AMERICAN JOURNAL OF ENVIRONMENT AND CLIMATE (AJEC)

ISSN: 2832-403X (ONLINE)

VOLUME 1 ISSUE 3 (2022)

PUBLISHED BY: E-PALLI, DELAWARE, USA

American Journal of Environment and Climate (AJEC)

Volume 1 Issue 3, Year 2022
ISSN: 2832-403X (Online)
DOI: https://doi.org/10.54536/ajec.v1i3.665
https://journals.e-palli.com/home/index.php/ajec

Entity-level Greenhouse Gas Emission of University of Science and Technology of Southern Philippines-Oroquieta

Mitchie Roa[1*]

Article Information

Received: October 12, 2022
Accepted: October 15, 2022
Published: October 17, 2022

Keywords

Carbon Dioxide Emission, Entity-Level Greenhouse Gas Emission, Greenhouse Gas Accounting

ABSTRACT

Presently, climate change is still one of the pressing environmental concerns in the world generally caused by greenhouse gas emission. Among the greenhouse gases emitted by various sources, carbon dioxide contributes largely to the emission. In this study, the entity-level greenhouse gas emission of the University of Science and Technology of Southern Philippines-Oroquieta for Year 2020 was estimated following the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Based on the results, emission from mobile combustion sources was estimated to be 0.0895 tCO_2e while emission from stationary combustion sources was 0.139 tCO_2e yielding a total GHG emission for Scope 1 of 0.2285 tCO_2e. Moreover, the electricity consumption of the campus which corresponds to the Scope 2 emission yielded 24.7135 tCO_2 constitutes largely to the overall greenhouse gas emission. This might be due to the flexible learning modality where faculty members stay at their respective offices to conduct their classes hence regularly utilizing electricity from air conditioners, computers, mobile phones and others.

INTRODUCTION

The issue about the global climate change caused by greenhouse gases was recognized in 1970s but international initiatives started in 1990s. Since then, the primary goal of global researches focused on reducing emission sources and enhancing carbon sinks to combat greenhouse gas emission (Montagnini & Nair, 2004). Some of these include innovative engine and vehicle technologies to reduce fuel consumption (Shaheen & Lipman, 2007), tree planting, maintaining and restoring forest ecosystems (Domke *et al.*, 2020), and ratification of global climate agreements such as the UNFCCC (United Nations Framework Convention on Climate Change), Kyoto Protocol and, the most significant to date, Paris Agreement (Maizland, 2021).

The Paris Agreement which entered into force last November 2016 aims to limit the increase in global temperature below 2 degrees Celsius by strengthening global response, which includes climate change adaptation and mitigation, to the threats and impacts of climate change (UNFCCC, 2020; Zhao *et al.*, 2018).

The University of Science and Technology of Southern Philippines (USTP)-Oroquieta is one of the satellite campuses of the USTP system. It is located at Mobod, Oroquieta City in the Province of Misamis Occidental which geographically lies within latitude 8°29' north and longitude 123°47" east (USTP-Oroquieta, n.d.).

An initiative of USTP-Oroquieta relevant to becoming a carbon-neutral campus has been conducted by select faculty members engaged in science-related profession to quantify and consequently suggest campus policies for low carbon emission through estimating the entity-level greenhouse gas (GHG) emission which results from the operations of the campus following the 2006 IPCC Guidelines for National GHG Inventory Accounting methodology.

As of 2020, there has been a significant decrease or interruption on the usual activities or operations in the campus brought about by the COVID-19 pandemic, hence, the results of this accounting might serve as a baseline data for future studies. The GHG accounting was created to monitor the direct and indirect GHG emissions of USTP-Oroquieta. This can also be considered as the initial step to planning the activities and programs that the campus could implement to mitigate GHG emission. Furthermore, it seeks to meet the following objectives:

- Identify the sources of GHG emissions from the operations of USTP-Oroquieta;
- Quantify the amount of GHG emissions from identified activity sources; and
- Determine appropriate projects and activities that would reduce the campus' GHG emission.

LITERATURE REVIEW

Climate change occurs because of natural and anthropogenic activities, and the main contributors to this are the greenhouse gases (Yue & Gao, 2018). These gases are naturally present in the earth's atmosphere, hence making the planet warm. Without these, the world would be as cold, or even colder, as ice (Ma, 1998). These can be emitted naturally by volcanic eruptions, ocean currents, solar radiations, and earth orbital changes, however excessive emission has been observed through the years because of human activities (Nunez, 2019).

Global Greenhouse Gas Emission

The World Resources Institute (WRI) reported that the global annual greenhouse gas emissions have increased to 48.94 $MtCO_2e$ since 1990 with the energy sector as the biggest source contributing 76% of the emission

[1] University of Science and Technology of Southern Philippines-Oroquieta, Philippines
[*] Corresponding author's e-mail: mitchie.roa@ustp.edu.ph

worldwide in 2018. At the same period, similar trend was observed in the Philippines which had approximately 136.60 $MtCO_2e$ increase in GHG emissions from 1990-2018. Approximately 59% of the total emission was contributed by the energy sector with a whopping 138.51 $MtCO_2e$ in 2018 followed by the agriculture sector with 26.14% (Climate Watch, n.d.).

Carbon dioxide is one of the key greenhouse gases emitted to the atmosphere through burning of fossil fuels, solid wastes and biomass (US EPA, 2020). It can also be emitted from direct human-induced impacts on forestry and other land use changes such as deforestation, grazing and degradation of soil, which dramatically elevated since the start of the industrial revolution (Arneth *et al.*, 2019). In the latest record of the World Resources Institute Climate Analysis Indicator Tool (WRI CAIT), the global total CO_2 emission excluding the land-use change and forestry (LUCF) in 2018 was 35.25 $GtCO_2$ while the total CH4, N2O and fluorinated gas (F-gas) only contributed 8.18 $GtCO_2e$, 2.99 $GtCO_2e$ and 1.14$GtCO_2e$, respectively (Climatewatch, n.d.).

Over the past decades, carbon dioxide emission was already increasing every year by about 1%; however, the impact of the COVID-19 pandemic in 2020 led to the drastic change in emission (Friedlingstein *et al.*, 2019; Jackson *et al.*, 2019; Peters *et al.*, 2020). Quéré *et al.* (2020) cited that although there is a decrease in global CO_2 emission in 2020 due to the reduced activity of the people and businesses during the pandemic as the world governments enforced stringent measures to lessen and stop the transmission of the virus, this is not enough to combat climate change. Although the COVID-19 pandemic struck every country and continues to immobilize and limit various sectors from emitting CO_2, researchers found that this is far from achieving net zero emissions due to the lack of enactment of "green" recovery policies. This decrease in emission is even just temporary as the adaptation and recovery measures of the government permits to continue people and business activities.

Entity-level Greenhouse Gas Emission

Generally, there are two types of reporting greenhouse gas emission, mainly the entity-level and community-level. Both types include three scope emissions, and the present study only applied the entity-level GHG accounting. Here, Scope 1 refers to the direct GHG emissions contributed by mobile and stationary combustion sources, Scope 2 refers to the indirect GHG emissions from the purchase of electricity, and Scope 3 refers to all the other indirect emissions such as domestic air travels, employee commuter travel, waste disposal and others (IPCC, 2014).

Carbon Dioxide Emission in the Philippines

The Philippines is known to have a very small carbon footprint; however, it is one of the countries that is most vulnerable to the impacts of climate change which slow down its economic development (Tribe, 2018; Durana, 2017). In 2020, Philippines had a carbon dioxide emission of 136.02 $MtCO_2$ while other developing countries such as Pakistan, Vietnam, Thailand and Malaysia have emitted 234.75 $MtCO_2$, 254.30 $MtCO_2$, 257.77 $MtCO_2$, and 272.61 $MtCO_2$, respectively (Ritchie & Roser, 2020). In the succeeding year, the country ranked 17th among all of the countries with the highest risks and most affected by extreme weather conditions according to the Global Climate Risk Index (Congressional Policy and Budget Research Department, 2021). The country experienced calamities and is in fact highly prone to natural disasters especially sea-level rise, coastal flooding, typhoons, earthquakes and volcanic eruptions (World Bank, 2005; Bollettino *et al.*, 2020). Other climate change impacts observed in the Philippines which generally resulted from the increase in global atmospheric carbon dioxide were experienced such as temperature rise, decreased regularity of precipitation, decreased quantity of surface water due to higher air temperatures, and northward shift of marine species due to increased temperature in the ocean (Tribe, 2018).

MATERIALS AND METHODS

Research Setting

The accounting estimates the entity-level GHG emissions from the operations of USTP-Oroquieta which cover the buildings and facilities in the campus for Year 2020 following the 2006 IPCC Guidelines for National Inventories methodology. The GHG emissions to be accounted for were determined through the boundary conditions, mainly the "organizational boundaries" which refer to the facilities owned or controlled by the campus and "operational boundaries" which refer to the types of emissions included or excluded from various emission sources.

Generally, USTP-Oroquieta consists of the Administration Building, IT Building, Dressmaking Building and Canteen; the canteen however stopped operating since the pandemic started because there was no longer face-to-face classes. Presently, the campus owned a car which has never been used and a motorcycle used for errands. Most of the fuel consumption for Year 2020 therefore came from the usage of the campus-owned motorcycle, rented vans for research and training purposes, and rented equipment for landscaping and construction of the makeshift classrooms. Moreover, the operational boundary categorizes emissions resulting from facilities and activities of USTP-Oroquieta classified as direct and indirect emissions and further into scopes as presented in Table 1.

Here, each emission sources are further classified according to scope and category. Scope 1 refers to direct GHG emissions from sources owned and controlled by USTP-Oroquieta such as the motorcycles and rented vans for official travel and errands, Scope 2 refers to indirect emissions from the purchase of electricity and Scope 3 are for all other indirect GHG emissions that occur as consequence of the activities and operations of the campus. Fugitive emissions from the use of fluorinated gases in refrigeration and air-conditioning equipment, emissions

Table 1: Direct and Indirect Emission of USTP-Oroquieta

Operational Boundary				
Classification	**Scope**	**Category**	**Included/ Excluded**	**Reason for Exclusion**
Direct Emissions	1	Mobile Combustion	Included	
		Stationary Combustion	Included	
		Fugitive Emission	Excluded	Data not available
Indirect Emission	2	Purchased Electricity	Included	
	3	Air Business Travel	Excluded	No air travel made
		Transmission and Distribution Loss	Excluded	Data not available
		Employee Commute	Excluded	No employee commute made
		Solid Waste Disposal	Excluded	Data not available

from transmission and distribution loss and emissions from solid waste disposal are excluded due to unavailability of data. Furthermore, emissions from air business travel as well as employee commute are excluded since no travel has been made through these means in 2020 due to various travel and gathering restrictions imposed by the COVID-19 Inter-Agency Task Force (IATF) nationwide.

Although various greenhouse gases are covered in the 2006 IPPC Guidelines for National Greenhouse Gas Inventories, this accounting shall only focus on the three most prevalent GHG, namely the carbon dioxide (CO_2), methane (CH4) and nitrous oxide (N_2O) for Scope 1 while only CO_2 is accounted for the Scope 2 emission assuming complete combustion has been achieved by power generating plants. A summary of the GHG covered in USTP-Oroquieta is shown in Table 2

In order for greenhouse gases to obtain an equivalent mass of carbon dioxide, the Global warming potential (GWP) is used. It is an index that attempts to integrate the overall climate impacts of a specific action (e.g., emissions of CH_4, NOx or aerosols). Table 3 shows the global warming potentials of the three GHGs based on the Fifth Assessment Accounting (AR5) of the Intergovernmental Panel on Climate Change (IPCC) which are considered in this accounting.

Table 2: Direct and Indirect Emission of USTP-Oroquieta

Emission Sources	**Scope**	**CO_2**	**CH_4**	**N_2O**	**SF_6**	**PFCs**	**HFCs**
Mobile combustion from owned vehicles and stationary combustion from generator set	1	✓	✓	✓	x	x	x
Electricity consumption of owned buildings/offices	2	✓	x	x	x	x	x
Employees' official air business travel	3	x	x	x	x	x	x
Employee's commute	3	x	x	x	x	x	x
Transmission and Distribution Loss	3	x	x	x	x	x	x

Table 3: Global Warming Potential Used (IPCC, 2014)

Common Name	**Chemical Formula**	**Global Warming Potential**
Carbon dioxide	CO_2	1
Methane	CH_4	28
Nitrous Oxide	N_2O	265

Data Collection and Data Quality Assurance

The data were collected from the designated personnel in USTP-Oroquieta. The activity data for Scope 1 were obtained from the Supply Inspector of the campus while the data for Scope 2 were taken from Misamis Occidental Electric Cooperative Inc. I (MOELCI-I). Presented in Table 4 is a summary of the quality of the activity data collected.

Table 4: Self-assessment on the Quality of Activity Data

Activity Data	**Data Source**	**Data Collector**	**Quality Assurance**	**Remarks**
Fuel Consumption (liters)	Fuel purchase receipts; Trip ticket	Campus Inspector	High	The quantity and fuel type were recorded by the supply inspector.

Electricity Consumption (kilowatt hour)	Monthly electrical bills	MOELCI-I	High	The entire campus only has one electric meter which measures the kWh used in a monthly basis. A summary of the electricity consumption of the campus for 2020 was requested from MOELCI-I.

Data Analysis

Generally, the calculation of scope emissions in the present study utilizes descriptive statistics. Here, the emissions from mobile combustion of USTP-Oroquieta are from the owned motorcycle as well as the rented vans utilized for research and training conducted by the campus. In 2020, only gasoline fuel was purchased. Pursuant to Republic Act No. 9367 or the Biofuels Act of 2006, "all diesel fuels sold throughout the Philippines are currently blended with 2% biodiesel by volume and 10% bioethanol by volume for gasoline," hence a correction factor was used to account for the biofuels blend in the fuel consumption of the campus (Official Gazette, 2007). The total CO_2e emission from the fuel consumption of USTP-Oroquieta for 2020 was determined using the formula

Emission ($tonsCO_2e$)=(Activity Data)(Emission Factor)(1)

Further, the stationary combustion sources such as the chainsaw, lawn mower, and mixer for landscaping and construction of makeshift classrooms are accounted. The emissions from methane and nitrous oxide were converted into its equivalent CO_2 emission using the respective global warming potentials. Similarly, the total tCO_2e emissions from stationary combustion was determined using the formula

Emission ($tonsCO_2e$)=(Activity Data)(Emission Factor)(GWP) (2)

The Scope 2 emission was calculated using the data collected from MOELCI-I and the grid emission factor for Mindanao obtained from the Department of Energy (Department of Energy, 2020). For the entire campus, there is only one meter reader hence there has been no difficulty in obtaining the monthly electricity consumption. The values of the emission factor for fuel combustion and purchased electricity were obtained from the US EPA (US EPA, 2021) and MOELCI-1, respectively, while no activity data have been recorded for Scope 3 emissions.

Emission ($tonsCO_2$)=(Activity Data)(Grid Emission Factor) (3)

RESULTS AND DISCUSSION

Accounting for all the greenhouse gas emissions excluding CO_2 from biogenic sources, the total GHG emission from both mobile and stationary fuel combustion is equivalent to 0.0895 tCO_2e and 0.139 tCO_2e, as shown in Table 5 and Table 6, respectively. Adding the emissions from mobile and stationary combustion sources, the total Scope 1 emission is 0.2285 tCO_2e.

The Scope 1 emission of USTP-Oroquieta categorized from mobile and stationary combustion sources is illustrated in Figure 1 while the monthly emission from the electricity consumption in 2020 is illustrated in Figure 2. As can be gleaned from Figure 1, the emission from mobile combustion is higher than the emission from stationary sources having 61% and 39%, respectively.

The monthly emission from the electricity consumption of the campus for 2020 is presented in Table 7. Here, it can be seen that the highest amount of electricity consumed was on February which therefore has the highest emission while the lowest was observed for the month of April. Overall, USTP-Oroquieta was found to obtain a total GHG emission of 24.7135 tCO2e.

Table 5: USTP-Oroquieta emissions from mobile combustion

Fuel Consumption (liters)		**Total tCO2e Emission (excluding tCO2 from biofuel)**
Gasoline	Bioethanol	
42.858	4.2858	0.0895

Table 6: USTP-Oroquieta emissions from stationary combustion

Fuel Consumption (liters		**tCO_2**	**tCO_2 from bioethanol**	**tCH_4**	**tN_2O**	**Total tCO2e Emission (excluding Biofuel tCO_2**
Gasoline	Bioethanol					
66.71	6.671	0.139	0.0155	1.689E-04	7.8E-07	0.139

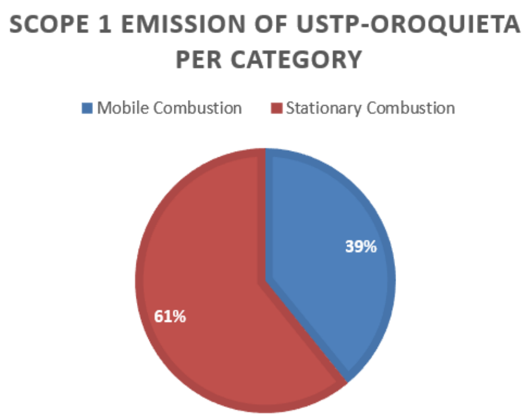

Figure 1: Scope 1 emission per combustion source

Table 7: USTP-Oroquieta emissions from monthly purchase of electricity

Month (2019)	Electricity Consumption (kWh)	Megawatt	Total GHG Emission (tCO_2)
January	2400	2.4	1.90104
February	4160	4.16	3.295136
March	2160	2.16	1.710936
April	1040	1.04	0.823784
May	1280	1.28	1.013888
June	1600	1.6	1.26736
July	2400	2.4	1.90104
August	3040	3.04	2.407984
September	3360	3.36	2.661456
October	3280	3.28	2.598088
November	3520	3.52	2.788192
December	2960	2.96	2.344616
Total	**31200**	**31.2**	**24.7135**

Finally, since no domestic air travel nor employee commutate has been made in 2020 due to the COVID-19 pandemic which imposed travel and gathering restrictions for safety, the campus has therefore no recorded Scope 3 emissions. The total greenhouse gas emissions from various sources and operations in USTP-Oroquieta for Year 2020 is summarized in Table 8. Generally, the scope with the highest emission is Scope 2 followed by Scope 1 emissions which consist of 99.086% and 0.914%, respectively. Scope 3 emissions on the other hand has obviously no GHG estimate since no activities have been made to account for it.

Table 8: GHG Emissions by Scope or Category

Scope	tCO_2e	% Total Emission
Scope 1	0.228	0.914
Scope 2	24.714	99.086
Scope 3	0	0
Total Emission	24.942	100

CONCLUSION

Based on the results and analyses obtained in this study, the author concludes that the total GHG emission produced from the activities and operations of the campus for Year 2020 was largely contributed by Scope 2 emissions. Similarly, the emission from mobile combustion is higher than the stationary combustion constituting 61% of the Scope 1 emission.

Although most of the operations were immobilized due to the COVID-19 pandemic, some activities, mostly for faculty development, were still conducted following strict health protocols. Lastly, no emission for Scope 3 has been recorded from the operations of the campus for 2020 since no air travel nor land commute was recorded even before the travel restrictions were imposed due to the pandemic.

Acknowledgements

The author would like to acknowledge Ms. Junefer Malinis, a faculty member of the campus, as well as the Misamis Occidental Electric Cooperative Inc. I for providing a summary of the monthly electricity bills of USTP-Oroquieta.

REFERENCES

Arneth, A., Barbosa, H., Benton, T., Calvin, K., Calvo, E., Connors, S., . . . Haughey, E. (2019). IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse gas fluxes in Terrestrial Ecosystems. IPCC.

Bollettino, V., Alcayna-Stevens, T., Sharma, M., Dy, P., Pham, P., & Vinck, P. (2020). Public perception of climate change and disaster preparedness: Evidence from the Philippines. *Climate Risk Management, 30.* doi:https://doi.org/10.1016/j.crm.2020.100250

Climate Watch. (2020). *World Resources Institute. (World Resources Institute Climate Analysis Indicators Tool)* Retrieved September 30, 2020, from www.climatewatchdata.org

Climatewatch. (2022). Historical GHG Emissions. Retrieved February 9, 2022, from *World Resources Institute Climate Analysis Indicators Tool.* https://www.climatewatchdata.org/ghg-emissions?breakBy=gas&end_year=2018&sectors=total-excluding-lucf&start_year=1990

Congressional Policy and Budget Research Department. (2021). GLOBAL CLIMATE RISK INDEX 2021 .

GovPH.
Department of Energy. (2020). *2015-2017 National Grid Emission Factor (NGEF)*. Retrieved August 18, 2021, from GovPH: https://www.doe.gov.ph/electric-power?q=electric-power/ngef
Domke, G. M., Oswalt, S. N., Walters, B. F., & Morin, R. S. (2020, October 6). Tree planting has the potential to increase carbon sequestration capacity of forests in the United States. *Proceedings of the National Academy of Sciences of the United States of America*. https://doi.org/10.1073/pnas.2010840117
Durana, A. L. (2017, February 2). *Towards a Low-carbon Economy for the Philippines*. Retrieved October 21, 2020, from National Academy of Science and Technology Philippines. https://nast.ph/index.php/13-news-press-releases/301-towards-a-low-carbon-economy-for-the-philippines
Friedlingstein, P., Jones, M. W., O'Sullivan, M., Andrew, R. M., Hauck, J., Peters, G. P., . . . Jackson, R. (2019). Global Carbon Budget 2019. *Earth System Science Data*, 1783–1838.
IPCC. (2014). Climate Change 2014: Synthesis Report. In T. C. Team, R. K. Pachauri, & L. Meyer (Ed.), Contribution of Working Groups I, II, and III to the Fifth Assessment Report of he Intergorvernmental Panel on Climate Change (p. 151). *Switzerland: Intergovernmental Panel on Climate Change*.
Jackson, R. B., Friedlingstein, P., Andrew, R. M., & Canadell, J. G. (2019). Persistent fossil fuel growth threatens the Paris Agreement and planetary health. *Environmental Research Letter*s, 121001.
Locatelli, B. (2011, August). Synergies between adaptation and mitigation in a nutshell.
Ma, Q. (1998, March). Greenhouse Gases: Refining the Role of Carbon Dioxide. Retrieved November 14, 2020, from *National Aeronautics and Space Administration Goddard Institute for Space Studies*. https://www.giss.nasa.gov/research/briefs/ma_01/
Maizland, L. (2021, November 17). *Global Climate Agreements: Successes and Failures*. Retrieved February 1, 2022, from https://www.cfr.org/backgrounder/paris-global-climate-change-agreements
Montagnini, F., & Nair, P. R. (2004). *Carbon sequestration: An underexploited environmental benefit of. Agroforestry Systems, 61*, 281-295.
Nunez, C. (2019, May 13). *Carbon dioxide levels are at a record high. Here's what you need to know. (National Geographic)* Retrieved October 20, 2020, from https://www.nationalgeographic.com/environment/global-warming/greenhouse-gases
Official Gazette. (2007, January 12). *REPUBLIC ACT NO. 9367*. Retrieved from GovPH: https://www.officialgazette.gov.ph/2007/01/12/republic-act-no-9367/
Peters, G. P., Andrew, R. M., Canadell, J. G., Friedlingstein, P., Jackson, R. B., Korsbakken, J. I., . . . Peregon, A. (2020). Carbon dioxide emissions continue to grow amidst slowly emerging climate policies. *Nature Climate Change*, 3–6.
Quéré, C. L., Jackson, R. B., Jones, M. W., Smith, A. J., Abernethy, S., Andrew, R. M., . . . Peters, G. P. (2020). Temporary reduction in daily global CO_2 emissions during the COVID-19 forced confinement. *Nature Climate Change*, 647–653.
Ritchie, H., & Roser, M. (2020). *CO_2 and Greenhouse Gas Emissions*. Retrieved January 28, 2022, from OurWorldInData.org: https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions
Shaheen, S. A., & Lipman, T. E. (2007). Reducing Greenhouse Emissions And Fuel Consumption: Sustainable Approaches for Surface Transportation *International Association of Traffic and Safety Sciences, 31*(1), 6-20. https://doi.org/10.1016/S0386-1112(14)60179-5
Tribe, H. (2018). Climate Change Impact on Communities in the Philippines: A Review of Current Literature and Policies. *Asia Pacific Perspectives, 15*(2), 30-48.
UNFCCC. (2020). *The Paris Agreement. (United Nations Climate Change)* Retrieved August 13, 2020, from https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement
US EPA. (2020, September 8). *Overview of Greenhouse Gases*. Retrieved from EPA: https://www.epa.gov/ghgemissions/overview-greenhouse-gases
US EPA. (2021, April). *Emission Factors for Greenhouse Gas Inventories*. Retrieved September 25, 2021, from https://www.epa.gov/sites/default/files/2021-04/documents/emission-factors_apr2021.pdf
USTP-Oroquieta. (n.d.). *USTP-Oroquieta*. Retrieved October 22, 2020, from http://oroquieta.ustp.edu.ph/#
World Bank. (2005). *Natural Disaster Risk Management in the Philippines : Reducing Vulnerability*. Retrieved August 21, 2021, from https://openknowledge.worldbank.org/handle/10986/8754
Yue, X.-L., & Gao, Q.-X. (2018). Contributions of natural systems and human activity to greenhouse gas emissions. *Advances in Climate Change Research, 9*, 243-252.
Zhao, C., Yan, Y., Wang, C., Tang, M., Wu, G., Ding, D., & Song, Y. (2018, May 3). Adaptation and mitigation for combating climate change – from single to joint. *Ecosystem Health and Sustainability, 4*(4), 85-94. doi:https://doi.org/10.1080/20964129.2018.1466632