Development of Multi-Criteria Assessment Tool for The Management Planning of Sustainable Urban Drainage: The Case Study of Bulaon Resettlement, City of San Fernando, Pampanga

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Abstract—Flood Mitigation Management (FMM) plays a vital role in reducing the adverse impacts of floods on different levels. The conventional urban drainage system which comprises of pipes and drains has been the primary target of FMM. Nonetheless, this system has been considered insufficient in addressing the challenges of flooding caused by rapid urbanization and climate change. The adoption of Sustainable Urban Drainage Systems (SUDS) presents a viable alternative, although their implementation is frequently difficult due to the intricate nature of incorporating sustainability principles into stormwater management. This study formulated an assessment tool that leverages the PESTLE framework to evaluate the suitability of locales for SUDS adaptation. The tool examined a range of external factors, encompassing political, economic, social, technological, legal, and environmental aspects that could impact the successful integration of SUDS. By utilizing the PESTLE framework, decision-makers and stakeholders gained valuable insights into specific areas that demand greater attention during the development and implementation of SUDS adaptation strategies for effective flood mitigation. This comprehensive understanding of external factors facilitated a more informed decision-making process. The assessment tool was designed with a specific focus on the Bulaon Resettlement barangay. Results indicate that the area faces significant data gaps that could impact the successful adaptation of SUDS. Consequently, the study recommends the development or updating of current data to increase the likelihood of successful SUDS adaptation. In conclusion, the developed assessment tool based on the PESTLE framework has the potential to improve flood mitigation management by providing decision-makers and stakeholders with a comprehensive understanding of locales' adaptation to SUDS. This would enable them to identify areas requiring focus and improvement when designing and implementing SUDS adaptation strategies, thus ensuring effective management of flood mitigation.

Indexed Terms—Flood Mitigation Management, PESTLE Framework, Sustainable Urban Drainage Systems

I. THE PROBLEM AND ITS REVIEW OF RELATED LITERATURE AND STUDIES

1.1 Introduction

Urban Drainage Systems (UDS) present a typical set of contemporary environmental challenges, including the need for technical advancements in existing systems that are economically viable and socially acceptable as well as the evaluation of those systems' effects as well as the pursuit of resilient and sustainable solutions (Butler et al, 2018).

Sustainable Urban Drainage Systems (SUDS) offer an alternative to conventional pipe-based drainage systems by employing natural drainage principles that predate their invention. Unlike traditional drainages, SUDS strategies aim to enhance the resilience of urban systems and re-evaluate the interactions between built and unbuilt components of cities (Lennon, Scott, & O'Neill et al., 2014). SUDS are a distinct concept that is independent from traditional pipes and drains found in UDS. This implies that SUDS can be implemented without the need for an existing drainage infrastructure, as it prioritizes natural filtration and management of stormwater before integrating with traditional drainage methods. These are concepts that can be applied as it meets the proper condition for construction. SUDS seeks to replicate natural systems by capturing, storing, and significantly reducing the volume of runoff in urban areas, utilizing techniques such as permeable pavements, green roofs, rain gardens, and swales.

To ensure the sustainability of Urban Drainage Systems (UDS), particularly in stormwater management, a comprehensive evaluation of the implementation of Sustainable Urban Drainage Systems (SUDS) is crucial to understand their real-world impact. In order to establish a systematic assessment approach for managing sustainable urban drainage systems, the PESTLE Framework will be employed. The PESTLE Framework examines key external factors that influence an organization, including political, economic, sociological, technological, legal, and environmental aspects. It is used to analyze how these factors can affect the functioning and objectives of a business or project. In this study, the primary focus will be on utilizing the six segments of the PESTLE Framework for a thorough assessment.

The political factor encompasses aspects such as government leadership, policy changes, foreign trade regulations, internal political challenges and trends, and tax policies. For the economic factor, everything that tackles globalization and urbanization is considered. In terms of social factors, this basically includes the interaction of people along with their living conditions. As the name suggests, technological factors discuss the development of applied science in different fields. Under Legal factors, a wide range of laws, rules, and regulations are included. Environmental factors are extremely significant, especially in areas like weather, climate, and geography, the issues centered on protecting the environment (Sarwar et al, 2016). By utilizing these segments of the framework as the foundation, the multi-criteria decision-making assessment tool can properly assess the parameters of the subject area and select the viable SUDS for its promotion of sustainability.

In the past, drainage systems were set up and run with open, uncontrolled outlets that allowed any water to enter the drainage conduit or channel to be released freely and without restriction. The traditional drainage system primarily focuses on regulating water quantity and tends to be designed with a single objective in mind. In contrast, Sustainable Urban Drainage Systems (SUDS) are specifically developed to mitigate the risks of flooding and pollution caused by urban runoff. They aim to reduce the speed and volume of water leaving a site, enabling natural processes to break down contaminants. Despite progress made in recent years, the design of an effective drainage system remains challenging (Huong & Pathirana et al., 2013).

As there are many types of Urban Drainage Systems, the subject area should be studied before the implementation of SUDS. This study aims to determine the suitability of various SUDS types for a multi-criteria assessment tool. This tool will consider various criteria inside the PESTLE Framework to decide which SUDS are acceptable in the barangay of Bulaon Resettlement, City of San Fernando, Pampanga to help mitigate floods.

Figure 1. Green Roof, Permeable Pavement, Swales, Rain Gardens

1.2 Review of Related Literature and Studies

- *Flood Mitigation Management*

Mitigation management involves dealing with the potential dangers and consequences of urban or pluvial flooding, which are primarily caused by human activities. These risks are closely linked to the negative impacts on urban communities, the environment, and the economy. Additionally, the understanding and assessment of these risks are subjective and depend on individual perspectives (O'Neill, Brereton, Shahumyan, & Clinch et al., 2016). The current shift in flood risk management is motivated by the recognition that it is highly improbable to completely prevent any potential flood hazards (Schelfaut et al., 2011). Diverse approaches, both involving physical infrastructure and non-physical strategies, such as controlling the amount and intensity of runoff, enhancing drainage systems, and implementing updated construction guidelines, have been suggested (Gourbesville et al., 2012) and spatial design approaches that incorporate nature-based solutions have the potential to act as viable strategies that contribute to the development of sustainable stormwater management (Dawson et al., 2011).

There are two types of flood mitigation strategies which are non-structural and structural. By rebuilding the landscapes, the structural forms of mitigation lessen the damage. Non-structural actions reduce damage by removing people and objects from danger zones. Due to the breakdown of ancient dams and locks, structural solutions have become less and less popular over time. Urban areas are becoming more and more susceptible to floods as a result of climate change, which can have disastrous effects on both the loss of life and property (Qi et al, 2021).

Urbanization can intensify natural sources of floods, which are typically caused by climate change (Waghwala and Agnihotri et al, 2019). Consequently, methods aimed at averting and reducing the risks associated with urban flooding are increasingly recognized as vital components of urban planning and administration (Baldassarre et al., 2010; Amoako et al., 2019). The increasing occurrence of urban flooding underscores the importance of implementing efficient flood mitigation strategies that can minimize both human casualties and property damage (Koc and Isik et al., 2020). Drainage systems are of special significance in this context. Modern drainage systems, such as SUDS, typically use separate pathways, which can quickly minimize runoff to prevent flooding. Assessment of SUDS is fundamental to creating an integrated and sustainable approach to regulate and minimize urban flood risks.

- *Sustainable Urban Drainage System*

Sustainable Urban Drainage Systems are gaining popularity as a solution to address numerous environmental and performance challenges associated with conventional drainage systems. Sustainable drainage involves considering long-term environmental and social factors when making decisions about drainage systems. It takes into account the quantity and quality of runoff, as well as the aesthetic and recreational aspects of surface water in urban areas. Many existing urban drainage systems have proven to be unsustainable, leading to issues such as flooding, pollution, and environmental degradation. This becomes even more critical in light of the challenges posed by climate change and urbanization. Implementing Sustainable Urban Drainage Systems can potentially enable urban expansion in areas where sewage systems are nearing their maximum capacity, facilitating new construction while managing the increased demands on infrastructure. Sustainable drainage is moving away from the old planning concept to control flood risk where runoff is considered a nuisance (Susdrain et al, 2019).

In a cost-benefit analysis for a town in Beijing (Liu et al, 2016) looked at the advantages of low-impact development for reducing stormwater and found that integrated solutions had good benefit-cost ratios. An economic analysis of SUDS advantages conducted in the United Kingdom shows that community-based adult services (CBAs) benefit when considering broader benefits that also apply at the neighborhood level (Ossa-Moreno et al, 2017).

The Rancho Bellavista housing development in Querétaro, Mexico, served as a case study for this approach. The results revealed that SUDS performed better than traditional drainage systems regarding the environment and society. However, their high maintenance costs and shorter life expectancy made them less economically viable. As a result, future urban planning should emphasize complimentary designs in which the capabilities of both drainage systems are combined with increasing their contributions to attaining sustainable development. (Jato-Espino et al, 2022).

Further investigation is needed to obtain accurate data regarding the operational and maintenance costs associated with Sustainable Urban Drainage Systems (SUDS) in order to ensure their ongoing functionality and effectiveness. The Dunfermline Eastern Expansion (DEX) project in the United Kingdom offers a comparative analysis between the expenses involved in the installation and upkeep of Sustainable Urban Drainage Systems (SUDS) and a conventional drainage system. The study assesses the costs of SUDS implementation in relation to traditional drainage expenses, as well as estimates the capital and maintenance costs of underground storage chambers with equivalent storage capacities. The data matters to a whole-life costing technique. The main objective was to establish a dependable cost analysis between Sustainable Urban Drainage Systems (SUDS) and conventional drainage. The cost investigation provides favorable evidence for SUDS, suggesting that properly designed and well-maintained SUDS are more cost-effective in terms of construction and maintenance compared to traditional drainage systems that do not meet the environmental requirements outlined in current legislation (Marlow et al., 2013).

It is clearly visible on how much SUDS can bring about benefits that can help several parties, especially the communities. In order to fully encapsulate the inner workings of SUDS, one must understand its structure. Within the concept of SUDS lies the principles of integration of nature and urbanization in which the two concepts can be seen as somewhat opposite. In the 21st century, the word “urbanization” has taken up several definitions as it can be appropriated into anything that is related to “progress”. For this study, urbanization will be defined into specific parameter and how can one location be described as an urbanized area.

- *Urbanization*

In accordance with the principles of Sustainable Urban Drainage Systems (SUDS), the urbanization process and the impacts of climate change are presenting challenges to urban drainage systems. These challenges arise from the adverse consequences associated with extreme precipitation events and their effects on the urban environment. Urban drainage systems have played a significant role as essential components of municipal infrastructure, effectively managing the conveyance of stormwater and wastewater from urban areas. However, the process of urbanization also emerges as a crucial factor influencing the quantity and quality of water within cities (Zhou et al., 2014).

Dr. Joan Clos explains three key elements behind planned urbanization in the Global Urban Lecture Series and these are (a) Rules and Regulations, (b) Urban Design, and (c) Financial Plan. They form a three-pronged approach to sustainable urbanization. In a planned urbanization, the advantages of cities are emphasized, including their power to provide income and jobs as well as the advantages of peaceful coexistence and the variety of cultural interactions.

"Rules & Regulations" are the first premise. The power of rules and laws to affect the structure and character of the city. Within this idea, three particular areas are essential and these are (a) management of public space, (b) building rights, and (c) building rules governing building quality and standards. Dr. Clos places special attention on public space since the quality of this area eventually determines the quality of the rest of the city.

Urban Design is the second premise and, in this premise, Dr. Clos examines spatial layout, open space design, and the significance of a well-planned street pattern. The third principle is concerned with the Financial Plan, which discusses the budget, the local authority taxation system, and central government money. Dr. Clos also cites the notions of value sharing and land readjustment under this principle, stating that it is necessary to think in novel ways when developing modern cities, and that concepts such as these should be integrated into the financial plan from the beginning (UN-Habitat, 2023).

Industrialization is the primary cause of urbanization. As a result, job opportunities have expanded, and rural populations have come to urbanized areas to get better job opportunities in cities. In addition, people are driven to cities for a range of sociological factors, such as the higher quality of living, more beneficial educational possibilities, and the desire for status. People in rural regions must mostly rely on agriculture for a living. During times of drought or other natural calamities, rural inhabitants are compelled to relocate to cities. Urban places have modern technology, improved infrastructure, connection, and medical services, among other things. People relocate to cities because they assume they will be able to live nicely there. (Ghosal et al, 2015).

By contemplating the given studies, it is clearly visible on how urbanization affects the drainage system and how SUDS came into existence. The relationship between urbanization and SUDS is significantly proportionate as higher urbanization rate means a more extensive application of such system. In order to address this, several organizations conduct preliminary assessments whether a certain urbanized location can fully implement SUDS, in which will be discussed in the following studies.

- *Assessment of Sustainable Urban Drainage System (SUDS)*

There is a growing recommendation to incorporate Sustainable Urban Drainage Systems (SUDS) as components of green infrastructure in urban areas, both during strategic planning and practical implementation. This approach aims to mitigate the hydrological effects of urban development on the surrounding environment by effectively managing water flow (Pappalardo, La Rosa, Campisano, La Greca, et al., 2017; Fletcher et al., 2015). Contemporary drainage systems emphasize the need to deliberately integrate additional essential aspects of urban water management, such as the quality of runoff, aesthetic appeal, recreational opportunities, ecological preservation, and diverse water utilization (Zhou Q. et al, 2014). An exemplary illustration of this is the European Union and Water Framework Directive, which sets targets for achieving a high ecological status in all water bodies. This highlights the pressing requirement to develop remedies for addressing the ingress of pollutants into water bodies and safeguarding the aquatic ecosystem. In addition to environmental concerns, conventional sewer systems have faced increasing criticism for their limited capacity to adapt to evolving climate conditions and urbanization. In light of the Brundtland Report, the Rio Declaration, and Agenda 21, there has been a notable focus on sustainable drainage systems as a viable alternative and/or supplement to the conventional methods in achieving long-term sustainability in system design (Zhou Q. et al, 2014). A notable shift is occurring towards adopting sustainable practices in water management within urban environments, wherein the natural behaviors and processes of water are harnessed to promote sustainability (Fryd, O.; Dam, T.; Jensen, M.B. et al, A planning framework for sustainable urban drainage systems. Water Policy 2012).

The research paper titled "A Multicriteria Planning Framework to Locate and Select Sustainable Urban Drainage Systems in Consolidated Urban Areas" by Ariza, S.L.J. et al. (2019) examines the adoption of Sustainable Urban Drainage Systems (SUDS) in Bogota City, Colombia. The study employs a comprehensive approach that considers various environmental, social, and economic factors at multiple scales. The analysis aims to address specific objectives related to managing runoff, enhancing water quality, and creating attractive urban spaces. During this procedure, it was divided into three distinct categories based on scale which are (a) citywide where participatory approach and development of spatial analysis was applied, (b) local scale where the integration of SUDS were analyzed depending on its prospective areas, and finally, (c) microscale, where the results of the previous scale was used to determine what type of SUDS can be implemented. For the results, the assessment aimed to identify the urban drainage sub-catchments where the implementation of SUDS could yield the most significant advantages and benefits. Furthermore, it was concluded that rain barrels, tree boxes, green roofs, and green swales are the most suitable Sustainable Urban Drainage Systems (SUDS) for private residential areas. On the other hand, for public areas, tree boxes, cisterns, bioretention zones, green swales, extended dry retention basins, and infiltration trenches were identified as appropriate components.

With the rapid growth of urbanization and the impacts of climate change, the expansion of urban areas and extreme precipitation events have created a dilemma for city drainage infrastructure. Sustainable Urban Drainage Systems (SUDS) have emerged as a crucial solution to address these environmental and developmental challenges. In a study conducted by Zhou et al. (2014), the development of SUDS across various disciplines and literature was examined. Several countries, such as those in Europe, have embraced the sustainability of water resources through their drainage systems, with a focus on safeguarding public health, preserving water resources, and conserving biodiversity and natural assets. Similarly, in the United States of America (USA) and Canada, the concept of Low-Impact Development (LID), which essentially aligns with SUDS, has been adopted to promote the integration of the natural hydrological cycle within urban settings, fostering the restoration of ecosystems in terms of water management.

- *Determining Factors for the Implementation of SUDS*

Despite the benefits it brings, an area cannot just implement a random SUDS for their flood mitigation management. Several factors must be considered which will be discussed via the following related literatures:

- *Political Factor*

One of the most important factors that would support the implementation of SUDS in the Philippines is the political involvement. It is very important that these technical approaches are applied in order to improve and sustain our drainage systems. Without the support of the government, this implementation will be impossible because there is no organization that will provide the support needed for this project. In the following studies, it will show how politics significantly affected the implementation of SUDS.

Over the past three to four decades, advancements in technology have emerged to tackle the evolving challenges faced by urban drainage systems. Sustainable Urban Drainage Systems (SUDS) have emerged as a supplementary and feasible alternative to conventional urban drainage methods. By implementing drainage management systems into the urban environment, SUDS is an innovative approach to stormwater management and urban design that aims to imitate and restore hydrological processes that existed before urban development.

Following the implementation of the Water Framework Directive (WFD), European governments have shown an increased focus on addressing drainage concerns in urban settings. After a span of two decades, the European Union (EU) rallied behind the European Green Deal (EGD), a comprehensive strategy aimed at enhancing resource efficiency through the transition to a clean and circular economy, with the overarching objectives of mitigating pollution and revitalizing biodiversity (Benzerra et al., 2012).

The European Green Deal (EGD) is a crucial element of the Commission's strategy to implement the United Nations' 2030 Agenda for Sustainable Development and the Sustainable Development Goals (SDG). Approaches that draw inspiration from, receive support from, or are replicated from nature are referred to as "Nature-based Solutions" or NbS. Nature-based solutions (NbS) are gaining increasing recognition. They are intended to improve sustainable urbanization, restore harmed ecosystems, and create ways to adapt to and reduce climate change and boost risk management and resilience (Union et al, 2015). The more general NbS idea includes specialized technology called SUDS. A European objective for improved drainage management in future cities is to increase their utilization.

The Day Water project, funded by the EU and led by the University of Exeter, conducted an evaluation of the implementation of best management practices (BMPs) in Europe and integrated stormwater source control into sustainable urban water management plans. The study revealed a limited adoption of BMPs in Southern European countries, including Greece, Italy, Spain, and Portugal. Specifically focusing on Spain, the research highlighted the more unpredictable and heavy rainfall patterns characteristic of the Mediterranean region compared to Northern Europe. Despite this, SUDS were gaining traction in Spain at that time, and the accumulated experience of nearly two decades demonstrated their effectiveness in enhancing urban drainage management, even in Mediterranean regions.

Sustainable Drainage Systems (SUDS) have gained significant recognition among municipal professionals and policymakers in Spain following two decades of implementation. Conducting research on SUDS holds great significance in facilitating this advancement, as the demonstration of favorable outcomes in terms of both quantity and quality becomes crucial for promoting this transition through tangible approaches.

Barriers were determined in terms of its political view where the governance sphere lacks involvement, knowledge, and organizational responsibilities. However, despite these setbacks, the regional and local authorities continue to evaluate and assess the current situation which leads to the creation of regulations in terms of SUDS (Andrés-Doménech et al, 2021).

- *Environmental Factor*

In the concept of SUDS, nature is one of the primary components in which all of its aspect is being utilized for the natural filtration cycle. Thus, the environmental factor must be considered towards developing and implementing such a system in every community which will be shown in the following studies.

The environment and drainage systems have an impact on each other. To acknowledge the adverse impacts of drainage systems and efficiently address them, numerous developed and developing nations have initiated the management of their drainage water and the establishment of evaluation guidelines (Walters et al., 2014). The urban environment is particularly susceptible to vulnerabilities resulting from a substantial proportion of impermeable surfaces and the increasing likelihood of drainage network overflow, a trend projected to intensify with urban expansion. The potential harm from urban floods is further amplified by the increasing frequency and size of projected strong precipitation events due to climate change (Slingo et. al, 2014). Environmental Impact Assessment (EIA) methodologies are now recognized and used in the majority of the world's nations when developing new systems and structures. In order to make informed decisions, an EIA is primarily used to calculate the social and environmental implications of a project (Toro et al, 2013).

In another case, the distribution of various socio-cultural groups inside metropolitan regions has altered over the past few decades as a result of population expansion, migration to cities, and fast urbanization (Zwiers et al, 2018). Disadvantaged groups in low-income neighborhoods have experimentally been shown to benefit less from infrastructure development and services in various cities (Collins et al., 2019; Taguchi et al., 2020; Wang & Pan et al, 2016). Techniques for designing urban infrastructure and decision-making processes employed by practitioners can have an impact on design choices made by planners and, consequently, the quality of life for city people. One of the primary objectives of sustainable urban planning is to guarantee, foster, and establish circumstances for a fair allocation of environmental, social, and economic resources among urban communities. These three criteria are known as the "three E's" of sustainability (La Rosa & Pappalardo et al, 2020). In the 1980s, a social movement in the United States presented the idea of environmental justice for the first time (Liu et al, 2014). Since then, infrastructure designers, urban planners, and stakeholders have started to take an interest in the subject of justice and equitable spatial allocation of resources, services, and environmental risks (O'Hare & White et al, 2018; Reckien et al, 2017; Thaler & Hartmann et al, 2016).

- *Social Factor*

With regards to the perspective of the community, opinions and insight from the very people that will be affected in the application of SUDS must be considered. In the study of Fontaneda, A.S., and Ramired, R.R. et al., 2019, social aspects, such as amenity, health, and many more, in application of SUDS are often ignored in the premise of design, planning, and operation. To transcend the current ideology, Smart PLS Path Modelling method has been formulated to fully integrate the social impacts in determining the application of SUDS. This approach is formulated to assess intangible social values based on the principles established by UNESCO (United Nations Educational, Scientific and Cultural Organization). By fully utilizing the modeling method and questionnaires, the results came to about a significance of sensitivity towards applying SUDS in the community.

In another study, the flood mitigation management of Vega Baja in terms of building SUDS focused on the socio-economic effects. The social effectiveness of the implementation of the said system was calculated and several factors in terms of the social construct were determined. The gender viewpoint was considered as one of the factors wherein the disparity between genders is very evident. In the paper "Turning Promises into Action: Gender Equality in the 2030 Agenda for Sustainable Development", it was stated that women experience discrimination more than the other gender in terms of urban development. Furthermore, the study emphasizes the importance of addressing gender disparities in urban management and development processes. Similarly, the study also takes into account the factor of age, which greatly enhances the safety, visibility, and ease of access to urban centers. Overall, the implementation of this plan would result in significant social benefits for Vega Baja, while also promoting a circular economy through water reuse, enhancing discharge quality, reducing greenhouse gas emissions, and fostering social cohesion by creating and enhancing the value of recreational spaces (Ortuño et al., 2022).

- *Legal Factor*

SUDS innovations are driven independently of the prejudices and assumptions of domestic policy and business circles because foreign donors support most SUDS-related activities. The need for more political support for the SUDS agenda from the highest levels and financial support for both expert communities and particular management initiatives is the central issue keeping Eastern Europeans from learning from the EU's experiences.

Most people are supported by overseas donors and promoted by NGOs. It is a significant hindrance to their incorporation into domestic institutional frameworks since NGOs, and "traditional" epistemic communities sometimes struggle to build connections based on trust and functionality.

For SUDS or NBS, in general, to be taken seriously by local authorities and other important stakeholders, they must be included in national policy documents. Due to the size of its national government and the complexity of its political system, adaptive management and integration across areas and departments are both necessary to effectively deploy SUDS, which is an iterative process. They all require a robust governance framework, and studies directly link governance deficiencies to several structural problems (Shkaruba et al, 2021).

In the United Kingdom (UK) and other countries, similar challenges hinder the progress of implementing Green Infrastructure (GI) or Sustainable Urban Drainage Systems (SUDS). These obstacles include the absence of appropriate legislation, such as SUDS Approval Bodies (SABs), as outlined in the 2010 Flood and Water Management Act (FWMA 2010), and a lack of regulatory oversight in SUDS design, construction, operation, and maintenance (White and Howe et al., 2005; Ashley et al., 2015). Planning professionals may hesitate to support SUDS or GI due to resource constraints and a perception of insufficient policy support (White and Howe et al., 2005). Regulatory issues, such as the coordination of multiple jurisdictions and integration, also arise in countries where SUDS are referred to as GI, as exemplified by the challenges faced in Santiago, Chile. The "Santiago Verde " or "Green Santiago " Plan, aimed at establishing an interconnected network of GI at the regional level, remained in the conceptual stage due to difficulties in coordinating various capacities and resources across jurisdictions (Vasqueze et al., 2016). However, solutions can be found by leveraging legal factors, as demonstrated by the "Sponge City" initiative in China. In some cases, GI implementation has been facilitated by synchronizing customized planning systems from different levels of government. China's Central Government launched the Sponge City Pilot Programme following severe floods in 2012, resulting in $1.6 billion USD worth of damages. This program is supported by the Ministry of Water Resources, the Ministry of Housing and Rural-Urban Development, and the Ministry of Finance (Dai et al., 2018; Li et al., 2017). Similarly, the United States faces challenges in implementing GI due to regulations. For example, the implementation of urban GI on private property at the household level is limited in some areas, despite federal regulations mandating GI in vulnerable locations such as coastal areas (under the Coastal Zone Management Act), water bodies (under the USEPA's stormwater regulation), and critical habitat for endangered species (under the Endangered Species Act) (Ekness and Randhir et al., 2015; Martin-Mikle et al., 2015).

- *Economic Factor*

Similarly, to other challenges in implementing change, the reluctance to support the adoption of Blue-Green

Infrastructure (BGI) can stem from concerns about the labor-intensive nature of the process or the perceived lack of factual data supporting novel techniques. Securing funding emerges as a major barrier, as highlighted in the article 'Recognising barriers to implementation of Blue-Green Infrastructure: a Newcastle case study, Urban Water Journal' by O'Donnell, Lamond, Thorne, et al. Neglecting to invest in resilience programs or take action in the face of climate change leads to escalating costs, as indicated by ULI (2018). Flooding disasters cause significant economic strain on cities due to damage to municipal infrastructure. Subramanian (2016) reveals that the United States spends approximately $2 billion USD annually on flood relief, while China has suffered damages amounting to around $15.77 billion USD (Li et al., 2017). Various studies, including those by Levy et al. (2014), Li et al. (2017), Tayouga and Gagné (2016), and Wild, Henneberry, and Gill (2017), demonstrate that BGI, also known as GI, is a more cost-effective alternative to traditional grey infrastructure. Furthermore, research conducted by Yang et al. (2015) in Daybreak, Utah, indicates a significant cost savings of $40 million USD in stormwater infrastructure through the use of GI techniques. Additionally, Wang, Eckelman, and Zimmerman (2013) analyze the environmental and financial cost-effectiveness of GI compared to grey infrastructure and mixed green and grey systems using life cycle analysis. Their research suggests that the most affordable approach for water quality is a combined GI system with a separate stormwater sewer system (Wang, Eckelman, and Zimmerman, 2013).

The implementation of SUDS in a community requires extensive research and analysis in order to achieve the desired beneficial outcome to the community and affected organizations. With this compilation of studies, the researchers will build a foundation towards developing an effective assessment tool for the implementation of SUDS within the subject area. The provided primary indicators of the PESTLE Framework will be based on the facts and studies gathered and observed in which it will use to extensively analyze the parameters and specifications of the subject area to produce the desired outcome for this study.

1.3 Background of the Study

Flooding is a common occurrence in the Philippines. Rainfall in the country is strongly influenced by the extreme precipitation that tropical cyclones bring. On September 26, 2009, Tropical Storm Ondoy made landfall in the Philippines, dropping unprecedented amounts of rain that caused Manila to flood. The government, with support from the World Bank, released a comprehensive Flood Management Master Plan for Metro Manila in 2012. This plan included a range of vital non-structural and structural measures aimed at long-term flood management. One of the project's four focuses is improving drainage areas, reducing solid waste in rivers, participating in housing and resettlement, and project administration and coordination. The initiative hopes to lessen floods in about 56 river basins. The initiative will directly impact at least 1.7 million people, many squatters living close to sewers and streams. If there is one lesson that tropical storms have taught people, it is that typhoons, floods, solid waste management, housing, and poverty are all interconnected. This project marks a significant turning point for controlling flood risk and Filipinos' social welfare and economic well-being. In order to promote inclusive and resilient flood management, the Metro Manila Flood Management Project employs cutting-edge strategies (Stoutjesdijk et al, 2018). An assessment technique will be used to evaluate the implementation of SUDS using a flood management master plan. Pampanga, let alone the City of San Fernando, has never had a flood management master plan. It is significant because it identifies several crucial non-structural and structural steps for long-term flood control.

As reported by the Pampanga River Basin Flood Forecasting and Warning Center (PFFWC), the overflowing of the Pampanga River was triggered by Typhoon Ulysses (Vamco), resulting in widespread flooding in certain municipalities of the province. The floods are expected to persist for several days. The Pampanga River Basin, located in the central plain of Luzon Island, is the fourth-largest river basin in the Philippines. Previous studies (JICA 2011; Shrestha et al. 2016) have indicated that the basin experiences at least one severe flood annually. The primary cause of these frequent large-scale flooding events in the basin is intense rainfall that exceeds the river's capacity to handle the water flow.

The City of San Fernando, also known as the City of San Fernando, is a prominent city located in the province of Pampanga. It serves as the provincial capital and administrative center of Central Luzon. The city comprises 35 barangays, including the specific area of interest for this study, which is the Bulaon Resettlement in the City of San Fernando.

The researchers have chosen this particular area to gain a more focused understanding of the implementation of Sustainable Urban Drainage Systems (SUDS). The selection was made based on the area's characteristics, as it represents a certain level of urbanization but avoids the complexities associated with the city's overall structure. As this location accommodates several essential facilities despite its distance to the capital of the province, unlike other barangays within the city.

Three crucial considerations—economic, social, and environmental—led to the selection of Bulaon Resettlement, City of San Fernando, Pampanga as the study's focus area. Prior to the start of data collection, these criteria were taken into consideration.

The choice of Bulaon Resettlement as the study's main location was heavily influenced by economic concerns. Due to its significant position, this community has seen economic expansion and has become a hub for both transportation and trade. The researchers thought that examining the economic situation in Bulaon could offer insightful information on the difficulties and opportunities faced by quickly emerging villages in the Philippines. Bulaon has seen tremendous advances in terms of infrastructure and commercial growth, according to manual observations made there. This progress is demonstrated by the existence of sturdy buildings and numerous, well-spaced businesses. The improvement of Bulaon's overall living standards and economic possibilities has been facilitated by these infrastructure improvements. An area's ability to move goods and services in and out of it has been made possible by the establishment of developed infrastructures, such as roads and buildings. The accessibility of commercial establishments has also given locals access to a wide variety of goods and services, enhancing their standard of living overall.

When choosing Bulaon as the study's focal point, social aspects were also considered. Indigenous people, immigrants, and urban poor make up the population of this neighborhood. The researchers aimed to learn more about the complicated problems marginalized communities in the Philippines face by examining the social dynamics in Bulaon. In classifying an area, whether it is urban or rural, several essential indicators are cited by the Philippine Statistics Authority. The researchers' chosen locale which is the barangay Bulaon Resettlement, City of San Fernando can be considered an urbanized area because it meets all the considered definitions of urban areas that the Technical Committee on Population and Housing Statistics (TCPHS) recommended. According to the NCSB Resolution No.9 in the Series of 2003 by the Philippine Statistics Authority, the scopes of an urbanized barangay are clearly defined by certain criteria which are: the population should account for 5,000 or more, and contains establishments that allow a minimum of 10 workers, in which the subject area is appropriately accustomed to as this area has a population of 27, 506 and contains several establishments, both essential and commercial as stated earlier. It contributes 19 7.76% of San Fernando's whole population. The annual population growth rate of the said barangay exceeds 2.30% from 2015-2020 (PhilAtlas et al, 2020).

Finally, the choice of Bulaon as the study's focus location was significantly influenced by environmental considerations. Due to the community's fast development, the environment has been degrading, which has resulted in several environmental issues, including water pollution and deforestation. In order to find ways to encourage sustainable development in rapidly expanding metropolitan regions, experts studied the environmental problems in Bulaon. The people of Bulaon Resettlement are experiencing significant damage to their homes, businesses, and infrastructure, causing them to suffer. This situation is also affecting wildlife and agriculture, with many animals being unable to find shelter or food sources. Each year the locale is in dire straits of disastrous flooding, worsened by persistent rainfall. Because of this, it requires a more suitable sustainable drainage system for the area that will prevent further damage and protect against future flooding. This study aims to create and utilize a

validated instrument to determine the various SUDS applicable in Bulaon Resettlement, City of San Fernando, Pampanga, based on criteria. This solution will help those affected by this current disaster and prevent future ones from occurring anywhere else in the Philippines. (Pampanga's Flooding—A Lesson on Initiative, 2016).
These three criteria were carefully reviewed before data collection began to guarantee that the study would provide a thorough understanding of the economic, social, and environmental difficulties affecting Bulaon and similar communities in the Philippines.

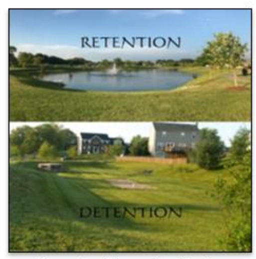
Sustainable Urban Drainage Systems (SUDS) encompass a diverse set of water management strategies designed to efficiently handle natural water processes in urban environments by leveraging modern drainage infrastructure. According to the Construction Industry Research and Information Association (CIRIA), SUDS strategies are focused on actively collecting, utilizing, storing, or absorbing rainfall, rather than simply discarding it as an inconvenience or problem. Many environmental advantages come with sustainable water drainage.

SUDS can be categorized into three main types: source control, site control, and regional control. Source control involves managing and addressing runoff at or near the surface where rainfall occurs. Site control measures are implemented to restrict surface water runoff in larger areas, such as subdivisions. Regional controls focus on managing accumulated runoff from a broader and more extensive area.

The most prominent examples of SUDS, as shown in Figure 2, are green roofs, soakaways, filter strips, infiltration systems, swales, bioretention, previous pavement, sand filters, infiltration basins, and detention basins. All these SUDS only have one function which is to help the traditional urban drainage system in managing stormwater run-off.

As part of the City of San Fernando, Bulaon Resettlement shares the topographic effect of the said city. The City of San Fernando sits between the northern and upper portion of floodplains of the Pampanga Basin, where it contains a one-million-hectare catchment area. Pampanga River Basin, the City's southern region, makes up a more significant portion of the area. As a result, flooding constitutes a threat to the City's physical growth, as will become apparent in subsequent analyses of land use patterns.

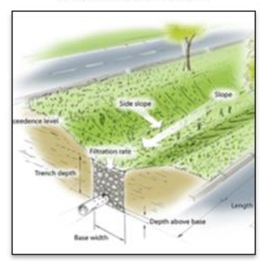
As Bulaon Resettlement is a part of the City of San Fernando as shown in Figure 3, it would also be considered a catch basin into which the stormwater overflow from surrounding areas may flow. As indicated in the preceding part of the study, this area is surrounded by water, specifically the San Fernando River, which makes it a high-risk flood zone. With this study, researchers will conduct a case study on the subject area to identify its many components, including topographic layout, rainfall data, and others. After identifying the requirements, researchers will cross-analyze them using the created assessment tool to evaluate whether SUDS methods are relevant for the subject area's flood mitigation management.



Retention/Detention Basins


Permeable Pavement


Rain Garden


Swales

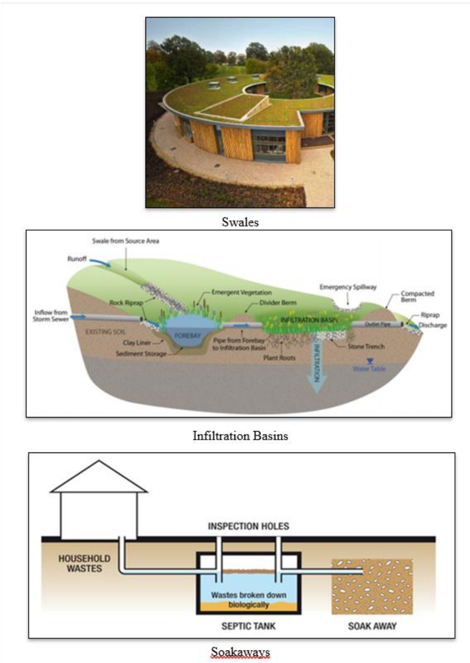


Figure 2. Examples of Common SUDS

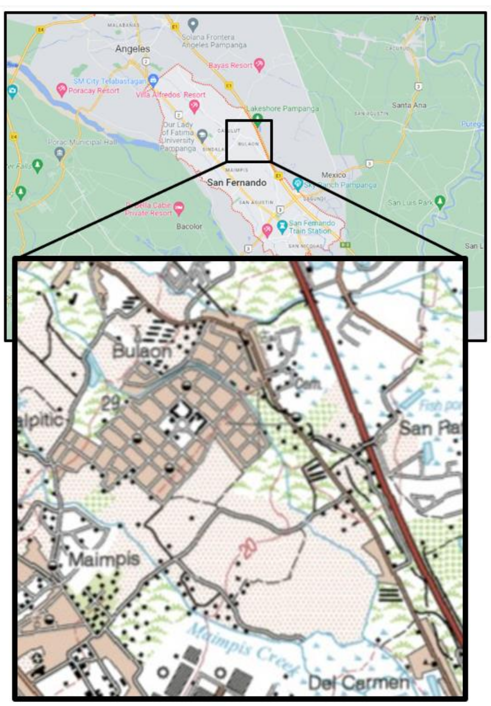


Figure 3. Vicinity Map of Bulaon Resettlement

1.4 Objectives of the Study

- *General Objective*

The objective of this study is to develop a criteria-based assessment tool for evaluating the suitability of implementing a Sustainable Urban Drainage System (SUDS) in Bulaon Resettlement, San Fernando, Pampanga.

- *Specific Objectives*

This study aims to formulate a validated multi-criteria assessment tool of variables that will allow the site conditions of the locale for the integration of different type of SUDS in a community; to assess whether Bulaon Resettlement can fully implement SUDS based on the evaluation of sustainability in terms of the site conditions. ; and to formulate a management planning proposal for determination of sustainable development in implementation of SUDS in Bulaon Settlement, City of San Fernando, Pampanga.

1.5 Significance of the Study

The outcomes of this study will be a long-term benefit to society as this will serve as a stepping stone to integrating sustainable urban drainage systems (SUDS) in every community. Specifically, this study will benefit the following:

Community. As this study can lead to the development or integration of SUDS in a community, its citizens can gain its benefits. By implementing such systems, the living conditions of every citizen will significantly improve. SUDS are modeled into recreational facilities where the citizens can fully enjoy and possess the ability to have a therapeutic benefit. It is also effective in mitigating water pollution and reducing the risk of disease transmission among residents. They achieve this by implementing proper water filtering techniques that leverage the natural components of the environment. As a result, SUDS improve water quality and contribute to creating healthier living environments for communities.

Environment. As SUDS focuses on utilizing nature as a flood mitigation management technique, the maintenance and development of the environment are required. Integrating green infrastructure in SUDS management can contribute to the amenity and biodiversity in which it can create habitat, recreational, and biodiversity areas. It also improves temperature control in which it provides thermal comfort by cooling in the summer or insulation in the winter. By the abundant existence of vegetation, greenhouse gas emission will significantly decrease, thus affecting climate change.

Government. The developed assessment tool can be utilized by government bodies and stakeholders to evaluate data and identify the most suitable SUDS or Sustainable Urban Drainage Systems for implementation. By implementing SUDS, the government can achieve development goals while ensuring environmental preservation. SUDS serve the fundamental purpose of mitigating flood risks in the community, leading to reduced resources needed for flood management in the future. Overall, the assessment tool facilitates informed decision-making for the adoption of SUDS, allowing for sustainable development while minimizing environmental impact.

Drainage and Water Resource Engineers. This study will be beneficial for the stated engineers as it can help them determine which type of SUDS can be implemented in a certain area. It lessens the time and effort to study a certain area and which SUDS can be integrated. It can also help them determine the various components and specifications of the subject area, such as stormwater runoff, water quality and many more, in which they can properly assess the implementation of SUDS.

Future Researchers. This paper may also serve as a reference and resource material for future researchers whose study is in connection with the assessment and implementation of SUDS in a community. This will serve as a guide to further improve the awareness of utilizing SUDS as a proper flood mitigation management technique.

1.6 Scope and Limitation

This study focuses on creating a multi-criteria assessment tool based on the PESTLE Framework for the analyzation of sustainability in stormwater management in Bulaon Resettlement, San Fernando, Pampanga. The data that is utilized for this study is based from related literature that tackles within the same scope of the study and government data. In terms of the needed specifications of the subject area, the data that was gathered is based on the parameters within the PESTLE Framework (political, economic, social, technological, and environmental). The primary focus of this study is the formation of the assessment tool and the evaluation of the subject area in terms of evaluation of sustainability in stormwater management. The government can use this study as a guide in determining the proper developmental action plan in terms of flood mitigation management for the subject area.

1.7 Conceptual Framework

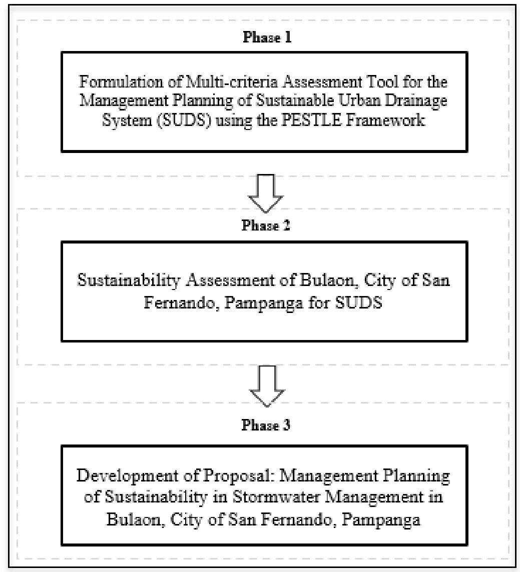


Figure 4. Conceptual Framework

1.8 Definition of Terms

The following terms are described in accordance with their conceptual and theoretical meaning for better understanding of the research study:

Aqueducts. A conduit to transport water from its source to a major distribution hub.

Climate Change. Refers to long-term changes in weather and temperature.

Flash Flood. An inundation caused by a significant amount of rainfall or intense precipitation occurring within a relatively brief period, typically less than six hours.

Flooding. It is rising and overflowing of a body of water, particularly onto typically dry terrain.

Flood Mitigation Management. To reduce the risks of flooding and coastal erosion, it is imperative to implement measures that protect, restore, and emulate the natural functions of catchments, floodplains, rivers, and the shoreline.

Green Infrastructure. A carefully designed and managed system of natural and semi-natural areas, along with associated environmental attributes, intended to offer a wide array of ecosystem benefits and safeguard biodiversity in both urban and rural environments.

Hydrological Cycle. The water cycle, also referred to as the hydrological cycle, is a biogeochemical process that depicts the uninterrupted circulation of water across the Earth's surface, atmosphere, and subsurface.

Meteorological Data. This category of data comprises the measurable physical attributes obtained through instruments, including temperature, dew point, wind direction, wind speed, cloud cover, cloud layers, ceiling height, visibility, present weather conditions, and precipitation levels.

PESTLE (Political, Environmental, Social, Technological, Legal & Economic) Framework. The PESTLE Framework is a strategic decision-making tool that concentrates on identifying and categorizing the essential external factors (Political, Economic, Social, Technological, Legal, and Environmental) that exert influence on a specific subject area or organization.

Reservoir. It is a vast lake, either natural or man-made, used as a water supply.

Street Flooding. This usually results from clogged storm drains, blocked culverts, or blocked roadside ditches, which overwhelm the drainage system.

Sustainable Urban Drainage System (SUDS). These methods encompass a range of management techniques, operational systems, and strategies designed to efficiently and sustainably remove surface water, minimize pollution, and mitigate the impact on the water quality of adjacent water bodies.

Urbanized Areas. It is an area that has been continuously built up and has 50,000 or more residents.

Urban Drainage. A stormwater drainage system specifically designed to swiftly collect and transport runoff from urban areas, with the primary goal of preventing flooding.

Urbanization. It is a growth in the population of towns.

II. METHODOLOGY

2.1 Research Design

The study used data gathered through the current program and an action research technique. Its objective is to address real-life issues. The fundamental principle of action research (AR) is based on the change-oriented approach, which suggests that complex social processes can be effectively explored by introducing changes and assessing their outcomes (Baskerville et al., 2001). Action research (AR) operates through action to transform the social system and generate data on the change and its impact. It is a subdomain of social science research that centers on real-world problems with theoretical significance (Clark et al., 1972). The current study intends to classify and quantify collected data based on specific criteria, which will then be transformed into a set of parameters to facilitate in-depth investigation. Moreover, the investigation adopted a mixed research approach that encompasses both qualitative and quantitative data during the study. Such information is essential in assessing individual indicators and their interrelationships.

As flooding is one of the severe problems in Bulaon Resettlement, City of San Fernando; evaluating its suitability for this research study as the subject area for deploying suitable SUDS. This study aims to provide a new assessment tool to evaluate the subject area and other settings to determine if the implementation of SUDS is possible. The concept of an action research design will be the most practical in this study because it focuses on solving a problem using existing data on a specific real-world difficulty, implementing change, and then calculating the effects of that change. After the formulation of the assessment tool, professionals specializing within the field of land management and water resources evaluated it.

2.1.1 Research LocaleThe research will take place in Bulaon, a barrio in San Fernando, a city in Pampanga province (76 km from Manila) an urban area. In thirty years, the population of Bulaon increased from 1,732 in 1990 to 27,506 in 2020, a gain of 25,774 people. The most recent census estimates for 2020 indicate a growth rate of 2.30 percent, or a rise of 2,821 individuals, compared to the 2015 population count of 24,688. Because this area has a history of flooding, it will provide the necessary data for evaluating the urban drainage system. The gathered data will be essential for the criteria-based decision-making instrument used to determine the viability of different SUDS. On the island of Luzon, the location of Bulaon is around 15.0818 and 120.6627. These coordinates' estimated height above mean sea level is 30,1 meters or 98.8 feet.

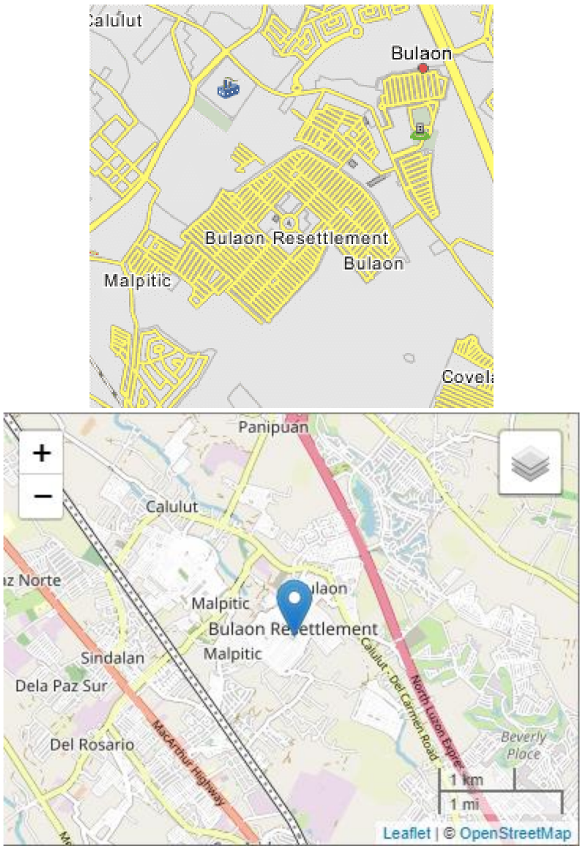


Figure 5. Town Layout of Bulaon, City of San Fernando, Pampanga

2.2 Methodological Framework

The first step in the study method is to develop a common knowledge and analysis of how sustainable urban drainage systems (SUDS) are implemented across various literatures. Within this collective, several factors will be considered such as its advantages, disadvantages, budget, installation and maintenance procedures, and other elements that are vital in determination of proper SUDS in the locale. After its establishment, the researchers will then proceed to formulate an assessment tool in which it encompasses several data that is required for proper evaluation. For this study, this assessment tool will be utilized to determine whether Bulaon Resettlement is viable for concept of sustainability towards its stormwater management.

2.2.1 Phase 1 – Formulation of Multi-Criteria Assessment Tool using PESTLE Framework

The study utilized an assessment tool to evaluate the data to be utilized. An assessment tool is a standardized instrument employed to evaluate a specific aspect or item. It furnishes a structured approach to data collection, enabling objective assessments, and promoting consistency throughout the evaluation process.

Given the complexity of this tool, skill, and proficiency are essential to ensure accurate and systematic results. Consequently, the recommended principal users include individuals possessing the following credentials and qualifications:

1. Water Resources Engineer
2. Land Use Planners
3.Other engineering professionals engaging with water reousces

Political, economic, social, technological, legal, and environmental concerns will all be taken into account in order to have a complete selection process for data collecting, as indicated in the paper's opening sections. Each segment will define the scope and parameters that need to be addressed for the management planning of SUDS. By using related literatures, the researchers will then specify the specific indicators within the following segments:

- *Political Factor*

Political variables involve how and to what extent the government intervenes in the economy. These are government policy, political stability or instability, corruption, tax policy, labor legislation, and environmental law. Government policy is a guideline or guiding concept that, ideally, leads to favorable outcomes that benefit the community or unit. Delegating before implementing a SUDS requires formal responsibility to the government agencies and departments responsible for the appropriate policy area. Political uncertainty can have an even more significant effect on the implementation of SUDS, 31 making them hesitant to invest in fresh capital. Therefore, to properly fulfill the boundaries of this factor, the following data are required in this study:

2.2.1.1.1. Disposition of local government in supporting sustainability towards stormwater management

Reforestation programs involve planting trees and restoring forests in areas where they have been lost due to deforestation or other reasons. (McPherson, E. G. & Simpson, J. R., 2016). A geohazard map is a tool used to identify areas that are susceptible to natural hazards such as landslides, floods, and earthquakes. Together, reforestation programs and geohazard maps can help support sustainable stormwater management by reducing the volume and velocity of stormwater runoff and minimizing the risk of flooding and erosion. These tools can help to create more resilient and sustainable urban environments. (Ercanoglu, M., & Gokceoglu, C., 2019).

2.2.1.1.2. Interventions in pursuing sustainability by the local government in terms administrative freedom in application policies

Integrated protected areas, population concerns, and social welfare are interventions that can be pursued by local governments to promote sustainability (Komorita, M. & Kataoka, M., 2018). In terms of sustainable urban drainage systems (SUDS), these interventions can help local governments choose SUDS solutions that are both effective and sustainable. (Dhakal, S., & Jha, A. K., 2019).

2.2.1.1.3. Application of the Philippine legislation in decision-making plans in area development plans for sustainability adoption in stormwater management

A comprehensive land use plan is a document that outlines a longterm vision for the development of a specific area, including policies, regulations, and guidelines for land use, zoning, and infrastructure. A comprehensive land use plan can help to ensure that SuDS solutions are integrated effectively into the built environment, promoting long-term 32 sustainability and resilience in the face of climate change. (National Institute of Standards and Technology., 2017).

2.2.1.1.4. Political agenda of the local government in terms of adopting sustainability in drainage system

The environmental program within the zoning ordinance of a comprehensive land use plan outlines policies and regulations related to environmental protection and sustainable development. This can include provisions for stormwater management and the use of sustainable urban drainage systems (SUDS) to mitigate the impacts of urbanization on the natural environment. It can regulate the placement and design of buildings, infrastructure, and other development to ensure that SUDS are integrated effectively into the built environment. (U.S. Environmental Protection Agency., 2014).

- *Economic Factor*

In terms of the economic segment, this will majorly focus on the budget that the government will willingly expend on such projects. For managing the budget, the development, operating costs, and maintenance should be considered. This would also entail the concepts within employment. As such, the following data are required to generate enough understanding of this factor:

2.2.1.2.1. Existing budget for the building projects of drainage system in areas susceptible to flooding

The flood control budget allocation for building projects of drainage systems in areas susceptible to flooding refers to the amount of funding that is set aside to implement sustainable urban drainage systems (SUDS) and other flood control measures in areas where flooding is a significant risk. This budget can be used to support the selection and implementation of sustainable drainage systems. This can help to promote long-term sustainability and resilience in the face of climate change. (Water Environment Federation, 2015).

2.2.1.2.2. Budgetary allocation for the implementation of sustainability concepts to the existing drainage system

An annual budget or annual investment plan is a financial plan that outlines the expected income and expenditures for a specific period, usually a year. Allocating a budget towards the implementation of SUDS can help in choosing sustainable drainage systems by providing the necessary resources for designing, building, and maintaining SUDS. (London.gov.uk.,2021).

2.2.1.2.3. Maintenance and construction procedure of the constructed urban drainage system

Choosing sustainable urban drainage systems requires consideration of both maintenance and construction procedures. (Defra.gov.uk., 2020). By selecting SUDS that are designed to be durable and easy to maintain, municipalities can ensure that the systems are effective over the long term. This, in turn, helps to promote sustainable urban water management and reduce the risk of flooding and pollution. (Engineering Nature's Way., 2021).

2.2.1.2.4. Annual performance plan (APP) showing the budgeted amount for the required funds regarding the construction of Green Infrastructure in the field of Stormwater management

A certificate of availability of funds (CAF) is a document that shows the budgeted amount for a specific project or program and certifies that the funds are available for use. This can enable municipalities to identify and prioritize SUDS projects that are most likely to provide the greatest benefit in terms of reducing flooding, improving water quality, and enhancing urban livability. (City of Chicago., 2021).

The AIP outlines the expected performance of the program or project for the upcoming year, and includes details on the expected outcomes, activities, and budget. (Philadelphia Water., 2021).

- *Social Factor*

This broad environment component reflects the demographics, norms, habits, and values of the people the organization serves. It includes population growth, age distribution, economic distribution, career attitudes, safety focus, health awareness, lifestyle attitudes, and cultural obstacles. These criteria are crucial for assessing the insight of the community, itself, towards SUDS. The following data are required for this factor:

2.2.1.3.1. Type of community residing in the selected locale

Statistics related to population, growth rate, households, and average household size are important in understanding the demographics and characteristics of a city or region. These statistics can provide insight into the demands placed on infrastructure, including urban drainage systems. Thematic maps can be used to identify areas of high demand for urban drainage systems, as well as potential areas for green infrastructure solutions. Traffic can affect the volume and quality of stormwater runoff, as well as the availability of space for green infrastructure. (Peng, C., & Chen, Y., 2015).

2.2.1.3.2. Sustainable and prospective approach for improvement of health in rapidly urbanized areas

Sustainable stormwater management policies aim to improve the health of rapidly urbanized areas by reducing the negative impacts of urban runoff on human and environmental health. By considering these policies and approaches, cities can develop sustainable urban drainage systems that can improve the health and well-being of their residents while also protecting the environment. (World Health Organization., 2017).

2.2.1.3.3. Social requirements, conditions, and maintenance process in terms of retrofitting to the subject area

Understanding the total population and number of active businesses in a locale is important in choosing sustainable urban drainage systems because it can provide insight into the demand for infrastructure and the 35 potential impacts of stormwater runoff. (United Nations, Department of Economic and Social Affairs, Population Division., 2019).

- *Technological Factor*

In this segment, the technology that will be applied or currently implemented in the subject area will be considered. The existing structural layout will be analyzed in order to integrate the right supplementary SUDS. Moreover, the availability of the technology for the construction and maintenance of SUDS will be included. In addition, software that are required for proper evaluation of data will also be considered. With that in mind, the following data are required:

2.2.1.4.1. Availability of location map or site development for most devices may aid in obtaining justifiable solutions for stormwater retention and surface infiltration into the ground

A location map or site development plan is a visual representation of a site that shows its boundaries, topography, existing infrastructure, and proposed development. (Mays, L. W., & Wong, T. H. F., 2018).

By using a location map, designers can assess the site's characteristics, such as its soil type, topography, and existing infrastructure, to determine the most effective SUDS components for the site. (Barros, R., et al., 2019).

2.2.1.4.2. Amount of rainfall water that the current drainage systems collect within a certain time frame
Rainfall data is essential for choosing a sustainable urban drainage system as it provides information on the amount, intensity, and frequency of rainfall events in each location. This data can be used to determine the appropriate size and design of SUDS components, such as infiltration basins, green roofs, or permeable pavement, and to assess the overall effectiveness of the SUDS system. (Tchouakam Kamgang, V., et al., 2020).

2.2.1.4.3. The spatial visualization and analysis of geospatial data on a specific location
ArcGIS and QGIS are Geographic Information Systems (GIS) software that are widely used for spatial visualization and analysis of geospatial data. (Lim, K. J., et al., 2020). In the context of sustainable urban drainage systems (SUDS), GIS can be used to analyze and visualize data related to rainfall, land use, soil types, and hydrological characteristics of a site. This information can help in selecting the most suitable SUDS components and designing the most effective SUDS system for a specific location. (Wang, Y., et al., 2019).

2.2.1.4.4. The vulnerability of the local area to flood risk is determined by the probability of flood hazards by using OpenFLOWS FLOOD by Bently
OpenFLOWS FLOOD is a software tool for flood modeling and risk assessment that is designed to help engineers, planners, and decisionmakers evaluate the potential impact of floods on urban areas. (Zhang, Y., & Li, B., 2019). OpenFLOWS FLOOD can be used to assess the flood risk of a local area by modeling the probability and magnitude of flood hazards. (Ma, J., et al., 2020).

2.2.1.4.5. Management of the quantity and quality of stormwater runoff from a piece of developed, privately owned urban land
The Storm Water Management Model (SWMM) is a widely used software tool for simulating the quantity and quality of stormwater runoff from urban areas. (Valiela, I., & Costa, J. E., 2018). SWMM can be used to evaluate different SUDS components and design measures for managing the quantity and quality of stormwater runoff from developed urban land. (Kim, J., et al., 2017).

2.2.1.4.6. The condition of the water, including chemical, physical, and biological characteristics
Water conditions refer to the chemical, physical, and biological characteristics of water, which can affect its suitability for various uses, including drinking water, aquatic life, and recreational activities. (Fu, X., et al., 2019). Sustainable urban drainage systems (SUDS) can play an important role in managing and improving water conditions in urban areas. (SandovalGómez, A. H., & Trápaga-Quincó, R. A., 2021).

- *Legal Factor*

Politics and legal factors may intersect; however, the latter is usually more specific and the rules and regulations are its main considerations. The norms and legislation of a government will always impact the application of a drainage system macroeconomically. The legal factor is the result of communities adopting certain political and legislative goals related to the utilization of alternative water sources, their quality, and flood protection. It relates to rules governing collaboration between regional authorities, businesses, and academic institutions. The following data are required for this factor:

2.2.1.5.1. The limitations and parameters of the law in adopting sustainability on the field of stormwater management
Sustainability in the field of stormwater management refers to the design, construction, and maintenance of urban drainage systems in a manner that promotes the efficient use of resources, minimizes environmental impact, and maintains ecological integrity over the long term. (Alibardi, L., et al., 2019). Sustainability in stormwater management involves the adoption of SuDS that promote the efficient use of resources, minimize environmental impact, and maintain ecological integrity over the long term. (Zhang, Q., et al., 2020).

2.2.1.5.2. The allowance of alteration of structure in terms of private property for the management planning of SUDS
Allowance of alteration of structure in terms of private property refers to the ability of property owners to modify their buildings or land to incorporate sustainable urban drainage systems (SuDS) into their property. (Brown, R. R., et al., 2014). This is an important consideration for SuDS implementation because some techniques, such as rain gardens or green roofs, require modifications to existing structures or land use. (Lundy, L., et al., 2016).

2.2.1.5.3. The allowance of change in the area development plans
A site development plan is a detailed plan that outlines the proposed development of a specific site, including the location and layout of buildings, infrastructure, and other features. (Environmental Protection Agency (EPA)., 2019). Site development plans are important for choosing a sustainable urban drainage system (SuDS) because they provide an opportunity to incorporate SuDS features into the design of new developments. (HM Government., 2019).

- *Environmental Factor*

This factor will revolve around the environmental condition of the subject area. This will include the topographical layout of the area, its corresponding biodiversity, its surrounding resources and many more. With this, the following data are required to fulfill the requirements in this factor:

2.2.1.6.1. The flood susceptibility of the locale in management planning for SUDS A flood hazard map is a geographical representation of the areas that are at risk of flooding. flood hazard maps can be an essential tool for managing flood risk and selecting appropriate drainage solutions. (Bates, P.D.,2019) By understanding the flood susceptibility of a locale, urban planners and engineers can design drainage systems that are effective, efficient, and sustainable. (Morris, J., et al.,2016)

2.2.1.6.2. The topographic layout of the locale in management planning for SUDS
A topographic map is a type of map that shows the physical features of a landscape, including elevation, contour lines, and other relief features. Topographic maps can be used to understand the land's shape and the location of natural and man-made features like water bodies, buildings, and roads. (Gironás, J., et al., 2018). In the context of sustainable urban drainage systems (SUDS), topographic maps can be useful in identifying areas of low-lying land and natural drainage patterns. (Tait, S., et al., 2017).

2.2.1.6.3. The soil type of the land of the locale in management planning for SUDS
A soil map is a type of map that shows the distribution and characteristics of soils in a particular area. Soil maps can be used to identify soil types, drainage patterns, and other soil-related properties that can be important for land use planning and management. (Li, X., et al., 2019). In the context of sustainable urban drainage systems (SUDS), soil maps can be useful in selecting appropriate drainage solutions that are compatible with the local soil conditions. (Zhang, H., et al., 2016).

2.2.1.6.4. The rate of vegetation over the total area of the locale
A vegetation map is a type of map that shows the distribution and characteristics of vegetation in a particular area. (Borselli, L., & Cassi, P., 2017). Vegetation maps can be used to identify different types of vegetation cover, such as forests, grasslands, or wetlands, as well as areas with little or no vegetation. Vegetation maps can be useful in selecting appropriate drainage solutions that are compatible with the local vegetation conditions. (Kumar, P., & Aggarwal, P., 2020).

After determining the scopes and parameters of the required indicators, the researchers created the comprehensive assessment tool that includes all the identified indicators. These indicators or factors will serve as a guide to gain an accurate understanding of each parameter. All the data gathered is necessary for each factor to meet the concepts and principles required for implementing SUDS. To evaluate the collected data, each factor will be graded from one (1) to five (5) based on the amount of information that can be extracted. The scores of all items will be analyzed to determine how to handle each data during analysis. Please refer to the table below for the grading criteria for each item.

Rating	Interpretation	Description
5.00	Very High Compliance	The gathered data/document provided all the required information for the assigned item and exceeded the expected additional details useful to the overall understanding of the tool.
4.00-4.99	High Compliance	The gathered data/document provided all the required information for the assigned item and provided additional details useful to the overall understanding of the tool.
3.00-3.99	Compliant	The gathered data/document provided the required information for the assigned item.
2.00-2.99	Low Compliance	The gathered data/document only reflected the concept of the required information but does not fully comply for the assigned item.
1.00-1.99	Very Low Compliance	The gathered data/document does not provide the required information for the assigned item.

Table 1. Criteria for Grading for the Assessment Tool

Table 1 presents the criteria utilized for evaluating the data gathered in this study. The first column displays the value range for the gradings used in the assessment tool. The corresponding qualitative interpretation is represented in the next column, while the final column provides an actual description of the requirements necessary for achieving the appropriate grading. After developing the initial assessment tool for this study, the researchers will validate its reliability and applicability in real-time. This will be achieved by seeking insights and preferences from various experts in the relevant field and the local government unit. During the consultation process, if an expert identifies a specification or parameter that requires modification, the researchers will revise the assessment tool accordingly. This process will continue until the expert confirms that the assessment tool is credible enough to be used in real-time situations.

- *Statistical Analysis*

In order to determine the internal consistency and reliability of the assessment tool, it must be subjected to Cronbach’s alpha and One-way ANOVA.

Cronbach's alpha is a widely used statistical measure of reliability that assesses the internal consistency of a set of items or questionnaire. It measures the extent to which the items in a questionnaire are related to one another and give similar results. The alpha coefficient ranges between 0 and 1, with higher values indicating greater reliability (Paul, R. H., Cohen, R. A., & Ott, B. R., 2005).

As for the One-way ANOVA (analysis of variance), it is a statistical method used to compare the means of three or more groups. It is typically used to determine whether the mean differences between groups are statistically significant. The one-way ANOVA compares the variance between groups to the variance within groups, using an F-test. The F-statistic is calculated by dividing the between-group variance by the within-group variance. If the F-value is greater than the critical F-value, it suggests that there is at least one statistically significant difference between the means of the groups (Gravetter, F. J., & Wallnau, L. B., 2014). One-way ANOVA typically considers a margin of error of 5%, or an alpha level of 0.05, to determine significance. This means that a significance value must exceed 0.05 to conclude that there is no significant difference between the items within the assessment tool being analyzed. If the calculated significance value is less than 0.05, then it is considered statistically significant, and there is evidence that there is a difference between the variables being compared. In other words, if the significance value is less than 0.05, one cannot attribute the observed differences to chance alone, and the differences are likely due to the variables being analyzed.

2.2.2 Phase 2 – Sustainability Assessment of Bulaon Resettlement for the Development of SUDS

The researchers evaluated Bulaon Resettlement to determine if the locale can successfully implement sustainable long-term drainage management practices or SUDS. In order to accomplish this goal, the researchers collected all the necessary data, including information about current drainage management practices, environmental factors, and any relevant local policies or regulations. Once all the required data has been obtained, the researchers analyzed it using the formulated assessment tool designed.

This tool will consider the PESTLE Framework as base to determine within the factors which are considered important for determining the overall sustainability of the drainage management practices being used by the Bulaon Resettlement.

By carefully considering all these different factors and analyzing the data collected in depth, the researchers can gain a comprehensive understanding of the sustainability of the Bulaon Resettlement's drainage management practices. Based on the established findings, the researchers are then able to make recommendations for any lacking aspect within the interpretation of the computation analysis. To fulfill the requirements of the assessment, the researchers collected various data from the following documents:

- Comprehensive Land Use Plan (CLUP) - This document is an instrument that local government units use to allocate available land resources to different sectors of their territory and materializes the vision of the local government for the territory on its land resources (enp. tipnio, 2019). • Local Development Plan - This document is the result of the LGU's intentional, logical, and ongoing efforts to speed up the development process. It entails formulating a set of choices while maximizing the use of available resources with the help of the local community. (Gil, S., 2015).

- Master Drainage Plan - The drainage systems meant to transport all surface and subterranean waters from a subdivision or development are shown in this plan, both on- and off-site. Additionally, any areas that are tributary to or carry drainage from the proposed subdivided land are included, together with information on the discharge of stormwater and the courses and channels of it, including floodplains. (Law Insider, 2021).

- Soil Map of the Locale - This is a detailed map of the natural bodies of soil, their classification, and grouping. Additionally, it provides data on soil characteristics that may be used to understand and visualize soil geographic distribution. (Drishti IAS, 2023). • Flood Susceptibility/Hazard Map - Based on physical traits that affect the likelihood of flooding, this data map indicates the most susceptible places (Vojtek, M., & Vojtekova, J., 2019).

- Socio-Economic Profile of the Locale - The document describes the region's economic development and social evolution as well as the overall well-being and standard of living of its residents (Guidelines on the Collection of Demographic and Socio-Economic Information on Fishing Communities for Use in Coastal and Aquatic Resources Management, 2023)

The aforementioned documents served as the fundamental prerequisites for the utilization of the developed evaluation tool in this study. The gathered data underwent grading analysis, in accordance with the criteria listed in Table 1, as deemed appropriate and necessary. Each data point was assessed for compliance and analyzed to determine its complementary details pertaining to the specified determining factors. The researchers computed the compliance level of each item and calculate the average of each factor. The determined average provided insight into the level of compliance about each specific aspect of sustainability.

Once the average score for each factor has been computed, the researchers calculated the overall average score, which provided an indication of the overall compliance level of the collected data. This provides a measure of how well the locale is prepared for sustainable adaptation in stormwater management in general.

The compliance score obtained from the grading analysis was used to evaluate the preparedness of the locale in terms of sustainability. The researchers can compare the overall compliance score against the established criteria to see if any improvements or adjustments are needed to comply with the required standards. This can aid in identifying the strengths and weaknesses of the locale's current stormwater management practices, as well as identify focus areas for further improvement or investment.

Considering the analysis's findings, the researchers can determine the potential for successful implementation of sustainable stormwater management practices in the locale. If the overall compliance score is high, it suggests that the locale is well-prepared for sustainable adaptation in stormwater management. Conversely, if the score is low, it suggests that more work needs to be done to improve the locale's readiness for sustainable stormwater management. In such cases, recommendations can be made to address the identified weaknesses in order to improve sustainability and help ensure the health and safety of the local environment.

2.2.3 Phase 3 – Development of Proposal: Management Planning Program of SUDS

Upon evaluating the compliance level of each individual factor and obtaining a comprehensive understanding, the researchers will create a management planning proposal. This proposal will comprise the utilization of the formulated assessment tool for analyzing the locale regarding its sustainability adoption for Sustainable Urban Drainage Systems (SUDS).

The management planning proposal served as a structured set of guidelines intended to analyze the locale systematically. The proposal outlined the critical steps involved in assessing the sustainability adoption of SUDS in the local area. It will provide the necessary framework for identifying the strengths and weaknesses of the locale in terms of its SUDS and sustainability adoption.

Furthermore, the proposal served as a benchmark for future analyses of the area's sustainability adoption levels for SUDS. It will also act as a tool to identify the potential future actions necessary for enhancing the sustainability adoption of SUDS in the locale.

In conclusion, the development of this management planning concept made it possible to examine the sustainability of SUDS adoption in the area in a complete and orderly manner. The proposal will function as a roadmap for identifying future actions required to improve the area's sustainable adaptation for SUDS. The management planning proposal will consist of several crucial elements to ensure its effectiveness and usefulness. These elements include:

1. Formulated Assessment Tool: The proposal will provide detailed information about the assessment tool that the researchers have developed to evaluate the sustainability adoption level of SUDS in the locale. It will highlight the determining factors indicated in this study for the assessment process, and the specific criteria used to measure compliance

2. List of Gathered Data: The proposal will contain a compilation of the data gathered during the assessment process.

3. Computation of Compliance Level: The proposal will compute the compliance level of the gathered data based on the established criteria. It will explain how the researchers determined the compliance level for each data point and how they arrived at a compliance score for each factor.

4. Interpretations of Average per Factor and Overall Consideration: The proposal will interpret the average compliance score for each factor and the overall consideration for sustainability adoption of SUDS in the locale. It will provide an explanation of what the average scores indicate and how they should be interpreted in terms of the area's sustainability adoption of SUDS.

5. Recommendations: Finally, the proposal will offer recommendations based on the assessment results. The recommendations will cover the actions necessary to improve the area's sustainability adoption of SUDS. The recommendations will be based on a

comprehensive analysis of the gathered data and will be designed to address any identified weaknesses and improve the area's overall sustainability adaptation to SUDS.

The proposal's critical elements ensure that the local authorities understand the essential aspects that contribute to the successful adoption of SUDS. This structured understanding empowers the authorities to prioritize areas that need immediate attention and action. Consequently, the proposed assessment tool identifies areas that require action and proposes actionable recommendations, aiming to improve the area's SUDS sustainability adoption.

In conclusion, the proposed management planning proposal provides clear guidance and tools for the local authorities to improve the area's sustainability adoption levels. The proposal and its assessment tool offer a comprehensive, structured, and organized approach to managing SUDS sustainability in the area. This approach is expected to result in enhanced sustainability adoption levels, leading to a healthier environment and a more sustainable community.

III. RESULTS AND DISCUSSION

This chapter will explain the interpretation of the collected data as well as the treatment of the statistical analysis. Furthermore, the formulated assessment tool will be discussed and how each factor was determined according to its requirement and expected information.

3.1 Formulation of Assessment Tool

The following table presents the official assessment tool, intended to serve as a guide in determining the appropriate SUDS to implement in the area. The table includes various parameters identified by the study as important determining factors for the sustainability of the SUDS. The table also specifies the required data and its corresponding collection location. The data collected will be evaluated based on the criteria outlined in Chapter 2 of this study.

Table 2. Multi-criteria Assessment Tool

PARAMETER	DETERMINING FACTOR		DATA COLLECTION [EVIDENCE/S]	SITE FOR DATA COLLECTION	GRADING	REMARKS
Political Factor	1.1	The disposition of the local government in supporting sustainability towards stormwater management	Ascertain on the position of the government towards achieving total sustainability in the field of stormwater management. a. Reforestation program, b. Implementation of geohazard maps,	City Planning and Development Coordinator's Office - City Environment and Natural Resources Office		
	1.2	The interventions in pursuing sustainability by the local government in terms administrative freedom in application policies	Impact assessments and continuity plans that help local governments deal with the problems that develop by pursuing sustainable development. a. Assessment regarding (Comprehensive Land Use Plan): 1. Integrated Protected Areas 2. Population concerns 3. Social Welfare	City Planning and Development Coordinator's Office		
	1.3	The application of the Philippine legislation in decision-making plans in area development plans for sustainability adoption in stormwater management	Determine the legislative standards in the formulation of the area development plans, particularly at the local government level. a. Comprehensive land use plan (CLUP)	City Planning and Development Coordinator's Office		Note: Data for 1.1 and 1.2 is inclusive in the Comprehensive Land Use Plan in 1.3.
	1.4	The political agendas of the local government in terms of adopting sustainability in drainage system	Determine that the environmental policies of the current local government coincide with the principles and concept of SUDS a. Environmental Program within the Zoning Ordinance of CLUP	City Planning and Development Coordinator's Office		
PARAMETER	**DETERMINING FACTOR**		**DATA COLLECTION [EVIDENCE/S]**	**SITE FOR DATA COLLECTION**	**GRADING**	**REMARKS**
Economic Factor	2.1	The existing budget for the building projects of drainage system in areas susceptible to flooding	Determine the breakdown of flood control allocation budget issued by the Barangay Officials and Municipal Engineering Office. a. Funding Requirements for Flood Control Budget Allocation (Installment of Drainage System)	City Engineering Office		
	2.2	Budgetary allocation for the implementation of sustainability concepts to the existing drainage system	Determine the expense based on a cost-benefit analysis and risk assessment of the region. Considering the budget needed for its construction. a. Certificate from the Local Treasurer or Bank Certificate detailing the Annual Budget or Annual Investment Plan (AIP)	Barangay Office of Locale		
	2.3	Maintenance and construction procedure of the constructed urban drainage system	Determine the standard procedure in the construction project of drainage system a. Maintenance Procedures for Drainage Structures b. Construction Procedures for Drainage Structures	Barangay Office of Locale		
	2.4	The annual performance plan (APP) showing the budgeted amount for the required funds regarding the construction of Green Infrastructure in the field of Stormwater management	Determine if the Office of the Mayor and DILG Provincial Office have approved the allocated funds required in constructing a Green Infrastructure in the field of Stormwater management. a. Certificate of Availability of Funds (CAF) amount stipulated in the MOA pertaining to sustainable development	Department of the Interior and Local Government (DILG) Provincial Office - Barangay Office of Locale		Note: Data for 2.1, 2.2, 2.3, and 2.4, is inclusive in Master Drainage Plan

PARAMETER		DETERMINING FACTOR	DATA COLLECTION [EVIDENCE/S]	SITE FOR DATA COLLECTION	GRADING	REMARKS
Technological Factor	4.1	The availability of Location map or Site Development for most devices may aid in obtaining justifiable solutions for stormwater retention and surface infiltration into the ground.	Determine the availability solution for stormwater retention and surface infiltration a. Location map or site Development from the local government.	Department of Public Works and Highways		
	4.2	The amount of rainfall water that the current drainage systems collect within a certain time frame.	Determine the indicated information by collecting: a. Rainfall data from the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA)	Philippine Atmospheric, Geophysical and Astronomical Services Administration		
	4.3	The spatial visualization and analysis of geospatial data on a specific location	Determine if the respective government agency uses the following software or similar software to determine the stated characteristic: a. ArcGIS a. QGIS	Department of Public Works and Highways		
	4.4	The vulnerability of the local area to flood risk is determined by the probability of flood hazards	Determine if the respective government agency uses the following software or similar software to determine the stated characteristic: a. OpenFLOWS FLOOD by Bentley for determining flood risks	City Disaster Risk Reduction Management Office		
	4.5	Management of the quantity and quality of stormwater runoff from a piece of developed, privately owned urban land	Determine the indicated factor by referring to the Master Drainage Plan: a. Storm Water Management Model (SWMM) for simulation of water runoff quantity and quality	City Disaster Risk Reduction Management Office		
	4.6	The condition of the water, including chemical, physical, and biological characteristics	Determine the water condition of nearby bodies of water of the locale by gathering the following data: a. PH, residual chlorine, turbidity, suspended solids, COD, BOD, conductivity, and dissolved oxygen.	City Environment & Natural Resources Office		

PARAMETER		DETERMINING FACTOR	DATA COLLECTION [EVIDENCE/S]	SITE FOR DATA COLLECTION	GRADING	REMARKS
Environmental Factor	6.1	The flood susceptibility of the locale in management planning for SUDS	Review the (a) flood hazard map from LiPAD FMC website of the area to identify the vulnerability of the areas from flood accumulation a. Flood Hazard Map	City Disaster Risk Reduction Management Office		
	6.2	The topographic layout of the locale in management planning for SUDS	Review the official topographic map of the subject area from National Mapping and Resource Information Authority (NAMRIA) to determine the elevation of the land surface and near bodies of water. a. Topographic Map	City Planning and Development Coordinator's Office		
	6.3	The soil type of the land of the locale in management planning for SUDS	Acquire the copy of the subject area's (a) soil map from the Bureau of Soils and Water Management (BSWM), then review and analyze the data to determine the land's soil permeability, texture, and structure. a. Soil Map	City Environment & Natural Resources Office		
	6.4	The rate of vegetation over the total area of the locale	Through (a) vegetation maps from the Department of Environment and Natural Resources (DENR) or through manual survey on the land, determine the vegetation available like grasslands, forests, wetlands etc. a. Vegetation Map	City Environment & Natural Resources Office		
	6.5	Existing bodies of water near or in the covered area	Using the (a) topographic map from National Mapping and Resource Information Authority (NAMRIA), locate the bodies of water	City Planning and Development Coordinator's Office		

PARAMETER		DETERMINING FACTOR	DATA COLLECTION [EVIDENCE/S]	SITE FOR DATA COLLECTION	GRADING	REMARKS
Social Factor	3.1	The type of community residing in the selected locale	Check the official survey and information of the community by collecting the required data such as census from the government to determine the demographics residing in the study area. a. Statistics showing the total population, growth rate, households, and average household size b. Thematic maps that present the population data of a specific area c. Traffic situation in the locale	City Planning and Development Coordinator's Office		
	3.2	Sustainable and prospective approach for improvement of health in rapidly urbanized areas	Determine whether there is an available data on pursuing sustainability in terms of stormwater management a. Policies that implement sustainability in terms of stormwater management	City Environment & Natural Resources Office		
	3.3	Social requirements, conditions, and maintenance process in terms of retrofitting to the subject area	Verify whether the area undergoes sufficient urbanization to warrant the development of a sustainable urban drainage system. a. Data of the total population and number of active businesses in the locale	Business Permit and Licensing Office		

PARAMETER		DETERMINING FACTOR	DATA COLLECTION [EVIDENCE/S]	SITE FOR DATA COLLECTION	GRADING	REMARKS
Legal Factor	5.1	The limitations and parameters of the law in adopting sustainability on the field of stormwater management	Determine existing policies or ordinances that mandates the implementation of sustainability in terms of stormwater management and its probable impact a. Review the indicated policy to determine the specifications required by the government to ensure sustainability	Sangguniang Panlungsod Office		
	5.2	The allowance of alteration of structure in terms of private property for the management planning of SUDS	The policy in which private property owners are inclined to follow in considering the implementation of SUDS in a small-scale area (housing property). a. Review the indicated policy to determine the allowance of alteration for such system	Barangay Office of Locale		
	5.3	The allowance of change in the area development plans	Determine the allowable area in which shareholders can freely act upon to implement SUDS. a. Site Development Plan of the locale	Barangay Office of Locale		

Table 2 comprises the subsequent elements: particular parameters, which define a specific aspect in the determination of SUDS in the locale; determining factors, as previously discussed in the preceding chapter; data collection, which enumerates the actual data required to satisfy the corresponding factor; site data collection, specifying where the data can be gathered from; grading, which shows of the compliance level of each data item required for analysis and determination; and remarks, which consist of notes that must be considered during data collection.

3.1.1 Statistical Analysis

To determine the internal consistency, reliability and means between respondent, the following statistical measures are used:

Cronbach Alpha
In terms of this statistical measure, all the twenty-five items within the assessment tool will be subjected as to determine its internal consistency. In order to confirm the internal consistency of all the items, the yielded α must be greater than 0.70. The table below shows the value of Alpha upon the twenty-five (25 items) within the developed assessment tool:

Table 3. Cronbach's Alpha

Reliability Statistics	
Cronbach's Alpha	N of Items
.808	25

The results showed that the tool had a Cronbach's alpha value of 0.808, indicating that all 25 items were within the acceptable range of internal consistency. This finding suggests that the assessment tool is reliable and can be used to measure the construct of interest with confidence.

One-way ANOVA
Four set of responses have been gathered along with those of the researchers for the testing of One-way ANOVA. Within that set of responses includes the gradings provided by the researchers in the evaluation of the gathered data. For 54 One-way ANOVA, the responses were compared in which that it must show that there is no significant difference between each parameter.

The tables below show the computation for each of the item included in the assessment tool by the respondents.

Table 4. One-way Anova – Standard Deviation

Factors	Respondent	Mean	N	Std. Deviation
Political	1	2.75	4	.500
	2	4.00	4	.816
	3	3.75	4	.500
	4	3.25	4	.500
Economic	1	2.00	4	.000
	2	2.00	4	.000
	3	2.50	4	.577
	4	1.75	4	.500
Social	1	2.67	3	1.528
	2	2.33	3	1.155
	3	2.33	3	1.155
	4	3.00	3	1.732
Technological	1	2.50	6	.837
	2	3.17	6	1.169
	3	3.17	6	.753
	4	3.17	6	.753
Legal	1	2.00	3	1.000
	2	2.67	3	.577
	3	2.33	3	.577
	4	2.67	3	1.528
Environmental	1	2.80	5	.447
	2	3.60	5	.894
	3	3.20	5	.837
	4	3.00	5	1.000
Total	1	2.48	25	.770
	2	3.04	25	1.060
	3	2.96	25	.841
	4	2.84	25	1.028

Table 4 included data on variables, respondents, means, sample sizes, and standard deviations related to aspects crucial for managing sustainable urban drainage. The factors column listed components, such as political, economic, social, technological, legal, and environmental concerns. The mean column showed the average scores, while the N column indicated the number of survey participants. The standard deviation column represented the mean deviation of each individual response.

Table 5. One-way Anova – Overall Significance

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4.590	3	1.530	1.759	.160
Within Groups	83.520	96	.870		
Total	88.110	99			

Table 5 provided various statistical measures to highlight the differences among evaluated management options/strategies. It displayed data dispersion, variations within and between groups, and degrees of freedom. Three management options/strategies were compared, revealing calculated "Mean Square" values for both "Between Groups" and "Within Groups." The F-statistic examined group mean variations, resulting in an F-value of 1.759. The p-value of 0.160 indicated no significant difference in the management options/strategies at a conventional significance level ($\alpha = 0.05$).

Table 6. One-way Anova – Significance per Factor

		Sum of Squares	df	Mean Square	F	Sig.
Political Factor	Between Groups	3.688	3	1.229	3.471	.051
	Within Groups	4.250	12	.354		
	Total	7.938	15			
	Between Groups	1.188	3	.396	2.714	.091
	Within Groups	1.750	12	.146		
Economic Factor	Total	2.937	15			
Social Factor	Between Groups	.917	3	.306	.153	.925
	Within Groups	16.000	8	2.000		
	Total	16.917	11			
Technological Factor	Between Groups	2.000	3	.667	.833	.491
	Within Groups	16.000	20	.800		
	Total	18.000	23			
Legal Factor	Between Groups	.917	3	.306	.306	.821
	Within Groups	8.000	8	1.000		
	Total	8.917	11			
Environmental Factor	Between Groups	1.750	3	.583	.864	.480
	Within Groups	10.800	16	.675		
	Total	12.550	19			

Table 6 illustrates the significant values identified among the determining factors within the specified parameters. It should be noted that this statistical measure accommodates a 5% margin of error, and thus, the significance value must not fall below 0.05. In this study, each of the values between the parameters observed exceeded the designated margin of error. Therefore, it can be concluded that the null hypothesis will be accepted, indicating no significant difference among the variables assessed by the measurement tool. Such a lack of deviation suggests that the groups have equal variances, presenting compelling evidence that the assumption of homogeneity of variance has been fulfilled. Fulfillment of this assumption conveys the F-statistic's ability to reflect the true disparities more precisely between the groups while upholding the Type I error rate. The analysis indicates that there is no significant difference among the values calculated for this statistical measure, and thus, the null hypothesis should stand.

3.2 Sustainability Assessment of Bulaon Resettlement
The following section of the proposal will entail the utilization of the formulated assessment tool in analyzing the gathered data regarding the level of sustainability in Bulaon Resettlement. The assessment tool was used to assess the area's current level of sustainability in terms of the adoption of various SUDS.

Based on the gathered data, the researchers have evaluated each data in terms of its compliance level in Table 1. Each item was individually assessed, and assigned a compliance level based on its degree of adherence to the criteria established by the researchers. The criteria used to evaluate the data were specifically tailored to assess the level of sustainability adoption of SUDS in the locale. The table below shows the grading that each item received and its corresponding sum per factor and overall grading.

Table 7. Gradings for the Assessment Tool based on Bulaon Resettlement

Parameter		Determining Factor	Grading
Political	1.1	The disposition of the local government in supporting sustainability towards stormwater management	3
	1.2	The interventions in pursuing sustainability by the local government in terms administrative freedom in application policies	3
	1.3	The application of the Philippine legislation in decision-making plans in area development plans for sustainability adoption in stormwater management	3
	1.4	The political agenda of the local government in terms of adopting sustainability in drainage system	4
		Subtotal	**13**
Economic	2.1	The existing budget for the building projects of drainage system in areas susceptible to flooding	1
	2.2	Budgetary allocation for the implementation of sustainability concepts to the existing drainage system	2
	2.3	Maintenance and construction procedure of the constructed urban drainage system	2
	2.4	The annual performance plan (APP) showing the budgeted amount for the required funds regarding the construction of Green Infrastructure in the field of Stormwater management	2
		Subtotal	**7**
Social	3.1	The type of community residing in the selected locale	4
	3.2	The interventions in pursuing sustainability by the local government in terms administrative freedom in application policies	1
	3.3	Sustainable and prospective approach for improvement of health in rapidly urbanized areas	4
		Subtotal	**9**
Technological	4.1	The availability of Location map or Site Development for most devices may aid in obtaining justifiable solutions for stormwater retention and surface infiltration into the ground.	3
	4.2	The amount of rainfall water that the current drainage systems collect within a certain time frame.	4
	4.3	The spatial visualization and analysis of geospatial data on a specific location	3
	4.4	The vulnerability of the local area to flood risk is determined by the probability of flood hazards	3
	4.5	Management of the quantity and quality of stormwater runoff from a piece of developed, privately owned urban land	4
	4.6	The condition of the water, including chemical, physical, and biological characteristics	2
		Subtotal	**19**
Legal	5.1	The limitations and parameters of the law in adopting sustainability on the field of stormwater management	4
	5.2	The allowance of alteration of structure in terms of private property for the management planning of SUDS	1
	5.3	The allowance of change in the area development plans	3
		Subtotal	**8**
Environmental	6.1	The flood susceptibility of the locale in management planning for SUDS	4
	6.2	The topographic layout of the locale in management planning for SUDS	3
	6.3	The soil type of the land of the locale in management planning for SUDS	4
	6.4	The rate of vegetation over the total area of the locale	2
	6.5	Existing bodies of water near or in the covered area	2
		Subtotal	**15**
		TOTAL	**71**

Table 7 presented a framework for appraising the sustainability of stormwater management in a chosen locale, based on various parameters organized into five categories: Political, Economic, Social, Technological, Legal, and Environmental. Each parameter received a grading value depending on its importance in determining stormwater management sustainability, and sub-factors were graded on a scale from 1 to 4. With an aggregate score of 71, a wide range of factors influenced stormwater management sustainability efforts. Evaluating these factors could have potentially aided in identifying strengths and weaknesses in the existing system, enabling the development of strategies to enhance sustainability efforts.

In order to assess the extent to which Bulaon Resettlement has adapted to sustainable urban drainage systems (SUDS), the researchers will compute the average score for each factor as well as the overall evaluation. The assessment will be based on specific criteria established in advance. The researchers will evaluate each factor's level of compliance in order to identify areas that require improvement. The degree of compliance for each factor will be incorporated into the calculation of the average score for that factor as well as the overall assessment. The calculated compliance levels will be used to determine the degree of compliance of the data collected and assess the sustainable development of the local region's stormwater management. The table displayed below illustrates the average score for each factor as well as the overall assessment.

Formula for computing the average of each score:

$$\bar{X} = \frac{\sum_{i=1}^{n} Xi}{n}$$

Where: $\bar{X}$ = Average of Score
Xi = Value of Score
n = Number of Items

Table 8. Computation of Average Rating per Factor

Parameter	Average	Qualitative Interpretation
Political	3.25	Compliant
Economic	1.75	Very Low Compliance
Social	3	Compliant
Technological	3.167	Compliant
Legal	2.67	Low Compliance
Environmental	3	Compliant
Overall	2.84	Low Compliance

In Table 8, each parameter evaluated yielded a computed sum and corresponding average. The political parameter has a computed sum of 13 and an average of 3.25. The economic parameter has a computed sum of 7 and an average of 1.75. The social parameter has a computed sum of 9 and an average of 3. The technological parameter has a computed sum of 19 and an average of 3.167. The legal parameter has a computed sum of 8 and an average of 2.67. Additionally, the environmental parameter has a computed sum of 15 and an average of 3. Finally, in terms of overall consideration, the evaluation of the 25 items resulted in a sum of 71 and an average of 2.84.

3.2.1 Interpretation

The corresponding statements provided context to the numbers in the presented table as to explain any patterns or trends that are present in the data.

- Political Factors

It was determined that Political Factor 1.1, 1.2, and 1.3 yielded a score of 3, indicating compliance. This suggests that data was gathered for all three items in question. On the other hand, item 1.4 was found to have a score of 4, indicating a high level of compliance. The data collected for this item provided all the necessary information as well as additional data that further enhanced the understanding of the instrument. Therefore, it can be inferred that the gathered data was not only sufficient but also comprehensive, contributing significantly to the accuracy of the assessment. This criterion received an average score of 3.25, which indicates a relatively higher compliance level. Therefore, the political parameter has given sufficient information and details to the whole assessment tool.

- Economic Factors

It was established that Economic Factor 2.1 had a score of 1, indicating very low compliance. The collected data or document did not contain the necessary details required for the allotted item, leading to a lack of sufficient information for the assessment. Items 2.2, 2.3, and 2.4 yielded a score of 2, indicating low compliance. While the collected data or document reflected the concept of the required information, it did not completely conform to the specified item. In this case, the average value of the economic factor is calculated, which results in a total score of 1.75. While the data available for economic analysis on the four factors is not deemed sufficient, it is essential to recognize potential gaps in the data or limitations in the available information, which might impact the accuracy and reliability of the economic analysis.

- Social Factors

It was determined that Social Factor 3.1 and 3.3 had a score of 4, indicating high compliance. The data or document collected for these items included all the necessary information for the assigned item, as well as additional details to enhance the overall understanding of the tool. However, item 3.2 had a score of 1, indicating very low compliance. The collected data or document for this item lacked the necessary information required for the given item, leading to a lack of comprehensive information for the assessment. This calculation yields a mean score of 3, which, in accordance with the assessment instrument, is within the compliance range. This indicates that the social factor data collected was still deemed to be adequate and in compliance with the pertinent standards or criteria even though one factor has an interpretation of very low compliance.

- Technological Factors

It was established that for Items 4.1, 4.3, and 4.4, a score of 3 was achieved, indicating a grade of compliance. The collected data or document contained the necessary information required for the task at hand. Meanwhile, for Items 4.2 and 4.5, a score of 4 was attained, indicating a high level of compliance. The gathered data or document contained all the necessary information for the allotted item, as 62 well as additional information that enhanced the overall understanding of the tool. However, Item 4.6 had a score of 2, indicating low compliance in the technological factor. The collected data or document only matched the notion of the needed information. The average score of 3.17 falls within the compliant range of grade 3, ascertaining that the collected data and documents furnished the necessary information for the designated item related to technological factors. These outcomes suggest that the technological aspect has been satisfactorily addressed and can be deemed compliant in the overall assessment.

- Legal Factors

It was determined that for Legal Factor, Item 5.1 had a score of 4, indicating high compliance. The collected data or document provided all of the necessary information required for the designated item, as well as additional information that enhanced the overall comprehension of the instrument. However, Item 5.2 had a score of 1, indicating low compliance. The collected data or document lacked the necessary information required for the designated task, leading to a lack of sufficient information for the assessment. Additional data or information may be necessary for Item 5.2 to ensure that the assessment of the legal factor is comprehensive and accurate. Lastly, Item 5.3 had a score of 3, indicating a grade of compliance. The collected data or document contained what was needed for the task at hand, providing adequate information for the assessment of the legal factor. The average computed for the legal factor, which resulted in a score of 2.67, it is evident that the data being evaluated is categorized under low compliance. This score indicates that the criteria's implementation falls below the expected level, with certain areas complying with the guidelines while the majority of the areas do not.

- Environmental Factors

It was established that in the Environmental Factor, Item 6.1 and 6.3 had a score of 4, indicating a high grade of compliance. The collected data or document contained all the essential information required for the assigned item, as well as additional details that were beneficial to understanding the tool. Additionally, Item 6.2 had a score of 3, indicating a grade of compliant data. The collected data 63 provided the necessary details for the assigned item. However, for Items 6.4 and 6.5, a score of 2 was achieved, indicating a low compliance of data. The data only reflected the notion of the needed information, rather than the allocated item, resulting in a lack of sufficient information for the assessment. It was determined that the Environmental Factor achieved an average score of 3, indicating a level of compliance in providing the necessary environmental data. This was inferred from the obtained scores and corresponding compliance levels, which indicated that while some items achieved high grades of compliance, others demonstrated a low level of compliance, resulting in an average compliance score for the Environmental Factor.

- Overall Considerations

Based on the evaluation it was found that the overall average score of the PESTLE factors was 2.84, which falls within the range of 2-3. This score indicates that the government's compliance with the external factors is not optimal and needs improvement. Although data/documents were acquired, they were not fully compliant with the assigned or necessary data, resulting in a less comprehensive understanding of the external factors that impact its operations. This could negatively impact the government's decision-making and overall performance. Therefore, it is recommended that further efforts are made to ensure that the necessary data is collected and that compliance with the PESTLE factors is improved.

3.2.2 Results

Upon assessing Bulaon Resettlement, it has been found that while other parameters had a satisfactory level of compliance within the collected data, the economic and legal parameters had a negative impact on the total rating. This indicates that the necessary conditions for implementation must be improved within the low compliance parameters.

Parameters with low or very low compliance levels signify the aspect that requires improvement. Updating the current data is one way to improve these parameters and boost their ratings, which will positively impact the overall assessment rating.

In terms of parameters that have already met or exceeded compliance levels, it indicates that within that parameter, there is enough information to determine the applicability of different types of SUDS. The data related to the parameter will serve as a guide for the implementation of SUDS. As such, it is essential to keep monitoring and assessing the identified parameters frequently to maintain compliance and ensure continuous improvement.

The overall assessment of Bulaon Resettlement revealed a low compliance level regarding sustainability. This indicates the inadequacy of available data concerning the area's sustainability practices. Gathering additional data or updating the available information is necessary to increase the area's compliance level. This data will aid researchers in gaining a deeper understanding of the area's sustainability practices, identifying areas that require improvement, and proposing actionable recommendations to enhance the area's sustainability.

The lack of sufficient data prevents researchers from suggesting applicable types of SUDS for this locale. Therefore, it is crucial to increase the area's compliance level of sustainability to develop a more sustainable and livable community.

3.3 Management Planning Proposal for Sustainability Assessment of Bulaon Resettlement for Implementation of SUDS

To implement the assessment tool practically, herewith is the concrete management planning proposal, which shall be presented to the local government unit for approval. The contents of the proposal are as follows:

- Executive Summary

This formulated assessment tool evaluates the availability and quality of data needed for the implementation of sustainable urban drainage systems (SUDS). The main objective of this tool is to determine whether a locale possesses enough data to transition to the usage of SUDS.

The assessment criteria include environmental, technological, and legal factors, each of which is populated with a set of maps and datasets. The criteria are assessed using a compliance rating system that ranges from low to high. The evaluation results are analyzed and presented as a comprehensive report, which identifies areas of compliance and those which need improvement.

The tool focuses on assessing the maps and related data crucial for SUDS implementation. Therefore, the tool is a vital resource in determining the completeness and accuracy of the required environmental, legal, and technological data for SUDS implementation. The tool is useful for local planners and other policymakers who are concerned about implementing sustainable urban drainage systems.

The assessment tool provides substantial benefits for policymakers and planners since it gives them clear insights into the availability and quality of data for sustainable urban drainage system implementation within their locality. By having access to reliable data, policymakers can make necessary adjustments to the implementation plans and, in turn, promote more data-driven decision-making.

- Goals and Objectives

To develop an assessment tool that evaluates the availability and quality of data required for the implementation of sustainable urban drainage systems, and to determine whether a given locality has sufficient data to transition to the utilization of SUDS. In order to achieve this, the following must be considered:

1. To identify the environmental, technological, and legal data required for the implementation of SUDS.
2. To design a user-friendly interface for the assessment tool to support policymakers and other planners in evaluating their locality's data.
3. To provide recommendations for improving the quality and completeness of data needed for the transition to SUDS implementation.
4. To promote data-driven decision-making by enabling local policymakers to make informed decisions based on accurate, reliable data.

- General Provisions:

1. The tool identifies several determining factors, each with a designated item number. Additionally, the required data and the site of the government agency from which it can be collected are also indicated.
2. The following are the general documents that must be initially gathered to effectively utilize this tool:
a. Comprehensive Land Use Plan
b. Local Development Plan
c. Master Drainage Plan
d. Soil Map of the Locale
e. Flood Susceptibility/Hazard Map f. Socio-Economic Profile
3. Upon completion of data collection, segregate and organize the required information according to the assigned item in the assessment tool.

4. After segregation, use the given rubric below to rate the collected information according to its compliance level in providing the necessary data required in the provided assessment tool.

Criteria for Grading in Evaluation of Gathered Data

Rating	Interpretation	Description
5.00	**Very High Compliance**	The gathered data/document provided all the required information for the assigned item and exceeded the expected additional details useful to the overall understanding of the tool.
4.00 – 4.99	**High Compliance**	The gathered data/document provided all the required information for the assigned item and provided additional details useful to the overall understanding of the tool.
3.00 – 3.99	**Compliant**	The gathered data/document provided the required information for the assigned item.
2.00 – 2.99	**Low Compliance**	The gathered data/document only reflected the concept of the required information but does not fully comply for the assigned item
1.00 – 1.99	**Very Low Compliance**	The gathered data/document does not provide the required information for the assigned item.

5. After rating the collected information, compute the average of each parameter (Political, Economic, Social, Technological, Legal, and Environmental), and the overall average of all the items.

Formula for computing the average of each score:

$$\bar{X} = \frac{\sum_{i=1}^{n} Xi}{n}$$

Where: $\bar{X}$ = Average of Score
Xi = Value of Score
n = Number of Items

Average and its Corresponding Interpretation per Parameter

Parameter	Average	Interpretation
Political		
Economic		
Social		
Technological		
Legal		
Environmental		
Overall		

6. Finally, generate an interpretation of the calculated averages to determine the compliance level per parameter and overall considerations. This interpretation will allow the user to provide recommendations towards the improvement of each sector with available data within the locale.

7. In relation to the parameters that met or exceeded compliance levels, it indicates that there is enough data available to identify the most applicable sustainable urban drainage system (SUDS) for the locale. The data related to these parameters can serve as a guide for the implementation of such systems. This highlights the importance of ensuring that compliance levels are met and maintained in order to have sufficient data for the successful implementation of sustainable urban drainage systems.

8. In regards to the parameters with low compliance levels, it is crucial for the locale to improve the current state of withheld data through updating the current specifications within the specified data. This means that any missing or incomplete data needs to be collected or updated to ensure that the compliance levels are met and there is enough information available to identify the most applicable sustainable urban drainage system for the locale. Without sufficient data, it will be challenging to determine the effectiveness and feasibility of implementing a sustainable urban drainage system. Therefore, the locale must take the necessary steps to improve the data and ensure that compliance levels are met in all parameters.

IV. CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

This study has formulated an assessment tool in which it contains several determining factors required for navigating through the concept of sustainability in stormwater management. This tool was then used to evaluate the gathered data pertaining to Bulaon Resettlement. These data were then subjected to a grading analysis in which the compliance level was determined per factor and overall considerations.

The findings of the research have revealed that political factors play a crucial role in the planning and management of SUDS (Sustainable Urban Drainage Systems). The data related to political factors is said to produce precise compliance, which means that the concepts and principles required for managing the SUDS are believed to be adequate.

Based on the statement, the research findings suggest that the current understanding and management of political factors related to SUDS planning is sufficient. In contrast to the political factors, the economic factor has a low compliance rate in terms of identifying principles and concepts required for the management planning of the locale. Therefore, data regarding the economic factor is not significant enough to be considered in the overall management planning. The low compliance rate for the economic factor might imply that the current understanding and management of economic factors related to SUDS planning are not adequately developed or are not considered in the overall management of the locale. Alternatively, it may be that the economic factors, although important, are not a significant priority in the area.

After analyzing the data related to both the social and technological factors, the evaluation was found to be within the compliant level, and the data was significant in terms of determining the sustainability of the locale in stormwater management. This implies that both social and technological factors have been given due consideration in the management planning, and their principles and concepts are well understood and applied. The social factor's compliance highlights that community and stakeholder engagement are well-established and integrated into the stormwater management plan, indicating sustainable practices incorporating the community's input. On the other hand, the technological factor's compliance suggests that technological solutions in stormwater management identify the challenges and opportunities of applying these innovations within the accepted standards of sustainable practice.

The data related to environmental concepts has yielded sufficient information that researchers can use to assess the sustainability development of the locale in stormwater management. This implies that environmental concepts have been adequately considered and integrated into the stormwater management plan. The evaluation of the data indicating that it yields enough information suggests that the current understanding and management of environmental concepts related to stormwater management are well developed, and environmentally friendly practices are being incorporated into the management plan.

The data related to legal factors provides a low compliance rate regarding the significance of the concepts of the study and the assessment tool. This indicates that the legal factors' role may not be adequately considered in the overall management planning of stormwater. The low compliance rate of the legal factor suggests that the current understanding and management of legal factors related to stormwater management may not be adequately developed or considered in the overall management of the locale. Alternatively, it may be that legal factors, although important, are not given sufficient priority in the area. Taking all the factors into consideration, the concept of sustainability in stormwater management lacks sufficient data related to Bulaon Resettlement, indicating that the concept of sustainability may not have been fully integrated into the stormwater management plan. The statement's implication is that although the individual factors related to stormwater management, such as technological, social, political, economic, legal, and environmental factors, may have been considered, the linkages between these factors to create sustainable stormwater management practices may not have been adequately developed. Therefore, it can be concluded that the current stormwater management plan lacks sufficient integration of data and information when it comes to evaluating and managing sustainability. This gap indicates an insufficiency in the overall understanding and management of stormwater systems

4.1 Recommendations

Based on their findings, the researchers recommend the implementation of the following measures to enhance the formulated assessment tool in evaluating the sustainable parameters of the locale with regards to stormwater management:

1. To further elaborate on the gathered data from the locale, it is essential to develop a tailored criteria between each item within the formulated assessment tool. The criteria will enable a more detailed evaluation of each parameter, thereby providing a more comprehensive understanding of the compliance levels of the locale. By developing

tailored criteria, it will be easier to identify areas that require improvement and determine the necessary steps that need to be taken to improve them.

2. Develop a specific set of criteria and basis of SUDS that can act as a reference in determining the sustainable aspects of the locale with regards to stormwater management. These criteria and basis will be used to guide the decision-making process on which SUDS are appropriate for the area, taking into consideration the locality's unique characteristics.

3. As per the previous recommendation, a program or software must be developed for the utilization of the assessment tool. This software should allow primary users to input their corresponding grading of the collected data, which the program will then display in its corresponding qualitative interpretation. Furthermore, the software should be capable of suggesting suitable SUDS that are applicable based on the given data.

By implementing these measures, the assessment tool will be more accurate and detailed in evaluating the sustainable parameters of the locale with regards to stormwater management. It will aid in the identification of appropriate and effective SUDS that can help mitigate flood risks and manage the stormwater runoff in a sustainable manner.

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