Master's Thesis of Environmental Studies

Examining the Trend and Characteristics of the Environmental Sustainability of Regions in the Philippines using SDG Pillars

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Abstract

Given the importance of natural resources towards economic and social productivity of the Philippines, and considering the country's vulnerability against natural disasters, it is important for the Philippines to move towards environmental sustainability. This study aims to reflect the trend of the indicators related to the environmental sustainability in the regional level, as well as examine the existing characteristics and strategies of the regions. It formulated an Environmental Sustainability Index (ESI) using the environmental-related Sustainable Development Goals (SDGs) pillars as the indicators to examine the performance of the 16 Philippine regions covering the period of 2016 to 2019. After establishing the four indices for each year, the study employed triangulation by examining the trend in the index level, SDG pillar level, and indicator level, as well as the corresponding characteristics of the highest and lowest scoring regions, and regions with improving and declining trends. The results show that Region XIII – Caraga and Region II – Cagayan Valley had the highest scores based on index scores and averages in 2016 to 2019, while the National Capital Region (NCR) and Region VI – Western Visayas had the lowest scores in the same period. Some regions such as Region XI – Davao Region and Region IX – Zamboanga Peninsula had improving and declining trends in the period of study. The results of the study also showed that the geographical characteristics, regional priorities, and interventions, monitoring and reporting, land management, and other factors contribute to the regional environmental sustainability. Overall, the study showed the varying trend of the regions in implementing its priorities related to environmental sustainability and the differences of the regional characteristics that affect environmental sustainability.

Keyword: environmental sustainability, Philippines, regions, environmental sustainability index, Sustainable Development Goals

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List of Abbreviations

BOD – biological oxygen demand
CAAQMS - Continuous Ambient Air Quality Monitoring System
CALABARZON – Cavite, Laguna, Batangas, Rizal, and Quezon
CARAGA – Caraga Administrative Region
CCC - Climate Change Commission
DENR - Department of Environment and Natural Resources
DO – dissolved oxygen
DOAS - Differential Optical Absorption Spectroscopy
DOH – Department of Health
DPSIR - Driving Force-Pressure-State-Impact-Response
DRR - disaster risk reduction
DTI - Department of Trade and Industry
EMB - Environmental Management Bureau
ENIPAS - Expanded National Integrated Protected Areas System
EPA - Environmental Protection Agency
EPI - Environmental Performance Index
ESI – Environmental Sustainability Index
FDES - Framework for the Development of Environment Statistics
FHSIS - Field Health Services Information System
GHG – greenhouse gas
HWG - Hazardous Waste Generators
LGU - local government units
MDG - Millennium Development Goals
MIMAROPA – Occidental Mindoro, Oriental Mindoro, Marinduque, Romblon, and Palawan

NCR – National Capital Region

NEDA - National Economic and Development Authority

NIPAS - National Integrated Protected Areas System

NSMNP - Northern Sierra Madre Natural Park

OCD - Office of the Civil Defense

PMS - Particulate Matter System

POR - partial order ranking

PSA - Philippines Statistics Authority

RDP - Regional Development Plan

RDR - Regional Development Report

RM – Results Matrix

SDG – Sustainable Development Goals

SDR – Sustainable Development Report

SMDA - Sierra Madre Development Authority

SOBER - State of Brown Environment

SWM – solid waste management

UN – United Nations

UNDP - United Nations Development Program

UNEP - UN Environment Programme

UNESCO - United Nations Educational, Scientific and Cultural Organization

Chapter 1. Introduction

1.1. Study Background

As the issue of climate change and global warming have grown in importance, governments throughout the world have been putting forth efforts to develop environmental plans and techniques that are effective, efficient, and long-term. In 2015, the United Nations General Assembly adopted the Sustainable Development Goals (SDGs) focusing on balance among economic, social, and environmental sustainability (UNDP, n.d.).

The achievement of the SDGs is one of the priorities of the countries around the world, thus understanding and monitoring the status and trend of the indicators are important to keep track of its progress. There are several methodologies in assessing the performance and priorities of the governments and organizations. For SDGs, the Sustainable Development Report (SDR) examines the progress made by different countries each year toward reaching each of the sustainable development objectives outlined in the report using an index with indicators related to sustainability (Sachs, et., al, 2021). However, Wang and group (2021) cited despite the necessity to balance the sustainability of the three pillars of SDGs, some progress reports concentrate primarily on social and economic growth, necessitating a further assessment of environmental sustainability.

In terms of evaluation of the environment pillar, a study of sustainability assessment methodologies revealed that there are numerous methodologies that may be utilized to determine environmental sustainability in order to achieve a sustainable environment (St Flour and Bokhoree, 2021). There is growing and expanding models to study the field of environment and sustainability especially when it comes to policy and decision-making such as retrospective analysis (Jabbour & Flachsland, 2017), comparative analysis (Marmaya & Mahbub, 2018), multicriteria decision analysis (Ceberio & Modave, 2006; Hernandez-Perdomo et al., 2017) and partial order ranking (Carlsen & Bruggemann, 2008).

One of the studies that covered the environmental pillar of the SDGs is the study conducted by Wang, et. al (2021), which evaluated the national and sub-national performance of environmental sustainability in China using an index built on the SDG indicators related to the environment, specifically SDGs 6: Clean Water and Sanitation, 11: Sustainable Cities and Communities, 12: Responsible Consumption and Production, 13: Climate Action, 14: Life Below Water, 15: Life on Land. The study collected and aggregated the indicators of the identified SDG pillars into one environmental sustainability index (ESI). It highlighted the role of SDGs in environmental sustainability, the monitoring and evaluation of the indicators and targets set by the government, and the importance of sub-national assessments in contributing to the achievement of the priorities of the government such as the SDGs.

Although some countries lack sufficient measures for tracking environmental sustainability across a wide variety of critical environmental and resource challenges (Usubiaga-Liano and Ekins, 2021), there are various studies that use ESI in evaluating its national and sub-national environmental sustainability.

In the Philippines, a study covered the importance of the environmental sustainability index in the Philippines based on the Driving Force-Pressure-State-Impact-Response (DPSIR) which emphasized the importance of ESI in the Philippines for both national and sub-national levels (Santiago, n.d.). In addition, the Philippines Statistics Authority (PSA) has published the SDG indicators for the Philippines (PSA Website, 2017), which includes pillars and indicators related to the environment. Therefore, this study aims to adopt the model of Wang, et. al (2021) in using the SDG pillars related to environmental sustainability to examine the trend and characteristics of the environmentally related indicators in the regional level.

1.2. Purpose of Research

This study aims to examine the environmental sustainability of the regions in the Philippines by focusing on the environmentally related areas set by the government in the SDGs. Similar to Wang and group (2021), this study will build upon the SDG pillars related to the environment, and it will also follow through the methodology used in the index of the SDR 2021.

Specifically, this study aims the following:

1. Reflect the trend and status of environmental sustainability of the regions in the Philippines using the SDG pillars related to the environment in the period of 2016 to 2019;
2. Examine the characteristics and existing strategies of the highest and lowest scoring regions in different perspectives such as the regions' geographic, social, environmental, and economic characteristics, available environmental resources, and the regions' existing priorities and policies; and
3. Present the role of the SDGs in environmental sustainability.

1.3. Research Questions

Since the use of the environmental-related SDG indicators is not new in measuring environmental sustainability and is already used in the study of Wang and group (2021), the study will focus on the adoption of this method in the regional-level in the Philippines to understand and analyze the performance of the regions in relation to the indicators related to environmental sustainability. Hence, the study will answer the following question:

1. What are the trends and status of environmental sustainability of the regions in the Philippines using an index based on the SDG pillars and indicators related to the environment in the period of 2016 to 2019?
2. What are characteristics and existing strategies of the highest and lowest scoring regions that are related to environmental sustainability such as geography, policies, and environmental strategies?

1.4. Significance of the Study

The significance of this study to reflect the trend and status of the of environmental sustainability of the regions in the Philippines using an index built upon the SDG pillars related to the environment in the period of 2016 to 2019. The study will help to determine the role of SDGs in environmental sustainability, specifically on areas such as water quality, air quality, terrestrial ecosystems, natural disasters, waste management, and others. The results of the study are expected to reflect the importance of the regional contributions in achieving national goals and it will also be an opportunity to identify and examine the state of environmental sustainability in achieving national goals.

The study will examine the characteristics of the highest and lowest regions that can be related to the performance of sustainability. It is important to identify the factors affecting this performance for a better, evidence-based, and well-informed decision-making of our policymakers.

The results of the study may serve as guidance for several policy implications in both national and sub-national level in implementing and achieving environmental sustainability, and it will contribute to achieving the goals of SDG 2030. Lastly, the study aims to be added to the body of literature tackling regional performance in environmental sustainability in academia.

1.5. Scope of the Study

As the study will conduct a regional assessment of the environmental sustainability at the sub-national level, the study will focus on the 16 regions of the Philippines. It will adopt the ESI models from previous studies mentioned above which will reflect an ESI based on the existing indicators used in the SDR and the Philippine SDG indicators related to the environment, specifically SDGs 6: Clean Water and Sanitation, 11: Sustainable Cities and Communities, 12: Responsible Consumption and Production, 15: Life on Land. After completing the index, the study will examine the trends and status of the regions, as well as explore the characteristics and strategies of the highest and lowest regions that are related to the environmental sustainability of regions. Although the study will not focus on this, it will also attempt to illustrate the relationship of environmental sustainability with the resilience of the regions against climate risks by examining the resilience and vulnerability of one region.

Due to time, capacity, and data availability limitations, the study will not cover the following: (1) standards on the identification whether the scores of the regions based on the ESI are passing or failing; (2) the intensive investigation on the specific reasons that may be attributed on the fluctuations of each region; and (3) comparisons of the characteristics and strategies of the regions on each other.

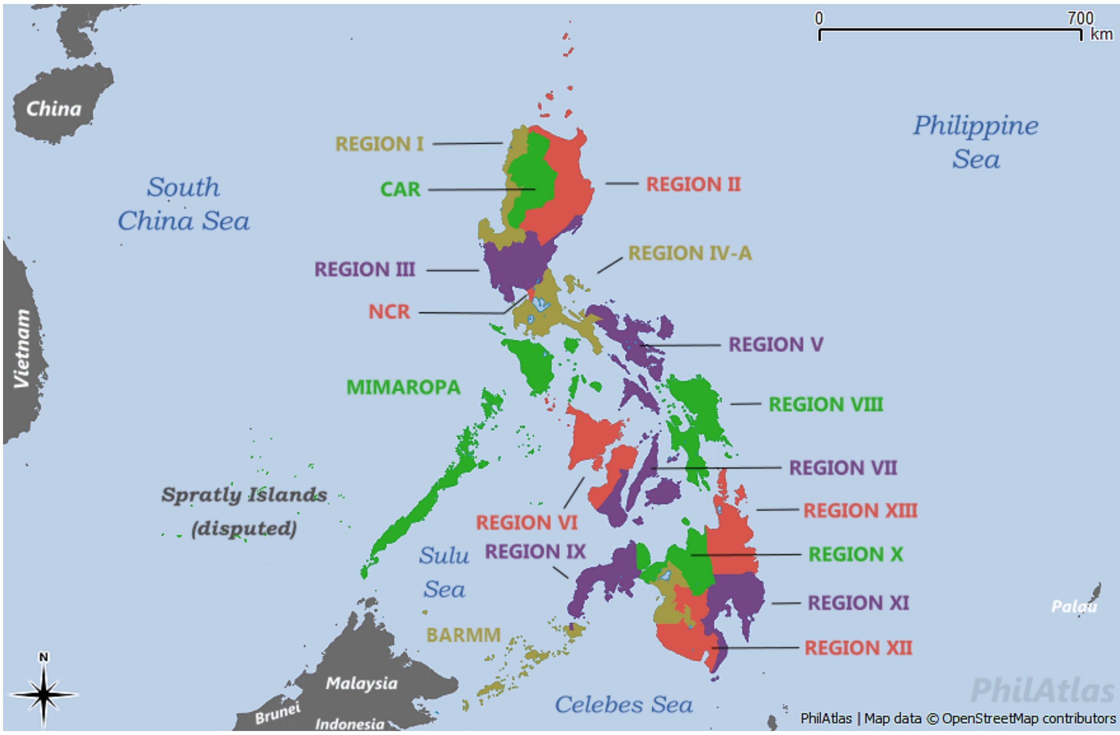

Figure 1: Regional Map of the Philippines (Source: https://www.philatlas.com/images/regions-light.png)

Chapter 2 Literature Review

2.1 Research Design

Previous studies show the measurement and monitoring of the SDG indicators, and some of these studies use the SDGs related to the environment to develop an index to measure environmental sustainability. This study adopts the index model to come up with a single score that can reflect the environmental sustainability of the 16 regions in the Philippines through the indicators related to the field within the period of 2016 to 2019. For this study, it will attempt to discuss the trend in the indicator level, SDG pillar level, and index level.

The study adopts the triangulation of both qualitative and quantitative approaches for the purpose of describing and understanding the trend in environmental sustainability at the regional level, and to describe the characteristics and existing strategies of the regions with highest and/or lowest scores. Use of both quantitative and qualitative is beneficial to complement and support the findings and conclusion of the study.

2.2 Conceptual Framework

The study aims to come up with the scores of the regions using the indicators reflect the trend and status of the environmental sustainability of the regions in the Philippines in the period of 2016 to 2019 using the indicators of the SDGs related to the environment. To guide and track the study, the following conceptual framework will be used.

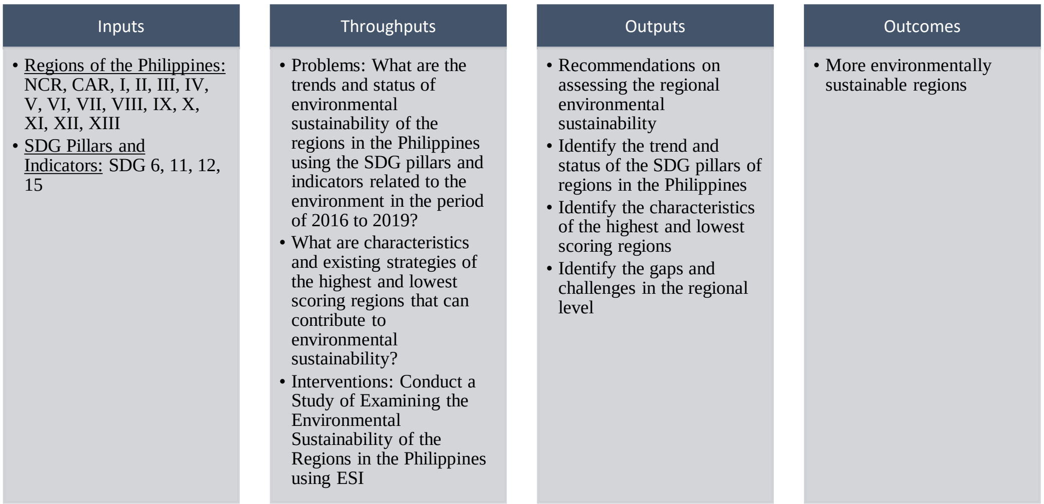

Figure 2: Conceptual Framework

The conceptual framework shows the inputs, throughputs, outputs, and outcomes of the study. The inputs are the regions and the environmental sustainability indicators included in the study to examine the identified problem and conduct the intervention under the throughputs. The inputs and throughputs are necessary to produce the desired immediate outputs and contribute to the achievement of the long-term outcome.

2.2 State of the Philippine Environment

The Philippines is one of the fastest-growing nations in Asia, and its economy relies on its natural resources for the agriculture, fisheries, and forestry sectors. However, the Philippines faces environmental challenges, such as typhoons, droughts, and floods, thus it needs to develop greater environmental resilience in order to better withstand the effects of natural disasters (USAID Website, 2021). The Philippines' natural capital is crucial for providing environmental services including electricity, water, flood management, and storm mitigation (USAID Website, 2021).

Based on the environmental resource statistics of the PSA, the Philippines has 29.56 million hectares land cover in 2015, covering several ecosystems which are bush/shrubs, built up, closed forest, fishpond, grassland, inland water, mangrove forest, swamp, and open/barren lands.

Table 1: Land Cover by Region (2015)
Unit: hectares

Region/Province	TOTAL	Percentage (%)
PHILIPPINES	29,563,341.2	100.00
NCR	59,726.7	0.20
CAR	1,798,844.4	6.08
I - Ilocos Region	1,261,402.1	4.27
II - Cagayan Valley	2,632,472.3	8.90
III - Central Luzon	2,117,099.3	7.16
IVA - CALABARZON	1,689,788.8	5.72
IVB - MIMAROPA	2,685,298.9	9.08
V - Bicol Region	1,735,254.8	5.87
VI - Western Visayas	2,016,848.3	6.82
VII - Central Visayas	1,420,713.8	4.81
VIII - Eastern Visayas	2,086,986.4	7.06
IX - Zamboanga Peninsula	1,454,472.6	4.92
X - Northern Mindanao	1,745,354.6	4.92
XI - Davao Region	1,880,442.8	6.36
XII - SOCCSKSARGEN	1,851,183.9	6.26
XIII - Caraga Region	1,894,864.7	6.41
ARMM	1,232,586.8	4.17

Source: National Mapping and Resource Information Authority (cited by PSA Website)

When it comes to the coastal environment of the Philippines, corals cover 797.81 thousand hectares, and mangroves cover 303.52 thousand hectares in 2013 to 2016.

Table 2: Philippine Coastal Environment by Region, 2013-2016

Region/Province	Area Per Class	
	Corals	Mangroves
NCR	0	106
I - Ilocos Region	16,770	1,378
II - Cagayan Valley	16,419	5,742
III - Central Luzon	14,117	1,900
IVA - CALABARZON	41,667	19,303

IVB - MIMAROPA	325,925	68,417
V - Bicol Region	69,674	24,405
VI - Western Visayas	21,597	14,400
VII - Central Visayas	61,670	19,037
VIII - Eastern Visayas	47,848	34,200
IX - Zamboanga Peninsula	21,941	25,275
X - Northern Mindanao	5,193	5,218
XI - Davao Region	12,573	3,501
XII - SOCCSKSARGEN	2,399	1,848
XIII - Caraga Region	31,120	27,049
ARMM	108,901	51,742

Source: National Mapping and Resource Information Authority (cited by PSA Website)

The Philippines has also proclaimed watersheds and protected areas in regions in the whole country as of 2019. Based on Presidential Decree no. 705, a watershed is a geographic region that is drained by a stream and its tributaries and has a single point of discharge for surface runoff. And according to Republic Act 7586, protected areas are defined as designated sections of land and water set apart by reason of their distinctive physical and biological value, maintained to increase biological variety, and protected against damaging human use.

Table 3: Proclaimed Watershed Areas by Region (2019)

Region	Total Count	Area (in hectares)	Percentage
Philippines	113	2,464,891.10	100
NCR	1	2,659.00	0.11
CAR	9	398,191.00	16.15
I - Ilocos Region	7	38,270.40	1.55
II - Cagayan Valley	6	455,677.20	18.49
III - Central Luzon	23	308,999.70	12.54
IVA - CALABARZON	12	58,003.60	2.35
MIMAROPA	5	8,653.80	0.35
V - Bicol Region	11	66,740.80	2.71
VI - Western Visayas	7	62,113.60	2.52
VII - Central Visayas	6	229,927.00	9.33

VIII - Eastern Visayas	7	15,378.50	0.62
IX - Zamboanga Peninsula	1	176	0.01
X - Northern Mindanao	2	309,886.00	12.57
XI - Davao Region	2	6,960.00	0.28
XII - SOCCSKSARGEN	5	282,659.10	11.47
XIII - Caraga	7	38,241.40	1.55
ARMM	2	182,354.00	7.40

Source: Forest Management Bureau, DENR (Cited by PSA Website)

Table 4: Protected Areas by Region (2019)

Region	Total	Area (in hectares)	Percentage
PHILIPPINES	243	5,132,954.90	100
NCR	4	587.4	0.01
CAR	7	167,242.00	3.26
I - Ilocos Region	15	16,871.20	0.33
II - Cagayan Valley	15	719,209.00	14.01
III - Central Luzon	24	276,569.40	5.39
IVA - CALABARZON	22	229,566.90	4.47
IVB - MIMAROPA	23	2,159,356.60	42.07
V - Bicol Region	26	122,401.00	2.38
VI - Western Visayas	14	177,868.00	3.47
VII - Central Visayas	19	98,487.90	1.92
VIII - Eastern Visayas	11	366,248.50	7.14
X - Northern Mindanao	12	137,855.70	2.69
XI - Davao Region	10	86,862.80	1.69
XII - SOCCSKSARGEN	5	174,470.70	3.40
XIII - Caraga	12	189,596.30	3.69
ARMM	10	176,062.10	3.43

Source: Biodiversity Management Bureau, DENR (as cited by the PSA Website)

These natural resources are important to the economic, social, and environmental productivity of the regions and the Philippines as a whole. The country is also home of the several species of flora, fauna, and other threatened species. However, given the Philippines' vulnerability to natural disasters and due to human activities, the need to protect and preserve these natural resources and attain environmental sustainability is further highlighted.

Based on the data obtained by the PSA from Office of the Civil Defense (OCD), the available data states that the Philippines had 1,071 disasters in total for eight years, 2010-2017. Although the frequency of disasters decreases in frequency based on available data through the years, the amount of damage does not depend on the frequency of the disasters. The highest recorded damage was in 2016 with PHP14235.73 million or USD281.88 million (PhP50.50 = USD1).

Table 5: Disasters in the Philippines, 2010-2017

Disasters	2010	2011	2012	2013	2014	2015	2016	2017
Total	234	355	186	112	112	71	68	45
Biological (bird strikes, disease outbreak, fish kill, pest infestation)	1	8	16	3	2	…	…	…
Climatological (drought/el nino phenomenon, dry spell, wildfire/bushfire)	1	…	…	…	16	3	6	…
Geophysical (coastal erosion, earthquakes, landslides, mudflow (lahar), soil erosion, volcanic activity, sinkhole)	165	144	74	1	18	12	17	14
Hydrological (flashfloods/flooding, storm surge)	47	121	61	40	45	18	34	22
Meteorological (monsoon, tornado, cyclones, etc)	20	34	34	40	28	34	10	6

N.E.C (intertropical convergence zone, sea mishaps, sea swelling, etc)	…	48	1	28	3	4	1	3

Table 6: Damages Due to Natural Extreme Events and Disasters (in million pesos)

	2010	2011	2012	2013	2014	2015	2016	2017
Total	12,684.2	2662.314	4902.276	4821.424	262.307	14003.95	14235.73	104.439

2.3 Environmental Sustainability

The concept of sustainability has been long established as important and necessary to the present and future generations. There are various lenses in viewing sustainability such as social, economic, and environmental perspectives or the combination of the three. Among these different perspectives, this study will focus on the environmental sustainability of regions.

The environment is the only one among the triad of sustainability (i.e., society-economy-environment triad) that does not need to depend on the economy and society to continuously exist, while the society and the economy depend on the environment for resources, goods, and services, thus Morelli (2011) argued that ensuring a sustainable environment is an important factor to attain socio-economic sustainability.

Environmental sustainability is often tied to the interaction of the human population with the environment. Morelli (2011) defined environmental sustainability as:

> "as a condition of balance, resilience, and interconnectedness that allows human society to satisfy its needs while neither exceeding the capacity of its supporting ecosystems to continue to regenerate the services necessary to meet those needs nor by our actions diminishing biological diversity."

Specifically, environmental sustainability is categorized into providing societal needs, preservation of biodiversity, capacity to regenerate, options to reuse and recycle, and the consideration of the constraints of the use of the non-renewable resources and waste generation (Morelli, 2011).

Moreover, the group of Ghosh (2019) stating that "global issues comprise concerns about greenhouse gas (GHG) mitigation, climate change, and renewable energy, while the location-specific issues are soil erosion, water management, soil quality, and air and water pollution."

At the very least, this study will be guided by following that a sustainable environment should be able to provide clean air, water, and land (Morelli, 2011). Considering this line of thought, examining the status of air, water, and land in the regions in the Philippines is important to contribute to the country's environmental sustainability.

2.4 Environment-Related SDGs

This section will explain the relationship of the pillars identified in the study to environmental sustainability. The following SDG pillars are identified as related to environmental sustainability: SDG 6: Clean Water and Sanitation, SDG 11: Sustainable Cities and Communities, SDG 12: Responsible Consumption and Production, SDG 13: Climate Action, SDG 14: Life Below Water, and SDG 15: Life on Land (Wang, et. al, 2021). In addition, the Philippine Department of Environment and Natural Resources (DENR) identified SDGs 6: Clean Water and Sanitation, 13: Climate Action, 14: Life on Water, and 15: Life on Land directly related to the environment (DENR, 2019).

However, this study will only include SDG 6, 11, 12, and 15, and will not be able to include SDGs 13 and 14 due to data availability in the regional level. The study initially intended to include the indicators of SDGs 13 and 14 as reflected in Table 7, which were also included in the list of requested data to the Philippine government agencies such as DENR, Climate Change Commission (CCC), National Economic and Development Authority (NEDA), and PSA (see Appendices 1-4 for the copies of the request letters to agencies). Upon consultation with these agencies, some of the data on the indicators is not available or the data is only on the national level, and not on the regional level.

Table 7: Initial Indicators of SDGs 13 and 14

SDG 13: Climate Action	Energy-related CO2 emissions per capita

	Imported CO2 emissions, technology-adjusted
	People affected by climate-related disasters
	CO2 emissions embodied in fossil fuel exports
SDG 14: Life Below Water	Mean area that is protected in marine sites important to biodiversity
	Fish caught by trawling

2.4.1 SDG 6: Clean Water and Sanitation

The seventh of the eight Millennium Development Goals (MDGs) is focused on ensuring environmental sustainability. Under this component, access to safe drinking water and basic sanitation are identified as part of its targets to contribute to environmental sustainability (UN Department of Public Information, 2013).

Clean water and sanitation, which refers to the "water supply for domestic use and management for human excreta," are vital factors of environmental sustainability considering that the deficiency on clean water and sanitation can reflect environmental health (e.g., food and water contamination) and environmental risks (e.g., water pollution and degradation) which can significantly affect people's health and daily practices of communities (Ireland's IrishAid – Department of Foreign Affairs, n.d.).

The determination of appropriate quality and quantity of accessible clean water and sanitation for human use is important for the communities (e.g., water for domestic use and livelihood, human health) and environment (e.g., wastewater disposal or sanitation, water infrastructures, pollutants) (Ireland's IrishAid – Department of Foreign Affairs, n.d.).

On environmental health, natural calamities, environmental deterioration, inadequate environmental services (such as poor water supply and sanitation), and environmental pollution all have a negative impact on society's health, and it may also increase the area's vulnerability (World Bank, 2007). For example, poor quality of water can result in disease transmission, particularly diarrhea (Cissé, 2019).

Aside from health problems, water stress and scarcity are also growing concerns of environmental sustainability. Since water demands are increasing and as global warming worsens, there is decreasing water supply for domestic and agricultural use that can hinder the access of communities to safe and clean water (Ireland's IrishAid – Department of Foreign Affairs, n.d.). Water stress and scarcity can cause high concentrations of bacteria through the sewers and contamination of water bodies, and at the same time, potentially endangering the biodiversity due to man-made activities to solve water problems (Ireland's IrishAid – Department of Foreign Affairs, n.d.).

Based on the SDR global indicators and Philippine indicators, the indicators included in the study for SDG 6 focus on the access to drinking water, basic sanitation, and the quality of water depending on the level of biochemical oxygen and dissolved oxygen present in the water.

2.4.2 SDG 11: Sustainable Cities and Communities

The UN Environment Programme (UNEP) emphasized that the sustainability of cities is strongly related to the environment by highlighting that urbanization, concentration of infrastructures, and other human activities directly affect the vulnerability of cities against climate change and natural disasters (UNEP, n.d.-a). The observation of the air quality, interventions on disasters, and the improvement of human settlements are included among the linkages of the SDG 11 to the environment (UNEP, n.d.). SDG 11 focuses on the guidelines to support the communities and their growing population considering that urban growth can increase environmental concerns such as air pollution and natural disasters (National Geographic Society, 2022b).

Air pollution is often associated with climate change that results from human activities particularly use of fossil fuel, forest fires, and others that significantly contribute to negative impacts such as air-borne diseases given the effects of air pollutants to the respiratory system (Urrutia-Pereira et al., 2022). Studies and reports cited that the rising concentrations of air pollutants have negative effects on various sectors such as health, economy, energy, transportation, and environment (Jo et al., 2020; Li et al., 2022). The Philippines monitors the concentration levels of particulate matter (PM) of less than 2.5 of diameter and PM 10. According to the United States Environmental Protection Agency (EPA) Website cited by the Framework for the Development of Environment Statistics (FDES) Glossary, the sources of fine particles or PM2.5 range from forest fire emissions to power plant and industrial emissions, while the sources of inhalable coarse particles or PM10 are from roadways and dusty industries (as cited by FDES, 2013).

Moreover, the formulation and implementation of disaster risk reduction (DRR) strategies in the subnational level is identified as one of the important factors in achieving the targets of SDG 11 in the Philippines. The integration of DRR strategies into local development is recommended to build resilience against the worsening effects of urban development on hazards (e.g., poor infrastructures and sewerage system and unsafe housing without access to clean water), exposure (e.g., high population density in a limited area), and vulnerability (e.g., unsafe location of housing, lack of basic necessities, and weak regulation) (UN Disaster Risk Reduction, 2013).

Based on the SDR global indicators and Philippine indicators, the indicators included in the study for SDG 11 are the concentration of PM2.5 and PM 10, the local governments' DRR strategies, and the improvement of the water sources on human settlements in regions.

2.4.3 SDG 12: Responsible Consumption and Production

The dependence of consumption and production cycles of the economy to the natural resources has a strong link to the quality of the environment such as on areas of waste management, release of chemical waste to air and water, and use of fossil fuels (UNEP, n.d.-b). Based on the SDR global indicators and Philippine indicators, the indicators included in the study for SDG 12 focus on waste solid waste, hazardous waste, and air pollutants such as NO_x and SO_2.

Unsustainable solid waste practices such as dumping on landfills, dumpsites, or water bodies and the burning of wastes to open spaces pose challenges to the environment and human health (Abubakar et al., 2022). Solid wastes are detrimental to the environment in different ways such as the release of methane gas, harm caused to marine and aquatic life, as well as damage to livelihood dependent to ocean and other water bodies (Downs and Acevedo, 2019). Specifically, environmental problems related to solid wastes are toxic emissions, explosive emissions, landfill, disease vector, leachate generation, surface ground water pollution, and offensive odor (Zhang et al., 2022). Another problem related to waste is the production and treatment of hazardous waste. Hazardous waste, which can be produced from domestic, commercial, and industrial sources, can release liquid or solid chemicals that are toxic to people and the environment, i.e., plants and animals (Wolters, 2021).

Meanwhile, in terms of pollutants, the main sources of harmful air pollutants such as NO_x and SO_2 are the industrial, transportation, and commercial sectors (US EPA, n.d.; European Environment Agency, 2015). These pollutants can cause acid depositions which can damage and decrease the growth of trees and plants, cause deforestation, harm aquatic life due to acidic water, and others (US EPA, 2022; Queensland Government, 2017).

2.4.4 SDG 15: Life on Land

Although the need for lands and fields are further highlighted as the population continue to increase, the protection and conservation of the forested lands should not be neglected considering the dependence of several factors to the terrestrial ecosystem and should be prioritized given the rate of deterioration of forests and biodiversity (Gigliotti et al., 2019). This implies that the protection and conservation of terrestrial ecosystem is a vital factor not only to achieve environmental sustainability, but also to meet domestic, social, and economic needs as well.

The terrestrial ecosystem not only provides food, livelihood, energy, and raw materials to different sectors, but the management of the terrestrial ecosystem also affects the regulation of air, soil, and water quality, including water flows and carbon capture, which are directly related to climate change and natural disasters (UNEP, n.d.-c). This is consistent with the research of Migliavacca and group (2021), which identified three main functions of ecosystems which focus on productivity, water-use strategies, and carbon-use efficiency.

Based on the SDR global indicators and Philippine indicators, the indicators included in the study for SDG 15 focus on the important terrestrial and freshwater ecosystems and forest cover. Section 2.2 of this study reflects the state of the Philippine terrestrial and coastal ecosystems, including land area, protected areas, and protected watersheds. Table 8 also provides specific descriptions of each indicator, including SDG 15.

2.5 State of Environment-Related SDGs in the Philippines

Based on the SDR 2021 (Sachs, et., al, 2021), out of the SDG pillars included in the study, three pillars, namely SDG 11: Sustainable Cities and Communities, and SDG 15: Life on Land, are marked as red which means that these pillars face major challenges in achieving the SDG targets. The paces of these three pillars in achieving the 2030 goals are all recorded as stagnating.

The status of the other three SDG pillars has better colors, which connotes better achievability. SDG 6: Clean and Water Sanitation has significant challenges, but it is moderately improving. And SDG 12: Responsible Consumption and Production showed good results marked as SDG achieved, but information is not available on its pace (Sachs, et., al, 2021).

The status of each pillar and indicator can reflect an overview of the status of the country's environmental sustainability through the progress of each pillar and indicator related to environmental sustainability. The progress of environmental sustainability is important for sustainable development as a whole, and it also serves as a guide for policy implementation. However, only a few studies have examined the temporal and geographical variance with regard to the SDGs connected to the environment at the national and sub-national levels (Wang, et. al, 2021). This highlights the importance of this study to measure the performance of the Philippines at sub-national level.

2.6 Environmental Sustainability Index

Sustainability assessment is seen as a crucial part to improve environmental sustainability (Bui, et. al, 2019). Contrary to Wang and group (2021) who stated that there are more economic and social assessment done in the academic field, Bui and group (2019) argued that the environmental pillar “gains massive attention” from the academic and professional communities because of its importance in socio-economic development. They stated that environmental sustainability is the capacity to preserve elements or properties that are important to the biological and natural surroundings (Bui, et. al, 2019).

Overall environmental development is quantified by the ESI (Schmiedeknecht, 2013; Socioeconomic Data and Application Center (SEDAC), n.d.). The index provides a comprehensive overview of national environmental stewardship based on a variety of variables derived from underlying sources (Schmiedeknecht, 2013; Socioeconomic Data and Application Center (SEDAC), n.d.).

Indicators are widely acknowledged in measuring the performance of different countries in sustainability as a whole and their specific areas and fields. Indicators can keep track of the quality and performance of a system that could serve as guides for decision-makers and policymakers in different levels of the country (St Flour and Bokhoree, 2021). Usubiaga-Liano and Ekins (2021) cited that “metrics are key part of environmental governance” because of how it provides information on the status of the environment, identifies key factors, compares performance over time, and monitors effects of policies and programs.

Different studies used indices and indicators to measure sustainability performance with the focus on the environment. Bui and group (2019) assessed the groundwater sustainability of Hanoi, Vietnam using an environmental sustainability framework. Shah and group (2019) developed an energy security and environmental sustainability index to measure and compare energy security in South Asian countries. Narula and Reddy (2016) also used a sustainable energy security index to assess the energy performance of developing countries. Usubiaga-Liano and Ekins (2021) used a strong ESI with 28 indicators to measure the critical natural capital and environmental functions to offer a theoretical foundation for the development of policy-relevant environmental sustainability indicators in European countries. And Mapar and group (2020) also used a sustainability index to assess healthy, safety, and environmental performance in municipalities of megacities.

In terms of indices focusing mainly on the environment, the Yale University-developed Environmental Performance Index (EPI) offers a data-driven evaluation of the global sustainability condition (Wendling, et. al., 2020). ESI is also recognized as one of the methodologies assessed by St Flour and Bokhoree (2021) in country level to measure sustainability.

The SDG Index and Dashboards developed in 2016, which is the basis of the methodology of this study, provides a simple and easy-to-understand overview of the progress and situation of each country (as cited in Wang, et. al, 2021). Comprehensive matrices are important practical tools for problem solving and performance tracker, and in mobilizing institutions such as the government, academia, civil societies, and other organizations (Sachs, et., al, 2021). The study adopted the SDGs related to the environment sustainability with targets directly connected to the natural environment to identify environmental problems and help achieve the 2030 agenda (Wang, et. al, 2021).

2.7 Index and Indicators

According to Gigliotti and group (2019), indicators are crucial for monitoring progress and identifying the weaknesses and strengths of the targets set by the countries at national and subnational levels. Table 8 presents the standards used to measure the country level performance in SDR 2021 (Papadimitriou, et., al, 2019), specifically the maximum and minimum values for normalization.

Table 9 shows the SDG pillars, indicators, measurements, descriptions, and the indicator and data sources of the index that will be used in the study.

Table 8: Standards Used in SDR 2021

	Indicator	**Unit**	**Min Value**	**Max Value**	**Direction**
SDG 6: Clean Water and Sanitation	Population using at least basic drinking water services	%	36.6	100	1
	Population using at least basic sanitation services	%	7.1	100	1
	Freshwater withdrawal (% of freshwater resources)	%	0	2603.5	-1
	Wastewater that receives treatment	%	0.1	148.2	-1
SDG 11: Sustainable Cities and Communities	Annual mean concentration of particulate matter of less than 2.5 of diameter	µg/m3	5.9	99.7	-1
	Improved water source, piped	% urban pop access	7.4	100	1
	Satisfaction with public transport	%	7.9	85.3	1
SDG 12: Responsible Consumption and Production	Solid Waste	kg/year/capita	0.1	5.7	-1
	E-waste generated	kg/capita	0.4	28.5	-1
	Production-based SO2 emissions	kg/capita	0.4	176.3	-1
	NO footprint	kg/capita	1	139.8	-1
SDG 13: Climate Action	Energy-related CO2 emissions per capita	tCO2/capita	0	47.5	-1
	Imported CO2 emissions, technology-adjusted	tCO2/capita	-19.5	4.3	-1
	People affected by climate-related disasters	per 100,000 pop	0	31953	-1
	CO2 emissions embodied in fossil fuel exports	kg/capita	0	160773	-1
SDG 14: Life Below Water	Mean area that is protected in marine sites important to biodiversity	%	0	99.6	1
	Ocean Health Index Goal - Clean Waters	0-100	15.1	94	1
	Percentage of Fish Stocks overexploited or	%	0.1	100	-1

	collapsed by EEZ				
	Fish caught by trawling	%	0	97.4	-1
SDG 15: Life on Land	Mean area that is protected in terrestrial sites important to biodiversity	%	0	99.4	1
	Mean area that is protected in freshwater sites important to biodoversity	%	0	100	1
	Permanent Deforestation	5 years average annual %	0	2.9	-1
	Imported biodiversity threats	threats per million pop	0	140.2	-1

Notes from the JRC Statistical Audit of the Sustainable Development Goals Index and Dashboards (Papadimitriou, et., al, 2019) cited in SDR 2021:

[1] "The indicators' values are normalised using the min-max normalization method on a scale of 0 to 100 using as minimum and maximum values the pre-set bounds."

[2] "For each indicator, sustainability 'targets' were determined either based on explicit/implicit SDGs targets, science-based targets or average performance of the best performers. At the same time, to remove the effect of extreme values, the developers capped the data at the bottom 2.5th percentile as the minimum value for the normalisation."

Note from the Author: The direction of refers on whether the indicator has a negative or positive relationship with environmental sustainability. For negative relationships, the higher the value, the worse the environmental sustainability, and vice versa.

Table 9: Description of the Index and Indicators

	Indicator	Data	Description	Indicator Source**	Data Source*
SDG 6: Clean Water and Sanitation	Population using at least basic drinking water services	Percentage of families by service level of drinking water by Region (%)	This is the proportion of homes (HHs) with enough access to basic, safe drinking water from various sources of enhanced drinking water supply (CPES Technical Notes from PSA)	Global	PSA
	Population using at least basic sanitation services	Number of households using safely managed sanitation service (%)	(1) sanitation facility is not shared with other HHS and (2) the sewage/excreta should either be: - processed (in situ) and applied to sanitation byproducts for reuse or disposal while being kept in a containment tank or - application of sanitation byproducts for reuse or disposal as well as storage in a containment tank, transportation, treatment, and off-site disposal or - stored in a containment tank or conveyed through a sewer/sewerage system and treated off-site and application of sanitation by-products for reuse/disposal (CPES Technical Notes from PSA)	Global	DOH
	Bodies of water with good ambient water quality: Dissolved Oxygen	Concentration level of Dissolved Oxygen (DO) of selected freshwater bodies by region (mg/L)	The amount of gaseous oxygen (O2) that is present in water is stated as either a percentage of saturated water or as a milligram of O2 per liter of water (percentage) (CPES Technical Notes from PSA) Standards: Minimum: 5 (DENR Administrative Order no. 2016-08) Maximum: 12 (Government of Northwest Territories - Environment and Natural Resources)	National	DENR-EMB

	Bodies of water with good ambient water quality: Biochemical Oxygen Demand (BOD)	Concentration level of Biochemical Oxygen Demand (BOD) of selected freshwater bodies by region (mg/L)	Dissolved oxygen needed by living things for aerobic breakdown of organic materials in water (CPES Technical Notes from PSA) Philippine standards (DENR Administrative Order no. 2016-08): Minimum - 1 Maximum - 15	National	DENR-EMB
SDG 11: Sustainable Cities and Communities	Annual mean concentration of particulate matter of less than 2.5 of diameter	Average concentration levels of Particulate Matter 2.5 (PM 2.5) by region (microgram per normal cubic meter)	Smaller than 2.5 micrometers in diameter are considered "fine particles," which include those in smoke and haze. These particles may be released directly from events like forest fires, or they may develop as a result of a reaction in the atmosphere between gases released by factories, power plants, and cars. (CPES Technical Notes from PSA)	Global	DENR-EMB
	Improved water source, piped	Number of households with access to piped water supply (%)	Included in the study are levels II and III: Level II: a system consisting of a source, with or without a reservoir, a piped distribution network, and community faucets positioned within 25 meters of the farthest house Level III: a system that includes a source, a piped distribution network, and pipes (CPES Technical Notes from PSA)	Global	DOH
	Annual mean concentration of particulate matter 10 of diameter	Average concentration levels of Particulate Matter 10 (PM 10) by region (microgram per normal cubic meter)	"Inhalable coarse particles," such as those found near highways and dusty industries, have a diameter greater than 2.5 micrometers but less than 10 micrometers (CPES Technical Notes from PSA)	National	PSA

	Proportion of local governments that adopt and implement local disaster risk reduction strategies in line with national disaster risk reduction strategies	Revisions/updates were based on the baseline data to incorporate the updated data based on the submitted and reviewed LDRRM plan of the provinces, cities or municipalities (scores are provided, 100)	Revisions/updates were made based on the baseline data to integrate the new data from the provinces, cities, or municipalities filed and reviewed LDRRM plans (PSA Baselines, 2021) The scores were provided for 2016 and 2018. Since these are policies, we used the same for 2017 and 2019.	National	NDRRMC, OCD
SDG 12: Responsible Consumption and Production	Solid Waste	Waste generation by region (tons per day) (%)	Solid waste generated per region	Global	DENR-EMB
	Hazardous waste generated	Amount of hazardous waste generated by region (tons per year) (%)	a) substances that have no safe commercial, industrial, agricultural, or economic use and are exported, transported, or carried from their place of origin for dumping or disposal into or in transit via any portion of the Philippine territory b) by-products, side-products, process residues, wasted reaction media, polluted plant or equipment, or other substances from manufacturing processes, as well as consumer discards of produced items that pose an excessive risk and/or injury to health and safety and the environment. (PSA Baselines, 2021)	National	DENR-EMB
	Proportion of hazardous waste treated, by type of treatment	Amount of hazardous waste treated by region (% share of hazardous waste treated as to the total regional hazardous waste)	Hazardous wastes as previously described that undergo treatment	National	DENR-EMB
	Production-based SO2 emissions	Concentration levels of Sulfur Dioxide (SO2) by region by monitoring station (micrograms per normal cubic meter) Average of concentration level of monitoring stations in the same region	The burning of fossil fuels produces a heavy, smelly, colorless gas. It is detrimental to humans and vegetation, and it adds to precipitation acidity. (CPES Technical Notes from PSA)	Global	DENR-EMB

	NO footprint	Concentration levels of Nitrogen Dioxide (NO2) by region by monitoring station (micrograms per normal cubic meter) Average of concentration level of monitoring stations in the same region	A byproduct of transportation and stationary combustion. It contributes significantly to acid deposition and the generation of ground-level ozone in the troposphere. (CPES Technical Notes from PSA)	Global	DENR-EMB
SDG 15: Life on Land	Protected area sites important to terrestrial and freshwater biodiversity	Proportion of protected watershed areas of the total regional land area (%)	Watershed: A land area drained by a stream and its tributaries that have a single outlet for surface runoff. Watershed Reservation: A forest land reservation created to safeguard or improve the conditions of the forest's water supply or to decrease sedimentation. (CPES Technical Notes from PSA)	Global	DENR-BMB
	Forest Cover Change	Proportion of open forests to total regional forest cover	Open forests are defined as formations with a discontinuous tree layer that is at least 10% but less than 40% covered. They are managed or uncontrolled forests in the early stages of succession. (CPES Technical Notes from PSA)	National	DENR-BMB
	Forest area as a proportion of total land area	Proportion of total forestland to total regional land area (%)	Forest is defined as terrain larger than 0.5 hectares in size with trees taller than 5 meters and a canopy cover greater than 10%, or trees capable of reaching these heights in situ. It excludes land that is primarily used for agriculture or urban development (CPES Technical Notes from PSA)	Global	NMRIA

* All data are gathered through the Philippine Statistics Authority (PSA). The sources indicated in the column are the original sources of the data (source of PSA data).

** Indicators marked as global means that the indicator is present in global and national indicators, while national indicators are only applicable for the Philippines

***All data descriptions are directly quoted from the sources.

Chapter 3: Research Methodology

3.1 Data Collection, Index Formulation, and Computation

The data used in the study are collected from several monitoring bodies and/or environmental-related government agencies of the Philippines such as the PSA, DENR, and NEDA. Copies of the letters to the agencies requesting data are in Appendices 1-4. Considering data availability, the study covers the period of 2016 to 2019. The reason for choosing this time period is because SDGs were formulated in 2015, and the data available during the data collection period was until 2019.

The study will use the SDG pillars and indicators to build an index. The index will be used for every year included in the study, i.e., 2016 to 2019. The scores generated will reflect the trend of the environmental sustainability of the regions in the Philippines for four years. Then, the characteristics, existing strategies, and policies of the highest and lowest regions will be discussed. The following summarizes the methodology of this study:

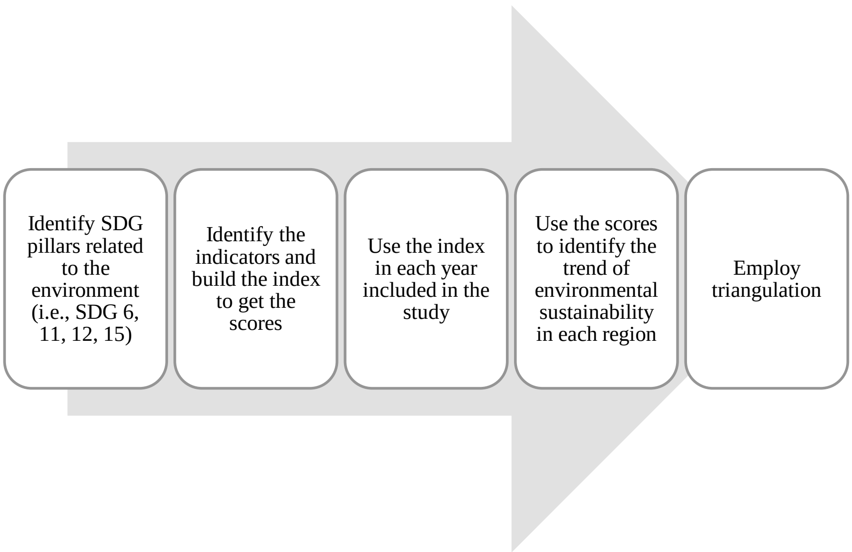

Figure 3: Summary of Methodology of the Study

Following the SDR 2021 (Sachs, et., al, 2021), the establishment of an ESI consisted of three steps: (1) identify the indicators; in this research, the indicators will be based on the SDG 6, 11, 12, and15; (2) normalize the data to ensure comparability across indicators; and (3) weigh and aggregate the indicators across and within SDGs.

The indicators used follow the indicators set from the SDG and the Philippine indicators. To assess the performance level of regions towards sustainability, each variable was scaled from 0 to 100, with 0 being the poorest possible performance and 100 representing the best possible performance. For the variables that must be rescaled, we have used the highest and lowest values among the regions as maximum and minimum values (refer to Table 9).

Table 10: Standards Used to Normalize Some SDGs

Indicator Code	Standards	Sources
6.3	Minimum: 5 Maximum: 12	DENR Administrative Order no. 2016-08 Government of Northwest Territories - Environment and Natural Resources
6.4	Minimum - 1 Maximum - 15	DENR Administrative Order no. 2016-08
11.1	Minimum: 5.9 Maximum: 25	National Ambient Air Quality Guideline Values (NAAQGV) SDR 2021 (Sachs, et., al, 2021)
11.3	Minimum - 0 Maximum - 60	National Ambient Air Quality Guideline Values (NAAQGV)
12.4	Minimum - 0.5 Maximum - 80	SDR 2021 (Sachs, et., al, 2021) DENR Administrative Order no. 2016-08
12.5	Minimum - 2.30 Maximum - 86.5	SDR 2021 (Sachs, et., al, 2021)

We have also used the same formula as the previous studies to normalize the rescaling (Sachs, et., al, 2021; Wang, et al, 2021):

$$x' = \frac{x - min(x)}{max(x) - min(x)} \times 100$$

where x is the raw data value; max/min denote the upper and lower bounds, respectively; and x' is the normalized value after rescaling.

Third, following the assumption that every SDG is equally important, each SDG is given equal weights (refer to Table 10). To calculate the SDG Index, each goal's score was estimated using the arithmetic mean of indicators, then it was averaged across SDGs included in the study.

Table 11: Weights of the Indicators

SDG 6	0.25	6.1	0.0625
		6.2	0.0625
		6.3	0.0625
		6.4	0.0625
SDG11	0.25	11.1	0.0625
		11.2	0.0625
		11.3	0.0625
		11.4	0.0625
SDG12	0.25	12.1	0.05
		12.2	0.05
		12.3	0.05
		12.4	0.05
		12.5	0.05
SDG15	0.25	15.1	0.083333
		15.2	0.083333
		15.3	0.083333

3.2 Validity

For measurement validity tests, the study used three tests of validity which are face validity, content validity, and criterion validity to ensure the representation of the variables the study used (Berman and Wang, 2018; Price et al., 2015). In face validity, the study adopted the global and national indicators applicable and available in the Philippines. In content validity, the study validated the data with the detailed description of the indicators (refer to Table 8). Lastly, the criterion validity or triangulation uses data, investigator, theory/perspective, and methodological triangulation (Hales, 2010). The study will focus on applying data and perspective triangulation. The following paragraphs explain the perspectives included in the study.

Section 2.4 discussed the relationship of the SDG pillars included in the study and its indicators with environmental sustainability. In examining the characteristics of the regions with highest and lowest scores, the study will explore the notable characteristics, best practices, and existing strategies of the regions related to the indicators such as the water quality for SDG 6, air quality and DRR for SDG 11, waste management and chemical pollutants for SDG 12, and forest areas for SDG 15. For example, the study will examine the geographical characteristics of the forested areas of the region which scored high in SDG 15, and so on.

Aside from these, the triangulation will also cover other regional characteristics that may negatively affect the environmental sustainability of the region in relation to the SDG pillars and indicators in the study such as demographic characteristics and consumption of goods (Agboola, et. al, 2021; Khan and Ozturk, 2021), and economic growth rate (Jiang, et. al., 2022; Pettinger, 2021).

Lastly, government priorities can influence the direction of environmental sustainability through policies (Cocklin, 2009). The study will explore whether the regional governments and/or legislative bodies issued any region-specific policy instruments that directly relate to the conservation and protection of the environment in the region. For example, the natural resources in the region are maximized for industrial and urban development to boost economic growth, and/or the issuance of policy directives and instruments related to environment protection and conservation.

3.3 Data Explanation

Table 11 shows the full details of the data used, including the code, direction, year, and data description. The direction pertains to whether the indicator is positively or negatively associated with environmental sustainability. For negative association, it means that the higher the numbers for these indicators, the lesser the environmental sustainability, thus the lower the score, and vice versa for the positive ones.

In normalizing negatively associated indicators, we used the higher number as minimum (higher number, less environmental sustainability, lower score), and the lower number as higher bound (maximum). Since all data are from the Philippine government, the accuracy and reliability of data are ensured. The data used in the study is cross-sectional, covering the period of 2016 to 2019.

Moreover, the following should be noted in formulating the index: (1) the index focuses on the level of performance of the regions towards environmental sustainability, thus most data reflect the regional share towards the national share; (2) due to the absence of monitoring stations in some regions, we have used the national average, such as for indicators 11.1, 12.4, and 12.5; (3) since our index scores focus on the 0 to 100 range, any value greater than 100 is considered as 100, while any value lower than 0 (e.g., negative values) is considered as 0 or the lowest score; and (4) some of the missing data are filled out from the adjacent years following the study of Wang, et. al, 2021.

Table 12: Index Code and Direction

	Indicator	Code	Direction (+/-)	Data Description
SDG 6: Clean Water and Sanitation	Population using at least basic drinking water services	6.1	1	Percentage of families by service level of drinking water by region (%)
	Population using at least basic sanitation services	6.2	1	Number of households using safely managed sanitation service (%)
	Bodies of water with good ambient water quality: Dissolved Oxygen	6.3	-1	Average concentration level of Biochemical Oxygen Demand (BOD) of freshwater bodies in the region (mg/L)
	Bodies of water with good ambient water quality: Biochemical Oxygen Demand (BOD)	6.4	-1	Average concentration level of Biochemical Oxygen Demand (BOD) of freshwater bodies in the region (mg/L)
SDG 11: Sustainable Cities and Communities	Annual mean concentration of particulate matter of less than 2.5 of diameter	11.1	-1	Average concentration levels of Particulate Matter 2.5 (PM 2.5) by monitoring stations in the region (microgram per normal cubic meter) National average = 21
	Improved water source, piped	11.2	1	Number of households with access to improved water supply (%)
	Annual mean concentration of particulate matter 10 of diameter	11.3	-1	Average concentration levels of Particulate Matter 10 (PM 10) by region (microgram per normal cubic meter)

	Proportion of local governments that adopt and implement local disaster risk reduction strategies in line with national disaster risk reduction strategies	11.4	1	Revisions/updates were based on the baseline data to incorporate the updated data based on the submitted and reviewed LDRRM plan of the provinces, cities or municipalities
SDG 12: Responsible Consumption and Production	Solid Waste	12.1	-1	Waste generation by region (tons per day)
	Hazardous waste generated	12.2	-1	Amount of hazardous waste generated by region (tons per year)
	Proportion of hazardous waste treated, by type of treatment	12.3	1	Amount of hazardous waste treated by region (tons per year)
	Production-based SO2 emissions	12.4	-1	Average concentration levels of Sulfur Dioxide (SO2) in the monitoring stations by region (micrograms per normal cubic meter)
	NO footprint	12.5	-1	Average concentration levels of Nitrogen Dioxide (NO2) in the monitoring stations by region (micrograms per normal cubic meter)
SDG 15: Life on Land	Protected area sites important to terrestrial and freshwater biodiversity	15.1	1	Proportion of protected watershed areas of the total regional land area (%)
	Forest Cover Change	15.2	-1	Proportion of open forests to total regional forest cover
	Forest area as a proportion of total land area	15.3	1	Proportion of total forestland to total regional land area (%)

Chapter 4: Presentation and Discussion of Results

4.1 Index Scores and Trends

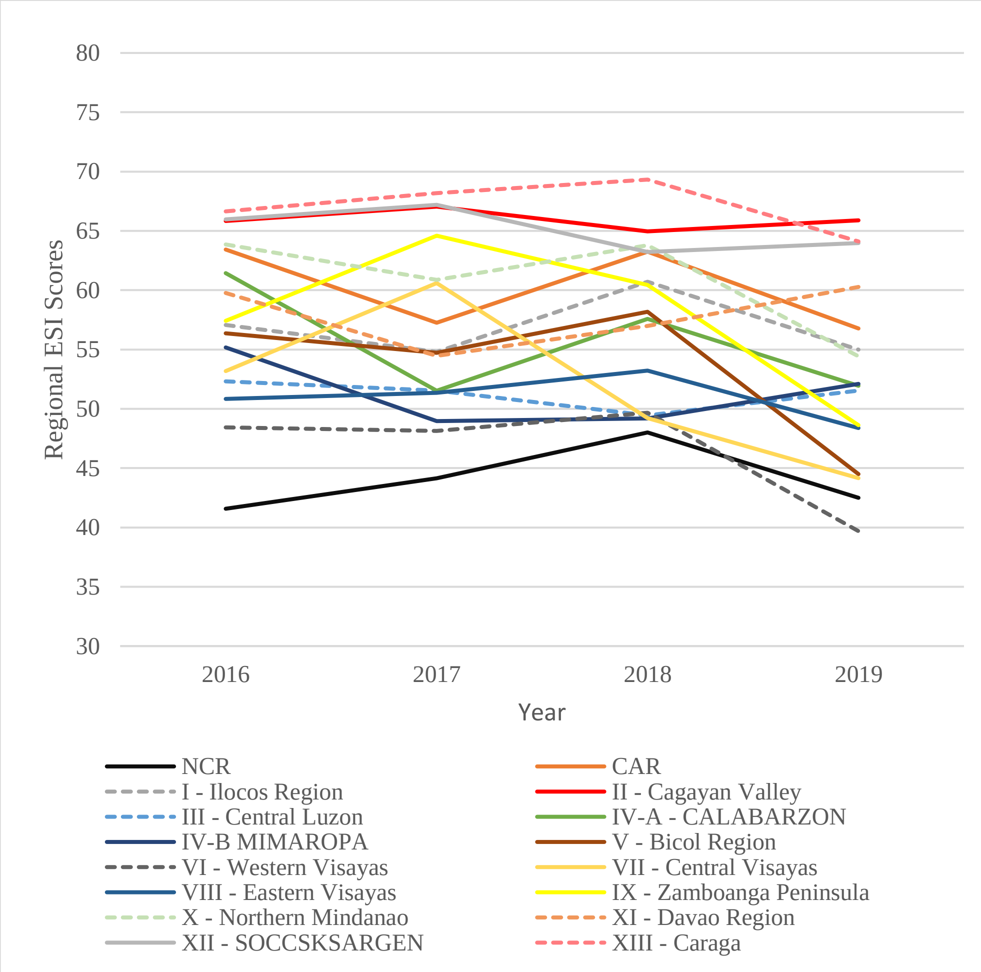

Figure 4: Scores and Trend of the Regional Environmental Sustainability 2016-2019

In general, most of the region's scores fluctuate within the period of 2016 to 2019. The highest and lowest regions, which are Region II - Cagayan Valley, Region XIII-CARAGA, NCR, and Region VI – Western Visayas, generally maintained their rankings within the period. It may also be observed that there was continuous increase for Eastern Visayas in 2016 to 2018 and Davao Region from 2017 to 2019, while there was a continuous decline for Region IX – Zamboanga

Peninsula and Region VII – Central Visayas in 2017 to 2019.

However, it may be emphasized that the study focused on reflecting the performance of each region based on the availability and completeness of data. Whether the scores are good/bad or passing/failing scores are not included in the scope of this study.

Figures 5-8 reflect the trend of SDG pillars and the averages within the period of 2016 to 2019. Examining the trend of SDG pillars in each region is advantageous to know the trend of performance of each region in each SDG in four years and also compare the regions among each other.

For SDG 6, it may be observed that regions IX, X, XI, XII, and XIII generally maintain the water quality and basic sanitation above average. One of the notable similarities of these regions is that these regions belong to the Mindanao group of islands. Whereas there are varying results for regions under the Luzon group of islands. Regions I, II and CAR have above average water quality and basic sanitation. These regions are part of Northern Luzon. While regions III, IV-A, IV-B, V, and NCR, which are part of Central and Southern Luzon, are below average. While the results of the remaining vary, these regions VI, VII, and VIII belong to the Visayas group of islands. Considering these trends, it may be helpful to review the relation of geographical characteristics and priorities of the regions on environmental sustainability (see the case of Cagayan Valley in Section 4.2).

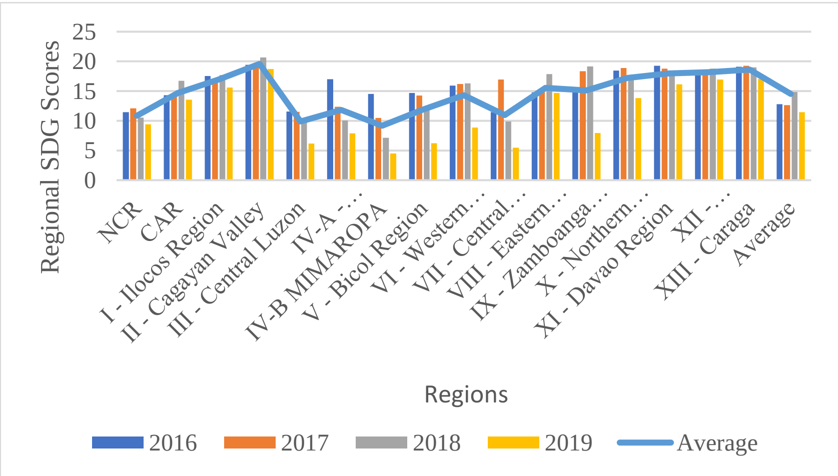

Figure 5: Trend of SDG 6 for 2016-2019

In terms of SDG 11, all regions aside from Region VI – Western Visayas perform within or around the average. SDG 11 focuses on sustainable communities, and the indicators of the study cover air pollution and natural disasters. The performance of Western Visayas in terms of SDG 11 will be discussed in the next section.

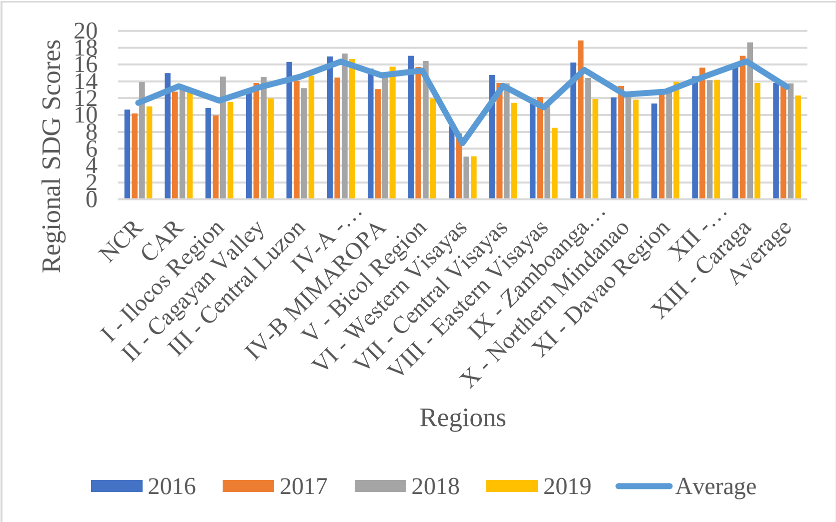

Figure 6: Trend of SDG 11 for 2016-2019

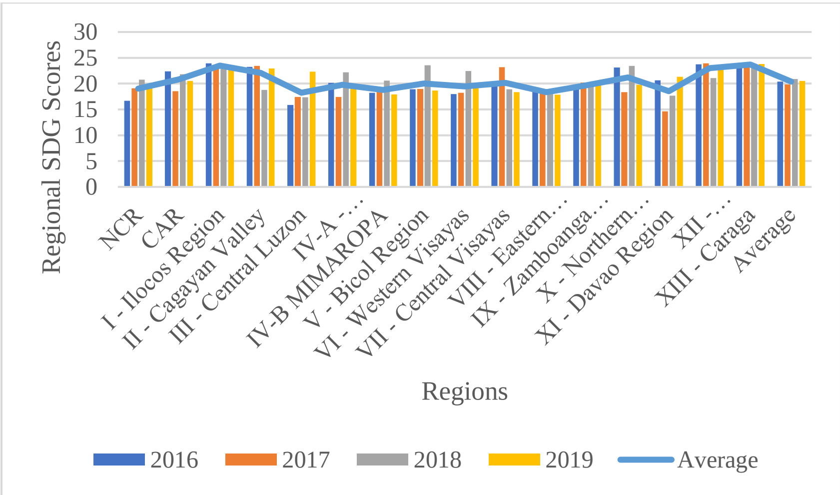

Figure 7: Trend of SDG 12 for 2016-2019

Meanwhile, the results in Figure 7 show that the regional scores under the SDG pillar 12 are within or around the average for four years (2016-2019). While for SDG 15 (refer to Figure 8), aside from NCR and Region I – Ilocos Region, the regions performed the average. Another notable change for SDG 15 is the increase of score in Region IV-B – MIMAROPA in 2019. This may be attributed to the additional protected areas in accordance with the DENR Administrative Order no. 2019-05, also known as the Implementing Rules and Regulations of Republic Act no. 7586, or the National Integrated Protected Areas System (NIPAS) Act of 1992, as amended by Republic Act no. 11038, or the Expanded National Integrated Protected Areas System (ENIPAS) Act of 2018. The case of NCR will be discussed in the next section.

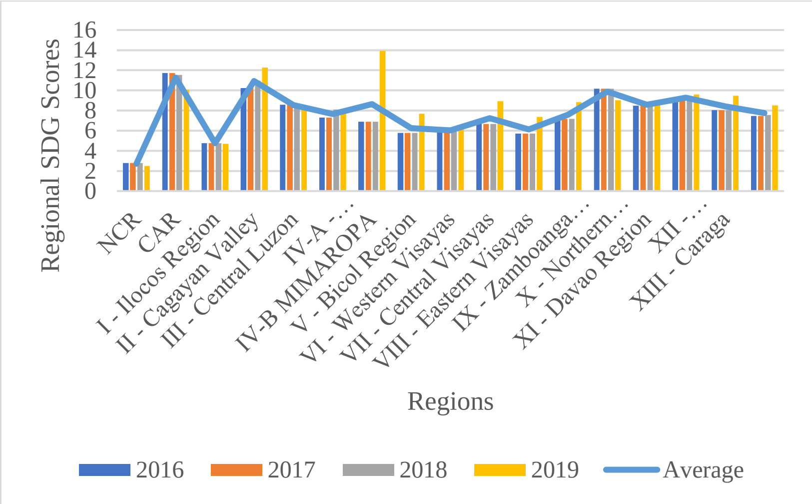

Figure 8: Trend of SDG 15 for 2016-2019

4.2 Rankings and Regional Characteristics

Table 13: Rankings of Regional ESI Scores 2016-2019

2016	
XIII - Caraga	66.63

2017	
XIII - Caraga	68.20

XII - SOCCSKSARGEN	65.98
II - Cagayan Valley	65.83
X - Northern Mindanao	63.86
CAR	63.43
IV-A - CALABARZON	61.44
XI - Davao Region	59.76
IX - Zamboanga Peninsula	57.42
I - Ilocos Region	57.08
V - Bicol Region	56.38
IV-B MIMAROPA	55.18
VII - Central Visayas	53.19
III - Central Luzon	52.32
VIII - Eastern Visayas	50.84
VI - Western Visayas	48.43
NCR	41.58

XII - SOCCSKSARGEN	67.20
II - Cagayan Valley	67.04
IX - Zamboanga Peninsula	64.59
X - Northern Mindanao	60.88
VII - Central Visayas	60.60
CAR	57.24
I - Ilocos Region	54.80
V - Bicol Region	54.71
XI - Davao Region	54.47
III - Central Luzon	51.55
IV-A - CALABARZON	51.53
VIII - Eastern Visayas	51.36
IV-B MIMAROPA	48.96
VI - Western Visayas	48.15
NCR	44.14

2018	
XIII - Caraga	69.32
II - Cagayan Valley	64.96
X - Northern Mindanao	63.78
CAR	63.25
XII - SOCCSKSARGEN	63.22
I - Ilocos Region	60.71
IX - Zamboanga Peninsula	60.44
V - Bicol Region	58.18
IV-A - CALABARZON	57.57
XI - Davao Region	56.99
VIII - Eastern Visayas	53.22
VI - Western Visayas	49.67
III - Central Luzon	49.45
VII - Central Visayas	49.22
IV-B MIMAROPA	49.20
NCR	48.01

2019	
II - Cagayan Valley	65.89
XIII - Caraga	64.11
XII - SOCCSKSARGEN	63.96
XI - Davao Region	60.27
CAR	56.77
I - Ilocos Region	55.00
X - Northern Mindanao	54.43
IV-B MIMAROPA	52.09
IV-A - CALABARZON	51.94
III - Central Luzon	51.54
IX - Zamboanga Peninsula	48.62
VIII - Eastern Visayas	48.38
V - Bicol Region	44.50
VII - Central Visayas	44.16
NCR	42.50
VI - Western Visayas	39.69

Table 14: Rankings of Average Scores of Regions for 2016-2019

Regions	2016	2017	2018	2019	Average
XIII - Caraga	66.63	68.20	69.32	64.11	67.07
II - Cagayan Valley	65.83	67.04	64.96	65.89	65.93
XII - SOCCSKSARGEN	65.98	67.20	63.22	63.96	65.09
X - Northern Mindanao	63.86	60.88	63.78	54.43	60.73
CAR	63.43	57.24	63.25	56.77	60.18
XI - Davao Region	59.76	54.47	56.99	60.27	57.87
IX - Zamboanga Peninsula	57.42	64.59	60.44	48.62	57.77
I - Ilocos Region	57.08	54.80	60.71	55.00	56.90
IV-A - CALABARZON	61.44	51.53	57.57	51.94	55.62
V - Bicol Region	56.38	54.71	58.18	44.50	53.44
VII - Central Visayas	53.19	60.60	49.22	44.16	51.79
IV-B MIMAROPA	55.18	48.96	49.20	52.09	51.36
III - Central Luzon	52.32	51.55	49.45	51.54	51.21
VIII - Eastern Visayas	50.84	51.36	53.22	48.38	50.95
VI - Western Visayas	48.43	48.15	49.67	39.69	46.48
NCR	41.58	44.14	48.01	42.50	44.06

Table 12 presents the rankings of the regions in the study based on the scores generated in the index, while Table 13 shows the rankings of the regions based on their average scores within the period. This section aims to closely examine and highlight some of the regions in the SDG pillar level and indicator level especially for indicators with notable changes, if any. As earlier mentioned, the study will use triangulation to explain the environmental sustainability-related characteristics of the regions with the lowest and highest scores such as the region's geography, policies, population size, economic growth rate, and others.

Out of 16 regions, the study will focus on presenting the characteristics of six (6) regions, namely, Region XIII – CARAGA, Region II – Cagayan Valley, NCR, and Region VI – Western Visayas, Region IX – Zamboanga Peninsula, and Region XI – Davao Region due to following reasons: (1) Region XIII – CARAGA has the highest scores for three years (i.e., 2016 to 2018), and has the highest average among the regions; (2) Region II – Cagayan Valley earned the highest score in 2019, and the second highest average following Region XIII; (3) NCR has the lowest scores for 2016-2018, and has the lowest average among the regions for four years; (4) Region VI – Western Visayas has the lowest score in 2019, and the second lowest average for four years following NCR; and (5) Region IX – Zamboanga Peninsula, and Region XI – Davao Region showed declining and improving trends at the index level.

4.2.1 Highest Scoring Regions

4.2.1.1 Region XIII – CARAGA

Region XIII -CARAGA scored the highest from 2016 to 2018 (see Table 12). In terms of average for four (4) years, Region XIII-CARAGA scored the highest among the regions in the Philippines with the average score of 67.07 (see Table 13). Specifically, CARAGA garnered the highest average within the period in SDGs 11 and 12 compared to all the regions. As stated in the literature review, SDGs 11 and 12 focus on air pollution, natural disasters, waste management, and chemical pollutants.

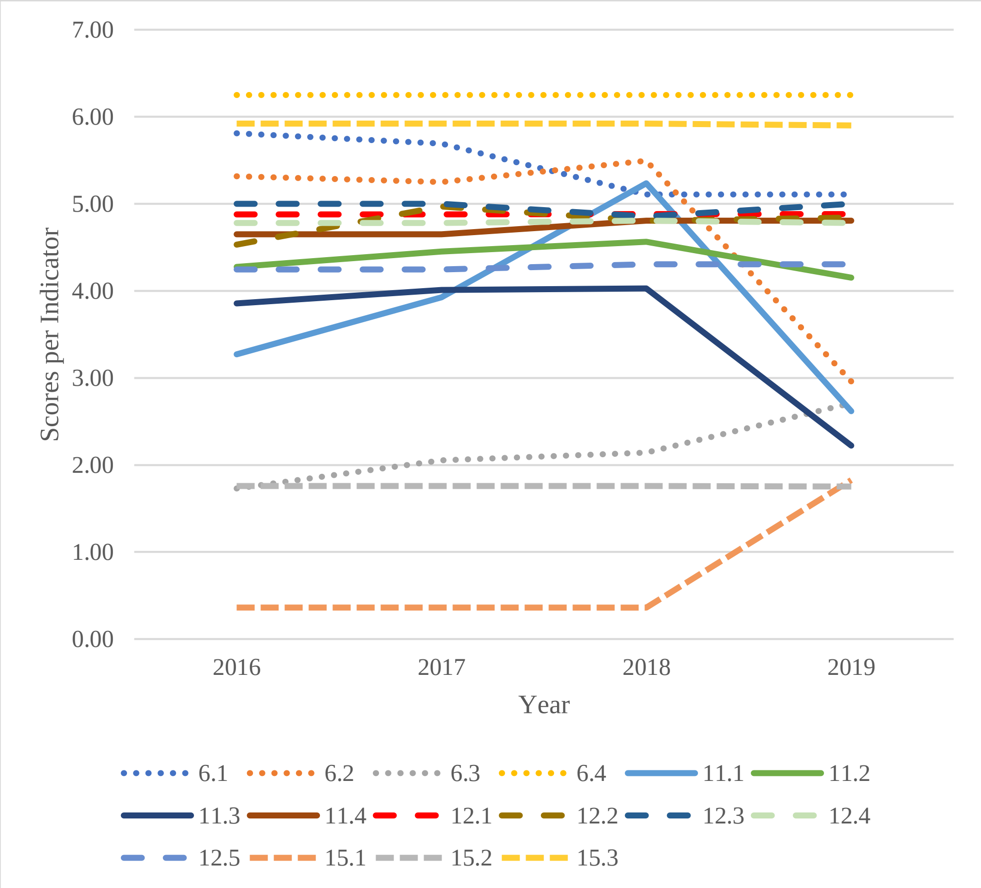

Figure 9: Trend of Indicators in Region XIII – CARAGA

Based on the report of DENR- Environmental Management Bureau (EMB), Region XIII installed the Continuous Ambient Air Quality Monitoring System (CAAQMS) to monitor the air quality in real-time within the vicinity. The region uses the Particulate Matter System (PMS) to monitor PM10 and PM2.5, and the Differential Optical Absorption Spectroscopy (DOAS) to monitor Carbon Monoxide (CO), Photochemical Oxidants as Ozone, Sulfur Dioxide (SO2), Nitrogen Dioxide (NO2), PM10, PM2.5, Benzene, Toluene, and Xylene (DENR-EMB Caraga, 2018). Figure 11 shows the PMS results of PM2.5 and PM10 for the period of 2015 to 2018, while Figure 12 presents the DOAS results for the same period. The PMS results show that the concentration of PM2.5 and PM10 are within the recommended guidelines set by the DENR, while the DOAS results show the continuous decline of the concentration of PM10 and PM2.5 from 2016 to 2018 implying better air quality. The DENR-EMB Caraga recorded 100% operationalization of the CAAQMS ensuring the reliability of data (DENR-EMB Caraga, 2018).

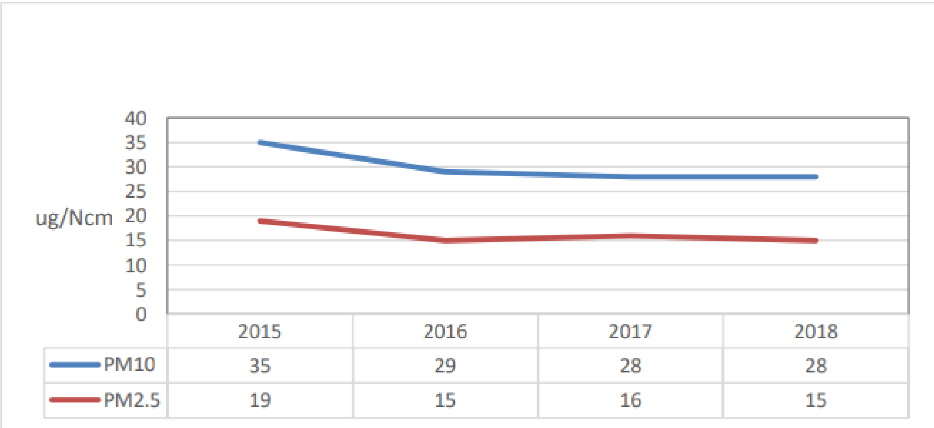

Figure 10: 4-Year Particulate Matter Trend measures at Particulate Matter System (PMS)
Source: DENR-EMB Caraga, State of Brown Environment 2018

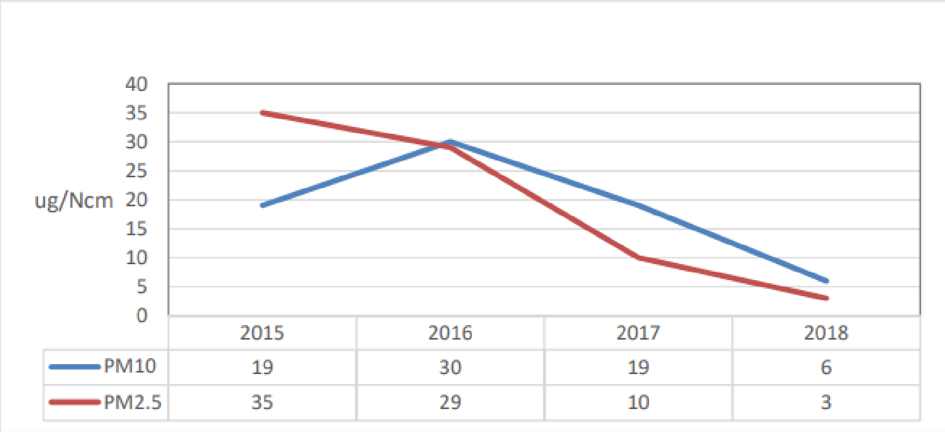

Figure 11: 4-Year Particulate Matter Trend measures at DOAS
Source: DENR-EMB Caraga, State of Brown Environment 2018

The monitoring stations also recorded the results of the concentration of other air pollutants such as NO_x and SO_x within the air quality guidelines (DENR-EMB Caraga, 2018). Region XIII also conducts industrial compliance monitoring, regulatory monitoring (stack sampling), and private emission testing, wherein the region recorded 105% accomplishment against the annual target for the three tests (DENR-EMB Caraga, 2018). The commitment of the region towards better air quality are also demonstrated through their best practices on roadside vehicle emission testing and strengthened support to manpower in the conduct sampling and reading of meteorological equipment (DENR-EMB Caraga, 2018).

On waste management, DENR-EMB in Region XIII conducted and implemented various programs and projects to achieve a comprehensive waste management system to contribute to the reduction of waste in the region. The DENR-EMB provided technical assistance to the LGUs on the formulation of a 10-year solid waste management (SWM) plans to maximize waste avoidance and waste recovery in the long term, closure and rehabilitation of dumpsites, and establishment of materials recovery facilities (DENR-EMB Caraga, 2018). The continuous monitoring of SWM facilities and sites to assess its operationalization and gather relevant data such as waste diversion rate (DENR-EMB Caraga, 2018).

In terms of hazardous waste, Region XIII is committed to improve the collection, processing, and transportation of hazardous waste by exceeding their annual targets on the registration of hazardous waste generators, working on the challenges on the numbers of transporters, conducting information campaign through surveys on potentially hazardous waste generators, and the management of the online manifest system for hazardous waste (DENR-EMB Caraga, 2018).

Moreover, CARAGA was also one of the six regions with 100% formulation and implementation of DRR strategies as early as 2016 (PSA Baselines, 2021). Upon examining the average score of the region for SDG 6 and 15, Region XIII got scores higher than average which are 18.59 compared to 14.54 average score in SDG 6, and 8.40 compared to 7.74 average score in SDG 15.

The study also tried to find an explanation for the decline of SDG 6 in 2019. The State of Brown Environment (SOBER) report of CARAGA in 2018 reported the passing status of the water quality of the region within the standards. Although the study tried to investigate the change of indicator 6.2 – basic sanitation in 2019, the RDP-RM 2017-2022 of CARAGA did not include the status of water quality in the region, while SOBER 2019 is not available online or is not yet published. However, upon closer examination in the data provided by the DOH to the PSA, which was used in the study, there was around 10% increase on the number of households from 2018 to 2019, and a severe decline on the percentage of households with basic sanitation services. It may be noted that the DOH updated its Field Health Services Information System (FHSIS) Manual of Operations in 2018 which may affect the standards of reporting in 2019.

In general, Region XIII – CARAGA shows that specific regional interventions and priorities can influence the improvement of the performance of the environmental sustainability of the region.

4.2.1.2 Region II – Cagayan Valley

Based on the results of study, Cagayan Valley (Region II) is the most environmentally sustainable region in 2019, and the second highest average in four years. In general, the indicators maintained their performance within the period of 2016 to 2019, aside from indicators 12.3: Treated Hazardous Waste, 15.1: Protected Areas, and 11.1: PM2.5, which showed notable changes. On region's average ESI score within the period in the SDG level, Cagayan Valley showed high performance on SDG 6 and SDG 15. These pillars focus on clean water and sanitation and protected areas and natural resources.

First, in terms of protected areas and natural resources in SDG 15, Cagayan Valley is the second largest region in land area geographically, and is bounded by three big mountain ranges namely, Cordillera, Caraballo, and Sierra Madre, and to its north is where the Cagayan River, the largest river system in the country, drains (NEDA, 2021). Cagayan Valley has three out of 18 major river basins in the country, namely Agno River Basin, Apayao-Abulug River Basin, and the Cagayan River. The Cagayan River Basin, which is the largest major river basin in the Philippines caters domestic water supply, irrigation, and power generation to the locality (Rubio et al., n.d.). It is also the home of the largest protected area having the richest biodiversity in the country, namely the Northern Sierra Madre Natural Park (NSMNP)[①], recognized by the United Nations Educational, Scientific and Cultural Organization (UNESCO) under its tentative list for World Heritage for its ecological significance (UNESCO, n.d.). Based on the Cagayan Valley Regional Development Plan (RDP) Results Matrices (RM) 2017-2022, the region reported an increase of forest cover and reforestation areas, and the region also sustained the protected areas.

[①] The Sierra Madre is the longest mountain range in the Philippines spanning from Cagayan Valley to parts of Luzon.

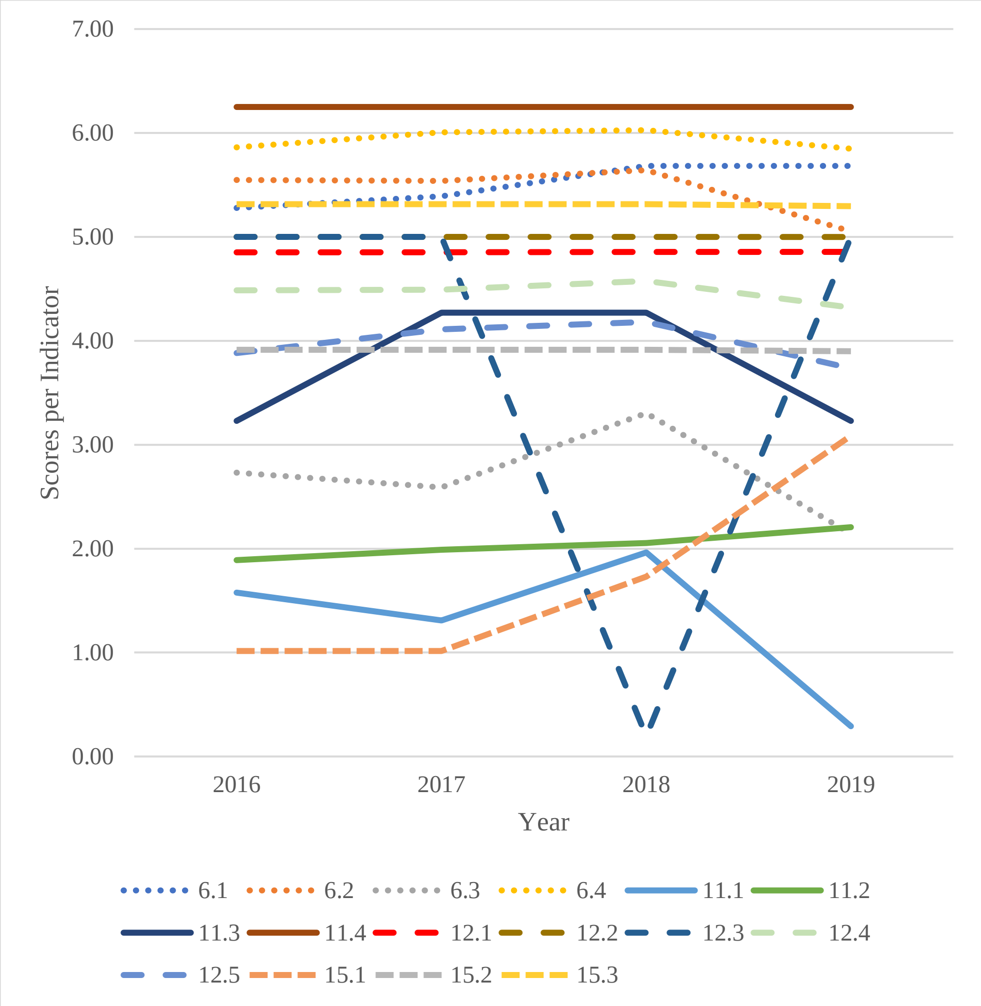

Figure 12: Trend of Indicators in Cagayan Valley

Due to its rich biodiversity, major conservation and protection efforts are poured in the region both by the national and regional governments. Studies show the importance of forest preservation in environmental sustainability (National Geographic Society, 2022a), and that rational planning on the optimal use of natural resources can contribute to sustainability (Aljero, 2018). The Regional Development Council (RDC) of Cagayan Valley formulated the Cagayan Riverine Zone Development Framework Plan 2005-2030 to serve as a guide for sustainable water and land management to maximize the multiple use of the Cagayan River, while preserving and protecting its biodiversity, fishery, and aquatic resources, as well as solving problems and issues related to it (NEDA Region 2, 2005).

In 2018, the President of the Philippines approved Republic Act no. 11038 also known as 'An Act Declaring Protected Areas and Providing for their Management, amending for this Purpose Republic Act no. 7586, Otherwise Known as the National Integrated Protected Areas System (NIPAS) of 1992 and for Other Purposes', which included more than 200,000 hectares of land area in Region II (Republic Act 11038, 2018). Consequently, the proportion of protected areas to the total land area in the region increased from 12.18% in 2017 to 20.78% in 2018.

Although it does not solely cover only the Cagayan Valley, another effort of the lawmakers is to establish Sierra Madre Development Authority (SMDA) to focus on the protection and conservation of the longest mountain range of the country through House Bill no. 1972 (Crisostomo, 2022; Ragasa, 2022).

On SDG 6, the region has improved water quality and has increased access to safe water supply and sanitation services (Cagayan Valley RDP-RM, 2017-2022). Recently, the region continued to provide accessible clean drinking water and sanitation through its Sagana at Ligtas na Tubig para sa Lahat (SALINTUBIG) Program where the "Department of Interior and Local Government (DILG) Region 2 constructed a total of 47 water and sanitation projects in 14 waterless municipalities in the provinces of Cagayan, Isabela, and Nueva Vizcaya" (NEDA Regional Office 2 - Cagayan Valley Page, 2021).

Moving to other environmental-related SDGs, Cagayan Valley, with an average score of 13.32 in SDG 11 in 4 years, was just within the overall average of the SDG 11 (13.34) throughout the period included in the study. The increase in indicator 15.1 may also be attributed to the DENR Administrative Order no. 2019-05, as previously mentioned.

Further, the region scored higher than average in SDG 12, with 22.097 out of 20.40 overall average of regions in 4 years. However, upon closer examination, the decline of the overall score of Cagayan Valley may attributed to its low score of treating hazardous waste in 2018 (see indicator 12.3 in Figure 12). Cagayan Valley has the second smallest number of Registered Hazardous Waste Generators (HWGs) in the country, with only 320 HWGs from hospitals, banks, gasoline stations, and telecommunications as of 2020 (Statistics of Registered Hazardous Waste Generators, n.d.) and is one of the four regions with only one (1) Registered

Hazardous Waste Transporters as of 2021 (Statistics of Registered Hazardous Waste Transporters, n.d.).

As key observation in Cagayan Valley, it may be said that, although there are still various areas of improvement towards environmental sustainability, the regional's geographic characteristics contributed to shaping the policies and strategies towards environmental sustainability.

4.2.2 Lowest Scoring Regions

4.2.2.1 National Capital Region (NCR)

From 2016 to 2018, NCR has the lowest environmental sustainability scores using the ESI in the study. The region scored below the average for all SDG pillars in the study, with the chunk of its low score attributed to SDG 6 and 15.

SDG 15 focuses on terrestrial ecosystems, and NCR has low proportion of protected areas in the region, low proportion of open forests to total forest cover of the region, and low proportion of total forestland to total land area. This implies the importance of land management in environmental sustainability. Many studies recognize the importance and effects of social and geographical factors in attaining environmental sustainability. According to the research of Mohanty (2009), the following can affect the environment: (1) urbanization expands the area covered of non-agricultural uses, and it can also result in the exhaustion and depletion of the environment; and (2) population growth adds to the environmental disturbance since it implies the need for increase of food production, increase in environmental stress (e.g., water, land, air), and other activities that affect the environment.

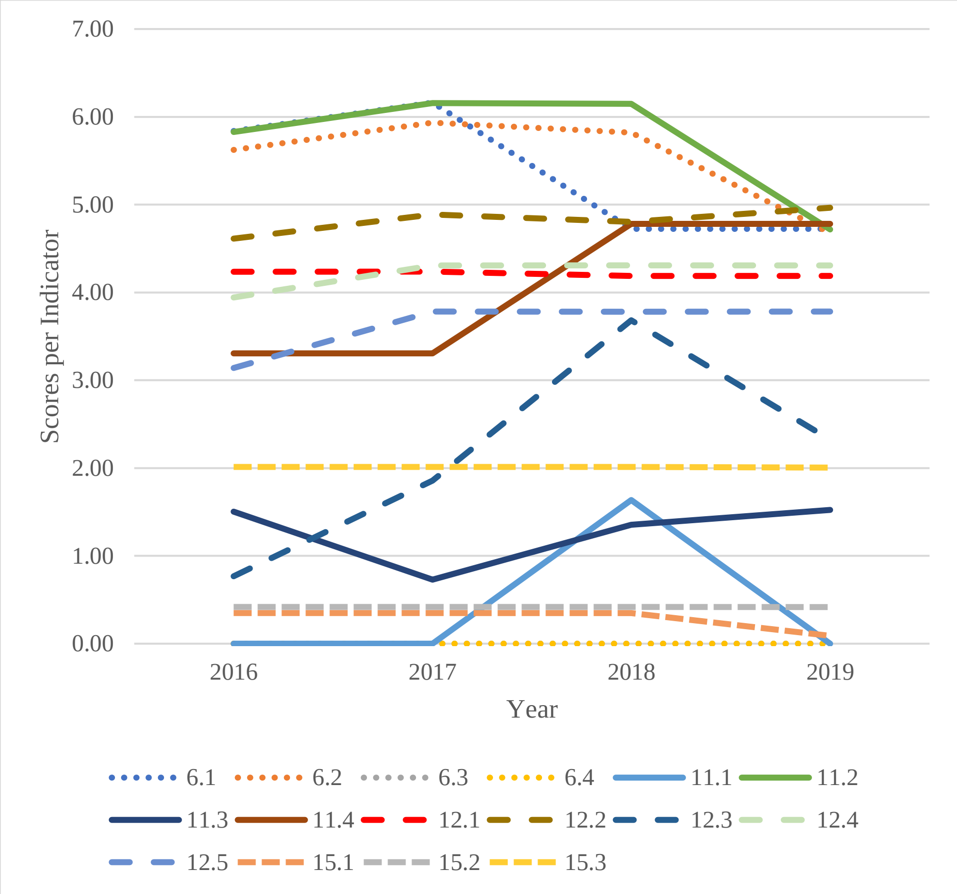

Figure 13: Trend of Indicators in NCR

Since land management is often associated with sustainability strategies on food production, biodiversity, and climate considerations (Kastner, et. al., 2021), land area may influence environmental sustainability on the amount and intensity of its effects to these sectors. Moreover, land use management plays a key role in conservation strategies such as reforestation and biodiversity conservation (Kastner, et. al., 2021), thus land area is an important factor towards environmental sustainability.

NCR is the smallest region in the country, but at the same time, it is the Philippines' center of politics, economy, and education [Department of Trade and Industry (DTI), n.d.]. Despite its small size, NCR has the largest population in the country, with 0.97% growth rate from 12.88 million in 2015 to 13.48 million in 2020, making it as the most densely populated region in the country with 21,765 inhabitants per square kilometer (PhilAtlas, n.d.). It was ranked as the "7th most populous metropolitan area in Asia, and the 3rd most populous urban area in the world" (DTI, n.d.).

Population size is said to be one of the most common variables to identify environmental quality (Khan and Ozturk, 2021). Different studies showed the positive correlation of population size and environmental degradation due to human dependency on natural resources for production and consumption of goods (Agboola, et. al, 2021; Khan and Ozturk, 2021), consequently resulting to its negative relationship with environmental sustainability.

While the region is surrounded by the Pasig River, Manila Bay, Marikina Valley, Marikina River, and Laguna Lowlands that can be maximized for its agricultural and fisheries resources, the geographical areas of NCR are eyed for industrial and urban development (DENR-EMB, n.d.). NCR houses six central business districts, namely Makati, Bonifacio Global City, Ortigas Center, Quezon City, Manila, Pasay and Alabang (DENR Environmental Management Bureau, n.d.). As the center of the country's economy, the NCR has growth rate of 7.2% (above the national growth rate of 6%) in 2018-2019, contributing 42.7% in the services sector and 20.9% in the industry sector (PSA, 2020).

Economic growth rate can have both positive and negative variations towards environmental sustainability. The increase in economic growth rate as a result of the increase in real output may be detrimental due to the increase of output and consumption, while it is advantageous when allocated to adaptation and mitigation efforts and strategies (Jiang, et. al., 2022; Pettinger, 2021).

Some of the important natural reserves and protected areas in NCR are Rizal Park, Ninoy Aquino Parks & Wildlife Center, and the Manila Bay Beach Resort, La Mesa Ecopark, and the Las Piñas-Parañaque Critical Habitat and Ecotourism Area (DENR Environmental Management Bureau, n.d.).

In terms of SDG 6, upon examining the air and water quality in NCR has the following averages:

1. NCR has an average of 27.86 μg/m3 of particulate matter less than 2.5 (PM 2.5) which exceeded the global standard of 20 μg/m3 annually recommended by the World Health Organization (Seposo et al., 2021) and

Philippine standard of 25 annually based on the National Ambient Air Quality Guideline Values (NAAQGV) from RA 8749, updated in 2016 (Department of Environment and Natural Resources, 2020);

2. NCR has an average of 47.73 µg/m3 out of the recommended 60 µg/m3 annually based on the NAAQGV;
3. In terms of dissolved oxygen in the water, NCR has an average of 1.98 mg/L from 2016 to 2019, which is below the minimum average of 5 mg/L based on the Water Quality Guidelines for Primary Parameters applicable to watersheds, water supply requiring conventional treatments, recreational water, and agricultural, fishery, and irrigation water (DENR Administrative Order no. 2016-08).
4. NCR has an average of 58.75 mg/L of biochemical oxygen demand (BOD), which is very high compared to the 15 mg/L recommended by the Water Quality Guidelines for Primary Parameters applicable to watersheds, water supply requiring conventional treatments, and others. However, it may be noted that the DENR has also provided another standard for strong wastewater, wherein 50 mg/L for fishery and agriculture, and 120 mg/L for navigable waters (DENR Administrative Order no. 2016-08). Since we used the data of the BOD concentration in freshwater bodies by region, even though we consider the 50 mg/L, the average of NCR is still beyond the maximum.

Given the heavy economic and social activities in the region, it may be assumed that it also influenced the water and air quality of the region, e.g., transport and industrial emissions. In the case of the lowest scoring region, we can observe that aside from the geographical factors, land management, social and economic activities can influence the environmental sustainability of a region.

4.2.2.2 Region VI – Western Visayas

As earlier mentioned, Region VI – Western Visayas has the lowest score in 2019, and the second lowest average for four years following NCR. In the SDG level, the region has the lowest average score in SDG 11, which focuses on air quality and natural disasters.

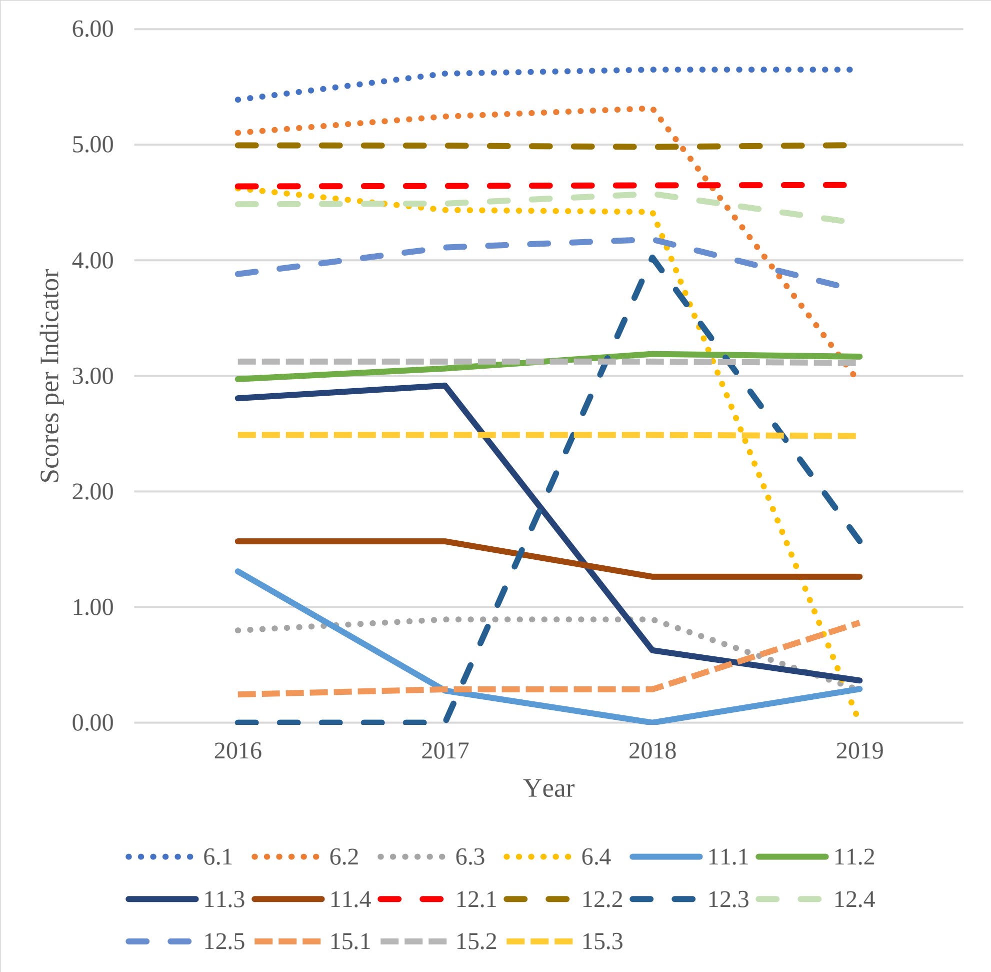

Figure 14: Trend of Indicators in Region VI - Western Visayas

In terms of air quality, the region noted the high concentration due to the dust from the construction and infrastructure development in the roads near the monitoring stations (Regional Development Report (RDR) – Region VI, 2018). Aside from the highway development, road construction, and bridge construction implemented by the region within the period, it may also be noted that the previous administration of the Philippines pushed for large-scale infrastructure development, i.e., Build Build Build (RDR – Region VI, 2019). To improve air quality aside from the air sheds and monitoring stations, the region strives to strengthen its anti-smoke belching campaign and regular roadside vehicle emission testing (RDR – Region VI, 2019).

On natural disasters, based on the data from the PSA, Western Visayas accomplished only 20.2% out of 100% of its adoption and implementation of local DRR strategies in line with national DRR strategies, which is the lowest among the regions included in the study (PSA Baselines, 2021). The region continuously integrates DRR strategies with its local plans, with 89 out of 127 targeted local government units (LGUs) to update its local plans with DRR strategies in 2019 (RDR – Region VI, 2019). In addition, the Philippine Air Force is in the process of acquiring lands to International Iloilo Airport for the construction of various facilities for disaster response (RDR – Region VI, 2019).

For SDG 6 pillar, the region performed above average within 2016 to 2019. However, there are notable changes for indicators 6.2: basic sanitation and 6.4 level of BOD. The following reasons are cited: (1) the decline of the implementation of the provision was because hygiene and sanitation in 2019 was because the program was not fully implemented because of scarce water sources; and (2) although the BOD level of the major rivers and water bodies improved within the standard, one of the major water bodies, namely Malihao River, exceeded the standard by almost five times, which was because of the surface runoff and drainage canals coming from the industrial, commercial, and domestic wastewater, consequently affecting the score of the region in this indicator in 2019 (RDR – Region VI, 2019). The region also noted that they are working on the improvement of provision of water supply, but it remains below the target.

Lastly, the region's average for SDG 12 and 15 are just around the average among all the regions. The reason for drastic change for 12.3: treatment of hazardous waste is not mentioned in the reports, but the region is still working on the treatment of hazardous waste, and continuously issuing penalties for violators (RDR – Region VI, 2019).

4.2.3 Improving and Declining Regions

4.2.3.1 Region IX – Zamboanga Peninsula

At the index level, Region IX – Zamboanga Peninsula continuously declined from 2017 to 2019. At the SDG level, the region's scores are above the average for SDGs 6 and 11 within 2016-2019, while the region's average for SDG 12 and 15 are slightly below the averages within the period. Upon closer examination, notable decline happened in 2019, specifically for indicators 6.1 – drinking water, 6.2 – basic sanitation, 6.3 – dissolved oxygen level, 11.2 – piped water, and 11.4 – integration of DRR strategies. Aside from indicator 11.4 – DRR strategies, all indicators with severe decline are connected to water quality or water management.

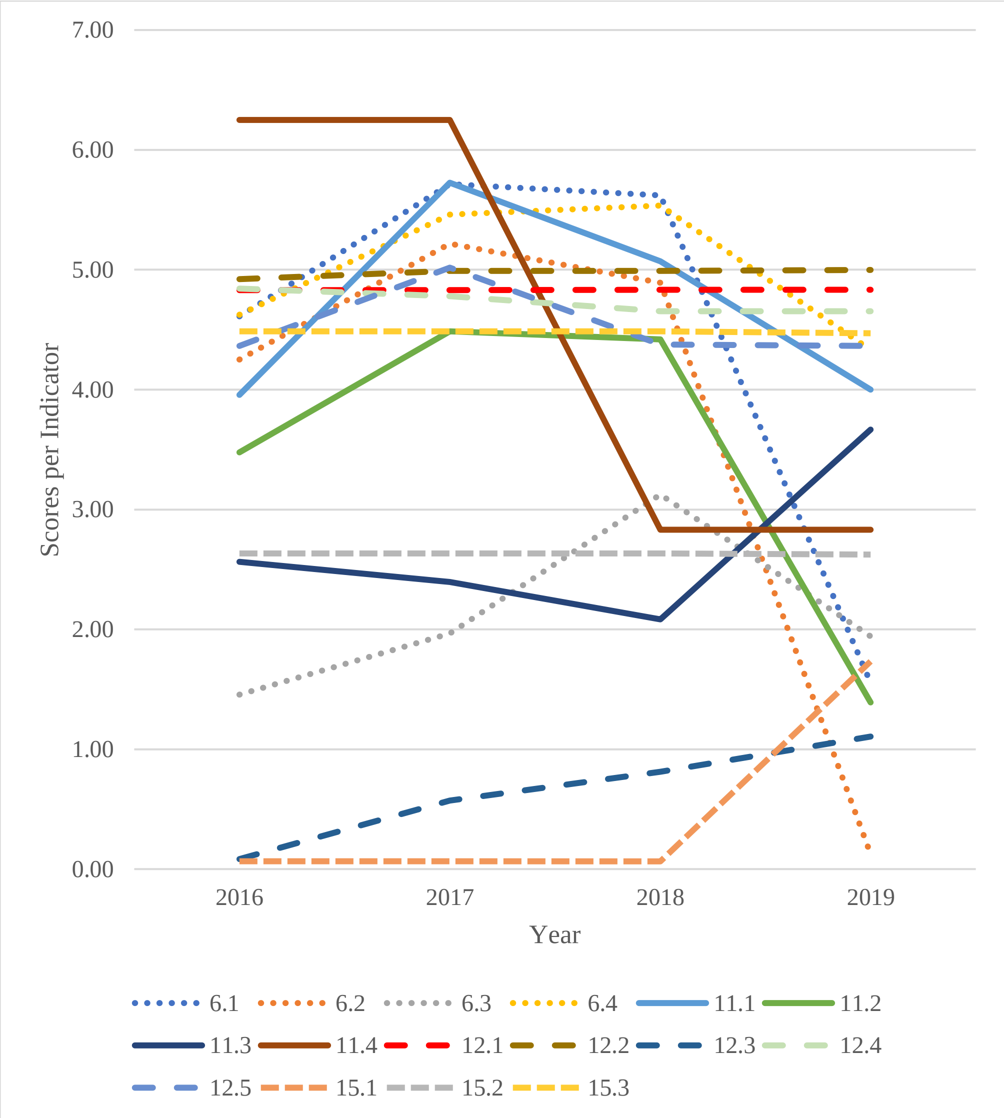

Figure 15: Trend of Indicators in Region IX - Zamboanga Peninsula

Similar to the previous regions, the study investigated the regional development reports of the region. The RDR 2019 of Region IX mentioned the consistent progress of the region in providing access to drinking water and basic sanitation services. However, the results of the study showed that there was a decline in both 6.1 and 6.2. Based on investigation, there was almost 21% increased number of households, from 662,461 in 2018 to 837807 in 2019, along with the decline of the households with access to drinking water and basic sanitation. As earlier mentioned in Region XIII-CARAGA, there was an update of FHSIS Manual of Operations in 2018. Aside from the effect of the increase of population, this implies that the changes in the manual of operations may have effects on the reporting and monitoring of the indicators. Although it may be beneficial to investigate these changes, it is no longer included in the scope of this study.

Meanwhile, in 2016, the waterbodies being monitored in Region IX were two rivers and 17 other waterbodies, but the number of waterbodies increased to 32 in 2017 and 36 in 2018 (Region IX RDR, 2016; Region IX RDR, 2017; Region IX RDR, 2018). The region reported the improving water quality from 2016 to 2018 which may be attributed to the efforts of the LGUs such as the quarterly clean-ups, information and education campaigns, and other program activities in coordination with the LGUs, residents and active donor partners (Region IX RDR, 2017; Region IX RDR, 2018). However, the report in 2019 did not include the causes or reasons of the decline of the water quality. The region only noted the continuous monitoring of the waterbodies without discussion on the DO and BOD levels unlike the previous years.

In indicator 11.2, there was an increase from 2016 to 2018, and then declined in 2019. The increase in 2016 to 2018 can be attributed to the continuous achievement of high performance when it comes to the provision of access to water supply of the six water districts (Region IX RDR, 2017; Region IX RDR, 2018). In 2018, it was noted that there was a bulk of water supply that increased the access of households in one of the areas (Region IX RDR, 2018), however, the report did not discuss the details of the bulk water supply, and whether it can be continued or expanded to other areas. In 2019, the region reported the widening gap of water supply due to increase of population and economic activities, and explained several reasons and considerations on the failure to achieve its targets and/or expand the services namely ongoing construction or development of water sources, rehabilitation and repairs of old and dilapidated pipelines, prioritization of the implementation of water clustering to alleviate water loss and traversing service water lines, technical issues on septic tanks and drainages, and narrow roads for de-sludging (Region IX RDR, 2019). Some of the other reasons that hindered the provision of service water to other areas are lack of funds (Region IX RDR, 2018) and the restriction to provide water services to households without proof of house ownership (Region IX RDR, 2019). In addition, it may also be noted that one of the water districts, Ipil-Titay Water District, continuously reflected low performance with 15, 19, 17 percent of households catered in 2017, 2018, and 2019 respectively.

In terms of the integration of DRR strategies in 11.4, the decline may be attributed to the failure of the LGUs in the region to utilize the budget allocated for the integration of DRR strategies in the local plans, as well as the lack of personnel for the local DRR office (Region IX RDR, 2018; Region IX RDR, 2019).

For air quality, there was an increasing trend for 11.3 – PM10 within 2016 to 2019, while for 11.1 – PM2.5, the increase stopped at 2018 then slightly decline in 2019. The region noted the increase in concentration in this year compared to other years but did not provide causes or regions for the said performance (Region IX RDR, 2019). Similar to the previous regions, there was an increase in 15.1 due to the expansion of protected areas.

Aside from the characteristics and interventions of the regions, Region IX showed that the data monitoring and reporting is related in accurately reflecting the environmental sustainability of a region (e.g., explanations and discussions of the reasons and causes of the performances of the indicators). The changes on the standards and operations of monitoring and reporting may also affect the results of environmental sustainability. Other factors can also influence environmental sustainability such as proper utilization of budget and prioritization of regions (e.g., construction and development of infrastructures to improve the services).

4.2.3.2 Region XI – Davao Region

At the index level, the scores of the Region XI – Davao Region continuously improved from 2017 to 2018, with an average score of 57.87. Looking at the region's ranks based on yearly index level scores, it was 7th in 2016, 10th in 2017 and 2018, and 4th in 2019. In terms of overall average, it ranked 6th among the 16 regions for the period of 2016 to 2019.

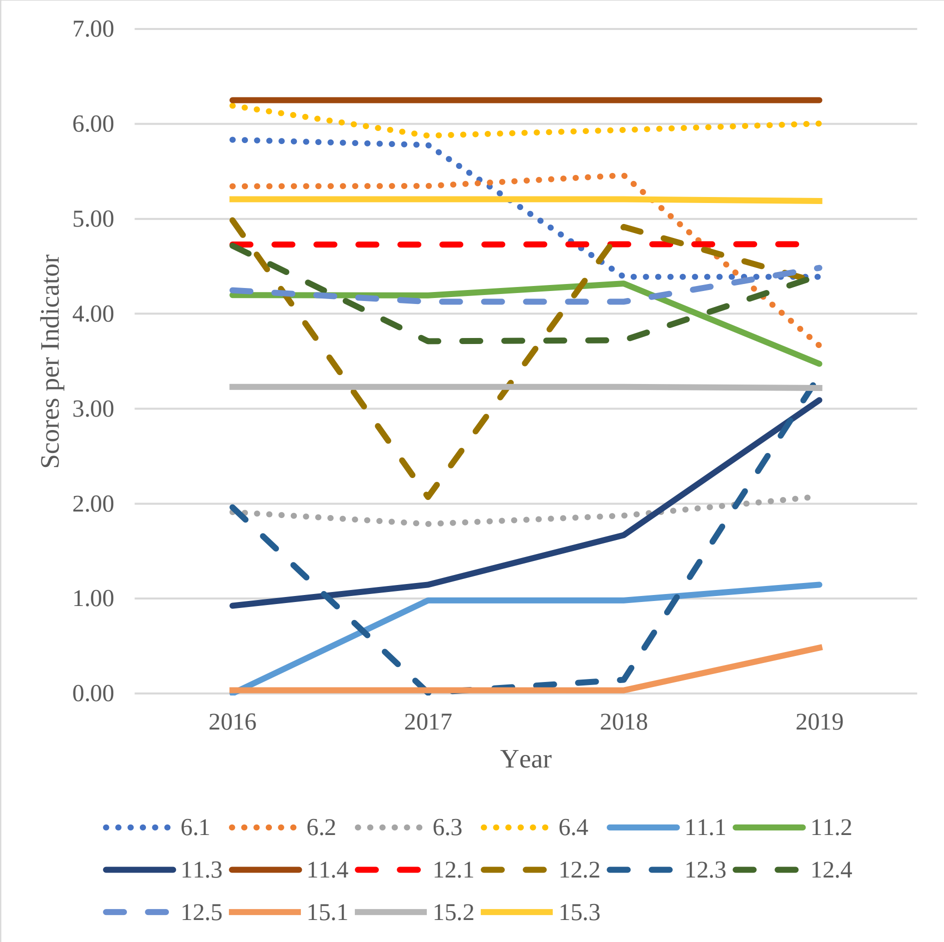

Figure 16: Trend of Indicators in XI - Davao Region

At the SDG level, there was an upward trend for SDG 11 during the period, a downward trend for SDG 6, fluctuations in SDG 12, and steady performance in SDG 15. While at the indicator level, indicators 6.1, 6.2, 11.1, 11.2, 11.3, 12.2, and 12.3 showed noticeable changes.

Given that the upward trend was observed in the period of 2017 t0 2019, the focus of this section would be the strategies of the region and characteristics in the same period that may be related to the SDG pillars included in the study. It may also be noted that the region published its Regional Development Plan covering the period of 2017 to 2022.

The improving air quality of the region (i.e., indicators 11.1 and 11.3) may be attributed to the commitment of the region to improve the air quality. In 2017, the region reported that the region operated five (5) air monitoring stations (DENR-EMB XI, 2017), and it increased to six (6) in 2018 and 2019, wherein six (6) of the monitoring stations record PM10, and two (2) also monitor PM2.5 (Davao Regional State of Brown Environment Report (SOBER), 2018 and 2019). The region also reported that there was a study conducted in 2018 entitled "Air Dispersion Modeling Study for Davao City Airshed" to assess the air quality in the region (Davao SOBER, 2019). In addition, the region also started to designate attainment areas for PM10 monitoring stations to maintain good air quality in 2019 (Davao SOBER, 2019). Some of the listed best practices of the region in 2019 are the following: first region to issue ordinance on the prohibition of smoking in public areas, banana industries changed their use of pesticide to minimize direct contamination to the environment, one of the cement plants use charcoal from wastewater and also use alternative fuels, a brewery use methane from activate sludge, all fuel refilling stations dispense bio-fuel blend, a technical team was designated to conduct of source emission testing for stationary sources, and other programs in partnership with different industries (Davao SOBER, 2019).

Strengthening the Industrial Enforcement Program, constant maintenance and monitoring of the monitoring stations, close monitoring of industries for compliance with regional standards; and offering technical assistance to LGUs and other concerned institutions in the development of plans and programs to address pollution from local sources are some of the strategies used by the region to improve air quality (Davao SOBER, 2018). Other recommendations for the improvement of the air quality are the issuance of guidelines for the correction of PM matter monitoring, enhance anti-smoking campaigns, expand private emission testing, and others (Davao SOBER, 2018 and 2019).

For SDG 6, the region reported possible reasons for the decline in SDG 6.

In terms of DO and BOD, the region monitors the water quality of twenty-five (25) waterbodies (Davao SOBER, 2018). There was an increasing trend of BOD in 2018 for Davao River, Matina River, Lipadas River, which implies that the water quality of the region was deteriorating. The rise in BOD was attributed to the direct discharge of untreated wastewater from industry as well as organic waste transported by run-off from farms and agricultural districts upstream (Davao SOBER, 2018). Meanwhile, there was also a decreasing trend of OD in Mal River and Balutakay River which also implies that the water quality of the region was declining. The region said that the decline was caused by the various items that floated in the river, and it may be attributed to direct sunlight penetration because there was a rise in temperature during the same period and at the same site in 2018 (Davao SOBER, 2018). For indicator 6.2, data shows that there was an increase of households from 2018 t0 2019, and a decline in households with access to basic sanitation. And similar to other regions, there may be changes due to the FHSIS update in 2018. Although the study attempted to further investigate the decline in indicator 6.1, the available reports did not mention it.

For indicators 12.2 and 12.3, the decline of treated hazardous waste from 2016 to 2017 may depend on the baseline year of the reporting of the region. Davao SOBER 2019 cited that the region was still treating the hazardous waste generated in 2017, which was 30.47% treated in 2019 of the 18,260.3 tons of hazardous waste from 2017 (Davao SOBER, 2019). Given that the treatment of hazardous waste is aggregated from 2017 to 2019, the gap between 2016 and 2017 may also because of the aggregate reporting in the previous years. However, another study or investigation must be done on this.

In 2018, the region has registered a total of 147 Hazardous Wastes Generators (HWGs) through the Manual and Online Manifest System Registration, while there is a total of 241 HWGs in 2019 (Davao SOBER, 2018 and 2019). On Treatment, Storage and Disposal (TSD) facilities, the region registered eleven (11) in 2018, while thirteen (13) in 2019 (Davao SOBER, 2018 and 2019).

Other efforts implemented by the region is the continuous increase of the issuance of chemical control order registration certificates, conduct of seminars, and issuance of Cease-and-Desist Orders or total stoppage of mineral processing plants using mercury and sodium cyanide (Davao SOBER, 2018 and 2019). Six (6) seminars for Hazardous Waste Transporters were conducted in 2018 (Davao SOBER, 2018), while four (4) seminars were held in 2019 to train drivers and helpers during transportation and storage of hazardous wastes (Davao SOBER, 2019).

In terms of other indicators for SDG 12, 36 Ten-Year Solid Waste Management (SWM) Plans were approved out of 49 LGUs in 2018, with 13 still awaiting update prior to NSWMC-Executive Committee consideration. The approval of these SWM Plans by the NSWMC was included in 2019. There were also two (2) workshops to update and finish LGUs' ten-year SWM Plans that had not yet been authorized for consideration in 2019. By the conclusion of fiscal year 2019, thirty-seven (37) of Region XI's fifty-four (54) LGUs have an authorized SWM Plan (Davao SOBER, 2018 and 2019). Other initiatives included the safe closure and rehabilitation of illegal dumpsites to mitigate the negative impacts they may cause, funding for the establishment of Materials Recovery Facilities (MRF) and the procurement/fabrication of solid waste management equipment, and the operationalization of the Davao Regional Ecology Center. Enforcement and education program for solid waste (Davao SOBER, 2018 and 2019).

Although the region has been working to improve the hazardous waste management, challenges remain on on-site storage of busted bulbs by commercial establishments, accumulation of impregnated polybags generated from banana plantations, and the absence of accredited local treater for vegetable oil and healthcare wastes (Davao SOBER, 2018).

The Davao Region shows that, although the region has been improving in its overall score, it is still important to examine the performance of specific sectors that can affect environmental sustainability (e.g., SDG 11 was improving, but SDG 6 was declining). And lastly, as the regions in the study demonstrated, specific regional priorities and efforts are important, along with the natural characteristics of the region.

4.3 What does environmental sustainability contribute to the region’s resilience to natural disasters?

Although the focus of this study is to establish an ESI to measure the level of performance of the regions in the Philippines towards sustainability, and that examining the relationship of environmental sustainability with resilience and vulnerability is not the focus of our study, we have included an attempt to illustrate the importance of environmental sustainability to contribute to the area's resilience to natural hazards, or at least on how it can reduce the area's vulnerability to climate risks.

Some studies have recognized the complementation and/or integration of vulnerability and resilience to environmental sustainability, describing that the field of vulnerability focuses on the most susceptible factors during disturbances, while resilience is directed to increasing the robustness of the subjects during disturbances in the human-environmental relationships of sustainability (Turner II, 2010). In terms of sustainability, the Philippines, with the score of 28.9 out of 100, ranked 158 out of 180 countries in the Environmental Performance Index 2022, assessing the country's strategies on environmental health, ecosystem protection, and climate change mitigation (BusinessWorld, 2022).

On the other hand, due to its geographical location and topography, the Philippines is prone to natural disasters. The Global Climate Risk Index 2021, which reflects the impacts of extreme weather events and the corresponding socio-economic data of the countries in the world, ranked the Philippines as the 17th most affected country in the world in terms of extreme weather events (Philippine House of Representatives, 2021). It was also reported that the Philippines is the 7th place in economic losses due to climate-related events (i.e.., USD 4.5 billion in 2018), 14th in the number of deaths per 100,000 inhabitants, and the 4th most affected country in the world, with an average economic loss of USD3.2 billion per year in a 20-year perspective (Philippine House of Representatives, 2021).

In this section of the study, we will attempt to examine whether higher environmental sustainability can increase the resilience of the regions against its vulnerability to natural hazards, and we will use Cagayan Valley as a case as we have already established its geographic and topographic characteristics.

Cagayan Valley is highly vulnerable to cyclones, floods due to heavy rainfall, and other hazards in coastal areas (Think Hazard, n.d.). In 2020, the Philippines was hit by Typhoon Ulysses (international name Vamco), which resulted to 3.67 million affected people by the floods, about 277,000 people displaced and at least 73 deaths according to the United Nations Office for the Coordination of Humanitarian Affairs (Macaraeg, 2020). Cagayan Valley was one of the regions that was hit the hardest, which affected around 294,987 individuals, around 5,000 homes were submerged under water, and deaths because of landslide, drowning, and electrocution (Antonio, 2020; CARE, 2020). It was said that the region faced a 100-year-old flood, which has 1% probability to happen in each year (Antonio, 2020).

Reports suggest that the flooding was the result of several factors such as the high-inflows and overflows of the Magat Dam in the region due to the four successive typhoons that hit the country within the quarter, saturated mountain ranges due to continuous rainfall, and the region is also the catch basin of rainwater in the Cagayan River Basin (Macaraeg, 2020).

One of the submerged municipalities is the Municipality of Alcala, which is located where "80% of water run-off in the Cagayan River Basin" (Antonio, 2020). Due to the flooding and riverbank erosion, the Mayor of Alcala sought help from one of the country's top river and marine geologists. The result of the study suggests multiple factors such as the lack of trees that regulate water and hold the soil due to man-made activities (e.g., illegal logging) and unsustainable agricultural practices such as yellow corn farming and herbicides weaken the soil (Antonio, 2020). Upon learning this, the local government of Alcala has put efforts in tree planting and agroforestry, but the widening of the river channel remains a challenge (Antonio, 2020). The local government further emphasized the need to follow science- and evidence-based solutions on more environmentally sustainable practices.

Meanwhile, as we have seen in the case of Cagayan Valley, its natural resources play a significant part in getting high environmental sustainability scores. The USAID has recognized the significance of the Philippines' natural resources in flood control, storm mitigation, and other environmental services (USAID Website, 2022). A study shows that the Sierra Madre Mountain Range acts as the natural barrier of Luzon and has the capacity to affect the shifts in rainfall and precipitation in the mountains, influence the changes of windward and leeward sides, and can also slow down the movement of tropical cyclones in varying degrees depending on the topography (Racoma, et. al, 2016).

Recently, the mountain range as a natural barrier against typhoons was further highlighted when areas were placed under signal no. 4 out of 5 (strongest level of Philippine typhoon signals) as announced by Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) during Typhoon Karding (international name Noru), but it reportedly weakened when it passed through the Sierra Madre mountains (Ragasa, 2022). This further pressed the lawmakers to push for the protection and reforestation of the mountain range, fight against illegal logging and illegal construction of infrastructures in the mountains, and sustainably utilize its resources (Ragasa, 2022; Crisostomo, 2022). This further suggests that pushing for environmental sustainability could protect the communities against the effects of climate risks, thus decreasing its vulnerability and increasing its resilience.

This section demonstrated that unsustainable practices could increase the vulnerability of a region to natural hazards, while efforts towards environmental sustainability such as preservation and conservation of natural resources can increase the resilience of the regions against climate risks. Thus, it is important to integrate environmentally sustainable practices in the regional programs and projects.

Chapter 5: Conclusion and Recommendations

This chapter will present the conclusion, policy recommendations, recommendations for future studies, and the limitations of our study.

5.1. Conclusion

This study aims to answer the following questions: (1) What are the trends and status of environmental sustainability of the regions in the Philippines using the SDG pillars and indicators related to the environment in the period of 2016 to 2019? and (2) What are characteristics and existing strategies of the highest and lowest scoring regions that can relate to environmental sustainability?

To answer these questions, the study adopted the methodology of previous studies which is to build an ESI using environmental-related SDG pillars as indicators and included variables that can influence regional environmental sustainability such as the study of Wang, et. al (2021). The ESI was used to measure the level of environmental sustainability performance of the 16 regions in the Philippines. The data was collected through the Philippine Government, which was organized based on its relationship with environmental sustainability, timeliness, and completeness.

The regional scores reflected the varying performances of regions in different areas of SDGs related to environmental sustainability which are not specifically presented in the national reports such as the SDR. It is important to examine the performance of each region in the different areas to monitor the regions' contributions in the achievement of national goals, and to understand the areas wherein regions are performing well or areas wherein regions are lacking. The trend of the scores of the regions also show the changes of the performance of the regions towards the national goals such as environmental sustainability. However, although the data used in the study were from the Philippine government, the consistency and reliability of the data are crucial factors in successfully measuring the performance of the environmental sustainability of the regions. Thus, the Philippine government should review the quality of data available, as well as provide a uniform standard on the collection, reporting, and monitoring of the data of the indicators related to environmental sustainability.

The study shows that measuring the level of performance of the regions towards environmental sustainability using an ESI built on SDG pillars is a step forward towards understanding the differences of the regions when it comes to environmental sustainability. Studies on measuring regional environmental sustainability in the Philippines are still lacking, if not absent in the research sector. The index of this research can serve as a baseline for future studies in measuring environmental sustainability. Since the SDGs served as a “blueprint” towards sustainability (Jiang, et. al., 2022), the study used the environment-related SDG pillars since several countries, including the Philippines, focus their priorities and strategies in attaining the SDG. It would be more efficient to align the index to the SDG instead of creating a new set of index and indicators.

The use of ESI to measure environmental sustainability shows that it can provide reliable and easy-to-understand information that can be used for more evidenced-based decision-making, to strengthen the independence of the regions in attaining environmental sustainability, and more efficient policy formulation.

Moreover, understanding the characteristics and existing strategies of the regions shows that different factors can affect environmental sustainability such as water quality, air quality, terrestrial ecosystems, protected areas, geographical characteristics, regional policies and priorities, and others. This highlights the differences of the regions that should be considered when it comes to achieving national goals. It is important to identify the factors affecting this performance for a better, evidence-based, and well-informed decision-making of our policymakers.

As the study demonstrated in the environmental commitments of Region XIII – Caraga and Region II - Cagayan Valley, policies and strategies are important in achieving environmental sustainability. Policymakers have the capacity to influence the direction of the government priorities, specifically towards environmental policy (Cocklin, 2009). However, it may also be noted that policymakers are not the only ones responsible in contributing to environmental sustainability, but the efforts of the civil society, communities, and non-government organizations (Cocklin & Moon, 2020) and the integration of environmentally sustainable practices (Benson & Jordan, 2015) are important to move towards the desired sustainable environment. Meanwhile, the regional characteristics of the lowest scoring regions, namely NCR and Region VI – Western Visayas, that aside from geographical factors, social and economic activities can contribute to environmental sustainability, vice versa environmental degradation.

However, it should be noted that the study had several limitations such as data availability and time period of study. Since the study was conducted by a single researcher, manpower and expertise may have also limited the study in dwelling deeper in the different areas involved related to environmental sustainability. The availability and completeness of reports from the national and sub-national government agencies also affected the analysis of the study.

Although this study has several rooms for improvement, it can conclude that it can measure the level of performance of the regions towards environmental sustainability using an ESI built on environmental-related SDG pillars. Further, the study can also examine the regional characteristics that can affect their level of performance by examining the scores of the regions from the index.

5.2. Policy Recommendations

The conduct of the study showed some strengths and weaknesses of evaluating the regional environmental sustainability performance, and even determined several opportunities and rooms of improvement for the Philippine government in achieving both environmental sustainability and the SDG.

First, it calls for a comprehensive database that is fully accessible and easy to understand. Data availability, along with reliable and complete data, is vital in measuring the performance of the country and the regions. Although the PSA has an accessible database for the Philippine SDGs, it did not cover the data for some indicators in the SDGs, such as SDG 13 and 14, even though these indicators are present for both the globally and locally identified SDG indicators, thus were omitted in the study. It may also be recommended to include energy and GHG emissions as indicators to attain better environmental sustainability.

Second, it would be beneficial for the Philippine government to establish an index similar to the ESI index of the study. The Philippine government has already developed its indicators for the SDGs; however, it would be helpful if the Philippine government can review these indicators to further ensure consistency (e.g., consistency of the indicators in the list of consolidated baselines and the metadata). It has already been established multiple times the Philippine environmental vulnerability, and the importance of decentralization from the national government to the sub-national government. Our index reflected the performance of the regions, whether it is lagging or advancing, thus priorities and strategies can be better formulated.

Third, in relation to our previous recommendation, the national and sub-national government of the Philippines must complement its efforts towards environmental sustainability. It would be beneficial to examine the end results and long-term effects of the programs and projects for more effective and efficient use of fiscal instruments.

Fourth, the regions should strictly comply with the recommended frequency of sampling, monitoring, and reporting with regards to the indicators of the SDGs. This implies that the factors that may affect the implementation of each indicator must be considered.

Fifth, the coordination of Philippine agencies, such as the NEDA, DENR, and PSA, is needed to resolve issues on lacking and missing data because of technological necessities, absence of monitoring stations for some regions, and the definition of the data on some indicators (i.e., clarification on why treated hazardous waste is higher than generated hazardous waste). It would also be beneficial if the national government coordinated with the sub-national governments on proper and efficient ways of reporting accurate and complete data.

Lastly, the presentation and discussion of the characteristics and interventions of the regions illustrated by Regions XIII, II, VI, IX, XI, and NCR showed that the regions have varying differences and priorities. These differences and priorities must not hinder the attainment of environmental sustainability; however, these factors should be considered in assessing the needs of the regions to attain environmental sustainability. The national agencies must oversee and ensure that the challenges reported by the regions are being properly resolved by providing technical assistance and/or budgetary support.

5.3. Recommendations for Future Studies

Since there is the lack of a preceding study on the level of performance of the Philippine regions towards environmental sustainability using an ESI, there are several rooms for improvement that future studies can dwell in.

First, future studies can expand the index used in this study either by using SDG pillars related to the environment or incorporating other indicators from other indices. As previously mentioned, the index in this study can serve as a baseline for future studies given that this study has many limitations including time and data availability.

Second, future studies can also examine other perspectives of the regional characteristics not included in this study. The environment sector has multiple and wide-ranging variables that can influence its performance; thus, it is recommended to look further for more comprehensive research.

Third, future studies can focus on the time series analysis of each indicator in each region by including longer period (e.g., 10 years), or to focus on one region for one index to be able to have a more in-depth analysis for each indicator or SDG pillar (e.g., analysis of one indicator in one region). Time-series analysis of the country level performance on SDG pillars related to environmental sustainability is also recommended.

And lastly, this study has focused on the use of ESI in measuring the environmental sustainability of regions in the Philippines. Future studies can use other methods in measuring regional environmental sustainability either by applying it in the Philippines or other countries.

5.4. Limitations of the Study

The following factors are possible limitations that may have affected the study:

1. The geographical conditions may affect the data collection of the study. Although there are already available data online, some of the data should be requested from the Philippine Government Offices, and since the author is currently located in Seoul, South Korea, the data will only be requested through online correspondence (e.g., e-mails).
2. The situation of the pandemic in the Philippines may affect the data collection because the Philippine Government still implements limited onsite workforce.
3. Time may limit the processing and analysis of the data. It will depend on how fast the author could acquire the data needed to process and analyze the results.
4. Missing and/or incomplete data and reports hindered the analysis of study.
5. Manpower and expertise may also be a limitation given that the study was conducted by a single author in a limited time period.

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DATA SOURCES

	Indicator	Data Source*
SDG 6: Clean Water and Sanitation	Population using at least basic drinking water services	Philippine Statistics Authority (PSA)
	Population using at least basic sanitation services	Department of Health (DOH)
	Bodies of water with good ambient water quality: Dissolved Oxygen	Department of Environment and Natural Resources - Environmental Management Bureau (DENR-EMB)
	Bodies of water with good ambient water quality: Biochemical Oxygen Demand (BOD)	DENR-EMB
SDG 11: Sustainable Cities and Communities	Annual mean concentration of particulate matter of less than 2.5 of diameter	DENR-EMB
	Improved water source, piped	DOH

	Proportion of urban population living in slums, informal settlements or inadequate housing	PSA
	Proportion of local governments that adopt and implement local disaster risk reduction strategies in line with national disaster risk reduction strategies	National Disaster Risk Reduction and Management Council (NDRRMC), Office of Civil Defense (OCD)
SDG 12: Responsible Consumption and Production	Solid Waste	DENR-EMB
	Hazardous waste generated	DENR-EMB
	Proportion of hazardous waste treated, by type of treatment	DENR-EMB
	Production-based SO2 emissions	DENR-EMB
	NO footprint	DENR-EMB
SDG 15: Life on Land	Protected area in terrestrial sites important to biodiversity	DENR-BMB
	Protected area in freshwater sites important to biodoversity	DENR-BMB
	Permanent Deforestation	National Mapping and Resource Information Authority (NMRIA)
	Forest area as a proportion of total land area	NMRIA

*All data are gathered from the Environmental Accounts through the Philippine Statistics Authority (PSA).
The sources indicated in the next column are the original sources of the data (source of PSA data).

Compendium of Philippine Environment Statistics Component 1: Environmental Conditions and Quality - https://psa.gov.ph/content/compendium-philippine-environment-statistics-component-1-environmental-conditions-and

Compendium of Philippine Environment Statistics Component 2: Environmental Resources and their Use - https://psa.gov.ph/content/compendium-philippine-environment-statistics-component-2-environmental-resources-and-their

Compendium of Philippine Environment Statistics Component 3: Residuals - https://psa.gov.ph/content/compendium-philippine-environment-statistics-component-3-residuals

Compendium of Philippine Environment Statistics Component 5: Human Settlements and Environmental Health - https://psa.gov.ph/content/compendium-

philippine-environment-statistics-component-5-human-settlements-and-environmental

Component 6 of the Compendium of Philippine Environment Statistics - https://psa.gov.ph/content/component-6-compendium-philippine-environment-statistics

Damages Due to Natural Extreme Events and Disasters Amounted to PhP 463 Billion - https://psa.gov.ph/content/damages-due-natural-extreme-events-and-disasters-amounted-php-463-billion

Appendices

Appendix 1: Request Letter to NEDA

December 27, 2021
SECRETARY KARL KENDRICK T. CHUA
National Economic and Development Authority
12 St. J. Escriva Drive, Ortigas Center
Pasig City

Dear Secretary Chua:

I am Guia Theresa Eguia, a master's degree student from the Graduate School of Environmental Studies in Seoul National University, majoring in Environmental Management. I am writing to request assistance on the provision of data to conduct my thesis entitled ***Examining Environmental Sustainability with Spatio-Temporal Variation Assessment: A Regional Study in the Philippines.***

This study intends to conduct a spatio-temporal assessment using an environmental sustainability index (ESI) to measure the environmental sustainability of the regions in the Philippines. It will build upon the pillars of the Sustainable Development Goals (SDG) related to the environment (i.e., SDG 6, 11, 12, 13, 14, and 15). Specifically, this study aims the following: (1) reflect the environmental sustainability at regional level in the Philippines by using ESI; (2) examine and project the trends of regional environmental sustainability in the Philippines; and (3) identify the factors that influence regional environmental sustainability. This study aims to highlight the importance of regional strategies in achieving environmental sustainability.

As the country's socioeconomic planning and monitoring body, with specific focus on Ambisyon 2040 and the Philippines SDGs, may I respectfully request the regional data related to the following SDG pillars that will be used for research purposes only:

	Indicator (by region, 2014-2019)
SDG 6: Clean Water and Sanitation	Freshwater withdrawal (% of freshwater resources)
	Wastewater that receives treatment
	Scarce water consumption embodied in imports
SDG 11: Sustainable Cities and Communities	Improved water source, piped
SDG 12: Responsible Consumption and Production	SO2 emissions embodied in imports
	Net imported emissions of reactive nitrogen

SDG 13: Climate Action	Energy-related CO2 emissions per capita
	Imported CO2 emissions, technology-adjusted
	People affected by climate-related disasters
	CO2 emissions embodied in fossil fuel exports
SDG 14: Life Below Water	Mean area that is protected in marine sites important to biodiversity
	Fish caught by trawling
SDG 15: Life on Land	Mean area that is protected in terrestrial sites important to biodiversity
	Mean area that is protected in freshwater sites important to biodiversity
	Permanent Deforestation

Attached is a copy of my proposal for reference. This study is a partial requirement for my graduation; hence, I am really hoping for the assistance of the Agency for the required data.

Thank you very much and hoping for a positive response.

Respectfully yours,

Guia Theresa Eguia
Environmental Management
Graduate School of Environmental Studies
Seoul National University

Approved by:

Professor Hong Jong Ho
Adviser
Professor of Economics
Graduate School of Environmental Studies
Seoul National University
Chairman, Energy Transition Forum of Korea

Appendix 2: Request Letter to DENR

December 27, 2021

SECRETARY ROY A. CIMATU
Department of Environment and Natural Resources
Visayas Avenue, Diliman,
Quezon City, 1100

Dear Secretary Cimatu:

I am Guia Theresa Eguia, a master's degree student from the Graduate School of Environmental Studies in Seoul National University, majoring in Environmental Management. I am writing to request assistance on the provision of data to conduct my thesis entitled ***Examining Environmental Sustainability with Spatio-Temporal Variation Assessment: A Regional Study in the Philippines.***

This study intends to conduct a spatio-temporal assessment using an environmental sustainability index (ESI) to measure the environmental sustainability of the regions in the Philippines. It will build upon the pillars of the Sustainable Development Goals (SDG) related to the environment (i.e., SDG 6, 11, 12, 13, 14, and 15). Specifically, this study aims the following: (1) reflect the environmental sustainability at regional level in the Philippines by using ESI; (2) examine and project the trends of regional environmental sustainability in the Philippines; and (3) identify the factors that influence regional environmental sustainability. This study aims to highlight the importance of regional strategies in achieving environmental sustainability.

As the agency responsible for the conservation, management, development, and proper use of the country's environment and natural resources, may I respectfully request the regional data related to the following SDG pillars that will be used for research purposes only:

	Indicator (by region, 2014-2019)
SDG 6: Clean Water and Sanitation	Freshwater withdrawal (% of freshwater resources)
	Wastewater that receives treatment
	Scarce water consumption embodied in imports
SDG 11: Sustainable Cities and Communities	Improved water source, piped
SDG 12: Responsible Consumption and Production	SO_2 emissions embodied in imports
	Net imported emissions of reactive nitrogen
SDG 13: Climate Action	Energy-related CO_2 emissions per capita
	Imported CO_2 emissions, technology-adjusted

	People affected by climate-related disasters
	CO_2 emissions embodied in fossil fuel exports
SDG 14: Life Below Water	Mean area that is protected in marine sites important to biodiversity
	Fish caught by trawling
SDG 15: Life on Land	Mean area that is protected in terrestrial sites important to biodiversity
	Mean area that is protected in freshwater sites important to biodiversity
	Permanent Deforestation

Attached is a copy of my proposal for reference. This study is a partial requirement for my graduation; hence, I am really hoping for the assistance of the Department for the required data.

Thank you very much and hoping for a positive response.

Respectfully yours,

Guia Theresa Eguia
Environmental Management
Graduate School of Environmental Studies
Seoul National University

Approved by:

Professor Hong, Jong Ho
Thesis Advisor
Professor of Economics
Graduate School of Environmental Studies
Seoul National University
Chairman, Energy Transition Forum of Korea

Appendix 3: Request Letter to PSA

December 28, 2021

PHILIPPINE STATISTICS AUTHORITY
PSA Complex, East Avenue
Diliman, Quezon City

Dear Sir/Madam:

I am Guia Theresa Eguia, a master's degree student from the Graduate School of Environmental Studies in Seoul National University, majoring in Environmental Management. I am writing to request assistance on the provision of data to conduct my thesis entitled ***Examining Environmental Sustainability with Spatio-Temporal Variation Assessment: A Regional Study in the Philippines.***

This study intends to conduct a spatio-temporal assessment using an environmental sustainability index (ESI) to measure the environmental sustainability of the regions in the Philippines. It will build upon the pillars of the Sustainable Development Goals (SDG) related to the environment (i.e., SDG 6, 11, 12, 13, 14, and 15). Specifically, this study aims the following: (1) reflect the environmental sustainability at regional level in the Philippines by using ESI; (2) examine and project the trends of regional environmental sustainability in the Philippines; and (3) identify the factors that influence regional environmental sustainability. This study aims to highlight the importance of regional strategies in achieving environmental sustainability.

As the central statistical authority of the Philippine government on primary data collection, may I respectfully request the regional data related to the following SDG pillars that will be used for research purposes only:

	Indicator (by region, 2014-2019)
SDG 6: Clean Water and Sanitation	Freshwater withdrawal (% of freshwater resources)
	Wastewater that receives treatment
	Scarce water consumption embodied in imports
SDG 11: Sustainable Cities and Communities	Improved water source, piped
SDG 12: Responsible Consumption and Production	SO2 emissions embodied in imports
	Net imported emissions of reactive nitrogen
SDG 13: Climate Action	Energy-related CO2 emissions per capita
	Imported CO2 emissions, technology-adjusted
	People affected by climate-related disasters
	CO2 emissions embodied in fossil fuel

	exports
SDG 14: Life Below Water	Mean area that is protected in marine sites important to biodiversity
	Fish caught by trawling
SDG 15: Life on Land	Mean area that is protected in terrestrial sites important to biodiversity
	Mean area that is protected in freshwater sites important to biodiversity
	Permanent Deforestation

Attached is a copy of my proposal for reference. This study is a partial requirement for my graduation; hence, I am really hoping for the assistance of the Department for the required data.

Thank you very much and hoping for a positive response.

Respectfully yours,

Guia Theresa Eguia
Environmental Management
Graduate School of Environmental Studies
Seoul National University

Approved by:

Professor Hong, Jong Ho
Thesis Advisor
Professor of Economics
Graduate School of Environmental Studies
Seoul National University
Chairman, Energy Transition Forum of Korea

Appendix 4: Request Letter to CCC

January 11, 2021

VICE CHAIRPERSON RACHEL ANNE HERRERA
Climate Change Commission
6th Floor, First Residences Building, 1557 J.P. Laurel Street,
Malacañang Complex, San Miguel, Manila

COMMISSIONER EMMANUEL DE GUZMAN
Climate Change Commission
6th Floor, First Residences Building, 1557 J.P. Laurel Street,
Malacañang Complex, San Miguel, Manila

Dear Vice Chairperson Herrera and Commissioner De Guzman:

I am Guia Theresa Eguia, a master's degree student from the Graduate School of Environmental Studies in Seoul National University, majoring in Environmental Management. I am writing to request assistance on the provision of data to conduct my thesis entitled ***Examining Environmental Sustainability with Spatio-Temporal Variation Assessment: A Regional Study in the Philippines.***

This study intends to conduct a spatio-temporal assessment using an environmental sustainability index (ESI) to measure the environmental sustainability of the regions in the Philippines. It will build upon the pillars of the Sustainable Development Goals (SDG) related to the environment (i.e., SDG 6, 11, 12, 13, 14, and 15). Specifically, this study aims the following: (1) reflect the environmental sustainability at regional level in the Philippines by using ESI; (2) examine and project the trends of regional environmental sustainability in the Philippines; and (3) identify the factors that influence regional environmental sustainability. This study aims to highlight the importance of regional strategies in achieving environmental sustainability.

As the country's lead in the development and mainstreaming of evidence-based climate adaptation and mitigation, may I respectfully request the regional data related to the following SDG pillars that will be used for research purposes only:

	Indicator (by region, 2014-2019)
SDG 13: Climate Action	Energy-related CO2 emissions per capita
	Imported CO2 emissions, technology-adjusted
	People affected by climate-related disasters
	CO2 emissions embodied in fossil fuel exports

Attached is a copy of my proposal for reference. This study is a partial requirement for my graduation; hence, I am really hoping for the assistance of the Agency for the required data.

Thank you very much and hoping for a positive response.

Respectfully yours,

Guia Theresa Eguia
Environmental Management
Graduate School of Environmental Studies
Seoul National University

Approved by:

Professor Hong Jong Ho
Adviser
Professor of Economics
Graduate School of Environmental Studies
Seoul National University
Chairman, Energy Transition Forum of Korea

Appendix 5: 2016 Normalized Data

	6.10	6.20	6.30	6.40	11.10	11.20	11.30	11.40	12.10	12.20	12.30	12.40	12.50	15.10	15.20	15.30
NCR	93.40	89.99	0.00	0.00	0.00	93.22	24.06	52.90	84.72	92.26	15.36	78.86	62.80	4.18	5.02	24.16
CAR	64.45	82.30	68.17	14.23	52.36	51.99	41.67	94.00	98.49	98.57	83.11	89.69	77.65	28.49	31.04	81.29
I - Ilocos Region	96.02	94.13	14.29	76.43	51.05	35.91	41.67	44.80	95.53	99.89	100.00	95.60	87.29	3.10	17.30	36.85
II - Cagayan Valley	84.46	88.77	43.71	93.81	25.24	30.23	51.67	100.00	97.02	100.00	100.00	89.69	77.65	12.18	46.98	63.80
III - Central Luzon	95.13	89.70	0.00	0.00	68.06	61.74	72.08	59.00	88.63	57.84	0.00	93.08	77.79	15.12	44.12	43.89
IV-A - CALABARZON	104.73	93.27	7.18	67.24	37.25	84.59	50.00	99.80	84.72	92.02	46.86	94.34	84.92	5.81	46.54	35.18
IV-B MIMAROPA	91.33	78.78	8.01	54.29	57.59	42.21	66.67	82.00	97.38	99.78	0.00	89.69	77.65	0.32	18.84	63.63
V - Bicol Region	83.55	72.54	25.29	53.33	68.69	58.38	54.65	91.00	95.00	98.21	1.92	95.60	87.29	5.60	32.88	30.69
VI - Western Visayas	86.24	81.64	12.77	73.96	20.94	47.55	44.92	25.10	92.80	99.92	0.00	89.69	77.65	2.93	37.50	29.88
VII - Central Visayas	89.92	81.78	11.61	0.00	25.24	73.81	36.96	100.00	92.66	74.18	71.10	89.69	77.65	16.16	29.27	35.25
VIII - Eastern Visayas	88.17	76.94	28.57	42.86	25.24	65.33	0.00	100.00	96.36	98.60	6.29	89.69	77.65	1.43	14.99	52.18
IX - Zamboanga Peninsula	73.78	68.02	23.29	74.02	63.30	55.62	41.00	100.00	96.61	98.44	1.67	96.86	87.29	0.78	31.61	53.86
X - Northern Mindanao	93.17	82.60	33.26	86.01	0.00	77.00	16.67	100.00	95.38	100.00	100.00	89.69	77.65	21.66	48.18	52.32
XI - Davao Region	93.33	85.51	30.59	99.07	0.00	67.16	14.78	100.00	94.57	99.70	39.26	94.34	84.92	0.40	38.77	62.50
XII - SOCCSKSARGEN	90.22	80.10	29.66	95.64	36.05	54.24	43.27	100.00	95.27	99.97	100.00	86.79	93.23	14.55	34.19	61.04
XIII - Caraga	92.96	85.07	27.68	100.00	52.36	68.38	61.67	74.40	97.56	90.62	100.00	95.60	84.92	4.34	21.11	71.09

Appendix 6: 2017 Normalized Data

	6.10	6.20	6.30	6.40	11.10	11.20	11.30	11.40	12.10	12.20	12.30	12.40	12.50	15.10	15.20	15.30
NCR	98.60	94.94	0.00	0.00	0.00	98.51	11.67	52.90	84.75	97.73	37.11	86.14	75.65	4.18	5.02	24.16
CAR	73.30	85.76	68.57	0.00	52.36	57.11	0.83	94.00	98.50	90.72	9.09	89.84	82.22	28.49	31.04	81.29
I - Ilocos Region	96.84	93.85	10.00	70.00	27.49	38.06	49.00	44.80	95.57	99.79	92.51	90.57	84.65	3.10	17.30	36.85
II - Cagayan Valley	86.24	88.62	41.43	96.11	20.94	31.84	68.33	100.00	97.04	99.99	100.00	89.84	82.22	12.18	46.98	63.80
III - Central Luzon	91.49	92.38	0.00	0.00	60.21	67.55	38.33	59.00	88.61	88.26	0.00	92.04	79.03	15.12	44.12	43.89
IV-A - CALABARZON	95.97	92.31	10.00	0.00	0.00	81.15	50.00	99.80	84.56	86.75	19.98	86.79	70.10	5.81	46.54	35.18
IV-B MIMAROPA	88.88	79.13	0.00	0.00	20.94	43.28	63.33	82.00	97.38	99.97	0.00	89.84	82.22	0.32	18.84	63.63
V - Bicol Region	85.96	76.60	18.57	47.26	52.36	58.20	50.00	91.00	95.03	98.89	2.20	95.60	87.29	5.60	32.88	30.69
VI - Western Visayas	89.86	83.90	14.29	70.95	2.62	49.02	46.67	25.10	92.85	99.83	0.00	89.84	82.22	3.45	37.50	29.88
VII - Central Visayas	91.04	80.03	30.00	69.97	20.94	74.94	25.00	100.00	92.67	99.14	100.00	89.84	82.22	15.44	29.27	35.25
VIII - Eastern Visayas	85.03	79.22	47.14	26.43	20.94	63.42	10.00	100.00	96.37	98.85	5.44	89.84	82.22	1.43	14.99	52.18
IX - Zamboanga Peninsula	91.43	83.48	31.43	87.39	91.62	71.78	38.33	100.00	96.61	99.84	11.44	95.60	100.36	0.78	31.61	53.86
X - Northern Mindanao	93.26	84.49	28.57	95.70	20.94	78.03	16.67	100.00	95.38	99.54	0.00	89.84	82.22	21.66	48.18	52.32
XI - Davao Region	92.46	85.52	28.57	94.02	15.71	67.08	18.33	100.00	94.57	41.38	0.14	74.21	82.54	0.40	38.77	62.50
XII - SOCCSKSARGEN	87.26	83.29	32.86	92.46	41.88	48.93	58.97	100.00	95.26	99.93	100.00	90.57	93.23	14.55	34.19	61.04
XIII - Caraga	91.04	83.99	32.86	100.00	62.83	71.21	64.17	74.40	97.58	99.38	100.00	95.60	84.92	4.34	21.11	71.09

Appendix 7: 2018 Normalized Data

	6.10	6.20	6.30	6.40	11.10	11.20	11.30	11.40	12.10	12.20	12.30	12.40	12.50	15.10	15.20	15.30
NCR	75.58	93.12	0.00	0.00	26.18	98.39	21.67	76.50	83.76	96.08	73.66	86.14	75.64	4.18	5.02	24.16
CAR	80.97	88.65	91.43	6.43	47.12	44.84	21.67	97.50	98.52	62.72	100.00	91.51	83.62	26.01	31.04	81.29
I - Ilocos Region	93.00	93.72	20.00	76.43	40.58	38.76	53.75	100.00	95.66	99.51	100.00	89.31	89.07	3.10	17.30	36.85
II - Cagayan Valley	90.93	90.27	52.86	96.43	31.41	32.85	68.33	100.00	97.10	99.98	3.91	91.51	83.62	20.78	46.98	63.80
III - Central Luzon	72.87	91.84	0.00	0.00	-8.73	68.68	51.67	99.30	88.73	66.55	20.67	93.50	78.18	15.12	44.12	43.89
IV-A - CALABARZON	62.00	88.41	10.00	0.00	36.65	78.29	61.67	100.00	84.60	89.29	100.00	91.82	77.79	15.32	46.54	35.18
IV-B MIMAROPA	33.78	80.82	0.00	0.00	5.24	47.65	80.00	100.00	97.42	99.97	39.13	91.51	83.62	0.32	18.84	63.63
V - Bicol Region	55.01	77.66	17.14	48.57	62.83	61.89	45.00	93.30	95.12	99.95	100.00	88.05	88.48	5.60	32.88	30.69
VI - Western Visayas	90.40	85.05	14.29	70.71	0.00	51.04	10.00	20.20	92.99	99.62	80.49	91.51	83.62	3.45	37.50	29.88
VII - Central Visayas	85.17	70.31	2.86	0.00	31.41	66.52	35.00	87.50	92.77	94.85	15.04	91.51	83.62	15.44	29.27	35.25
VIII - Eastern Visayas	66.68	81.72	44.29	92.86	31.41	61.83	25.00	59.50	96.44	98.90	0.57	91.51	83.62	1.43	14.99	52.18
IX - Zamboanga Peninsula	90.02	78.28	50.00	88.57	81.15	70.71	33.33	45.30	96.66	99.79	16.26	93.08	87.52	0.78	31.61	53.86
X - Northern Mindanao	89.60	88.16	27.14	78.57	31.41	76.70	5.00	85.70	95.44	98.56	100.00	91.51	83.62	21.66	48.18	52.32
XI - Davao Region	70.23	87.34	30.00	95.00	15.71	69.09	26.67	100.00	94.64	98.31	2.91	74.43	82.54	0.40	38.77	62.50
XII - SOCCSKSARGEN	86.42	79.43	40.00	95.00	41.88	54.45	30.00	100.00	95.32	99.83	42.78	90.54	93.27	15.08	34.19	61.04
XIII - Caraga	81.72	87.91	34.29	100.00	83.77	73.02	64.44	76.90	97.62	96.10	97.10	96.14	86.10	4.34	21.11	71.09

Appendix 8: 2019 Normalized Data

	6.10	6.20	6.30	6.40	11.10	11.20	11.30	11.40	12.10	12.20	12.30	12.40	12.50	15.10	15.20	15.30
NCR	75.58	74.82	0.00	0.00	0.00	75.48	24.38	76.50	83.79	99.30	46.46	86.14	75.65	1.08	5.02	24.16
CAR	80.97	41.56	93.91	0.00	0.00	64.97	40.33	97.50	98.53	50.16	100.00	86.39	74.70	9.14	31.04	81.29
I - Ilocos Region	93.00	60.47	20.00	76.43	0.00	38.97	45.86	100.00	95.69	99.92	100.00	91.45	75.91	2.25	17.30	36.85
II - Cagayan Valley	90.93	80.84	34.29	93.57	4.66	35.30	51.67	100.00	97.11	99.98	100.00	86.39	74.70	37.18	46.98	63.80
III - Central Luzon	72.87	25.50	0.00	0.00	41.88	46.91	47.04	99.30	88.71	98.98	100.00	85.53	72.60	13.19	44.12	43.89
IV-A - CALABARZON	62.00	0.00	31.71	32.37	44.50	46.37	75.66	100.00	84.44	75.71	87.54	81.12	59.98	14.21	46.54	35.18
IV-B MIMAROPA	33.78	7.31	0.00	30.71	78.53	16.39	57.22	100.00	97.42	99.99	0.00	86.39	74.70	85.23	18.84	63.63
V - Bicol Region	55.01	26.46	7.71	10.27	2.62	42.81	52.88	93.30	95.15	99.78	11.87	86.79	78.98	28.94	32.88	30.69
VI - Western Visayas	90.40	47.05	4.50	0.00	4.66	50.66	5.83	20.20	93.04	99.94	31.42	86.39	74.70	10.42	37.50	29.88
VII - Central Visayas	85.17	2.26	0.00	0.00	4.66	70.27	20.83	87.50	92.78	96.03	16.64	86.39	74.70	42.84	29.27	35.25
VIII - Eastern Visayas	66.68	29.54	45.71	92.86	4.66	49.68	21.67	59.50	96.46	97.30	2.60	86.39	74.70	21.55	14.99	52.18
IX - Zamboanga Peninsula	24.88	2.00	31.07	69.30	63.98	22.24	58.67	45.30	96.67	99.97	22.11	93.08	87.29	20.88	31.61	53.86
X - Northern Mindanao	89.60	0.00	40.39	90.91	24.43	73.83	5.00	85.70	95.44	99.61	39.75	86.39	74.70	8.11	48.18	52.32
XI - Davao Region	70.23	58.64	33.20	96.04	18.32	55.56	49.45	100.00	94.64	86.56	66.99	88.05	89.67	5.80	38.77	62.50
XII - SOCCSKSARGEN	86.42	53.25	37.79	93.96	23.56	47.48	56.03	100.00	95.30	99.96	84.95	90.57	93.23	20.51	34.19	61.04
XIII - Caraga	81.72	47.35	43.36	100.00	41.88	66.43	35.56	76.90	97.63	96.80	100.00	95.60	86.10	22.00	21.11	71.09

Appendix 9: 2016 Weighted Scores and Total Scores

	6.10	6.20	6.30	6.40	11.10	11.20	11.30	11.40	12.10	12.20	12.30	12.40	12.50	15.10	15.20	15.30	Scores
NCR	5.84	5.62	0.00	0.00	0.00	5.83	1.50	3.31	4.24	4.61	0.77	3.94	3.14	0.35	0.42	2.01	41.58
CAR	4.03	5.14	4.26	0.89	3.27	3.25	2.60	5.88	4.92	4.93	4.16	4.48	3.88	2.37	2.59	6.77	63.43
I - Ilocos Region	6.00	5.88	0.89	4.78	3.19	2.24	2.60	2.80	4.78	4.99	5.00	4.78	4.36	0.26	1.44	3.07	57.08
II - Cagayan Valley	5.28	5.55	2.73	5.86	1.58	1.89	3.23	6.25	4.85	5.00	5.00	4.48	3.88	1.01	3.91	5.31	65.83
III - Central Luzon	5.95	5.61	0.00	0.00	4.25	3.86	4.51	3.69	4.43	2.89	0.00	4.65	3.89	1.26	3.68	3.66	52.32
IV-A - CALABARZON	6.55	5.83	0.45	4.20	2.33	5.29	3.13	6.24	4.24	4.60	2.34	4.72	4.25	0.48	3.88	2.93	61.44
IV-B MIMAROPA	5.71	4.92	0.50	3.39	3.60	2.64	4.17	5.13	4.87	4.99	0.00	4.48	3.88	0.03	1.57	5.30	55.18
V - Bicol Region	5.22	4.53	1.58	3.33	4.29	3.65	3.42	5.69	4.75	4.91	0.10	4.78	4.36	0.47	2.74	2.56	56.38
VI - Western Visayas	5.39	5.10	0.80	4.62	1.31	2.97	2.81	1.57	4.64	5.00	0.00	4.48	3.88	0.24	3.12	2.49	48.43
VII - Central Visayas	5.62	5.11	0.73	0.00	1.58	4.61	2.31	6.25	4.63	3.71	3.55	4.48	3.88	1.35	2.44	2.94	53.19
VIII - Eastern Visayas	5.51	4.81	1.79	2.68	1.58	4.08	0.00	6.25	4.82	4.93	0.31	4.48	3.88	0.12	1.25	4.35	50.84
IX - Zamboanga Peninsula	4.61	4.25	1.46	4.63	3.96	3.48	2.56	6.25	4.83	4.92	0.08	4.84	4.36	0.07	2.63	4.49	57.42
X - Northern Mindanao	5.82	5.16	2.08	5.38	0.00	4.81	1.04	6.25	4.77	5.00	5.00	4.48	3.88	1.80	4.01	4.36	63.86
XI - Davao Region	5.83	5.34	1.91	6.19	0.00	4.20	0.92	6.25	4.73	4.98	1.96	4.72	4.25	0.03	3.23	5.21	59.76
XII - SOCCSKSARGEN	5.64	5.01	1.85	5.98	2.25	3.39	2.70	6.25	4.76	5.00	5.00	4.34	4.66	1.21	2.85	5.08	65.98
XIII - Caraga	5.81	5.32	1.73	6.25	3.27	4.27	3.85	4.65	4.88	4.53	5.00	4.78	4.25	0.36	1.76	5.92	66.63

Appendix 10: 2017 Weighted Scores and Final Scores

	6.10	6.20	6.30	6.40	11.10	11.20	11.30	11.40	12.10	12.20	12.30	12.40	12.50	15.10	15.20	15.30	Scores
NCR	6.16	5.93	0.00	0.00	0.00	6.16	0.73	3.31	4.24	4.89	1.86	4.31	3.78	0.35	0.42	2.01	44.14
CAR	4.58	5.36	4.29	0.00	3.27	3.57	0.05	5.88	4.92	4.54	0.45	4.49	4.11	2.37	2.59	6.77	57.24
I - Ilocos Region	6.05	5.87	0.63	4.38	1.72	2.38	3.06	2.80	4.78	4.99	4.63	4.53	4.23	0.26	1.44	3.07	54.80
II - Cagayan Valley	5.39	5.54	2.59	6.01	1.31	1.99	4.27	6.25	4.85	5.00	5.00	4.49	4.11	1.01	3.91	5.31	67.04
III - Central Luzon	5.72	5.77	0.00	0.00	3.76	4.22	2.40	3.69	4.43	4.41	0.00	4.60	3.95	1.26	3.68	3.66	51.55
IV-A - CALABARZON	6.00	5.77	0.63	0.00	0.00	5.07	3.13	6.24	4.23	4.34	1.00	4.34	3.50	0.48	3.88	2.93	51.53
IV-B MIMAROPA	5.56	4.95	0.00	0.00	1.31	2.71	3.96	5.13	4.87	5.00	0.00	4.49	4.11	0.03	1.57	5.30	48.96
V - Bicol Region	5.37	4.79	1.16	2.95	3.27	3.64	3.13	5.69	4.75	4.94	0.11	4.78	4.36	0.47	2.74	2.56	54.71
VI - Western Visayas	5.62	5.24	0.89	4.43	0.28	3.06	2.92	1.57	4.64	4.99	0.00	4.49	4.11	0.29	3.12	2.49	48.15
VII - Central Visayas	5.69	5.00	1.88	4.37	1.31	4.68	1.56	6.25	4.63	4.96	5.00	4.49	4.11	1.29	2.44	2.94	60.60
VIII - Eastern Visayas	5.31	4.95	2.95	1.65	1.31	3.96	0.63	6.25	4.82	4.94	0.27	4.49	4.11	0.12	1.25	4.35	51.36
IX - Zamboanga Peninsula	5.71	5.22	1.96	5.46	5.73	4.49	2.40	6.25	4.83	4.99	0.57	4.78	5.02	0.07	2.63	4.49	64.59
X - Northern Mindanao	5.83	5.28	1.79	5.98	1.31	4.88	1.04	6.25	4.77	4.98	0.00	4.49	4.11	1.80	4.01	4.36	60.88
XI - Davao Region	5.78	5.35	1.79	5.88	0.98	4.19	1.15	6.25	4.73	2.07	0.01	3.71	4.13	0.03	3.23	5.21	54.47
XII - SOCCSKSARGEN	5.45	5.21	2.05	5.78	2.62	3.06	3.69	6.25	4.76	5.00	5.00	4.53	4.66	1.21	2.85	5.08	67.20
XIII - Caraga	5.69	5.25	2.05	6.25	3.93	4.45	4.01	4.65	4.88	4.97	5.00	4.78	4.25	0.36	1.76	5.92	68.20

Appendix 11: 2018 Weighted Scores and Final Scores

	6.10	6.20	6.30	6.40	11.10	11.20	11.30	11.40	12.10	12.20	12.30	12.40	12.50	15.10	15.20	15.30	Scores
NCR	4.72	5.82	0.00	0.00	1.64	6.15	1.35	4.78	4.19	4.80	3.68	4.31	3.78	0.35	0.42	2.01	48.01
CAR	5.06	5.54	5.71	0.40	2.95	2.80	1.35	6.09	4.93	3.14	5.00	4.58	4.18	2.17	2.59	6.77	63.25
I - Ilocos Region	5.81	5.86	1.25	4.78	2.54	2.42	3.36	6.25	4.78	4.98	5.00	4.47	4.45	0.26	1.44	3.07	60.71
II - Cagayan Valley	5.68	5.64	3.30	6.03	1.96	2.05	4.27	6.25	4.85	5.00	0.20	4.58	4.18	1.73	3.91	5.31	64.96
III - Central Luzon	4.55	5.74	0.00	0.00	-0.55	4.29	3.23	6.21	4.44	3.33	1.03	4.67	3.91	1.26	3.68	3.66	49.45
IV-A - CALABARZON	3.87	5.53	0.63	0.00	2.29	4.89	3.85	6.25	4.23	4.46	5.00	4.59	3.89	1.28	3.88	2.93	57.57
IV-B MIMAROPA	2.11	5.05	0.00	0.00	0.33	2.98	5.00	6.25	4.87	5.00	1.96	4.58	4.18	0.03	1.57	5.30	49.20
V - Bicol Region	3.44	4.85	1.07	3.04	3.93	3.87	2.81	5.83	4.76	5.00	5.00	4.40	4.42	0.47	2.74	2.56	58.18
VI - Western Visayas	5.65	5.32	0.89	4.42	0.00	3.19	0.63	1.26	4.65	4.98	4.02	4.58	4.18	0.29	3.12	2.49	49.67
VII - Central Visayas	5.32	4.39	0.18	0.00	1.96	4.16	2.19	5.47	4.64	4.74	0.75	4.58	4.18	1.29	2.44	2.94	49.22
VIII - Eastern Visayas	4.17	5.11	2.77	5.80	1.96	3.86	1.56	3.72	4.82	4.95	0.03	4.58	4.18	0.12	1.25	4.35	53.22
IX - Zamboanga Peninsula	5.63	4.89	3.13	5.54	5.07	4.42	2.08	2.83	4.83	4.99	0.81	4.65	4.38	0.07	2.63	4.49	60.44
X - Northern Mindanao	5.60	5.51	1.70	4.91	1.96	4.79	0.31	5.36	4.77	4.93	5.00	4.58	4.18	1.80	4.01	4.36	63.78
XI - Davao Region	4.39	5.46	1.88	5.94	0.98	4.32	1.67	6.25	4.73	4.92	0.15	3.72	4.13	0.03	3.23	5.21	56.99
XII - SOCCSKSARGEN	5.40	4.96	2.50	5.94	2.62	3.40	1.88	6.25	4.77	4.99	2.14	4.53	4.66	1.26	2.85	5.08	63.22
XIII - Caraga	5.11	5.49	2.14	6.25	5.24	4.56	4.03	4.81	4.88	4.81	4.86	4.81	4.31	0.36	1.76	5.92	69.32

Appendix 12: 2019 Weighted Scores and Final Scores

	6.10	6.20	6.30	6.40	11.10	11.20	11.30	11.40	12.10	12.20	12.30	12.40	12.50	15.10	15.20	15.30	Scores
NCR	4.72	4.68	0.00	0.00	0.00	4.72	1.52	4.78	4.19	4.97	2.32	4.31	3.78	0.09	0.42	2.01	42.50
CAR	5.06	2.60	5.87	0.00	0.00	4.06	2.52	6.09	4.93	2.51	5.00	4.32	3.74	0.76	2.58	6.75	56.77
I - Ilocos Region	5.81	3.78	1.25	4.78	0.00	2.44	2.87	6.25	4.78	5.00	5.00	4.57	3.80	0.19	1.44	3.06	55.00
II - Cagayan Valley	5.68	5.05	2.14	5.85	0.29	2.21	3.23	6.25	4.86	5.00	5.00	4.32	3.74	3.09	3.90	5.30	65.89
III - Central Luzon	4.55	1.59	0.00	0.00	2.62	2.93	2.94	6.21	4.44	4.95	5.00	4.28	3.63	1.10	3.66	3.64	51.54
IV-A - CALABARZON	3.87	0.00	1.98	2.02	2.78	2.90	4.73	6.25	4.22	3.79	4.38	4.06	3.00	1.18	3.86	2.92	51.94
IV-B MIMAROPA	2.11	0.46	0.00	1.92	4.91	1.02	3.58	6.25	4.87	5.00	0.00	4.32	3.74	7.07	1.56	5.28	52.09
V - Bicol Region	3.44	1.65	0.48	0.64	0.16	2.68	3.31	5.83	4.76	4.99	0.59	4.34	3.95	2.40	2.73	2.55	44.50
VI - Western Visayas	5.65	2.94	0.28	0.00	0.29	3.17	0.36	1.26	4.65	5.00	1.57	4.32	3.74	0.87	3.11	2.48	39.69
VII - Central Visayas	5.32	0.14	0.00	0.00	0.29	4.39	1.30	5.47	4.64	4.80	0.83	4.32	3.74	3.56	2.43	2.93	44.16
VIII - Eastern Visayas	4.17	1.85	2.86	5.80	0.29	3.11	1.35	3.72	4.82	4.87	0.13	4.32	3.74	1.79	1.24	4.33	48.38
IX - Zamboanga Peninsula	1.55	0.13	1.94	4.33	4.00	1.39	3.67	2.83	4.83	5.00	1.11	4.65	4.36	1.73	2.62	4.47	48.62
X - Northern Mindanao	5.60	0.00	2.52	5.68	1.53	4.61	0.31	5.36	4.77	4.98	1.99	4.32	3.74	0.67	4.00	4.34	54.43
XI - Davao Region	4.39	3.67	2.08	6.00	1.15	3.47	3.09	6.25	4.73	4.33	3.35	4.40	4.48	0.48	3.22	5.19	60.27
XII - SOCCSKSARGEN	5.40	3.33	2.36	5.87	1.47	2.97	3.50	6.25	4.77	5.00	4.25	4.53	4.66	1.70	2.84	5.07	63.96
XIII - Caraga	5.11	2.96	2.71	6.25	2.62	4.15	2.22	4.81	4.88	4.84	5.00	4.78	4.31	1.83	1.75	5.90	64.11

Abstract in Korean

필리핀 지역의 환경 지속가능성 동향과 특성에 대한 연구

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필리핀의 경제 및 사회 생산성에 대한 천연 자원의 중요성과 자연 재해에 대한 취약성을 고려할 때, 필리핀이 환경 지속 가능성을 향해 나아가는 것이 중요하다. 본 연구는 지역 차원의 환경 지속가능성 관련 지표 동향을 반영하고, 지역의 기존 특성과 전략을 살펴보는 것을 목적으로 한다. 2016년부터 2019년까지 필리핀 16개 지역의 성과를 조사하기 위한 지표로 환경 관련 지속가능개발목표(SDGs) 기둥을 사용하여 환경 지속가능성 지수(ESI)를 공식화하였다. 본 연구는 연도별 4개 지수를 설정한 후 지수수준, SDG 기둥수준, 지표수준의 추이와 최고점과 최저점 지역, 개선점과 하락점 지역의 대응특성을 분석하여 삼각측량을 적용하였다. 결과에 따르면 2016년부터 2019년까지 지수 점수와 평균을 기준으로 지역 13 – 카라가 및 지역 II – 카가얀 밸리가 가장 높은 점수를 기록했으며, 수도 지역(NCR)과 지역 6 – 웨스턴 비사야는 같은 기간에 가장 낮은 점수를 기록했다. 지역 XI – 다바오 지역과 지역 IX – 잠보앙가 반도와 같은 일부 지역은 연구 기간 동안 개선 및 감소 추세를 보였다. 연구 결과는 또한 지리적 특성, 지역 우선순위 및 개입, 모니터링 및 보고, 토지 관리 및 기타 요인이 지역

환경 지속 가능성에 기여한다는 것을 보여주었다. 전반적으로, 연구는 환경 지속가능성과 관련된 우선순위를 이행하는 지역의 다양한 경향과 환경 지속가능성에 영향을 미치는 지역적 특성의 차이를 보여주었다.

주제어: 환경 지속 가능성, 필리핀, 지역, 환경 지속 가능성 지수, 지속 가능한 개발 목표
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