

Carbon Footprints of Selected Urban Barangays in Davao City, Philippines

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Abstract

Rapid urbanization, especially in developing countries, presents a significant challenge to global efforts to reduce carbon emissions. As cities grow and populations increase, the demand for energy, transportation, and resources intensifies, leading to a rise in greenhouse gas emissions. It is crucial to explore strategies for reducing the carbon footprint of urban areas to mitigate the impacts of climate change. The study aims to determine and assess the carbon footprints of urban barangays, specifically examining food waste, water, and energy consumption, resident awareness, and resident participation in reducing carbon footprints. The study utilizes a mixed-methods approach, combining literature reviews, policy document analysis, expert interviews, and surveys of barangay officials, residents, and businesses in two selected urban barangays: Matina Aplaya and Matina Crossing. Key findings reveal differences in carbon footprint levels between the two barangays, with variations in food waste generation, water consumption, and electricity usage. The findings reveal that Matina Aplaya has higher daily food waste generation (60%) compared to Matina Crossing (55%), indicating a greater carbon footprint. Water consumption was rated as excessive by 10% of households in Matina Aplaya, while none in Matina Crossing reported excessive usage. Electricity usage was mostly moderate in both barangays, with 85% in Matina Aplaya and 95% in Matina Crossing reporting such levels. Awareness of carbon footprints varies significantly, with 35% of Matina Aplaya residents somewhat familiar with the concept, compared to 65% of Matina Crossing residents. Participation in carbon footprint reduction activities is higher in Matina Aplaya, where 50% of households are very active, compared to 30% in Matina Crossing. The study also highlights a disparity in awareness levels regarding carbon footprints, with Matina Aplaya residents showing greater familiarity compared to Matina Crossing, indicating a need for targeted educational programs in Matina Crossing. Despite varying levels of awareness, residents in both barangays demonstrate a willingness to participate in carbon footprint reduction activities. The research concludes that targeted interventions are necessary to address the specific challenges identified in each barangay, focusing on waste management, energy and water conservation, and community education.

Keywords: Carbon Footprint, Urban Barangays, Davao City.

I. INTRODUCTION

Carbon footprints have emerged as a significant environmental concern as the global population continues to rise, coupled with rapid urbanization and industrialization. It is a measure of the total greenhouse gas emissions caused directly or indirectly by human activities, which play a critical role in the ongoing climate crisis. The Intergovernmental Panel on Climate Change (IPCC) highlights that global carbon dioxide emissions reached unprecedented levels, primarily driven by energy production, transportation, agriculture, and waste generation (*IPCC Sixth Assessment Report, 2021*). Urban areas, which consume over two-thirds of global energy and account for more than 70% of carbon emissions, are critical arenas for intervention (*UN-Habitat, 2020*).

In the Philippines, the situation is no less concerning. The country is particularly vulnerable to climate change impacts due to its geographic location, experiencing rising sea levels, increased frequency of extreme weather events, and biodiversity loss. Rapid urbanization recorded at an annual rate of 2.8% from 2015 to 2020 (*Philippine Statistics Authority, 2022*) has significantly contributed to the nation's carbon footprint. Urban areas, which house over 47% of the population (*PSA, 2020*), are primary sources of greenhouse gas emissions through energy consumption, transportation, and waste mismanagement.

Davao City, one of the largest cities in the world by area, is not exempt from these issues, as it faces threats such as water scarcity, urban flooding, and degradation of water quality (Frias & Maniquiz-Redillas, 2021). To mitigate these impacts and build resilience, it is essential to explore strategies for reducing the carbon footprints of the city's urban barangays.

The necessity of multi-level governance and cooperative initiatives engaging local stakeholders is emphasized by research on carbon footprint reduction (C40 Cities, 2019). Knowing how barangays can adopt sustainable practices is essential as Davao City's urbanization increases. In addition to analyzing current local regulations and looking at past successful interventions, this study will offer a framework for sustainable development that is specific to Davao City's features. Contributing to the corpus of knowledge on urban sustainability, the findings will lay the groundwork for future studies and policy development in the area.

The pressing need to address climate change and its associated impacts underscores the urgency of this study. As urbanization accelerates globally, cities are increasingly becoming hotspots of carbon emissions, with significant implications for environmental sustainability, public health, and economic stability. In the Philippines, rapid urbanization poses unique challenges, particularly in urban centers like Davao City. The city's vulnerability to environmental issues highlights the critical need for localized interventions to mitigate carbon footprints and enhance resilience. This study is essential because it focuses on urban barangays, the smallest governmental units that serve as frontline implementers of environmental policies. By addressing these gaps, the research aims to empower barangays with practical, community-driven solutions tailored to their unique socio-environmental contexts.

Engaging with local stakeholders, including residents, businesses, and government agencies, can foster a collaborative approach to identifying and addressing the specific challenges faced by different barangays. By incorporating these strategies, Davao City can work towards reducing the carbon footprints of its urban communities and building a more sustainable and resilient future.

Urban communities are under increasing pressure to create policies that effectively reduce carbon emissions due to growing worries about climate change (Broto, 2017). Davao City presents distinct problems as well as opportunities when it comes to sustainable urban development (Bartsch & Environment, 2017). The Philippines' smallest governmental units, barangays, are essential to citizen involvement and local governance (Ishii, 2016). Wherefore, there is a need to conduct this study in urban barangays of Davao City to be able to determine the carbon footprints of the people living therein and that appropriate policies and strategies shall be undertaken in line with the sustainable development goals established by the United Nations and the Government

II. OBJECTIVES OF THE STUDY

This study aimed to determine and assess the carbon footprints of Urban Barangays, specifically on the following;

1. The level of carbon footprints of urban barangays in terms of food waste, water and energy consumption;
2. The level of awareness of residents on carbon footprints;
3. The involvement and participation of residents in reducing carbon footprints;
4. To compare the carbon footprints between and among urban barangays; and,
5. To formulate strategies for reducing Carbon Footprints.

III. METHODOLOGY

Study Location

The study was conducted in two urban barangays of Davao City, Philippines namely, Barangay Matina Crossing and Barangay Matina Aplaya (Figure 1).



Figure 1: Map of the two Urban Barangays: Barangay Aplaya, and Barangay Crossing, Davao City, Philippines

Brgy. Matina Crossing is located on the southernmost part of Davao City composed of residential-commercial areas (Carating et al., 2014). This barangay is an economic center for many business activities. Thus, it is also important in order to evaluate the carbon emissions related to urban living. Brgy. Matina Aplaya is located along Matina Crossing and is typified by a coastal environment, with residential neighborhoods. Other environmental issues that face this barangay include those in shoreline proximity-specific issues: those problems concerning waste management and impacts of urban living on local ecosystems. Indeed, there is a good reason why these two barangays have been chosen to be put to a stratified light with respect to their socio-economic profiles and respectively to their environmental conditions, thus making it an ideal place for this study on the strategy toward reducing carbon footprints and enhancing sustainability for the urban community.

Participants of the Study

The study had a total of 40 respondents, divided into two equally selected barangays. There will be 20 respondents from Brgy. Matina Crossing and 20 respondents from Brgy. Matina Aplaya. These respondents were the main stakeholders for each of the barangays composed of residents, businessmen, and barangay officials.

From the officials, the participants includes but not limited to the Barangay Captain, Barangay Kagawad, and other persons working in the environmental social events of the barangay. Their experiences were shared which believed to be beneficial regarding the existing programs and issues of the executive component as well as the effective approaches in mitigating the carbon footprint of the barangay.

From among residents, participants were chosen so that each household type and each income group are represented. The group had provided information on how much individuals understand and practice concepts, behaviors that cause a person’s carbon footprint.

In the last category, local businessmen consisted of the owners or management staff of small to medium scale businesses within the barangays. The data gathered had provided a day to day operations, barriers to the integration of sustainable practices, and benefits to the overall carbon footprint to be achieved by the community.

The inclusion of the responses received from these 40 respondents, have addressed and allowed for a more rounded view of environmental engagements, challenges and improvements within the barangays.

Data Collection Methods

The study had applied varied and strong methods of data collection in order to efficiently conduct a more thorough rounded assessment of carbon footprints and likewise, come up with practical measures of reduction for

both Brgy. Matina Crossing and Brgy. Matina Aplaya. It has utilized existing studies, policy papers, experts experiences and the barangay Officials and members.

Existing Studies: The research undertook a systematic exploration of the literature on strategies for cut-out emissions, city sustainability, as well as, studies related to evaluating the environmental impact i.e. carbon footprints of similar geographies. This will assess the success, limitations, and gaps in the practice that will form the subject of this study. In the end, this study seeks to ground its findings on existing literature in practical and scientific ways.

Policy Documents: A review and analysis of the national and local government policies that have been issued with regard to the aspects of urbanization, environmental management and climate change to provide an understanding of the legal and institutional framework. Such understanding does the work of ensuring that the strategies of this study are in line with strategies that are already in place which enhances the chance of such strategies being adopted.

Expert Interviews: Urban planners and specialists in environmental and sustainability fields were interviewed purposely to obtain detailed insights and recommend relevant actions suited for the barangay.

Barangay Surveys and Interviews: There were barangay stakeholders that have been engaged in this study. For instance, interviews with barangay officials, namely, barangay chairman, kagawad or its council members, and staff provided information on the current ecological sustainable practices, issues faced, and active or prospective programs. Survey questionnaires were distributed to local residents to determine their knowledge on climate change, daily habits that contribute to carbon footprints and their readiness to participate in carbon management programs. In addition, some local businesses were also interviewed in order to find out their current approaches, challenges and possibilities for cutting down on carbon footprint in their business activities.

Research Instrument

A researcher self made survey questionnaires were used to obtain the objective of the study. Specifically, consisted of five parts namely; (1) Demographics Information, (2) Carbon Footprint Assessment, (3) Awareness of carbon footprints (4) Participation in Reducing Carbon Footprints, (5) Suggestions and Recommendations.

Statistical Analysis

Descriptive statistics using Microsoft Excel were utilized to assess the level of carbon footprints of the two barangays, awareness, strategies, and participation and involvement in reduction of carbon footprint. This involves calculating the various measures such as means, frequency, and percentages. Descriptive Statistics offer a comprehensive overview of the data allowing researchers summarize and understand critical characteristics of the respondent's response.

IV. RESULTS AND DISCUSSION

Carbon Footprint Levels in Urban Barangays

This section presents the findings from a survey conducted in two urban barangays of Davao City, Philippines: Matina Aplaya and Matina Crossing.

Food Waste Generation

The frequency of food waste generation varied between the two barangays (Figure 2). In Matina Aplaya, 60% of households reported generating food waste daily, 35% generated food waste 2-3 times a week, and only 5% reported waste once a week. In contrast, Matina Crossing had a slightly different pattern, with 55% of households generating food waste daily, 15% 2-3 times a week, 10% once a week, and 20% rarely producing food waste.

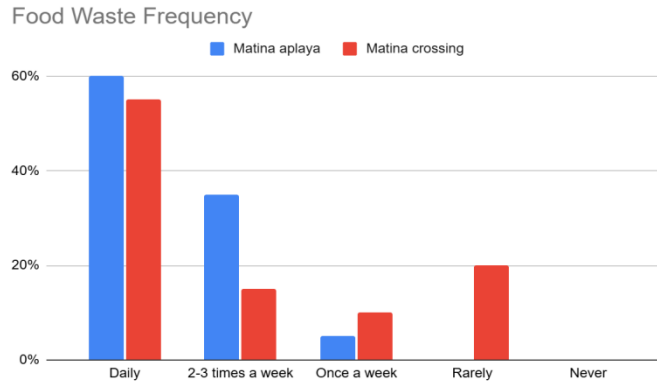


Figure 2: Frequency of Food Waste Generation in Households of Both Barangays

The data indicates that households in Matina Aplaya are more likely to generate food waste daily, contributing to a potentially higher carbon footprint related to food disposal. This high level of regular waste indicates a significant area for improvement, suggesting that a shift in household behavior towards food conservation or composting could reduce this footprint. Households should be encouraged to adopt strategies like meal planning, waste segregation, and composting, as even small reductions in daily waste can contribute to lowering overall carbon emissions.

Water Consumption

Regarding water consumption, most respondents in both barangays rated their usage as moderate. Specifically, 60% of households in Matina Aplaya and 75% in Matina Crossing indicated moderate water consumption. However, 10% of households in Matina Aplaya rated their water usage as excessive, compared to 0% in Matina Crossing. Additionally, 25% of households in Matina Crossing reported minimal water consumption, while none in Matina Aplaya did.

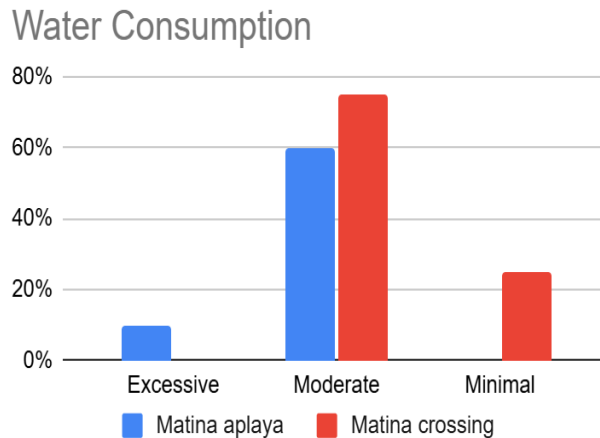


Figure 3: Household Water Consumption Ratings of Barangay Matina Aplaya and Matina Crossing

Moderate water consumption may result from inefficient fixtures or lack of awareness about conservation techniques. To mitigate this, households could benefit from water-saving practices, such as using efficient appliances, fixing leaks, and recycling water when possible. Educating residents on simple conservation strategies like reducing shower times or collecting rainwater could help balance water usage and lower associated carbon footprints.

Electricity Usage

In terms of electricity usage, the majority of respondents from both barangays reported moderate usage. In Matina Aplaya, 85% of households described their electricity use as moderate, and 15% reported high usage, with none indicating low usage. In contrast, 95% of households in Matina Crossing reported moderate electricity usage, and 5% reported low usage, with no households reporting high usage.

Electricity Consumption

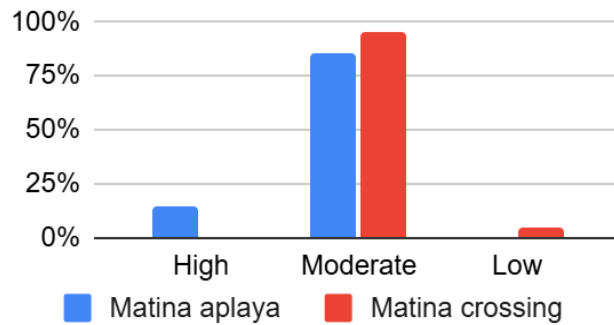


Figure 4: Distribution of Household Electricity Usage Descriptions of Selected Urban Barangays in Davao City

Moderate energy consumption is a key contributor to urban carbon footprints, highlighting the need for increased awareness and adoption of energy-efficient appliances. Additionally, promoting behaviors such as switching off appliances when not in use and exploring renewable energy sources, such as solar panels, could help households reduce their energy footprint. Community initiatives could focus on providing resources to make energy-saving more accessible.

Awareness of Carbon Footprints

The survey results regarding the level of awareness of local residents on carbon footprints reveal noteworthy differences between the two barangays, Matina Aplaya and Matina Crossing, in terms of familiarity with the concept.

Awareness of Carbon Footprints

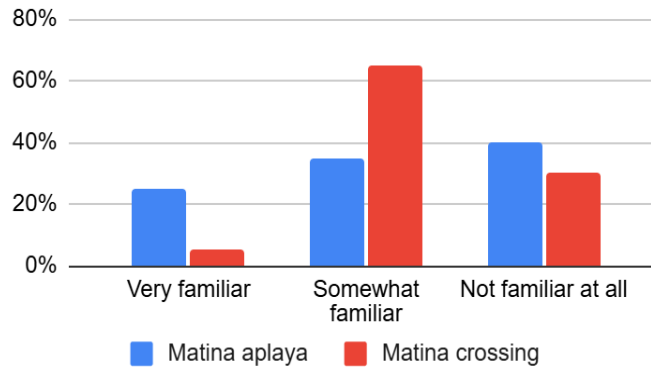


Figure 5. Comparative Analysis of Carbon Footprint Familiarity in Matina Aplaya and Matina Crossing

These findings bring out a very evident differentiation in terms of awareness levels between the two barangays. More residents of Matina Aplaya know what carbon footprints are and their importance as opposed to Matina Crossing where the levels of knowledge are considerably lower. The fact that in Matina Aplaya, a high percentage of the residents claim to be only somewhat familiar (35%) means that an element of awareness already exists and therefore can be expanded on by educational programs.

Conversely, in Matina Crossing, the small proportion of the population that is very familiar with the term (5%) provokes fears in relation to the comprehension of that community concerning environmental issues. The fact that in Matina Crossing most of the residents (65%) are somewhat familiar means that they may have heard of the concept but do not have any comprehensive knowledge of it. These deficiencies are the reasons why there is a need to do outreach and educational programs in this barangay concerning carbon footprints.

Involvement and Participation in Carbon Footprint Reduction

In assessing the involvement and participation of households in reducing carbon footprints in the respective selected barangays, it can be seen that, in case of, Matina Aplaya, the number of very active households is recorded at 50%, when carrying out such activities as tree planting, waste segregation, recycling to mention but a few, whereas 40% are partially active, and 10% are inactive. On the other hand, Matina Crossing another village engaging in similar initiatives ad a lower level of participation with the following structure: 30 % of households are very active, 65% of them moderately active and 5% inactive. These findings acknowledge differences in the residents of both barangays towards the adoption and implementation of sustainable practices.

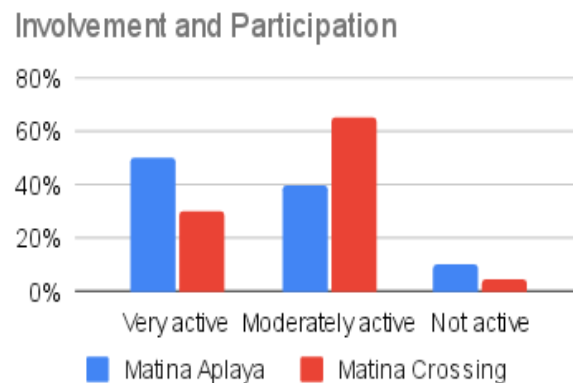


Figure 6: Household Participation Levels in Carbon Footprint Reduction Activities in Barangays Matina Aplaya and Matina Crossing

The results reveal a significant interest in carbon footprint reduction activities among the residents of both barangays, that the residents have great enthusiasm towards carbon footprint reduction activities; however, the extent of active participation differs among the two groups. In Matina Aplaya, there were more households (50%) that were very active when compared to carbon footprint reducing measures. This could be due to greater awareness, better community organizing or local programs that promote environmental stewardship. The rate of active participation in the case of the barangay corresponds with the expectation that the people are educated on sustainable mannerism towards waste but have the willingness to act especially in waste management practices such as segregation and recycling along with energy and water conservation.

On the other hand, Matina Crossing reveals a clear pattern of moderating activity or make use of less energy among its residents (65%), while only a few (30%) are engaged in very active activities. This shows that there is a basic desire to get involved in the activity but the residents of this area may be restricted in one way or the other from getting involved actively as the residents of Matina Aplaya. Such restraint can be in the form of some resource or program being out of bounds, or even the simple factor of time being a constraint on pressing engagements or priorities.

Comparison of the Carbon Footprints of the Two Urban Barangays

Comparing the carbon footprints of Matina Aplaya and Matina Crossing, it can be seen that they differ on many counts. For Matina Aplaya, there is a greater prevalence in the rate of daily food waste generation (60%), water consumption is also excessive (10% high users) and electricity usage is charged to be high (15% high usage) indicating that there is a higher carbon footprint overall in that place relative to Matina Crossing where 55% of the households generate food waste on a daily basis and only 5% of the households report high consumption of electricity while 25% have low consumption of water. Furthermore, in Matina Aplaya, there is a stronger consciousness and involvement on the cause of reduction of the carbon footprint as a significant amount, 50% of households tend to be active anyways in this regard while in the case of Matina Crossing, the participation is at a lower level (30% active). There are still a number of issues affecting the situation in combatting carbon footprint from this waste and electricity usage in Matina Aplaya, while all Matina Crossing can do is raise awareness for such sustainability practices within its community and encourage people to actively practice them.

Strategies for Reducing Carbon Footprints

Waste segregation and recycling were mentioned by many of the participants as vital measures that can help in reducing one's carbon footprint. Several of them supported the idea of waste segregation guidelines to reduce landfill waste and ultimately reduce gas emissions from the landfilling of biodegradable waste. Further, they suggested holding community workshops on waste segregation and disposal practices, thus asserting the need for teaching the public on environmentally sustainable practices. This suggests that the general public is aware of the consequences of careless disposal of waste and is also willing to promote sustainability in the barangay.

Energy savings was another critical strategy that many respondents put forward. Most of them argued that family units should cut back on the use of electrically operated devices, especially the high power consuming devices and also switch off all the lights and appliances when they are not in use. This emphasis on energy saving practices shows that there is an awareness among the people at the center about their energy consumption and its effect on greenhouse gas emissions.

Additionally, water conservation became one of the issues that most of the respondents shared with households and recommended measures on how to save it. This is especially true because a lot of energy is used for the purpose of treating water and even for the distribution of the same, demonstrating a concept of interdependence in the usage of water and energy leading to carbon emissions.

Community engagement and participation were highlighted as vital for the success of sustainability initiatives. Respondents recognized the importance of collective action in reducing carbon footprints and called for greater community involvement in discussions and initiatives related to sustainability. This reflects the need for collective responsibility and the potential for grassroots movements to drive meaningful change.

Finally, the reduction of food waste was identified as a critical strategy, with respondents suggesting that households should aim to eat less and limit food disposal. This can significantly lower the carbon footprint associated with food production, processing, and waste.

V. SUMMARY, CONCLUSIONS AND RECOMMENDATION

Summary

The study highlights the growing need to address environmental challenges accompanying the rapid urbanization in the Philippines. It emphasizes the role of urban communities in implementing effective policies for carbon footprints reduction. It employed a mixed-methods approach, combining data from literature reviews, policy documents, expert interviews, and surveys of barangay officials, residents, and businesses. A survey questionnaire with five sections was used to gather data on demographics, carbon footprint assessment, awareness levels, resident participation in reduction initiatives, and suggestions for improvement.

The key findings of the research revealed differences in carbon footprint levels between the two barangays, with variations in food waste generation, water consumption, and electricity usage. Matina Aplaya exhibited higher daily food waste generation compared to Matina Crossing. Both barangays showed moderate levels of water and electricity consumption.

Significantly, the study highlighted a disparity in awareness levels regarding carbon footprints between the two barangays. Matina Aplaya residents demonstrated higher familiarity with the concept compared to Matina Crossing, suggesting a need for targeted educational programs in the latter barangay.

Conclusion and Recommendations

The research concluded that both barangays exhibited moderate levels of resources consumption, however, it has shown that there is a need to improve waste management practices, particularly in Matina Aplaya. The study underscores the importance of community engagement and participation in driving sustainable practices. The variations in awareness levels between the two barangays necessitate tailored educational interventions to enhance understanding and promote the adoption of carbon footprint reduction strategies.

To address these findings, the following recommendations are proposed:

1. **Implement comprehensive waste segregation and recycling programs:** Established comprehensive guidelines for proper waste disposal and conduct community workshops on effective waste management practices.
2. **Promote energy conservation measures:** Encourage households to adopt energy-saving behaviors, such as turning off lights and appliances when not in use, and lessen their reliance on high-energy-consuming appliances.
3. **Encourage water conservation techniques:** Educate residents on water-saving strategies, such as using efficient appliances, fixing leaks, and exploring rainwater harvesting methods.
4. **Develop and implement targeted educational programs:** These programs should focus on raising awareness about carbon footprints, particularly in Matina Crossing, and emphasize the importance of individual and collective actions in reducing emissions.
5. **Foster community engagement and participation:** Facilitate platforms for residents to actively participate in discussions and initiatives related to sustainability, encouraging a sense of shared responsibility.
6. **Reduce food waste:** Implement initiatives to encourage households to reduce food waste through meal planning, proper storage, and composting

By integrating these strategies, the barangays can effectively reduce their carbon footprints and contribute to a more sustainable urban environment

VI. REFERENCES:

- Intergovernmental Panel on Climate Change (IPCC). (2021). *Sixth Assessment Report*. Retrieved from <https://www.ipcc.ch/report/ar6/syr/>
- UN-Habitat. (2020). *World Cities Report 2020: The Value of Sustainable Urbanization*. Retrieved from <https://unhabitat.org/>
- <https://psa.gov.ph/statistics/population-and-housing/node/1684059981>
- Bartsch, K., & Environment, S. O. a. a. B. (2017). *Multi-Step transition in housing provision and progressive development of urban settlements: case of Davao City, Philippines*. <https://hdl.handle.net/2440/119353>
- Broto, V. C. (2017). Urban Governance and the Politics of Climate change. *World Development*, 93, 1–15. <https://doi.org/10.1016/j.worlddev.2016.12.031>
- Ishii, R. (2016). Community participation in local Governance – An empirical analysis of urbanized local governments in the Philippines and Uganda. *International Journal of Public Administration*, 40(11), 907–917. <https://doi.org/10.1080/01900692.2016.1242610>
- C40 Cities. (2019). The C40 Cities Climate Leadership Group: Strategies for reducing urban carbon footprints. Retrieved from <https://www.c40.org/>
- <https://psa.gov.ph/content/urban-population-philippines-2020-census-population-and-housing>
- Frias & Maniquiz-Redillas, 2021, Modelling the applicability of Low Impact Development (LID) technologies in a university campus in the Philippines using Storm Water Management Model (SWMM), IOP Conf. Ser.: Mater. Sci. Eng.
- Carating, R. B., Galanta, R. G., & Bacatio, C. D. (2014). The soils of the lowlands. In *World soils book series* (pp. 51–106). https://doi.org/10.1007/978-94-017-8682-9_2