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Emissions Characteristics of Greenhouse Gas at Gwangyang Bay Area in 2005

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ABSTRACT

The distribution of CO_2 concentration in ambient air and the characteristics of greenhouse gas (GHG) emissions at Gwangyang Bay Area are investigated in this study. The range of the mean CO_2 concentration was from 378.5ppm to 394.6ppm. Because of the increasing of absorbing capacity of plant for CO_2 absorption, it was shown the lowest mean CO_2 concentration during summer. We also confirmed that the industrial activities have a big effect on the atmospheric CO_2 concentration. There was approximately 62 $MtCO_2eq$ GHG emissions at Gwangyang Bay Area in 2005 and the total GHG emissions at the 3 cities were in the order of Gwangyang > Yeosu > Suncheon. Because large numbers of GHG was released from energy sector by petrochemical and steel industries at Gwangyang Bay Area, so the proportion of GHG emissions from energy sector was about 99.4% of the total GHG emissions at this area while it was only about 77.1% in Korea. In addition, Gwangyang Bay Area's CO_2 emission/capita was 69.01 tCO_2/capita, it was much higher than the national average of 9.30 tCO_2/capita and any other OECD country. Especially at Gwangyang, the CO_2 emission/capita was 211.07 tCO_2/capita, this means that the Gwangyang Bay Area is a highly industrialized area.

Key words : Greenhouse Gas Emissions, Inventory, Yeosu, Suncheon, Gwangyang, Gwangyang Bay Area, CO_2 Concentration

1. Introduction

The principal greenhouse gas (GHG) such as carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6) that are emitted to the atmosphere through natural processes and human activities have contributed to global warming. Average temperature rose by 1.5 ℃ in the last 100 years, while sea level rose 22cm in the last 40 years.[1-3] Korea's GHG emissions were about 590 $MtCO_{2eq}$ in 2005 and had more than doubled in the last fifteen years (1990~2005). The emissions growth has slowed during this decade, but it has still increased since 2000. In fact, Korea has become the 16th largest emitter of GHG all over the world. The 95 % of the total GHG emissions came from the energy and industrial process sectors reported by the Korea government.[4-6] Against this backdrop, the Korea government set the announcement of "Low-Carbon, Green Growth" as the nation's vision for the next 60 years.[7] Recently, the government has set out three mitigation scenario options for 2020 to reducing the GHG emissions from current trend. The Scenario 1 shows 21 % reduction from Business as Usual (BAU) and it also means 8 % increase from 2005 level. The Scenario 2 shows 27 % reduction from BAU (Return to 2005 level) and the Scenario 3 shows 30 % reduction from BAU (4 % reduction from 2005 level).[8] There are two large industrial complexes located at Gwangyang Bay Area and large numbers of GHG was generated from this area. The objectives of this study were to investigate the distribution of CO_2 concentration in ambient air and the characteristics of GHG (CO_2, CH_4, N_2O) emissions at Gwangyang Bay Area (Yeosu, Suncheon and Gwangyang) in 2005.

2. Materials and Methods

In this study, CO_2 concentration was measured from the Yeosu Industrial Complex area, control area, Gwangyang Industrial Complex area and the Yeosu Expo area, a total of 31 sampling sites around the Gwangyang Bay Area by a mobile carbon dioxide meter(Sibata, Japan). Sampling was carried out from a total of 3 times at June, August and November in 2008. Fig 1 shows the specific location of sampling sites. To ensure that the GHG emissions inventory is comparable to those of national GHG emissions data reported, the emission sector divides into 4 parts including: 1) energy, 2) agriculture, 3) waste, 4) land use and forestry. The estimates presented in this study were calculated using the methodblogies which are consistent with the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories.[9), 10)] Table 1 shows the activity data of the GHG emissions for each sector. In addition, we also used the way of questionnaire to obtain

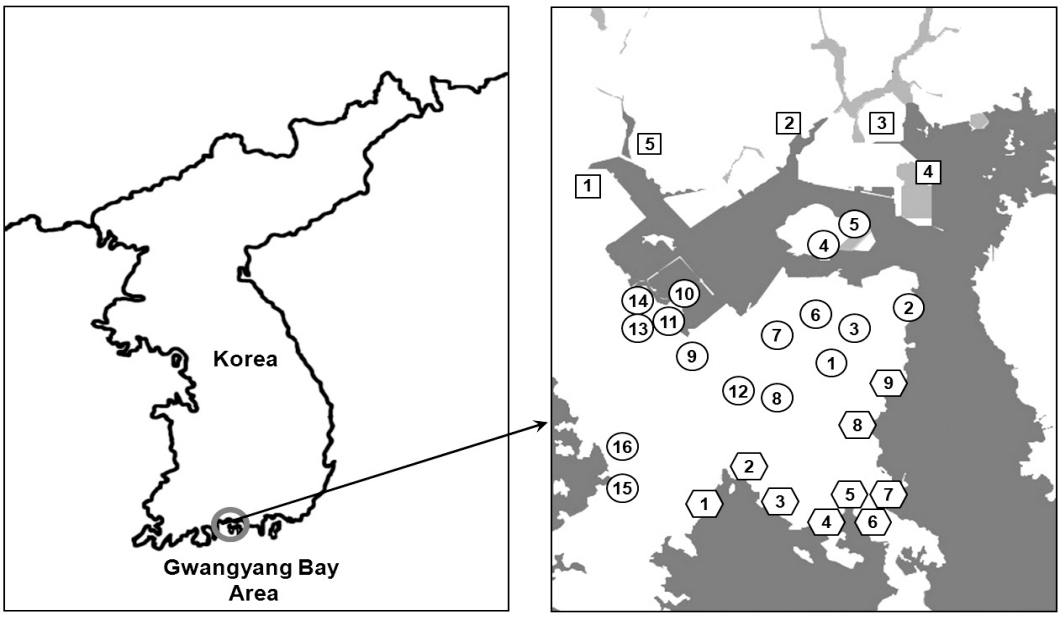

Fig 1. Specific location of sampling sites. (◯): Yeosu Industrial Complex area (Site: Y-1 ~ Y-14) and control area (Site: Y-15 ~ Y-17, site Y-17 is not showed on the map), (□): Gwangyang Industrial Complex area (Site: G-1 ~ G-5), (⬡): Yeosu Expo area (Site: E-1 ~ E-9).

Table 1. Activity data of the GHG emissions for each sector

Sector	Portion	Activity Data
Energy	Industry	- Fuel combustion: Questionnaire - Electric Power: Questionnaire - City Gas: Sales Volume from City Gas Suppliers (Jeonnam City Gas, Daehwa City Gas)
	Transport	- Annual Report (Ministry of Land, Transport and Maritime Affairs) - Annual Report
	Household/Commercial	- Electric Power: Internal Sales Data from Korea Electric Company - City Gas: Sales Volume from City Gas Suppliers (Jeonnam City Gas, Daehwa City Gas)
Agriculture	Fermentation	- Annual Report
	Excreta Decomposition	- Agriculture Annual Report - Annual Report
	Rice Farming	- Data from National Academy of Agricultural Science & Technology - Annual Report
	Arable Soil	- Annual Report
Waste	Landfill	- Questionnaire
	Incineration	
	Wastewater Treatment	
Land Use and Forestry	Forestry	- Statistical Data (Korea Forest Service) - Annual Report
	Deforestation	
	Soils	- Annual Report
	Arable Soil	- Fertilizer Yearbook (Korea Fertilizer Industry Association)

more detailed information from 1~3 groups of air polluting facilities, these air polluting facilities were the main sources of GHG emissions. In order to verify the results, we should compare our results with the Greenhouse Gas - Clean Air Policy Support System (GHG-CAPSS) in the further work. Fig 2 shows the GHG emissions calculation and verification process.

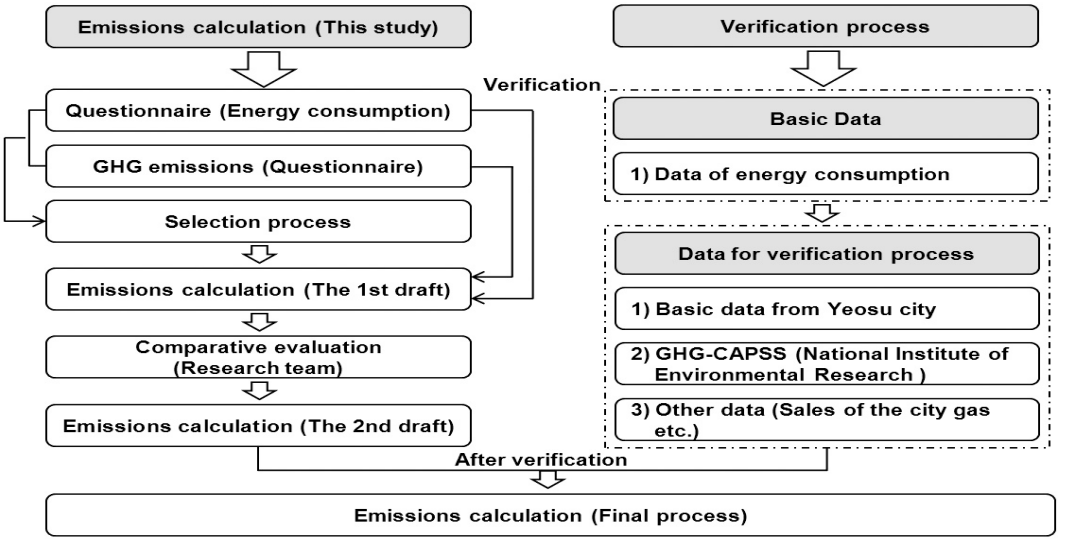

Fig 2. GHG emissions calculation and verification process.

3. Results and Discussion

3.1. Distributions of CO_2 concentration

Fig 3 and 4 show the variation of CO_2 concentration at each sampling site and the concentration distributions at Gwangyang Bay Area, respectively. In the case of the mean CO_2 concentration at each sampling site, the mean CO_2 concentration was calculated from a total of 3 times at June, August and November in 2008. The highest value as 420 ppm presented at site Y-14 while the lowest value as 370 ppm presented at site E-8. Because the site Y-14 is seated at a crossroads where a large number of vehicles have frequently been passed through this area, CO_2 emission from vehicle exhaust had a great impact on the experimental results, so it showed a higher mean CO_2 concentration than any other area. For the site E-8, it is located in the seaside. Because of the CO_2 absorption by the ocean, so this position presented the lowest mean CO_2 concentration. In the case of the distributions of CO_2 concentration at Gwangyang Bay Area, the mean CO_2 concentration varied from 378.5 ppm to 394.6 ppm. In addition, the mean

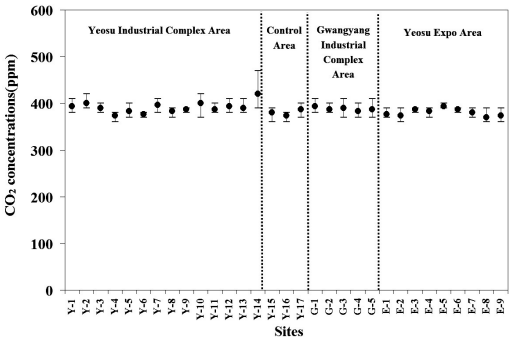

Fig 3. Variation of CO_2 concentration at each sampling site. [Error bars denote the range(R) values]

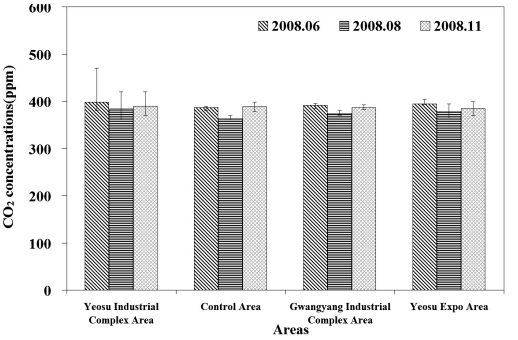

Fig 4. Distributions of CO_2 concentration at Gwangyang Bay Area. [Error bars denote the range(R) values]

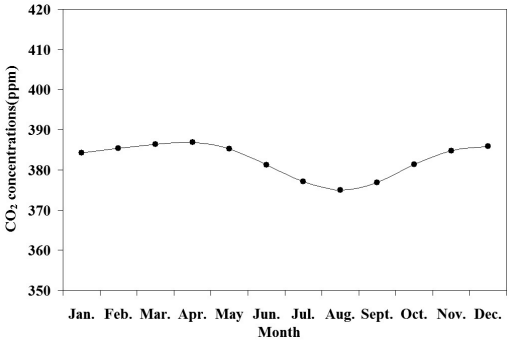

Fig 5. Monthly mean CO_2 concentration at Annmyon-do from 1999 to 2008.

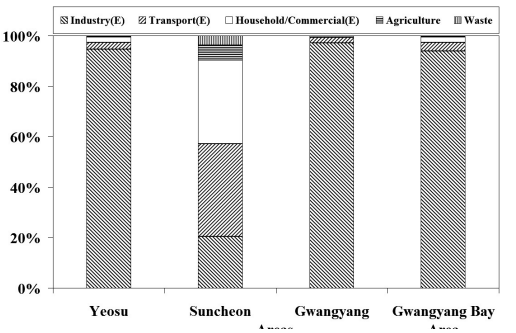

Fig 6. Distribution of GHG emissions at Gwangyang Bay Area. (E): energy sector.

concentration during summer is lower than the concentration of any other season, it showed the similar concentration trends to the national data at Annmyon-do from 1999 to 2008 as shown in Fig 5.[11] Because the photosynthesis in summer is higher than in other seasons, with the increase of absorbing capacity of plant for CO_2 absorption, the CO_2 concentration in summer is lower than the concentration of any other season. The average trend of the distribution of CO_2 concentration was shown to be in the order of Gwangyang Industrial Complex area > Yeosu Industrial Complex area > Yeosu Expo area > control area, it was confirmed that the industrial activities have an effect on the atmospheric CO_2 concentration.

3.2. Characteristics of GHG emissions

The distribution of GHG emissions of Gwangyang Bay Area and the distribution of GHG emissions of each sector are shown in Fig 6 and 7, respectively. In the case of Yeosu, Gwangyang and Gwangyang Bay

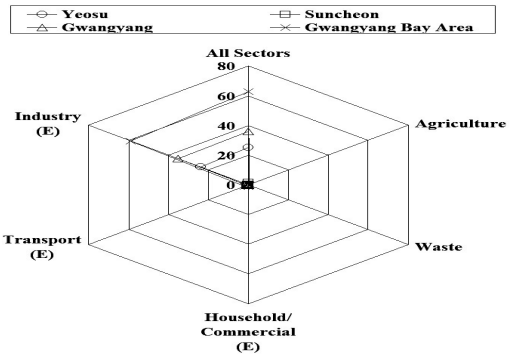

Fig 7. Distribution of GHG emissions of each sector (Unit: $MtCO_{2eq}$). (E): energy sector.

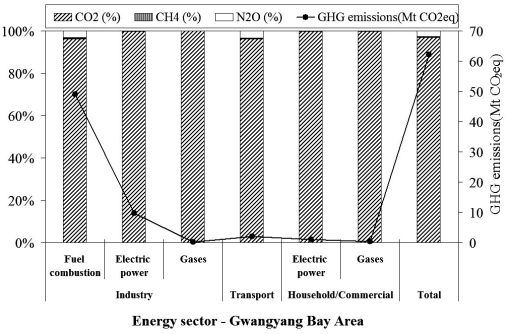

Fig 8. GHG emissions from energy sector at Gwangyang Bay Area.

Area, the energy sector including industry, transport and household/commercial portion is the single largest source of GHG emissions, accounting for about 99.4% of total GHG emissions from all emissions sources. There are approximately 62 $MtCO_{2eq}$ GHG emissions at Gwangyang Bay Area in 2005, and the GHG emissions proportion was in the order of Gwangyang (35.9 $MtCO_{2eq}$) > Yeosu (25.0 $MtCO_{2eq}$) > Suncheon (1.7 $MtCO_{2eq}$). As illustrated in Fig 8, the industry portion consists of fuel combustion, electric power and gases while the household/commercial portion consists of electric power and gases. Most of the GHG emissions from energy sector came from fuel consumption at Gwangyang Bay Area. Energy-related activities are also responsible for CH_4 and N_2O emissions, but the proportion of the CH_4 and N_2O emissions is lower than 3 % of the total GHG emissions from energy sector. As the CO_2 absorbing source, the land use and forestry sector removed CO_2 about 0.2 Mt and it was lower than 0.3 % of total GHG emissions at Gwangyang Bay Area in 2005.

3.3. GHG emission/capita at Gwangyang Bay Area

Table 2 shows the Gwangyang Bay Area's CO_2 emission/capita compared to other countries in 2005. The GHG emissions related to energy sector from the Organization for Economic Cooperation and Development (OECD) countries was estimated about 16,376 $MtCO_{2eq}$. It was near to one-half of the world total GHG emissions. The proportion of GHG emissions from energy sector at all of the OECD countries are higher than 50% except New Zealand. In the case of Gwangyang Bay Area, the proportion of GHG emissions from energy sector are about 99.4% of the total GHG emissions, it is higher than 77.1% in Korea, 80.3% in USA, 89.3% in Japan and

Table 2. Gwangyang Bay Area's GHG emission/capita compared to other countries in 2005

Country/ region	Total GHG emissions ($MtCO_2eq$)	GHG emissions from energy sector ($MtCO_2eq$)	The proportion of GHG emissions (%) (Energy sector to the total GHG emissions)	CO_2eq/pop[a] (tCO_2eq/capita)	Reference
Yeosu	25.0	24.9	99.4	64.80[b]	This study
Suncheon	1.7	1.6	90.2	0.01[b]	
Gwangyang	35.9	35.8	99.8	211.07[b]	
Gwangyang Bay Area	62.6	62.3	99.4	69.01[b]	
Korea	582	449	77.1	9.30	OECD[c]
Canada	747	549	73.5	17.00	
Mexico	553	389	70.3	3.70	
USA	7,241	5,817	80.3	19.61	
Japan	1,360	1,214	89.3	9.50	
Australia	525	377	71.8	18.41	
N.Zealand	77	35	45.4	8.51	
Austria	93	77	82.5	9.38	
Belgium	144	112	77.9	10.67	
Czech Rep.	146	118	81.0	11.55	
Denmark	64	48	75.1	8.77	
Finland	69	55	79.4	10.56	
France	558	388	69.5	6.19	
Germany	1,001	813	81.2	9.87	
Greece	139	96	68.9	8.62	
Hungary	80	58	72.3	5.72	
Iceland	4	2	54.0	7.37	
Ireland	70	44	62.9	10.55	
Italy	580	454	78.3	7.76	
Luxembourg	13	11	86.4	24.67	
Netherlands	212	183	86.3	11.21	
Norway	54	37	68.3	8.01	
Poland	399	296	74.2	7.75	
Portugal	86	63	73.7	5.97	
Slovak Rep.	48	38	79.4	7.11	
Spain	441	342	77.6	7.87	
Sweden	67	51	76.2	5.64	
Switzerland	54	45	83.9	6.00	
Turkey	312	219	70.1	3.04	
UK	657	530	80.6	8.80	
OCED(Average)	546	430	78.8	-	

Source:

(a) CO_2 emissions from fuel combustion only (OCED). Emissions are calculated using IEA's energy balances and the Revised 1996 IPCC Guidelines, The International Energy Agency (IEA), www.iea.org

(b) http://kostat.go.kr/nso_main/nsoMainAction.do?method=main&catgrp=nso2009

(c) OECD, 2007[12]

78.8% in OCED average. Because the Gwangyang Bay Area is the center of petrochemical and steel industries in Korea, so large numbers of GHG was released from the energy sector. In addition, Gwangyang Bay Area's CO_2 emission/capita was 69.01 tCO_2/capita, it is much higher than the national average of 9.30 tCO_2/capita and any other OECD country. Especially at Gwangyang, the CO_2 emission/capita was 211.07 tCO_2/capita, this implied that the Gwangyang Bay Area is a highly industrialized area. In order to reduce the use of and change the framework of fossil-based energy sources at Gwangyang Bay Area, actions will be taken to enhance energy efficiency and increase the use and supply of clean, renewable energy for decreasing the GHG emissions. In addition, further works will be to obtain the more accurate activity data and ensure the transparency, completeness, consistency, comparability and accuracy of the inventory quality for more accurate calculation of GHG emissions.

4. Conclusions

In this study, the distribution of CO_2 concentration in ambient air and the GHG emissions at Gwangyang Bay Area are investigated. The mean CO_2 concentration varied from 378.5 ppm to 394.6 ppm and the mean concentration during summer is lower than the concentration of any other season. The average trend of the distributions of CO_2 concentration is shown to be in the order of Gwangyang Industrial Complex area > Yeosu Industrial Complex area > Yeosu Expo area > control area. It was confirmed that the industrial activities have an effect on the atmospheric CO_2 concentration. There are approximately 62 $MtCO_{2eq}$ GHG emissions at Gwangyang Bay Area in 2005, and the GHG emissions proportion was in the order of Gwangyang > Yeosu > Suncheon. The energy sector is the single largest source of GHG emissions, accounting for about 99.4 % of total GHG emissions at Gwangyang Bay Area and it is higher than the proportion of 77.1 % in Korea, 80.3 % in USA, 89.3 % in Japan and 78.8 % in OCED average. The CO_2 emission/capita at Gwangyang Bay Area was 69.01 tCO_2/capita. Especially at Gwangyang, the CO_2 emission/capita was 211.07 tCO_2/capita, it is much higher than the national average of 9.30 tCO_2/capita and any other OECD country. This means that the Gwangyang Bay Area is a highly industrialized area and large numbers of GHG was released from energy sector by petrochemical and steel industries. In order to decrease the GHG emissions, it should to enhance energy efficiency and increase the use and supply of clean, renewable energy to instead of fuel consumption.

5. Acknowledgement

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