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Social Impact Assessment of Sustainable Drainage Systems in Ozamiz City, Philippines

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Abstract

Assessing the social impacts of sustainable drainage systems (SuDS) provides relevant information for planners, developers and engineers to establish or improve systems that benefit the society and environment. This study aimed to assess the social impacts of SuDS in three flood-prone areas in Ozamiz City. Specifically, the paper obtained general information on SuDS. The knowledge of residents about SuDS was also assessed. The paper also examined if the existing drainage systems are safe, and affect the economic value and purchases of real properties. The fears of the residents associated with SuDS and the actions to improve or develop them were identified. A standard survey instrument was administered to 149 residents who were randomly selected. Results showed that water pollution and solid waste disposal are the major environmental concerns and urban areas were most polluted. Waste disposal via drains contributed most to water pollution. Sixty-four percent of the respondents were not aware of SuDS. Using SuDS could prevent flooding but the drainage stench is sickening. Economic value of surrounding real properties increases with SuDS and leading more individuals to purchase real properties in the vicinity. Risks for the children was the biggest fear with SuDS, followed by the risk of contamination and infection from the drainage canals. Creating walkways for the residents living near SuDS was highly recommended. The SuDS was regarded as the most beneficial environmental practice. The findings of this study may help the planners, developers, and engineers in improving or establishing SuDS in Ozamiz City.

Keywords: environment, flood, pollution, society, water

Introduction

The ability of lands to absorb rainwater is becoming deliberately slow and might be eventually lost as the grounds are paved and cement-covered through the continuous rehabilitation of national and barangay roads by the government. Rivers would overflow due to heavy rains, inundating roads, residential areas, and other built-up areas (Minns & Hall, 1996). Urbanization often increases significantly the storm water runoff as buildings, parking lots and paved surfaces replace pastures and woods (Wurbs & James, 2002). Hence, an efficient drainage system must be put in place.

The drainage system is categorized into sanitary and storm water drainage. A system that carries both sanitary and storm water is called a combined system (Galamiton & Flores, 2009). The potential disadvantage found in implementing the combined system is it can lead to pollution when the culvert is not huge enough to transport both sanitary and storm water. The standard requirement is to design a separate pipe network for clean water and rainwater for a drainage system.

Sustainable Drainage Systems (SuDS) is a catch-all term for various diverse frameworks, which moderate and sometimes hold spillover to lessen surface waste (Charlesworth et al., 2003). Furthermore, the system possesses three major advantages from a drainage perspective (Jones & Macdonald, 2007) which includes reducing the overall load on the standard drains, holding back peak flows to prevent overloading, and removing diffuse source pollution to clean up discharges. The systems are widely used to reduce the impact of urban runoff to the aquatic environment providing new water habitats for organisms. They also provide water-based recreational activities. Thus, SuDS can also bring ecological benefits especially when ponds and wetlands are used (Jones & Macdonald, 2007). Also, SuDS reduces pollution, attenuates flooding, and supports low flows in streams and rivers (Graham, 2012).

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The techniques of SuDS are widely recommended and applied in Europe, Australia, United States and Canada; the name varies in different areas, but SuDS has a similar design approach (Zhou, 2014). In Europe, SuDS is used in maintaining good public health, protecting water resources against pollution and help in preserving organisms and other natural resources for future needs (Willems et al., 2012). In Australia, Water Sensitive Urban Design (WSUD) was suggested as a catchment-wide approach of which SuDS is just a part. It describes the planning and engineering approach for the integration of urban water management into city landscape to minimize environmental degradation for water and urban environment (Roy et al., 2008; Sharma et al., 2008). The term SuDS is originally coined as Low-Impact Development (LID) in the United States and Canada that promotes interaction of natural processes with the urban environment to preserve and recreate ecosystems for water management (Coffman et al., 1998). The goal of sustainability is increasingly being applied to all sectors of public life and development. Therefore, it is important to promote SuDS as a construction practice that embodies the principles of sustainability and contributes to the improvement of a more sustainable society.

In 2015, the office of the Regional Director of the Department of Public Works and Highways (DPWH) of Region 10 in Northern Mindanao, Philippines invited contractors to apply to bid for the construction of the Ozamiz City drainage system and tender an estimated cost of 100 million (Tender Tiger, 2015). Little is known about the urban drainage system plan but on-going widening of channels of creeks is observed in the city. Clean-up of esteros (estuary/drainage canal) is taking place; this is due to the clogging and massive organic pollution brought about by indiscriminate dumping of solid wastes to this waterbody (Enguito et al., 2013). The situation could be a threat to public health without a proper drainage system because low-lying areas in the city are easily flooded with heavy rain that causes the overflowing of canals, thereby making possible the spreading of pollutants lodged in these canals.

Despite the varied uses of SuDS, there is a dearth of studies conducted on the social impacts of SuDS in Ozamiz City. Assessing the social impacts of SuDS provides relevant information for planners, developers, engineers, and the local government unit to establish or improve drainage systems that is relevant to the times in the light of combatting global warming and addressing Disaster Risk Reduction and Management. Hence, the study assessed the social impacts of SuDS in Ozamiz City among the residents of the identified flooded barangays. Specifically, the paper obtained general information on SuDS. The knowledge of residents about SuDS was also assessed. The paper also examined if the existing drainage systems are safe, and affect the economic value and purchases of real properties. The fears of the residents associated with SuDS and the actions to improve or develop them were identified. The findings may provide insights to all concerned sectors in the city in developing a comprehensive plan for a sustainable drainage not only for flood control but also to maximize the ecological benefits of SuDS.

Materials and Methods

The research design of this study is descriptive. A survey of the perceptions of 149 residents randomly selected in three barangays (Aguada, Carmen Annex, Baybay Triumfo) of Ozamiz City regarding the social impacts of SuDS was carried out. The criteria for choosing the respondents are being residents near the esteros and residing for over five years in their respective area. Ozamiz City is situated at the southern part of Misamis Occidental province in Northern Mindanao, Philippines. The selected barangays frequently experience flooding for the past decade. Brgy. Aquada is the most populated among the three barangays with approximately 7196 residents, followed by Brgy. Carmen Annex with around 6,233 dwellers. Brgy. Baybay Triumfo is a coastal barangay with around 2,487 residents.

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The study made use of a questionnaire adopted from Apostolaki (2003) which is also an assessment of the social impacts of SuDS in the UK that aimed to collect and analyze information on attitudes of people (whose homes are served by ponds) towards SuDS. Hence, the questionnaire is suitable for the current study.

The questionnaire for the survey consists of six sections which include the respondent's demographic profile, general information on sustainable drainage systems, respondent's knowledge of a sustainable drainage system, an assessment of the existing drainage system, fears and concerns associated with SuDS, and recommendations for actions to improve or attain a sustainable drainage system. The survey was applied using door-to-door, interviewer-administered questionnaires consisting mainly of open-ended questions to residents. All householders who were approached, agreed to participate in the survey by giving their informed consent.

Results and Discussions

Respondent's demographic profile

Table 1 shows that majority of the respondents are female, aged 18-60 years old, married and with children ranging from 0-5 years old. Keeping the children safe at various ages is a parental responsibility, and safety of children takes a different form and substance at different stages. The workplace of most respondents is about 1-10 meters away from the drainage system. The distance from the residence to the drainage of respondents is 5-15 meters. The data suggests that majority of the respondents have first-hand experience on the impacts of the drainage system in their area.

Table 1. Frequency and percentage distribution of the respondent's demographics (N=149).

Demographic profile	Frequency	Percentage
Gender		
Male	72	48.32
Female	77	51.68
Age		
18-29 years old	36	24.16
30-44 years old	43	28.86
45-60 years old	40	26.85
60 years old and above	30	20.13
Marital Status		
Single	44	29.53
Married	85	57.05
Separated	4	2.68
Widow/Widower	16	10.74
Age of children		
0-5 years old	60	40.27
6-10 years old	26	17.45
11-15years old	18	12.08
16 years old and above	54	36.24
Distance from the workplace to the drainage		
1-10 meters	108	72.48
11-20 meters	24	16.11
21-30 meters	9	6.04
31 meters and above	8	5.37

General information

Water pollution and disposal of solid waste are the top environmental concerns of the respondents (Figure 1). Indiscriminate dumping of solid wastes to esteros in Ozamiz City has contributed to water pollution in urban creeks (Enguito et al., 2013). Solid wastes clog drainage canals and culverts causing water to overflow during heavy rains. The situation of poor waste management in the city has to be considered in setting up appropriate infrastructure and drainage facilities. Other urban areas in developing countries also have the same concerns (Kafando et al., 2013; Muzyamba, 2015).

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Majority of the respondents perceived that the urban center is the most polluted area within the city (Figure 2). Poor waste management has been the primary cause of pollution in urban areas (Guerrero et al., 2013), and this applies also to Ozamiz City. The scenario becomes worst during heavy rainfall as urban storm water runoff picks up bacteria from pet wastes and failing septic systems, fertilizers, pesticides and other chemicals from point sources. This scenario was also described by Zhou (2014) and Goonetilleke et al. (2014) in their studies. As a consequence, there is a growing trend towards managing water courses in a more sustainable way by activating the natural processes in the urban environment (Charlesworth et al., 2003; Ashley et al., 2007; Fryd et al., 2012). Ozamiz City has been observed to be catching up on this trend with the DPWH's initiative to improve the city's drainage system.

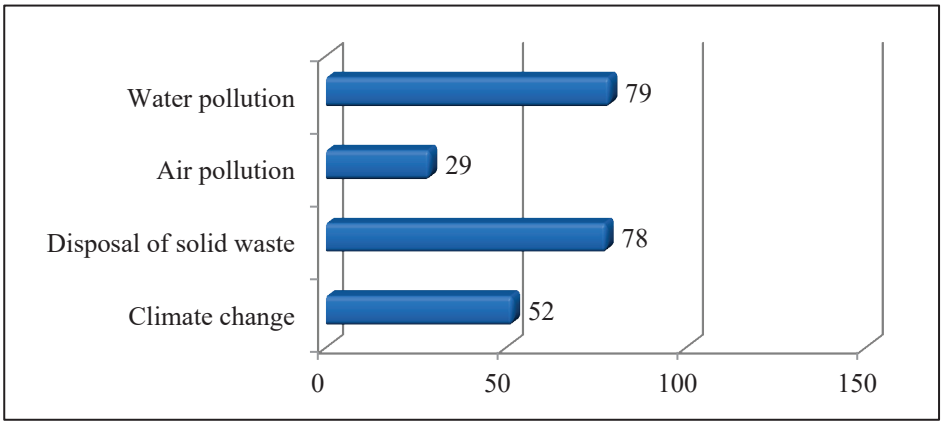

Figure 1. Environmental concerns of the residents with SuDS.

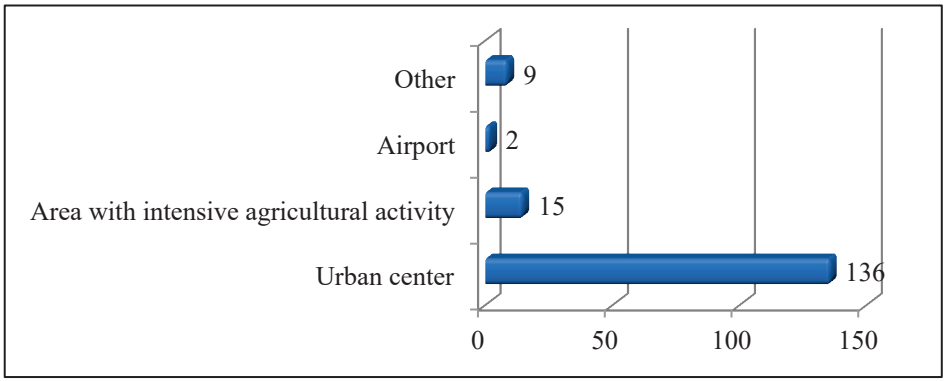

Figure 2. Polluted environment as perceived by the respondents.

Figure 3 presents the perception of the respondents as to the area where storm water runoff must drain. Based on a follow-up interview, most residents prefer that this water must drain to sewer facility for treatment before being released to the sea, or to the nearest stream or pond. A study conducted abroad by Hwang et al. (2016) stated that unmanaged storm water runoff may cause serious damage to streams, lakes and estuaries. Hence, this information with regard to storm or rain water has to be considered in designing or improving SuDS.

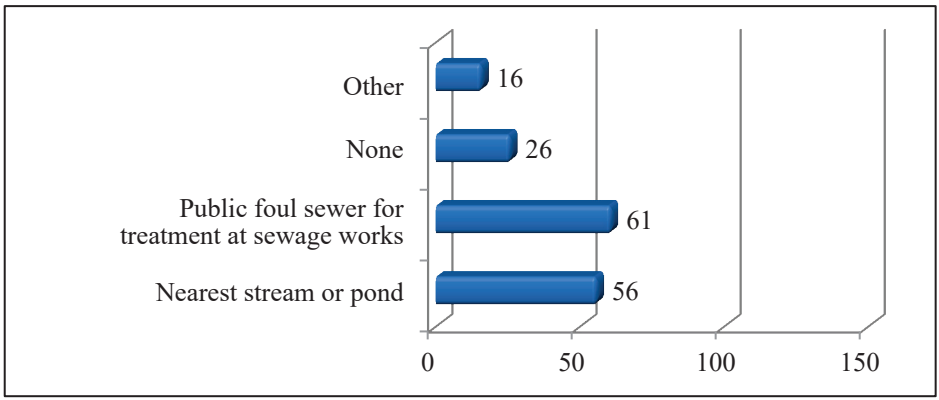

Figure 3. Respondent's perception as to the area where rain water runoff must drain.

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Figure 4 shows the activities which contribute to water pollution via drains as perceived by the respondents. Respondents perceived that disposal of waste down road grids primarily contributes to water pollution. As Eriksen et al. (2013) have warned, pollutants may enter along concrete pathways and aquatic environment through the drainage systems.

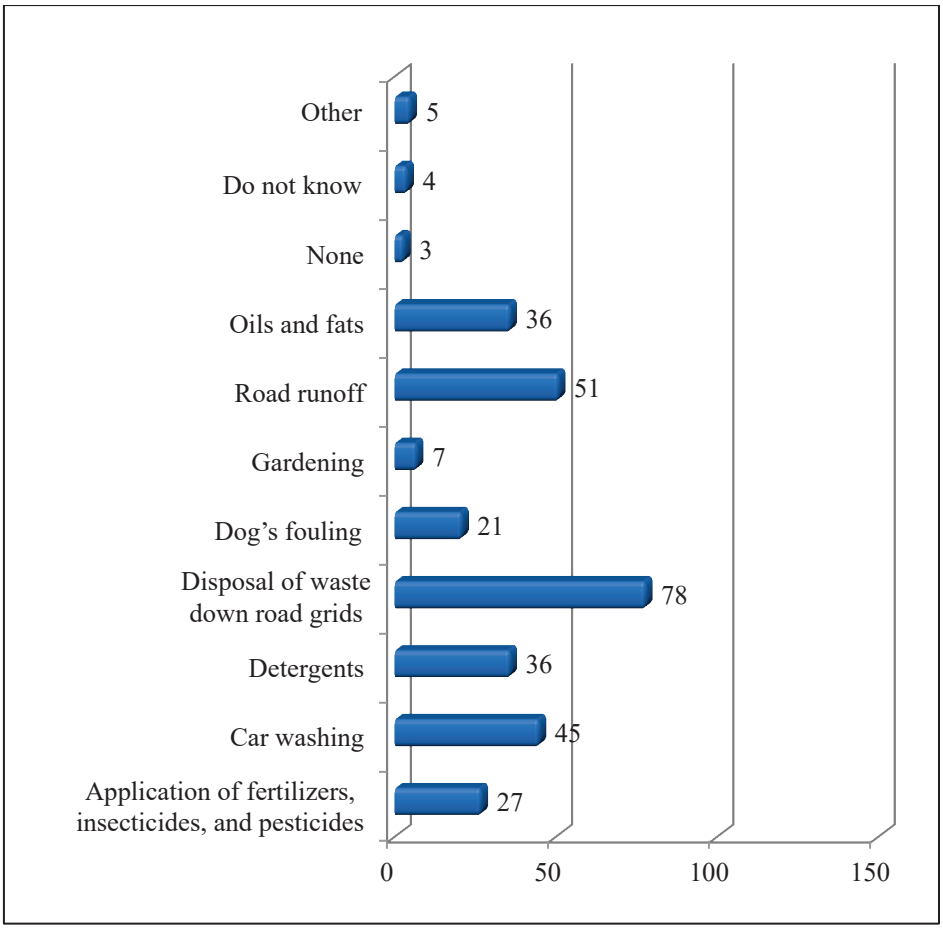

Figure 4. Activities that contribute to water pollution via drains.

Knowledge on sustainable drainage system

Results show that more respondents are not aware of the existence of sustainable drainage system in the city (Figure 5). However, most of the respondents were knowledgeable that SuDS can prevent floods (Figure 6). Also, many respondents are knowledgeable that SuDS can reduce water flow. Orientation and discussions about improvement projects can be conducted during barangay assemblies. This forum can set forth the importance of the locally-based decision system and participative implementation of any developmental projects such as the drainage system (Elazegui et al., 2016).

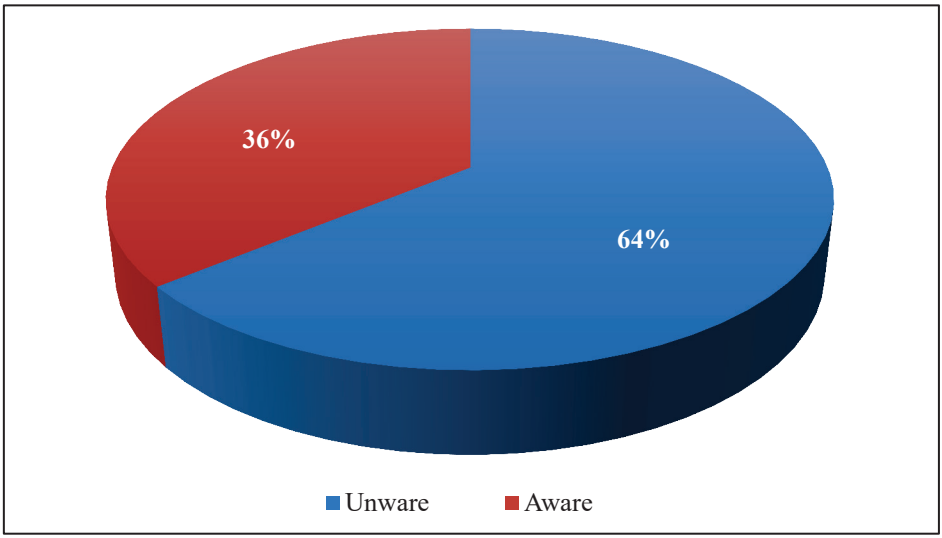

Figure 5. Percentage distribution of respondents as to awareness with any SuDS in the locality.

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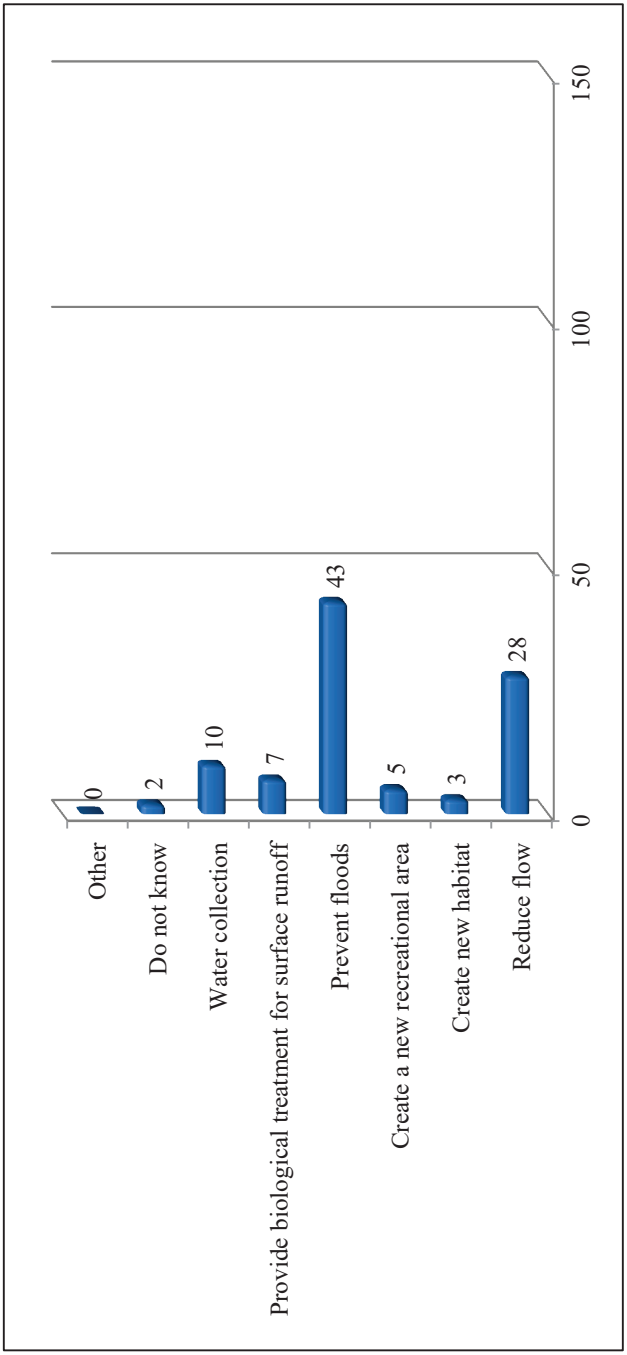

Figure 6. Respondent's knowledge on the use of SuDS.

Those respondents that are aware of the existence of sustainable drainage system in the city obtained the information mainly through the local press and word of mouth (Figure 7). The results are supported by the study of Bhattacharyya et al. (2015) that word-of-mouth approach which is often fueled by mass media is considered to be a major communication channel for spreading news and other relevant information. This form of communication is what the public prefers (Jin et al., 2014).

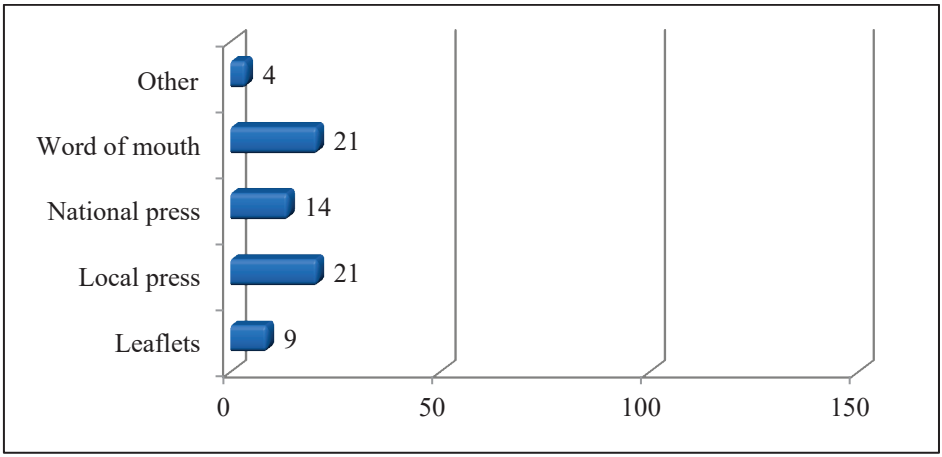

Figure 7. Sources of information about SuDS.

Figure 8 shows that avoidance of floods was the main advantage of SuDS as perceived by the respondents. The result is the same in Melbourne, Australia wherein drainage services are required to prevent flooding through the use of stormwater management techniques (Furlong et al., 2015). Ahammed et al. (2014) also added that the runoff volume from roofs and paved areas can be managed by the existing drainage system.

Meanwhile, the respondents also perceived that the drainage system has some disadvantages. Unpleasant smell, groundwater pollution and attracts insects were perceived as the top three disadvantages (Figure 9). Same findings were reported in the study of Roberts Jr. (2015) especially when there are some maintenance concerns.

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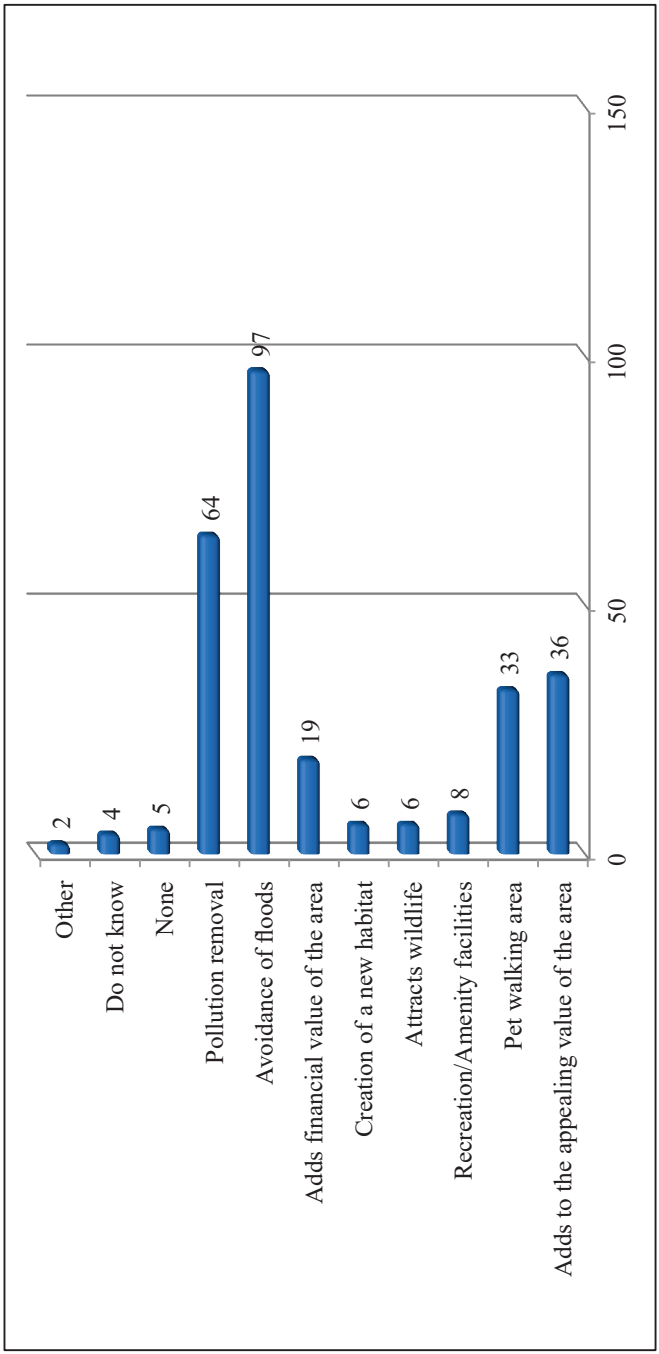

Figure 8. Advantages of drainage systems as perceived by the respondents.

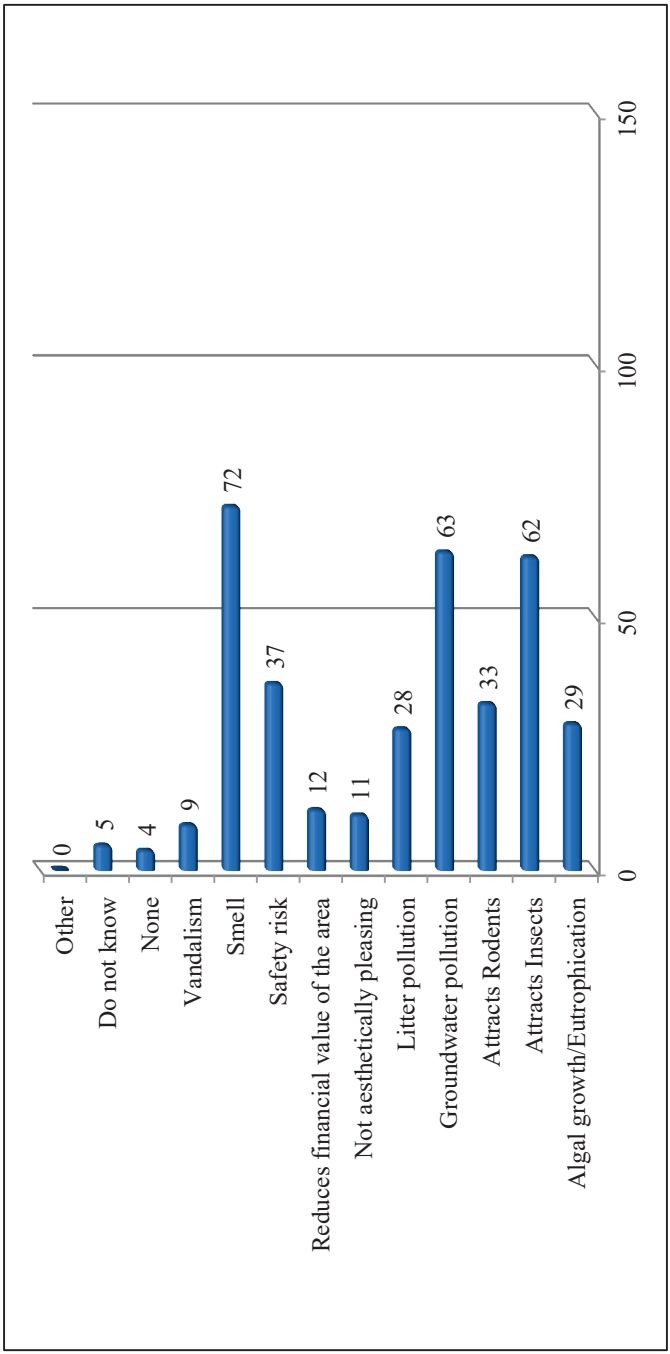

Figure 9. Disadvantages of drainage system as perceived by the respondents.

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Perceived socioeconomic benefits resulting from the drainage system

Respondents perceived that there is an increase in the economic value of an area where the sustainable drainage system exists (Figure 10). As Madramootoo et al. (1997) found out in their study in United States, in zones where SuDS are present, new structures are developed with increased employment and relatively high economic value of any property available. A sustainable drainage brings environmental and socio-economic benefits associated with public health advantages.

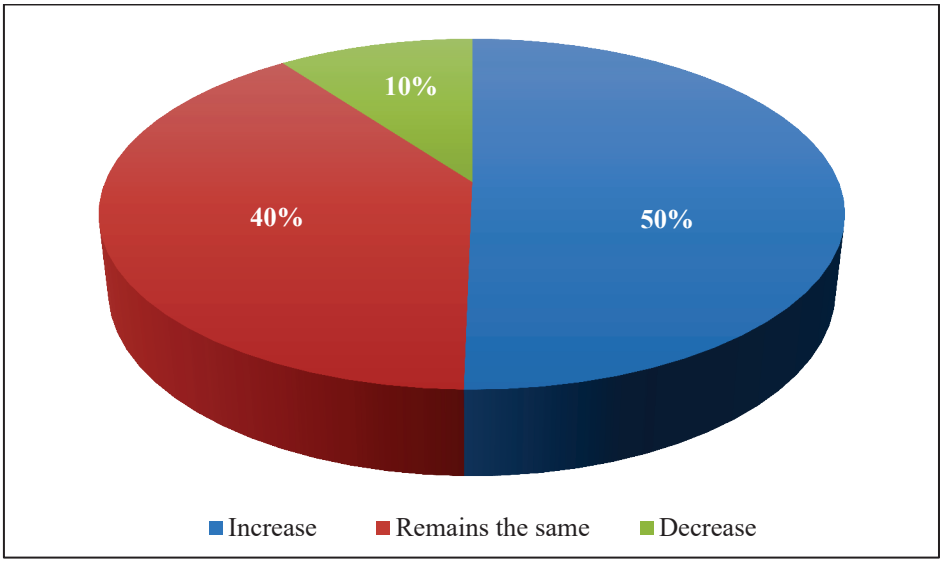

Figure 10. Percentage distribution of respondents as to their perception on the economic value of the real property in areas with SuDS.

The high value of real property in an area with SuDS does not limit the respondents to purchase and acquire property (Figure 11). The many benefits of SuDS significantly affect the desire of any individual to buy any property such as land, buildings and the like in urban areas with SuDS.

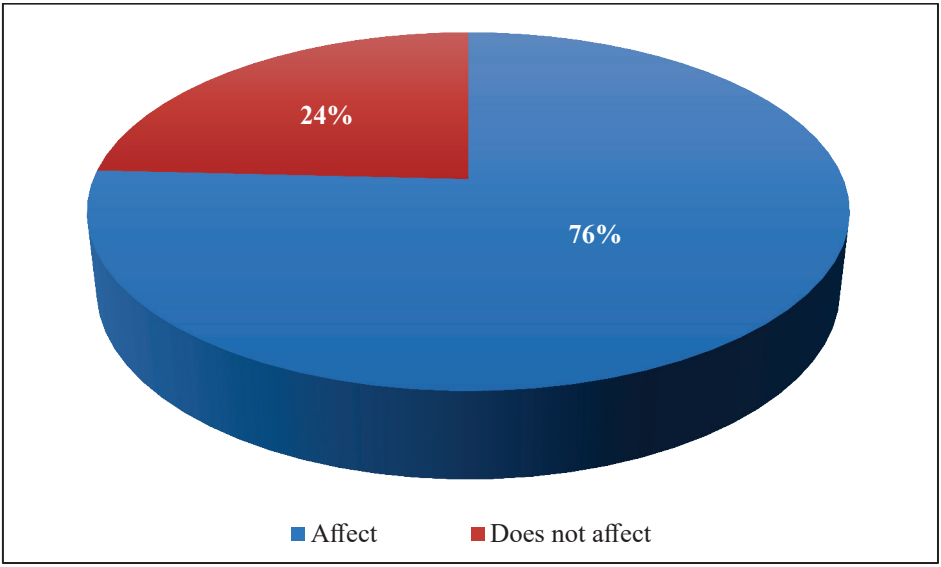

Figure 11. Percentage distribution of respondents as to their perception that SuDS affects the desire to purchase property.

Fears/concerns associated with SuDS

Figure 12 illustrates that most respondents are afraid for the safety of their children in relation to SuDS. It has been reported that parents are concern for their child's safety because of possible car or motor accident owing to the absence of walkways that could separate the travel lanes. Hence, the younger children (aged 9-10 years old) are less likely to walk or ride to school because their parents are more concerned about any accidents on the roads. Reports showed that the biggest fear of parents with children is car accident (The Telegraph, 2014).

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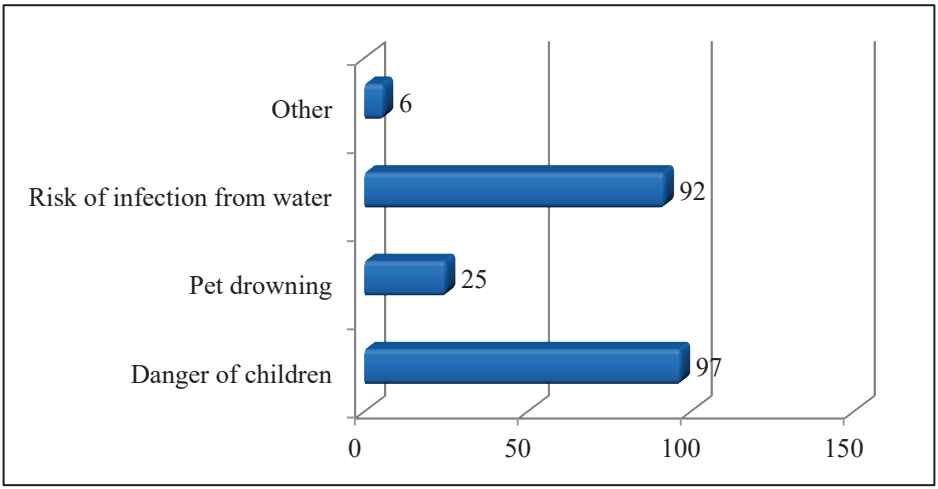

Figure 12. Fears/concerns associated with SuDS.

Recommendations for SuDS

Most of the respondents recommended the creation of walkways along the drainage (Figure 13). Providing walkways separated from travel lanes can help prevent accidents caused by car or motor vehicles (McMahon et al., 1999).

Results showed that sustainable drainage system was regarded as the most beneficial and friendly environmental practice as perceived by the respondents (Figure 14). For many years, the SuDS have been considered as an essential infrastructure of any locality that is responsible for collecting rain water and waste water in urban areas (Charlesworth et al., 2003; Graham, 2012).

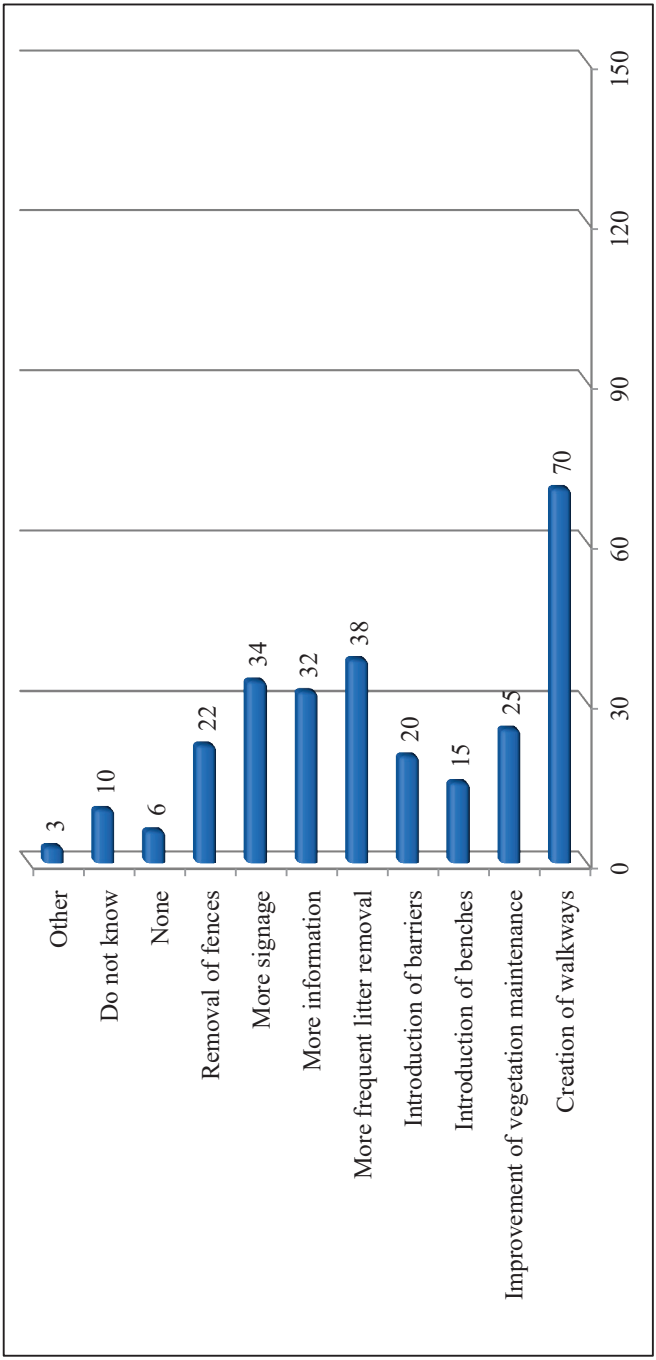

Figure 13. Recommendations for SuDS.

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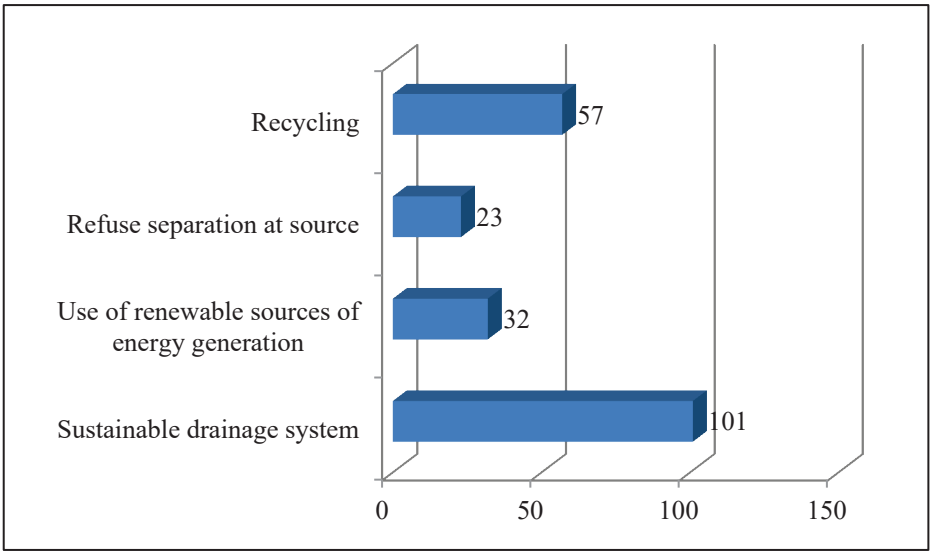

Figure 14. Beneficial and friendly environmental practices as perceived by the respondents.

Conclusion and Recommendations

Sustainable drainage system was perceived as the most beneficial environmental practice which does not only prevent flood in Ozamiz City but also increases the economic value of real property and influences the decision to purchase it. However, the residents in Ozamiz City have concerns with SuDs that include environmental pollution attributed more from human-related activities that result to foul smell of the drainage and risk of contamination and infection. The safety of children was also considered an issue with SuDS. Hence, creating walkways for the residents living near SuDS could help. The planners, developers, and engineers need to consider these social impacts of SuDS to ensure environmental sustainability and safety of residents. Ways to increase the awareness of residents with SuDS have to be discussed by the local government.

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Literature Cited

Ahammed, F., Hewa, G. A., & Argue, J. R. (2014). Flood management using'stormwater source control'principles in Dhaka city, Bangladesh. In *Hydrology and Water Resources Symposium 2014* (p. 413). Engineers Australia.

Apostolaki, S. (2003). An assessment of the social impacts of sustainable drainage systems in the UK. Retrieved from http://eprints.hrwallingford.co.uk/980/1/SR622-Assessment-social-impacts-suds-uk.pdf

Ashley, R., Garvin, S., Pasche, E., Vassilopoulos, A., & Zevenbergen, C. (Eds.). (2007). *Advances in urban flood management*. USA: CRC Press.

Bhattacharyya, S., Bauch, C. T., & Breban, R. (2015). Role of word-of-mouth for programs of voluntary vaccination: A game-theoretic approach. *Mathematical Biosciences*, *269*, 130-134. doi: http://dx.doi.org/10.1016/j.mbs.2015.08.023

Charlesworth, S. M., Harker, E., & Rickard, S. (2003). A review of sustainable drainage systems (SuDS): A soft option for hard drainage questions?. *Geography*, *88*(2) 99-107.

Coffman, L., Clar, M., & Weinstein, N. (1998). Overview of Low Impact Development for Stormwater Management. In *Water Resources and the Urban Environment:* (pp. 16-21). ASCE.

Journal of Multidisciplinary Studies
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doi: http://dx.doi.org/10.7828/jmds.v5i1.1019

Elazegui, D. D., Espaldon, M., & Sumbalan, A. (2016). *Enhancing the role of local government units in environmental regulation*. Laguna, Philippines: University of the Philippines Los Baños. Institute of Strategic Planning and Policy Studies.

Enguito, M. R., Matunog, V., Bala, J. J., & Villantes, Y. (2013). Water Quality Assessment of Carangan Estero in Ozamiz City, Philippines. *Journal of Multidisciplinary Studies*, *1*(1), 19-36. doi: http://dx.doi.org/10.7828/jmds.v2i1.397

Eriksen, M., Mason, S., Wilson, S., Box, C., Zellers, A., Edwards, W., ... & Amato, S. (2013). Microplastic pollution in the surface waters of the Laurentian Great Lakes. *Marine Pollution Bulletin*, *77*(1), 177-182. doi: http://dx.doi.org/10.1016/j.marpolbul.2013.10.007

Fryd, O., Dam, T., & Jensen, M. B. (2012). A planning framework for sustainable urban drainage systems. *Water Policy*, *14*(5), 865-886.

Furlong, C., Guthrie, L., De Silva, S., & Considine, R. (2015). Informing infrastructure planning processes for IUWM projects. *WIT Transactions on The Built Environment*, *168*, 395-406. doi: 10.2166/wp.2014.185

Galamiton, L. M., & Flores, F. C. D. (2009). An Assessment of the Drainage System Located at Zone 7, Vicmar Area, Carmen, Cagayan De Oro City: Basis for the Proposed Drainage Design. *Capitol Unversity Engineering Journal*, *8*(1), 1-1.

Goonetilleke, A., Yigitcanlar, T., Ayoko, G. A., & Egodawatta, P. (2014). *Sustainable urban water environment: climate, pollution and adaptation*. Edward Elgar Publishing.

Graham, A. (2012). Sustainable drainage systems. Sustainable Surface Water Management: A Handbook for SuDS, 91-104.

Guerrero, L. A., Maas, G., & Hogland, W. (2013). Solid waste management challenges for cities in developing countries. *Waste management*, *33*(1), 220-232.

Hwang, H. M., Fiala, M. J., Park, D., & Wade, T. L. (2016). Review of pollutants in urban road dust and stormwater runoff: part 1. Heavy metals released from vehicles. *International Journal of Urban Sciences*, *20*(3), 334-360.

Jin, Y., Liu, B. F., & Austin, L. L. (2014). Examining the role of social media in effective crisis management: The effects of crisis origin, information form, and source on publics' crisis responses. *Communication Research*, *41*(1), 74-94. doi:10.1177/0093650211423918

Jones, P., & Macdonald, N. (2007). Making space for unruly water: Sustainable drainage systems and the disciplining of surface runoff. *Geoforum*, *38*(3), 534-544.

Kafando, P., Segda, B. G., Nzihou, J. F., & Koulidiati, J. (2013). Environmental impacts of waste management deficiencies and health issues: A case study in the city of Kaya, Burkina Faso. *Journal of Environmental Protection*, *4*(10), 1080-1087. doi: http://dx.doi.org/10.4236/jep. 2013.410124

Madramootoo, C. A., Johnston, W. R., & Willardson, L. S. (1997). *Management of agricultural drainage water quality* (Vol. 13). Food & Agriculture Organization. Rome, UN: FAO Corporate Document Repository

McMahon, P., Duncan, C., Stewart, J., Zegeer, C., & Khattak, A. (1999). Analysis of factors contributing to "walking along roadway" crashes. *Transportation Research Record: Journal of the Transportation Research Board*, (1674), 41-48.

Journal of Multidisciplinary Studies
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Minns, A. W., & Hall, M. J. (1996). Artificial neural networks as rainfall-runoff models. *Hydrological Sciences Journal*, *41*(3), 399-417.

Muzyamba, C. M. (2015). Knowledge and perceptions on urban health hazards in Zambia: A case study of Kitwe District. *Journal of US-China Public Administration*, *12*(4), 262-272.

Roberts Jr, W. H. (2015). Homeowner Association Resident's Perceptions on Stormwater Retention Ponds and Clean Drinking Water: (Montgomery West Homeowners Association (MWHOA) Gaithersburg, Maryland).

Roy, A. H., Wenger, S. J., Fletcher, T. D., Walsh, C. J., Ladson, A. R., Shuster, W. D., ... & Brown, R. R. (2008). Impediments and solutions to sustainable, watershed-scale urban stormwater management: lessons from Australia and the United States. *Environmental Management*, *42*(2), 344-359.

Sharma, A. K., Gray, S., Diaper, C., Liston, P., & Howe, C. (2008). Assessing integrated water management options for urban developments–Canberra case study. *Urban Water Journal*, *5*(2), 147-159.

The Telegraph. (2014, August 27). Parents' greatest fear is that their child will be in a car crash. Retrieved from http://www.telegraph.co.uk/motoring/11059211/Parents-greatest-fear-is-that-their-child-will-be-in-a-car-crash.html

Tender Tiger. (2015). Invitation to bid (ITB). Retrieved from http://www.computersoftware.tendertiger.com/viewtenderdetail.aspx?SrNo=17443222&tendertype=9d09819bf4266dce2eviL&Year=2015&Construction%20of%20Ozamiz%20City%20Drainage%20System,%20Misamis%20Occidental.

Willems, P., Arnbjerg-Nielsen, K., Olsson, J., & Nguyen, V. T. V. (2012). Climate change impact assessment on urban rainfall extremes and urban drainage: Methods and shortcomings. *Atmospheric Research*, *103*, 106-118. doi: https://doi.org/10.1016/j.atmosres. 2011.04.003

Wurbs, R. A., & James, W. P. (2002). *Water resources engineering*. USA: Prentice Hall.

Zhou, Q. (2014). A review of sustainable urban drainage systems considering the climate change and urbanization impacts. *Water*, *6*(4), 976-992.