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Effects of GHGs and air pollutants control in Northeast Asia on future air quality over Korea

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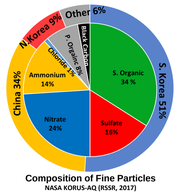
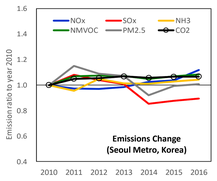
Ⅰ. Introduction & Objectives

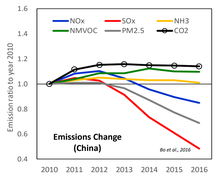
- Korean peninsula is located in the far east of the Eurasian continent where many industrial countries are located. NASA KORUS-AQ research shows that transboundary of China account for 34 % of fine particle concentration over the Seoul Metropolitan Area(SMA) in Korea.
- China has a significant influence on Korea's air quality, and China's emission reduction is expected to have a positive impact on Korea's air quality improvement
- Korea has entered an aging, will gradually approach red color. So, the sensitivity to health impact caused by PM2.5 is expected to continue to increase in Korea.

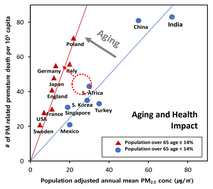
Research Questions

- What is the impact of PM2.5 concentration in Korea according to changes in air policies in Northeast Asian countries?
- How does the health impact change according to the PM2.5 concentration? and the effect of aging?

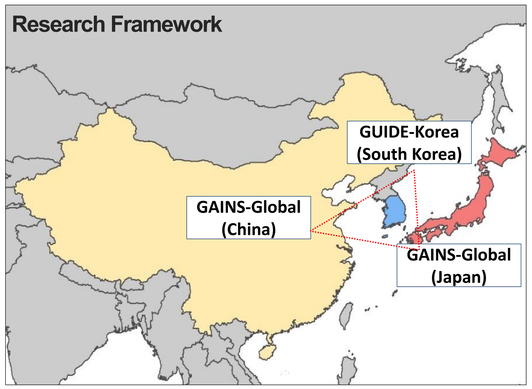






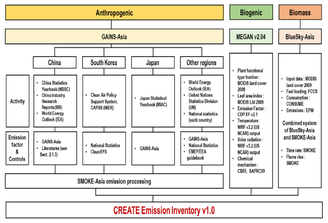


Ⅱ. Methodology



Ⅱ-1. CREATE(Comprehensive Regional Emissions inventory for Atmospheric Transport Experiment)

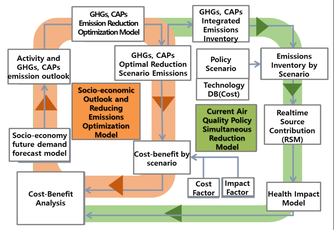
: Asia Emissions Inventory



Source: J-H Woo et al. , Development of the CREATE Inventory in Support of Integrated Climate and Air Quality Modeling for Asia, 2020

Ⅱ-2. GUIDE-Korea (GHGs and air pollutants Unified Information DEsign system-Korea)

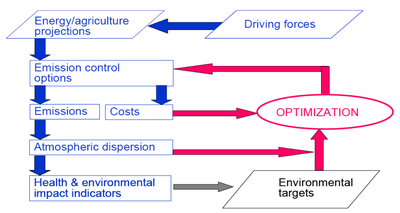
: Integrated Assessment Model in Korea



Source: Woo et al., KEITI, 2020

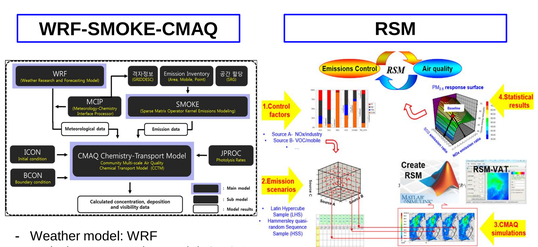
Ⅱ-3. GAINS- Global (Greenhouse Gas and Air Pollution Interactions and Synergy-Global)

: Integrated Assessment Model in Global



Source: Amann et al. , GAINS-Asia Methodology, 2008 ; http://gains.iiasa.ac.at/gains

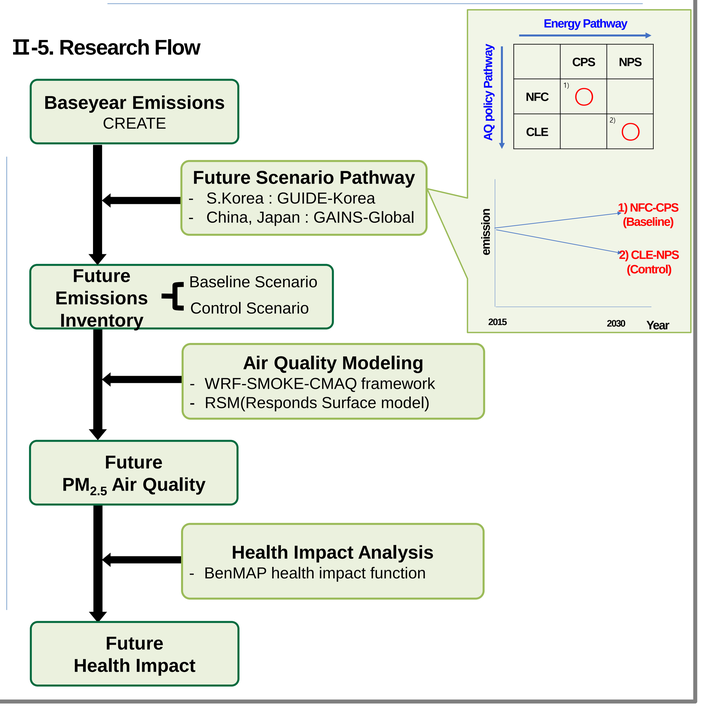
Ⅱ-4. Air Quality Modeling Framework



- Weather model: WRF
- Emissions Processing model: SMOKE
- Air Quality model : CMAQ

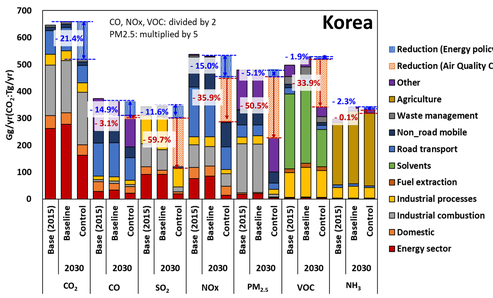
Source : Yun Zhu, Training and Demo of RSM-VAT(2017)

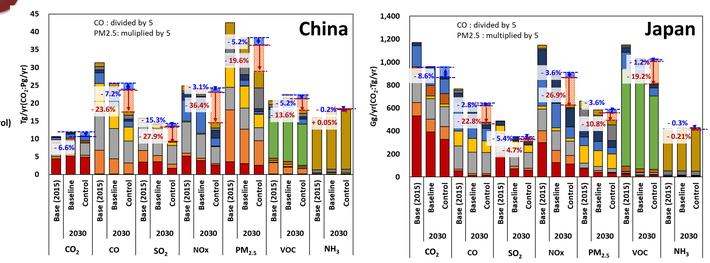
Ⅱ-5. Research Flow



Ⅲ. Result

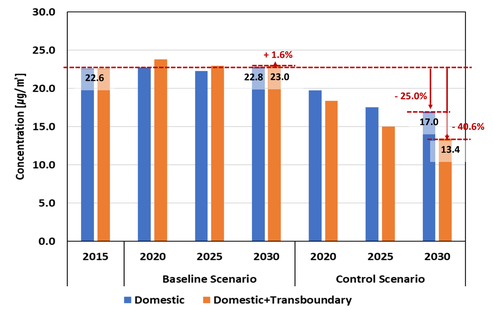
Ⅲ-1. Future Emissions Projection (2030)





- CO_2 has decreased due to energy policies, and air pollutants have decreased due to co-control effects. But co-control effects was not as large as the CO_2 reduction rate. The reduction rate of air pollutants was mainly due to the air quality control.
- Most pollutants decreased emissions in 2030 control scenario. But NH_3 shows a continuously increasing trend. This is because mitigation policies for NH_3 have been rarely applied.

Ⅲ-2. Future PM2.5 Concentration in Korea



- In the base year, Korea's PM2.5 concentration was 22.6 ㎍/㎥, and in the control scenario applied only to Korea, it decreased by 25.0% to 17.0 ㎍/㎥. When the three countries' control scenarios are applied, it is calculated as 13.4 ㎍/㎥, which reduces by 40.6% and decreases by 15.6% due to transboundary effects.

Ⅲ-3. Future concentration-based health impact

<BenMAP health impact function>

$$\Delta Y = Y_0 \left(1 - \frac{1}{e^{(\beta \times \Delta X)}}\right)$$

$$\Delta Y = \left(1 - \frac{1}{e^{(\beta \times \Delta X)}}\right) \times Incidence \times Population$$

ΔY: **Changes in health impact (i.e. changes number of premature deaths and patients)**

Y_0: Current in health impact (i.e. current number of premature deaths and patients)

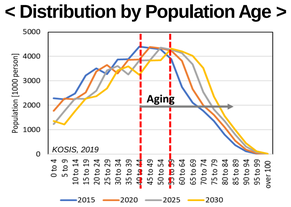
β: Concentration response (CR) function coefficient

ΔX: Air pollution concentration

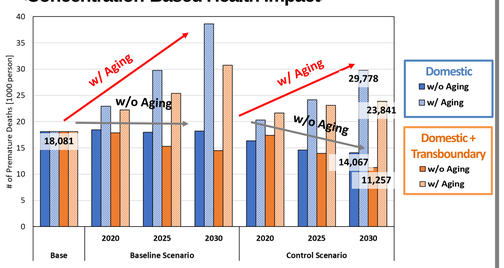
Incidence: Incidence rates (i.e. current mortality and morbidity rates)

Population: Exposed population

< Distribution by Population Age >



<Concentration-Based Health Impact>



- The number of premature deaths was 18,081 persons in baseyear, and in the control scenario applied all 3 countries, it decreased by 37.7% to 11,257 without Aging. However, considering population aging, the number of premature deaths increased by 31.9% from the base year to 23,841.

Ⅳ. Summary & Future Works

- We created future emission scenarios considering both energy-climate policies and air quality control in Korea, China and Japan. Most pollutants continue to decrease in all 3 countries, when considering both energy and air quality control, except NH_3.
- CO_2 has decreased due to energy policies, and air pollutants have decreased due to co-control effects.
- Calculated $PM_{2.5}$ Concentration in Korea was 22.6 ㎍/㎥ in base year, and calculated 13.4 ㎍/㎥, 40.6% decreased in 2030. Transboundary effects resulted in an additional 15.6% improvement in air quality.
- The number of premature deaths from related diseases is also reduced according to the decrease in PM2.5 concentration. However, health impact estimates that reflect an aging population could increase even with improved air quality.
- This study proceeded with the future emission scenario until 2030, the NDC target year. We plan to conduct further research by 2050, the target year for carbon neutrality.

• **ACKNOWLEDGEMENT**

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