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Baseline Emission Inventory (BEI) of Greenhouse Gas (GHG) in the Lomé Golfe 3 Commune in Togo

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ABSTRACT

Aware of the real impacts of climate change on all socio-economic sectors, Togo has ratified the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol. In Togo, as elsewhere, Greenhouse Gas (GHG) emissions attributable to human activities are contributing to global warming, and IPCC reports indicate a continuous increase in the Earth's average temperature over the last few decades. Country Parties are called upon to step up climate action at national and EU level to meet the requirements of implementing the Paris Agreement to keep global warming below 2°C by 2050. As a contribution to the reduction of its emissions, the country has made several commitments, including the adhesion of municipalities to the "Covenant of Mayors for Sub-Saharan Africa" (CoMSSA) in order to develop their Action Plan for Sustainable Energy Access and Climate (PAAEDC). One of the pillars of this plan is mitigation based on the Baseline Emissions Inventory (BEI). It is in this sense that this study on the BRI of GHG emissions in the commune of Lomé Golfe 3 is conducted to provide a first overview of emissions. The methodology used is the one contained in the 2006 IPCC guidelines and the CIRIS_standard_V2.5 model to inventory carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) emissions in addition to hydrofluorocarbons (HFCs). In 2019, the reference year, GHG emissions are estimated at 360061 tCO_2-eq. The Energy sector (Stationery and Transportation) is the largest emitter (95%), followed by the Waste sector (3 %) and the Utilities sector (2 %). The Energy sector is responsible for almost all the CO_2 emitted, i.e., 99.88%, against 0.12 % attributed to the Waste sector. Overall, CO_2 emissions are estimated at 331206 tCO_2-eq, i.e., 92.76 % of aggregate emissions. CH_4 is estimated at 17061 tCO_2-eq or 4.76 %, HFCs at 7276 tCO_2-e (1.97 %) and finally N_2O at 1820 tCO_2-eq or 0.51 %. Over the period 2019-2021, emissions are expected to increase.

INTRODUCTION

Climate change is real and its impacts on all socio-economic sectors leave no one in different[1]. Greenhouse Gases (GHGs) attributable to human activities are those that reinforce global warming and the IPCC reports indicate a continuous increase in the Earth's average temperature over the past decades[2-6]. Country Parties are called upon to step up climate action at national and EU level to meet the requirements of implementing the Paris Agreement to keep global warming below 2°C by 2050. To this end, the first global initiative of cities and local governments called the "Global Covenant of Mayors for Climate and Energy" was created by merging in 2015 the Covenant of Mayors and the Covenant of Mayors to lead the fight against climate change. Subsequently, the "Covenant of Mayors for Sub-Saharan Africa" (CoMSSA) is initiated for cities in Sub-Saharan Africa in their fight against climate change and in their efforts to ensure access to clean energy for their populations[7-9]. Several from Togo have joined CoMSSA and are required to develop their Climate and Sustainable Energy Access Action Plan (CESAP) based on three (03) pillars namely the "Mitigation", "Adaptation" and "Energy Access" pillars. The basis of the mitigation pillar is a Baseline Emission Inventory (BEI). This study on the BEI of GHG emissions in the commune of Golfe 3 of Greater Lomé is intended to contribute to community development by providing a first overview of the emissions of the said commune. The specific aim is to make available the commune's BEI in order to contribute to the identification of appropriate mitigation measures that can be converted into development projects.

METHODOLOGY

Materials and tools Methodology

The BEI was carried out in accordance with the methodologies proposed in the IPCC guidelines available to Governments for inventorying their emissions. To avoid bias in the analysis of the data, appropriate tools were used to update and analyze the data. These include

- CIRIS User Manual (CIRIS_User_Guide_v1.2);
- CIRIS_Standard_v2.5;
- Computer tools (Word, Excel).

Methods of collection and estimation of data

Data collection was done iteratively on the basis of query sheets, field visits and observations of socio-economic conditions[10-11]. Specifically, data on energy was collected from the Directorate of Mines and Energy and from documents of the Togo Energy Information System (SIE-Togo), socio-economic and demographic parameters from the main town hall of the Golfe 3 commune and from INSEED. Data on waste was obtained from the Technical Services Directorate of the Autonomous District of Greater Lomé and the laboratory of Management, Treatment and Valorization of Wastes (GTVD) of the University of Lomé (UL). Data on the use of products, particularly refrigerant gases, were collected from the National Ozone Office (NOB-Togo) and the Togo Refrigerators Association (AFRITO). IPCC guidelines and EMEP CORRINAIR guides were consulted for the choice of emission factors and parameters as well as national communications, articles and papers[12-19]. Proxies were used to substitute missing data.

Methods of calculating emissions

In all sectors, which are sources of GHG emissions, the default Tier 1 method was applied. It combines activity data with emission factors through the algorithm:

$$\textbf{GHG emission} = \textbf{AD.EF}$$

With:

- AD: Activity data
- EF: Emission Factor

In the Energy sector, DA is determined by energy consumption. In the Waste sector, CH_4 emissions from Solid Waste Disposal Sites (SWDS) combine the mass of solid waste sent to landfill (MSWx) with the methane generation potential (L_O), and estimates of non-biogenic CO_2 and nitrogen hemi oxides from waste burning depend on the mass of waste incinerated (m) and the dry matter content (dm), among others. For the Industrial Processes and Product Use (IPUP) sector, hydrofluorocarbons (HFCs), Ozone Depleting Substances (ODS) substitutes were estimated by combining production, imports, exports and destruction.

RESULTS AND DISCUSSION

Results of data collection

The collection of available data coupled with the data generated and obtained by expert judgement are compiled in Tables 1, 2, 3 and 4.

Table 1: Residential energy consumption

Residential (2019)	Firewood	Charcoal	LPG	Paraffin	Wood	Charcoal	LPG	Paraffin	Wood	Charcoal	LPG	Paraffin
Quantity in ktoe	1,521	35,49	12,67	1	1,57	36,55	13,05	1,04	1,61	37,64	13,44	1 ,07
Quantity in TJ	63,67	1485,5	530,5	42,44	65,58	1530,15	546,48	43,72	67,54	1575,99	562,85	45,03

Table 2: Fuel consumption in transport

Transport (2019)	Petrol	Diesel	Petrol	Diesel	Wood	Petrol	Diesel
Quantity in ktoe	27,01	10,89	29,61	15,31	1,61	30,03	17,45
Quantity in TJ	1134,118	457,7	1239,71	640,96	67,54	1257,3	730,64

Table 3: Waste generation by population

	Population	Waste enerated (Tonne)	Landfill waste (Tonne)	Burnt waste (Tonne)
2019	86800	25345,6	23064,5	3037
2020	94227	26027,5	23684,1	3122
2021	91533	26727,5	24322	3205

The per capita waste production ratio is 0.56 kg/dr/inhabitant with an estimated waste collection rate of 70 % of which 91 % is Municipal Solid Waste sent to landfill.

Table 4: Quantities of HFCs (metric tonnes)

	2019	2020	2021
Fixed installations			
R32	9,56	9,28	26,12
R125	10,93	9,95	9,26
R134a	30,73	19,17	23,42
R143a	1,19	0,79	0,66
Mobile facilities			
R134a	1,28	0,8	1,02

BEI results

GHG emission results for the 2019 base year

The 2019 estimation results are compiled in Table 5 and cover the direct GHGs carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and hydrofluorocarbons (HFCs). These aggregated emissions amount to 360262 tCO_2-eq and are distributed over the Energy, Waste and Utilities sectors.

Table 5: Emission results for the base year 2019

	GHG emissions in tCO_2-eq				
GHG source categories	CO_2	CH_4	N_2O	HFCs	TOTAL
Total estimates	331206	19968	1820	7276	360262
A. ENERGY					
1. STATIONERY (RESIDENTIAL)	210185	8938	483	-	219606
1. 1. Wood or wood debris	7168	538	68	-	7774
1.2. Charcoal	166432	8322	394	-	175148
1.3. Oil	3079	4	7	-	3090
1.4. LPG	33506	74	14	-	33595
2. ROAD TRANSPORT	120640	1201	1216	-	123049
2.1. Petrol	86279	1150	1056	-	88485
2.2. Diesel	34361	51	160	-	34564
B. DECHETS	381	9829	121	-	10331
3. A. WASTE DISPOSAL	-	3023	-	-	3023
3. B. WASTE BURNING	381	1805	121	-	2307
3. C. DOMESTIC WASTEWATER	-	5001	-	-	5001
C. IPPU	-	-	-	7276	7276
Products use (HFCs) as substitutes for ODS	-	-	-	7276	7276

Results of GHG emission trends

Estimated direct GHG emissions (CO_2, CH_4 and N_2O, HFCs) from 2019 to 2021 are compiled in tCO_2 e in Table 6.

Table 6: Evolution of GHG emissions expressed in tCO_2-eq

GES	YEAR			TOTAL
	2019	**2020**	**2021**	
CO_2	331206	350106	364487	1045799
CH_4	19968	22922	25125	68015
N_2O	1820	1892	1987	5699
HFCs	7276	6962	5503	19540
TOTAL	360061	382002	397070	

Analysis and discussion

GHG emissions in the base year 2019

In 2019, total global GHG emissions are estimated at 360262 tCO_2-eq. It is distributed between carbon dioxide (331206 tCO_2-eq) or 91.93 %; methane (17061 tCO_2-eq) or 5.54 %, hydrofluorocarbons (7276 tCO_2-eq) or 2.02 % and nitrous oxide (1820 tCO_2-eq) or 0.51 % (Figure 1).

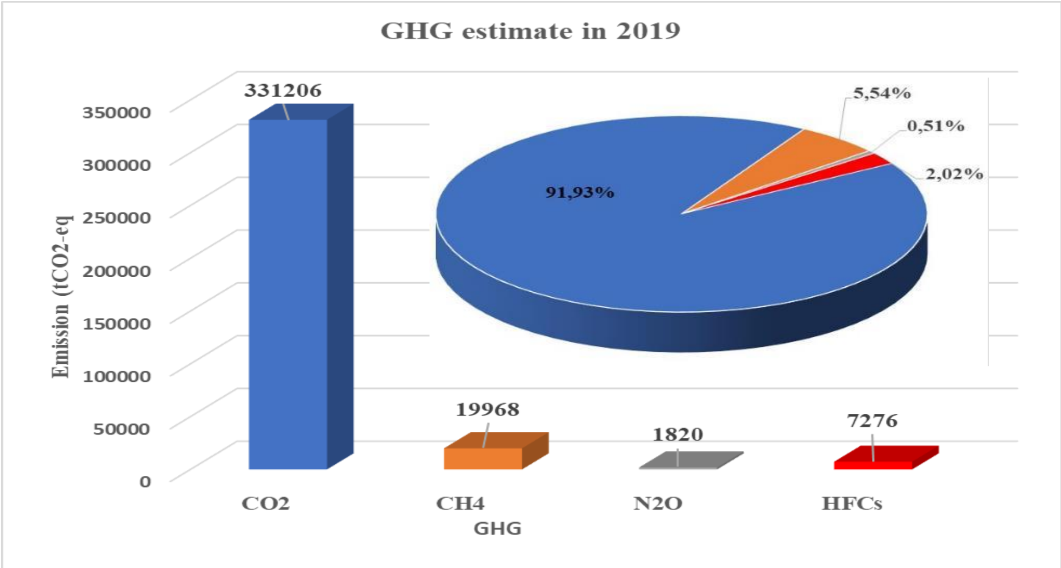

Figure 1: Breakdown of aggregated emissions by GHG

Almost all of the municipality's GHG emissions are attributable to the energy sector (95.11 %), while 2.87 % and 2.02 % are attributable to the waste and PIUP sectors respectively. The main sources of CO_2 emissions are the use of charcoal and the consumption of petrol, diesel and LPG. Methane is mainly generated by waste management and fuel consumption, while HFCs are released into the atmosphere when ODS substitutes are used in the cooling sector (Figure 2). These emissions by sector are in Table 7.

Table 7: Emissions by sector

GHG	FRACTION (%)	SECTOR	QUANTITY (tCO_2-eq)
CO_2	99.88	Of CO_2 emissions come from the energy sector	33,325
	0.12	Of CO_2 emissions from the waste sector	381
CH_4	51	Of CH_4 emissions from the energy sector	10139
	49	Of CH_4 emissions are attributable to the waste sector	9829
N_2O	93	Of N_2 O emissions are emitted by the Energy sector	1699
	7	Of N_2O emissions are emitted by the waste sector	121
HFCS	100	Of HFCs emissions come from the use of products in refrigeration and air conditioning	7276

CO_2 emissions from the stationary energy sub-sector are estimated at 210185 tCO_2-eq in 2019 in the municipality and distributed in the following proportions: 79 % for charcoal use, 15 % for LPG, 4 % and 2 % for wood and oil respectively. In the same year and for the same sector, CH_4 emissions reached 8938 tCO_2-eq while nitrous oxide (N_2O) emissions are estimated at 483 tCO_2-eq. The road transport subcategory is the key source of emissions due to fuel consumption with a total of 120640 t CO_2-eq of which petrol consumption represents 71 % and diesel 29 %. In the Gulf 3 municipality, the key sources of HFC emissions (7276 tCO_2-e) are fixed installations (91 %) and mobile installations (9 %).

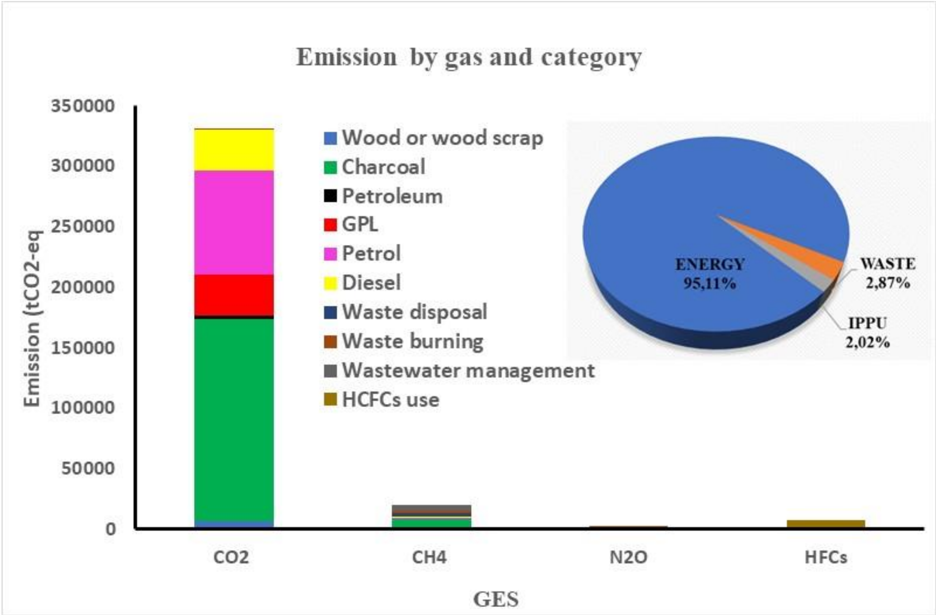

Figure 2: Breakdown of emissions by GHG and by category

Emission trends from 2019 to 2021

Over the period 2019, 2020 and 2021 and in the Gulf 3 municipality, total GHG emissions increased by 10 % from 2019 to 2021, 6 % from 2019 to 2020 and 4 % from 2020 to 2021. Of these gases, only HFCs experienced a gradual decrease with rates of 4.5 % and 26 % between 2019-2020 and 2020-2021 respectively.

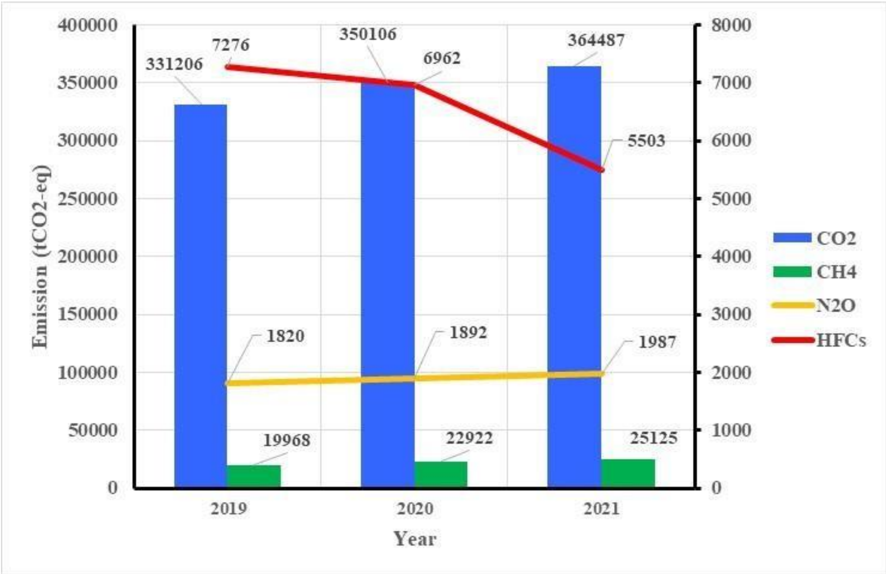

Figure 3: Evolution of emissions by GHG over the period 2019-2021

CONCLUSION

This study, carried out in the context of climate change, made it possible to estimate the GHG emissions attributable to the socio-economic activities of the Gulf 3 commune. It was conducted in accordance with the methodologies contained in the 2006 IPCC guidelines and the calculations were carried out by the CIRIS_V2.5 software using activity data (AD) collected in the field and default emission factors (EF). Thus, for the base year 2019, GHG emissions are estimated at 360262 tCO_2-eq and split between carbon dioxide (CO_2), methane (CH_4), hydrofluorocarbons (HFCs) and nitrous oxides (N_2O) at 331206; 19968; 7276 and 1820 tCO_2-eq respectively. The Energy sector (Stationery and Transportation) is the largest emitter (95.11 %) followed by the Waste sector (2.87 %) and then the Utilities sector (2.02 %). Over the period 2019-2021, aggregate GHG emissions have increased by 10 %. Given the annual increase in population with a consequent intensification of activities, this rate may be revised upwards in the status quo although the parameters used are default. It is therefore urgent to raise awareness among the population of the said commune about the harmful effects of GHGs on the climate and to draw up an environmentally friendly communal development plan.

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