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A Study on Reduction of Fine Dust in Relation to National Greenhouse Gas Inventory

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ABSTRACT

With the increase in economic activities in Korea since 1970, air pollution problems such as greenhouse gases and fine dust have started to occur. In recent years, the risk of fine dust has become well known, causing the requirement for it to be reduced. Therefore, this study investigates mitigation methodology to reduce fine dust at the national level. In addition, fine dust and greenhouse gases both originate from fuel combustion. Therefore, they have been studied in connection with the national greenhouse gas emissions. Furthermore, this research was conducted on the building sector. Existing literature involves studies to reduce concentrations at the building and city levels. However, these studies focused on reducing total dust emissions at the national level. This study primarily analyzed the items proposed in the "Micro Dust Management Plan" and proposed a method to reduce fine dust. In addition, it was established that the national greenhouse gas emissions and emission sources are very similar, suggesting a linkage in reduction plans.

Keywords: fine dust; national greenhouse gas emissions; national units

Introduction

Korea has been experiencing air pollution problems, due to increased concentrations of greenhouse gas and fine dust, as economic activities have increased because of the rapid economic growth since 1970. In recent years, fine dust is becoming a social issue among air pollutants. Fine dust can be classified into two types according to the size of particles, as stated by acts 2 (6) of the Air Quality Preservation Act. Dust particles with a diameter of 10 μm or less are defined as PM10, and particles with a diameter of 2.5 μm or less are defined as PM 2.5, which is called ultrafine dust. PM2.5 ultrafine dust is known to be more harmful to the human body than is PM10, because PM10 is partially filtered out from the bronchial tubes, while PM2.5 sized fine dust penetrates into the lungs. The substances that produce fine dust are nitrogen oxide, sulfur oxides, and volatile organic compounds. The production of fine dust can be classified according to natural, artificial, and complex causes. Natural causes include dust, iron and calcium carbonate in wind-blown fugitive dust. Most of the micro dust generated by natural causes is fine dust of PM10 size. Anthropogenic causes include power plants, fuel combustion, industrial activities, and heavy metals

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such as sulphate, nitrate, and water. Artificially generated fine dust is PM2.5 sized ultrafine dust [1]. Most fine dust is caused by artificial causes. Fuel combustion is attracting attention as a primary cause of artificial fine dust. As a result, ultrafine dust tends to increase in the winter when heating is increased and when the greenhouse gas emissions also increase. For coal-fired thermal power plants, efforts are being made to shut down old power plants and reduce the proportion of thermal power plants [2]. Fine dust is caused by combination of artificial and natural factors.

According to statistics on fine dust, the notices of fine dust (PM2.5) occurred 51 times in 2016 and 86 times in 2017, exhibiting an increase of 45%. In addition, because the International Agency for Research on Cancer (IARC) has designated fine dust as a Group 1 carcinogen that is known to cause various diseases in the human body, there is a desperate need for fine dust reduction. To address this need, the Korean government has announced various action plans for the generation of fine dusts and fine dusts, including the "Special Act on Fine First Reduction and Management" (hereinafter referred to as the "Fine Dust Law") and various other policies for the reduction of fine dust. Therefore, this study investigates the mitigation methodology for the reduction of fine dust at the national level. In addition, fine dust and greenhouse gases both originate from the same fuel combustion source, so fine dust has been studied in connection with the national greenhouse gas emissions [3]. The cause of fine dust generation in each field is different, and research studies have been conducted with a focus on the building sector. The reason for this choice is that it accounts for approximately 45% of the nation's total electricity consumption. This study investigates mitigation methodology to reduce fine dust in the building sector focused on the national greenhouse gas inventory connection plan.

Literature Review

An existing literature analysis on the fine dust reduction in the building sector was conducted. Existing papers focus primarily on the study of building units and urban units [4]. The studies on building units were primarily based on the ventilation system for fine dust removal, the amount of fine dust inflow according to the ventilation method, and the fine dust inflow path. The ventilation system for fine dust removal covers the air shower system, which prevents fine dust inflow through the paper [5]. The study on the micro dust reduction according to the ventilation method analyzed the contents of the mechanical ventilation system and the inflow amount of micro concentrations with respect to time. The study on the fine dust inflow route found that the path differs according to the layer of the building, and therefore, the contents of the inflow route analysis necessary for the layer are included. The existing study on the reduction of fine dusts in urban areas explored the introduction of a wind route in the city and the urban management plan to cope with the fine dust. Most studies investigated the reduction of fine dusts through the formation of a wind path at the city level. A study on the urban management plan to reduce fine dust through the wind route has also been conducted [6]. However, in the case of Seoul in Korea, the reduction of fine dust in Seoul was studied in terms of the policy aspect. Table 1 presents the results of the analysis of existing studies on fine dust reduction in buildings and cities.

Table 1. Analysis of existing research on fine dust reduction in building units

Research Purpose	Main Content	Fine Dust Reduction Methodology
Removal of fine dust in the room (Building level)	Study on reduction of indoor fine dust by improving building ventilation system	Air shower system reduces the amount of fine dust in the building
Reduction of fine dust inflow (Building level)	Analysis of fine dust concentration by mechanical ventilation method	Reduction of fine dust inflow through suggestion of hourly mechanical ventilation method
Analysis of causes of fine dust inflow (Building level)	Analysis of causes of fine dust infiltration by floor of building	Reduction of fine dust inflow through floor management plan
City's fine dust reduction (City level))	City fine dust through wind route formation Concentration reduction	Decrease of fine dust concentration using wind path not causing fine dust generation
City's fine dust management plan (City level)	Need to design wind route in urban planning	Reduction of fine dust concentration considering wind route in city planning stage

After analyzing existing literature, a study was conducted on the mitigation measures implemented at the building and city levels. In addition, the research focused on reducing the concentration of fine dust in the room rather than analyzing and reducing the root cause [7]. At the city level, the study was carried out to reduce the fine dust concentration through the formation of a wind path in the city rather than a reduction at the origin of the fine dust. Therefore, research on the reduction of fine dust from the stage of micro dust generation is required rather than the reduction in the generated fine dust density. In addition, an overall reduction in Korea is required through a reduction at the national level.

Based on the analysis of existing literature, this study examines the reduction from the cause of fine dust at the national level, which is wider than the city level. In addition, a study was conducted in connection with national GHG emissions, which are very similar to micro dust and its origins.

Fine dust reduction plan

Research methodology and process

This study was conducted by selecting the scope of the research based on the results of the existing literature analysis and conducting the process as shown in Figure 1.

The scope of the research was limited to the building sector. The research was conducted to calculate the amount of fine dust reduction at the national level. It proposes a methodology to reduce the micro dust generation at the national level rather than reducing the fine dust concentration in buildings. In addition, the generation of fine dust and greenhouse gases is caused by fuel combustion, and we have studied the reduction plan through the linkage at the national level.

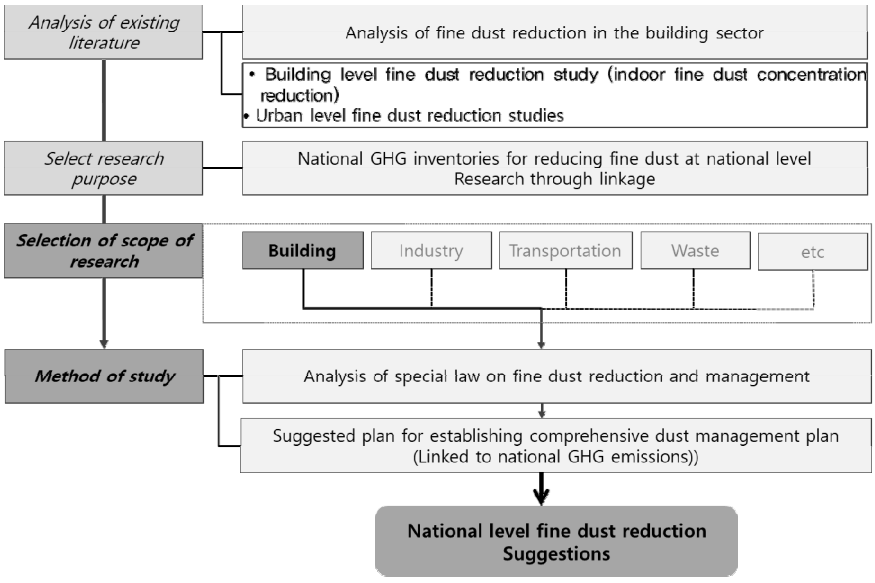

Figure 1. Research methodology and process.

Research scope selection

The scope of this study was limited to the building sector, and the methodology for fine dust reduction at the national level was studied. Existing papers focus on the reduction of the fine dust concentration in the interior of the building. However, if the concentration of fine dust in a building is simply reduced, the total amount in the nation is unchanged, making it difficult to solve the fundamental problem of Korea. Our study was conducted by considering the amount of fine dust.

To reduce the amount of fine dust, the 'Fine Dust Act' studied the reduction plan for that phase of the micro dust management comprehensive plan. The Special Act on Fine Dust Reduction and Management is the national law that Korea announced in 2019 to reduce fine dust. This study has no clear methodology for the abatement in the statute of the state, and it proposes relevant methodology. In other words, the scope of the study is shown in Figure 2.

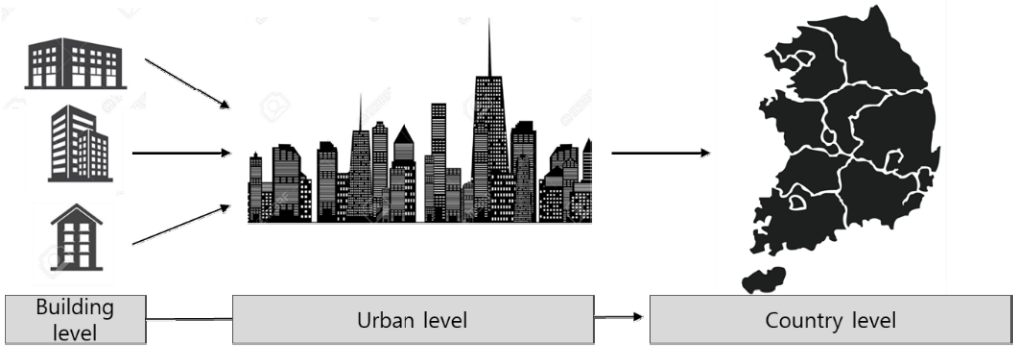

Figure 2. Scope of research.

Study on the reduction plan

The Fine Dust Act Article 7 (Establishment of comprehensive dust management plan) should establish a comprehensive plan for fine dust reduction and management every five years. Table 2 presents the items for the comprehensive micro dust plan [8]. The comprehensive plan consists of 8 items, which can be segregated into technical items and economic items. The economic items are excluded from this study because they cannot be linked to greenhouse gases. Economic items and the fine dust vulnerable categories are not required to be linked to greenhouse gases, and it is impossible to link them with GHG emissions. It is difficult to establish individual measures in the case of greenhouse gases, because problems arise at the national level.

Table 2. Type of fine dust comprehensive plan

Division	Contents
Technical items	Objective and basic direction for improving fine dust concentration
	Status and forecast of fine dust concentration
	Status and forecast of fine dust emissions
	To reduce emissions of fine dusts and other measures to achieve this goal
	Investigation and study on the effect of fine dust on the public health
Economic item	Matters concerning protection of fine dust layer
	Matters concerning the size of the financial resources required for implementing the comprehensive plan and the financing plan

There is no specific plan in the fine dust comprehensive plan. Therefore, in this study, the technical items suggested the fine dust reduction method as shown in Figure 3.

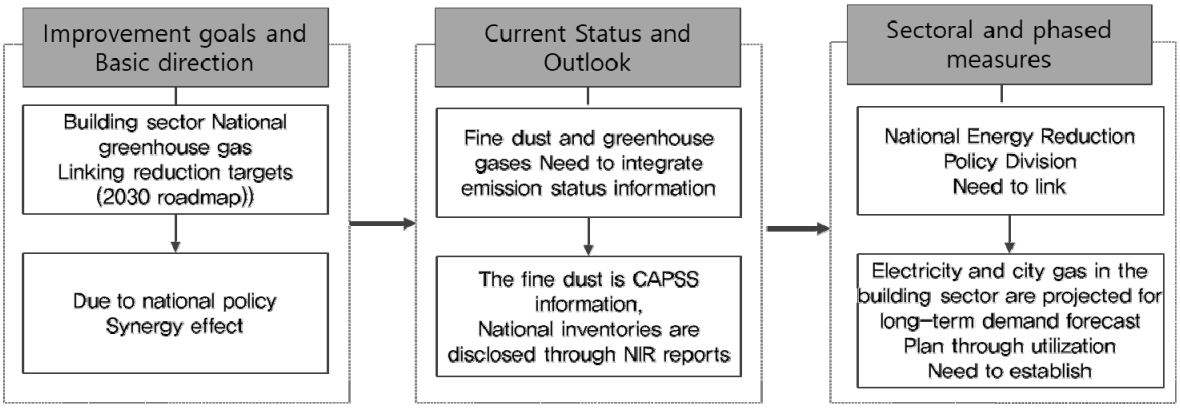

Figure 3. Fine dust reduction plan by item.

※ CAPSS(Clean Air Policy Support System)

① Goal of fine dust concentration improvement and basic direction

Both fuel combustion and national greenhouse gases are caused by fine dust. Accordingly, it is necessary to link the fine dust reduction with the Korean GHG reduction target. If two independent improvement targets are

established, it will be impossible to reduce both effectively due to policy inconsistency. Korea proposed a reduction target of 32% for greenhouse gas reduction in buildings by 2030. All greenhouse gas reductions are caused by energy use reduction. Hence, it is necessary to establish a fine dust plan through a linkage with these reductions.

② Status and forecast of fine dust concentration / emission

The fine dust concentration statistics are obtained through the atmospheric environment information, and national greenhouse gas emission statistics are obtained through 'NIR(National Greenhouse Gas Inventory Report Korea)'. Since the causes are the same, it is necessary to unify the concentration and emission status information in a binary manner and integrate their status. It is necessary to provide information on fine dust and GHG emissions simultaneously through unification. In the case of prospects, Korea is announcing its electricity supply and demand plan and its city gas long-term supply and demand plan. In terms of the current national greenhouse gas prospect, it is necessary to establish policies by linking with the electricity supply and demand plan and the city gas supply and demand plan. Policy agreements on the national energy policy and the fine dust and greenhouse gas reductions are required [8].

③ Target to reduce emission of fine dusts and measures for each sector and steps to achieve this

South Korea submitted its target for reducing greenhouse gases by 2030 to the international community under the Paris Climate Change Agreement. The total reduction goal of the country was announced to be 37%, and reduction scenarios were presented for each sector. Reducing the energy use in buildings is a policy that can reduce greenhouse gases and fine dust simultaneously. Separate micro dust and greenhouse gas policies create budget and policy disruptions. Therefore, it is necessary to show the emission reduction targets associated with Korea's 2030 greenhouse gas reduction roadmap and suggest measures for each sector. In particular, the building sector accounts for approximately 60% of electrical energy. Therefore, a step-by-step policy proposal regarding the reduction of electrical energy consumption is required [9].

④ Investigation and study on the effect of fine dust on the public health

Fine dust on the gutter is generated with the increase of greenhouse gas. It is difficult to directly link the dust with GHG, and it is impossible to directly link it with GHG emissions. The effect on public health due to the generation of fine dust is an item that needs to be linked with the reduction plan through an analysis of the total amount of fine dust.

Conclusion

This study involves a methodology for the reduction of fine dust and national greenhouse gas emissions.

1. Existing research focuses on reducing concentrations at the building level rather than reducing the total dust amount in Korea. Urban-level research was also conducted by reducing the concentration of fine dust in the city through the wind route.
2. To solve the root cause of fine dust, it was determined that a total reduction study is necessary from the

national point of view.

3. It was determined that the fundamental cause of fine dust is the same as that of greenhouse gas generation. Therefore, dust reduction needs to be linked with the greenhouse gas reduction plan.
4. The establishment of a fine dust reduction target requires a linkage with a roadmap for reducing GHG emissions, and a unified policy on the same cause.
5. The prospect of fine dust emission needs to be linked with national energy policies such as Korea's electricity supply and demand plan and long-term demand forecast for city gas. It is necessary to link with the national policy because this is the beginning of micro dust generation.
6. The establishment of reduction targets for each fine dust sector requires the prevention of duplication of policies in conjunction with the sectoral policies of the GHG reduction roadmap.

This study was conducted to reduce the amount of fine dust associated with greenhouse gas emissions at the national level. Korea is making efforts to find a clear cause of fine dust. In the future, it will become necessary to continuously study reduction by analyzing the causes of micro dust. This study can be used as a basis for the reduction of greenhouse gas emissions through the linkage of fine dust and national greenhouse gases.

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