Whenever urinals are provided, one (1) water closet is subtracted from the number specified on the table, except that the number of water closets in such cases shall not be reduced to less than two-thirds (2/3) of the minimum specified.

Source: Revised National Plumbing Code of the Philippines

The first step is to determine the amount of water consumed by a person per day. Using the given data, we multiplied the highest number of occupants 340 (Refer to Figure 6) by the water consumption rate (75.7) (Refer to Figure 5), resulting in a total water consumption of 25,738 liters or 25.738 m^3 per day. This value was the estimated average daily demand for the Sci-Tech building. Using a water bill computation method, we calculated the cost of water usage, which was ₱759.5 per day (daily charge per person or ₱22,785.00 per month (Average monthly costing of water bills at Sci-Tech building from ground floor to third floor). By multiplying this monthly cost by 12, we arrived at the annual water consumption cost which is ₱8,316,525.00.

To determine the monthly water consumption, we multiplied the daily water consumption of 25.738 m^3 (Estimated average monthly demand at Sci-tech from ground floor to third floor) by 30 to get 772.14 cu.m. Then, we subtracted the volume of rainwater tanks (220 cu.m.) from the monthly water consumption 772.14 cu.m. (monthly water consumption), resulting in 552.14 cu.m. Dividing this annual cost by 12, we arrived at a monthly cost of ₱693,043.75, which was then divided by the number of buildings (7) and floors in the Sci-Tech building to determine the estimated individual cost of water consumption for Sci-Tech. Subtracting this estimated monthly cost (₱49,503.125) from the actual monthly cost (₱22,785.00) gives us the remaining cost to pay (₱26,718.125).

Finally, we calculated the percentage of the average cost of water bills that can be saved by Sci-Tech building through the use of rainwater tanks, which is 59.86%.

- **Assumed individual costings of each building**

= 693,043.75/7

= 99,006.25/2 (since we're only using 3 floors of Sci-Tech)

= 49,503.125

- **Average costing of water bills at Sci-Tech building from ground floor to third floor**
  Given that the estimated average monthly demand at Sci-Tech from ground floor to third floor is 25.738 m^3/day:

CLASSIFICATION	SIZE	MINIMUM CHARGE	COMMODITY CHARGE			
			11-20 m3	21-30 m3	31-4 m3	41 m3 up
Residential/ Government	½"	280.00	30.80	34.30	38.50	43.40

Solution:

280 + (30.80 x 10) + (34.30 x 5)

759.5 x 30 = ₱22,785.00

- **Monthly cost left to pay (Sci-Tech)**

₱49,503.125 - ₱22,785.00 = **₱26,718.125 to pay**

To determine the monthly water consumption, we multiplied the daily water consumption of 25.738 m^3 by 30 to get 772.14 cu.m. Then, we subtracted the volume of rainwater tanks (220 cu.m.) from the monthly water consumption (772.14 cu.m.) resulting in 552.14 cu.m.

- **Average costing water bills that could be saved by the use of rainwater tanks (Sci-Tech bldg.)**
  Given that the estimated average monthly demand at Sci-Tech from ground floor to third floor is 220 m^3:

CLASSIFICATION	SIZE	MINIMUM CHARGE	COMMODITY CHARGE			
			11-20 m3	21-30 m3	31-4 m3	41 m3 up
Residential/ Government	½"	280.00	30.80	34.30	38.50	43.40

Solution:

280 + (30.80 x 10) + (34.30 x 10) + (38.50 x 10) + (43.50 x 10) + (43.50 x 10) + (43.50 x 10) + (43.50 x 10) + (43.50 x 10) + (43.50 x 10) + (43.50 x 10) + (43.50 x 10) + (43.50 x 10) + (43.50 x 10) + (43.50 x 10) + (43.50 x 10) + (43.50 x 10) + (43.50 x 10) + (43.50 x 10) + (43.50 x 10) + (43.50 x 10) + (43.50 x 10)

= **₱9,146.00 save**

- **Monthly cost left to pay (Sci-Tech) with the help of rainwater tanks**

₱22,785.00 - ₱9,146.00 **= ₱13,639.00 total remaining payment with the use of rainwater tanks**

- **Percentage of the average costing water bills that could be saved by Sci-Tech bldg. through the usage of rainwater tanks**

₱13,639.00/₱22,785.00= 0.59 x 100 = **59.86%**

Finally, we calculated the percentage of the average cost of water bills that can be saved by Sci-Tech building through the use of rainwater tanks, which is 59.86%.

To sum up, using rainwater tanks can result in substantial savings on water bills for the Science and Technology building. Rather than paying ₱49,503.125 per month for the building's water consumption on three floors, the campus could spend only about ₱26,718.125 using rainwater tanks. It is due to the average savings of around ₱₱22,785.00 on water bills that could be achieved using rainwater tanks.

Using rainwater tanks can save up to 59.86% of their usual costs at the Science and Technology building for the three floors. Additionally, the rainwater tanks can collect an average monthly supply of 62.08 cu.m. of rainwater which can help prevent flooding on the campus. This approach can create a significant positive impact, mainly since the campus is susceptible to flooding. Overall, using rainwater tanks can serve as an excellent innovation to mitigate environmental concerns in the region.

Integrating rainwater tanks on the campus can effectively tackle the problem of flooding, a prevalent concern in the region. It is considered one of the most practical and effective measures to deal with this environmental problem, and it can substantially change the campus. The entire projected cost of the project is ₱3,430,000.00, broken down into three main components: Tank Fittings & Accessories costing 201,271.50, Poured Reinforced Concrete which is the Settling Tank (1.8m x 8m x 15.3m), Cistern Tank (1.8m x 2.20m x 6m), and Filter Box (1.3m x 1.2m x 1.0m) totaling 2,003,143.50, and Solar Panels for the 1.5HP Pump with a working time of 20 hours which costs 512,055.00. Additionally, there is an 8% allowance for Overhead, Contingencies, and Miscellaneous expenses (OCM), a 10% profit for the contractor, and a 7% charge for Value Added Tax (VAT) and Expanded Withholding Tax (EWT).

Proposed Estimated Budget

- Material Cost ₱ 2,012,200.00
- Labor Cost ₱ 704,270.00
- Overhead ₱ 713,345.02
- Total ₱ 3,500,000.00

Breakdown of Budget:

1. For Internal funding- P300,000.0
2. External Funders- P3,200,000.00

ROI Water Savings- 59.86% estimated reduction on the monthly water bill.

Conclusion

This proposed water-efficient technology is central to the conservation of tackling water scarcity; with harnessing technology in nature, we see the role in meeting the challenges of water scarcity by designing and installing commercial water harvesting and water treatment solutions for the university. The application of this technology includes reducing water usage at the campus, such as ancillary use and toilet and urinal flushing. By encouraging sustainable practices, we hope to be leaders in water management, reduce the impact of water scarcity & reduce flooding and erosion.

In summary, using rainwater tanks can result in substantial savings on water bills for the Science and Technology building. Rather than paying ₱49,503.125 per month for the building's water consumption on three floors, the campus could spend only about ₱26,718.125 using rainwater tanks. It is due to the average savings of around ₱₱22,785.00 on water bills that could be achieved using rainwater tanks.

Using rainwater tanks can save up to 46% of their usual costs at the Science and Technology building for the three floors. Additionally, the rainwater tanks can collect an average monthly supply of 62.08 cu.m. of rainwater which can help prevent flooding on the campus. This approach can create a significant positive impact, mainly since the campus is susceptible to flooding. Overall, using rainwater tanks can serve as an excellent innovation to mitigate environmental concerns in the region.

Integrating rainwater tanks on the campus can effectively tackle the problem of flooding, a prevalent concern in the region. It is considered one of the most practical and effective measures to deal with this environmental problem, and it can substantially change the campus.

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