S · U · M · M · A · R · Y

SUMMARY

Climate Change and Sustainable Land Management Strategies in Korea

Yeong-Kook Choi, Jin-Kyu Chung, OuBae Sim,
Moon-Woun Lee, Eun-Sun Im, Myung-Soo Kim,
Kwangik Wang, Yeonmi Seo, Jung-Eun Park

Chapter 1. Introduction

At the present, inventories of Korea's greenhouse gases (GHG invent ories) are available at a national level. They are useful both to compare adaptation policies on climate change between countries and to identify the levels of GHG reduction followed by intergovernmental agreements. However, they have limited abilities to detect vulnerable areas in terms of climate change, as their geographical units are too largeto display detai led spatial information on GHG emissions. In order to acquire the practic alities necessary for carrying out adaptation policies to climate change, as well as to take into account local conditions, it is necessary to build GHG inventories at a regional level and subsequently to detect the pocket s of areas that are vulnerable to climate change.

The study is designed to tackle these problems over a time period of three years, 2008-2010. The main purposes are (1) to investigate and assess vulnerability to climate change across regions and (2) to address sustainable national land management strategies. During the first year, the focus of this study is on calculating GHG emissions and identifying local conditions. In the following year, the study aims to predict the impa cts of climate change and derive potential projects. Finally, it continues to address adaptation strategies to climate change across regions and to suggest suitable institutional measures aimed at pursuing sustainable national land management to adapt to climate change.

This first year report is organized into seven chapters. Chapter 1 provides a general introduction. Chapter 2 reviews previous studies on climate change to understand the limitations of contemporary policies. Chapter 3 reviews previous studies conducted in other countries, includi ng Japan, the UK, the USA, the Netherlands and Canada in order to discover their implications for Korea. Furthermore, Chapter 4 explains the methods used to calculate GHG emissions across regions and Chapter 5 presents GHG emissions in Korea at a regional level and its local conditi ons. Using these GHG inventories, Chapter 6 investigates the relationship between local conditions and GHG emissions. Moreover, the basic emissi ons unit of carbon dioxide for each type of land use is presented in this chapter. As a concluding section, Chapter 7 presents the motivations, limitations and academic and political implications of this study.

Chapter 2. Climate change and policies in Korea

Recently climate change has become one of our main concerns, as it affects human life in various ways. However, the climate change policie s of Korea have not dealt with these issues effectively due to a lack of studies, in particular, on the establishing of relevant spatial and attribute databases. After building GHG inventories at a regional level and underst anding the characteristics of emissions and the potentials for GHG reduct ion in each region, it is possible to address targets for GHG reduction levels and subsequently to set out suitable climate change policies for adaptation to climate change. However, there is still a long way to go.

More specifically, local governments are promoting a number of tentative projects for adaptation to climate change with the support of the Ministry of Environment. For instance, some local governments, such as Seoul Metropolitan Government, are carrying out projects using their own budget. However, most of them are not conducted in a planned and systematic way, but on an ad hoc basis. As only a small number of local governments investigate emission sources and emission levels, there is a need to improve on their performance.

Chapter 3. Experiences of other countries and their implications for Korea

In order to set up GHG inventories based on regions and GHG emissions sectors, the report reviews a number of previous case studies that have been carried out in other countries. As there is no fully agreed method of creating GHG inventories, we will investigate in detail how each country chooses different methodological options from the GHG emissions inventories guidelines suggested by the Intergovernmental Panel on Climate Change (IPCC). The five selected countries include Japan, the UK, the Netherlands, the USA and Canada. Taking the example of Japan's climate change policy, we will review how to set out guidelines on regional promotion plans for adaptation to climate change and how to calculate GHG emissions. In the case study of the UK, it is investigated how to build GHG inventories at a small area level. Furthermore, this report deals with the Netherlands'land use planning and assessment system for adaptation to climate change in relation to transportation. In the examples of the USA and Canada, it examines a number of important climate change policies and case studies on GHG inventories at regional levels.

The central government of Japan has developed the regionally-based promotion of climate change planning, which is used to describe a way of building GHG inventories and how local authorities play an important role in coping with climate change. This makes it possible both to build several GHG reduction scenarios and to address suitable policies for adap ting to climate change. In the UK, the detailed GHG inventories have been developed in order both to assess emissions across local authorities and to create scenarios for each sector of GHG emission categories, which is eventually used to mitigate GHG for each sector of GHG sources. In order to avoid a development-oriented paradigm towards constructing roads, the Netherlands has begun to pursue 'sustainable and green transp ortation'which aims to minimize environmental deterioration. Furthermo re, local authorities aim to minimize GHG emissions by reviewing the negative impacts of the construction of transportation facilities on the economy, the environment, society and culture. After identifying the pres ent conditions of GHG emission, the USA has developed regional action plans to meet the reduction target of GHG. Eventually, each municipal government will work in close collaboration to achieve GHG reduction goals by monitoring and sharing relevant information. In addition, Canad a is adopting a comprehensive approach, in reducing both GHG emission s and air pollution.

Chapter4. Calculation of regionally-based GHG emissions

This chapter describes how to create GHG inventories and how to calculate the GHG emissions. In this study, the categories of emissions cover only the following sectors: (1) energy, (2) agriculture, (3) waste and (4) land use change/forests, although the IPCC guidelines suggest seven categories, including industrial processes, solvents and the use of other products. This is because it is difficult to identify GHG emissions from sectors of industrial processes and solvent production. At the same time, because of data constraints, only three greenhouse gases are conside red in this study. They include carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), although GHG inventories generally take account ofother gases such as hydrofluorocarbons (HFC), perfluorocarbons (PFC) and sulphur hexafluoride (SF6). The time period of the study is the years 2000, 2003, 2005 and 2006, while the study areas cover 234 local authorities.

The IPCC guidelines, which are often used to assess GHG emissions, have been reviewed. In particular, in order to help understand how to compute carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), this study summarizes and describes the IPCC guidelines. For instance, the emissions of carbon dioxide (CO_2) can be measured for each stage of the industrial process, including (1) the combustion of fuel products, (2) the conversion from fuel consumption to common units, (3) the emissi on factor for each fuel, (4) the estimation of potential emissions from products and (5) the conversion from non-CO_2 gases into the equivalent masses of carbon dioxide in global warming.

In addition, the study deals with the limitations of these approaches and the issues involved in setting up the database and measuring GHG emissions for the two approaches: nationally and regionally based emissi on inventories. The energy sector shows the greatest limitations in addres sing GHG inventories since it is mostly controlled by central government which mainly focuses on its supply side. For example, there is no consiste nt emissions sources data available for energy providers (i.e., industrial, commercial, public and domestic sectors). This leads to difficulties in addressing climate change policies designed to mitigate GHG at a regiona l level. Thus, data availability was a major challenge in assessing regional ly based GHG emissions for each sector. Furthermore, it is necessary to develop more accurate emission factors, which are the most well suited to the Korean situation. Finally, the most important factor is for local authorities to create and renew GHG inventories on a regular basis for the use of GHG reduction.

Chapter 5. The geography of GHG in Korea and its characteristics

In this study, GHG emissions are divided and summarized into the following categories: (1) annual emission rates and emission/absorption sources of GHG, (2) metropolitan, provincial, municipal, county (Gun) or borough (Gu) geographical units and (3) emissions based on cities and population sizes. For the period 2000-2006, the total emissions rise slightly. In terms of emission and absorption sources, GHG emissions increase in the energy sector, whereas they decrease in the agriculture and waste sectors. At the same time, the absorption rates decrease. This indicates that it is necessary both to mitigate GHG in the energy sector, in particular, by saving energy and protecting the absorption sources of GHG with the setting out of institutional support. In the energy sector, emissions from the use of petroleum are declining, whereas those from electricity use are increasing. This indicates that energy consumption mai nly relies on electricity in Korea.

In terms of the spatial differences of GHG emissions, GyeongGi-Do shows the largest emissions, whereas Jeju Special Self-Governing Provinc e shows the smallest. When taking population size into account, the highe st GHG emissions per capita can be found in Jellanamdo, whereas the least are found in Jeju Special Self-Governing Province. On a larger scale, GHG emissions per capita are recorded at high levels for local authorities such as Yeosu, Seo-San City, Uljugu-Gun(Ulsan), Nangu (Ulsan) and Buk gu(Ulsan). Thus, Ulsan is identified as a city which produces high levels of GHG.

In terms of the energy sector, which emits most of the GHG, the local authorities of Yeosu(Jellanamdo), Namgu(Ulsan), Uljugu-Gun(Ulsa n) and Gumi(Gyeongsangbuk-Do) show highemissions levels. Furthermo re, low emissions are found in Ulleung-Gun(Gyeongsangbuk-Do), Yeong yang-Gun, Ongjin-Gun(Incheon), Shinan-Gun(Jellanamdo) and Gyeryong City (Chungcheongnam-Do). In general, the regions with the higher GHG emissions per capita are also grouped as those with the higher total GHG emissions. However, Seoul and Busan show higher total emissions per capita, whereas the two cities show relatively smaller annual total GHG emissions per person. The total GHG emissions are large, but when one considers the population size, emissions are relatively small.

Regarding GHG emissions (per capita) for cities, cities in the range of middle-sized/large cities show the highest emissions. Further, emissio ns are recorded in the following order: (1) middle-sized, (2) large, (3) middle-sized/small, and (4) small cities. In other words, when taking into account the population size, the cities with populations ranging from 300,000 to 500,000 are likely to emit more GHG than metropolitan cities. Comparing the average value of total emissions per capita in Korea, midd le-sized /large cities show higher GHG emissions, whereas large, middle-sized/small and small cities show lower emissions.

It also reveals that the more the GHG absorption rate per capita increases, the larger the population size is or the smaller cities are. In other words, GHG absorption is more active for the regions with the smaller population sizes. On the contrary, GHG emissions in the agricult ural sector generally rise when city sizes decline. The reasons behind this will be understood when we investigate the relationship between local conditions and GHG emission rate.

Chapter 6. Capabilities of GHG inventories for sustainable national land management

In order to address adequate GHG reduction policies, correlation ana lysis is carried out between carbon dioxide emissions per capita (depende nt variable) and 39 independent variables, which represent local conditio ns. As a result, GHG emissions are positively related to built-up areas per 10,000 population, industrial area rate and car-ownership, whereas they are negatively associated with population density and green space. This reveals that parks and green spaces, as a GHG absorption source, play a significant role in mitigating GHG. In addition, these results make it possible to identify the main indicators which determine GHG emission s. Finally, it can be found that the size of areas of land, patterns of land use and transportation factors are more closely related to GHG emissions than socio-economic characteristics. In other words, the findings suggest that GHG reduction can be achieved by improving urban physical structu re in relation to urban land use and development.

As various human activities have impacts on characteristics of CO_2 emissions, land use types may determine the levels of CO_2 emissions. Thus, the basic unit of CO_2 emission for each type of land use would be very useful to adapt to climate change and to pursue a low carbon society in the future. As a case study, we will consider the GIS database, which includes comprehensive information on energy use and land use for each address, created for the metropolitan city of Daegu. In the case of the averaging of CO_2 emissions for each type of land use, commercial facilities emit the greatest amount of GHG, totaling 315.9 (kg/㎡·year, CO_2), whereas facilities in relation to industry and goods distribution emanate 193.6 (kg/㎡·year, CO_2) on the basis of floor space. In the domest ic sector, detached houses and apartments respectively emit 63.3(kg/㎡·y ear, CO_2) and 48.5(kg/㎡·year, CO_2). Apartments emit lesser carbon dioxi de based on the basic unit for floor space. Furthermore, common commer cial buildings and central commercial buildings emit 163.4 (kg/㎡·year, CO_2) and 83.0 (kg/㎡·year, CO_2), respectively. Thus, it is found that centra l commercial buildings emit less CO_2.

In the case of public facilities, welfare or community public facilities (in particular, those involved in producing air or water pressures) use high levels of energy to emit 147.0 (kg/㎡·year) of carbon dioxide. In industrial processes, on the basis of floor space, carbon dioxide is emitted at 193.6(kg/㎡·year), which is recorded at the highest level. Probably, the reason is that low-density land use is likely to occur in areas with industry and goods distribution facilities. As a result, this study can ident ify local characteristics in terms of spatial differences in carbon dioxide emission on the basis of energy consumption at the small area level. In addition, in order to cope with climate change, the findings can be used as a basic unit for addressing land use policies, which aim to save energy and to pursue a low carbon society.

Although the GHG inventories developed in this study have limited capabilities in terms of the data and analytic methods used, this study is still meaningful in that it suggests the potential use of inventories in adapting to climate change. Apart from this use of GHG inventories, they can also be used to measure sustainable national land management.

Chapter 7. Conclusion

The first year report, aiming to cope with climate change and address sustainable national land development strategies, is significant from these three angles. First, it paves the ground for establishing a variety of strateg ies and action plans by calculating GHG emission sat a local authority level. Next, it takes the first steps towards revealing the dominant factors which have an impact on GHG emissions, by analyzing the relationship between GHG emissions and local conditions. Third, it makes it possible to review the ways of mitigating GHG emissions based on the basic emiss ion unit for each land use type.

The common focal point of the above three angles is that it is a 'first attempt'in this field. The originality of this study can be characterize d by saying that 'for the first time'it calculates GHG emissions at the small area level, it attempts to regress them with local conditions and it subsequently derives the basic unit of GHG emission sources using top-down and bottom-up approaches. As the research shows a highlevel of originality, it would be very useful for establishing climate change polices in Korea. On the other hand, it is true that this research has certain limitations, since both the data and the results are complete new. This requires the conducting of further research. Nevertheless, the results of this study will play a crucial role in carrying out the second and third year projects. On this basis, it will be possible to conceive action plans to meet GHG reduction targets for each region.

Further research topics may vary. They may include: (1) creating

database guidebooks for coping with climate change, (2) establishing gui delines for creating GHG inventories, (3) predicting GHG emissions base d on the correlation analysis results in the study, (4) selecting indicators which have an impact on GHG emissions, (5) determining the basic unit of carbon dioxide emission sources, while taking into account local condit ions across Korea and (6) assessing and simulating the effectiveness of central and local government policies.

Recently, green growth has become a major issue in Korea. Central government and local authorities have tried to develop a new policy on green growth. As such, the idea of green growth is suggesting a new national agenda for tackling climate change as well as overcoming the energy crisis. In order to make green growth successful, we desperately need to pursue a low carbon society. This must begin with the mitigating of GHG. Then a new growth mechanism should be adopted on the basis of developing new renewable energy sources and renovating green techn ologies. In turn, this will lead to the mitigating of GHG emissions. In this context, there is no doubt that identifying the current situation in relation to GHG emissions across regions is central to the achieving of successful green growth.

■ Key words _ Adaptation to climate change, greenhouse gases inventories, estimation methods, correlation analysis, basic emission unit for each land use type