The economic benefits of international co-operation to improve air quality in Northeast Asia

POLICY HIGHLIGHTS

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Air pollution in Northeast Asia

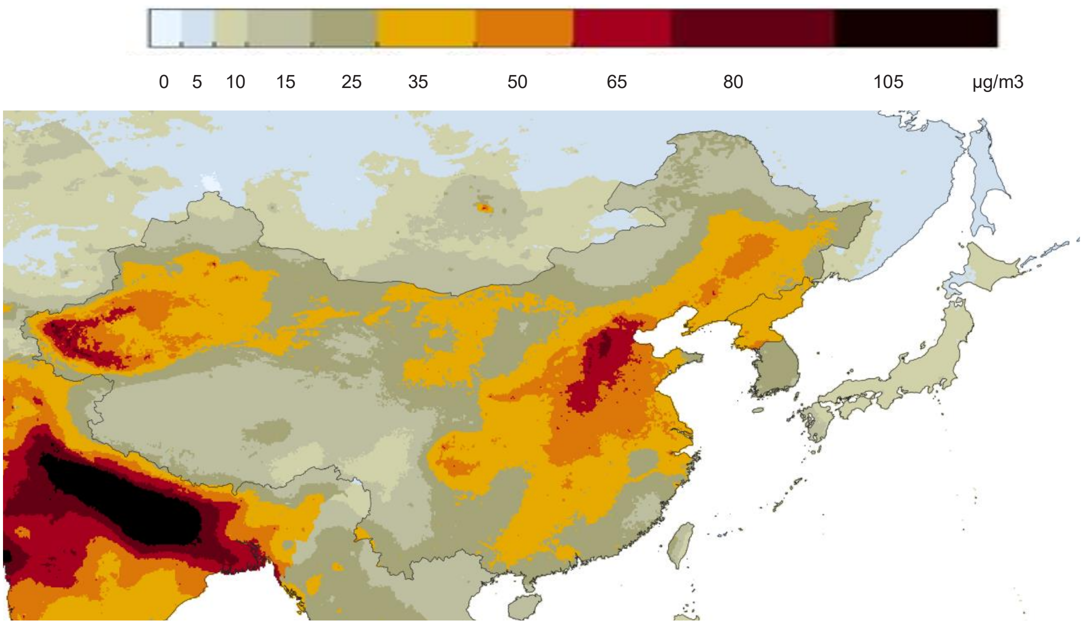
Air pollution is one of the most severe environmental risk affecting human health and well-being. Air pollution is associated with millions deaths and a number of debilitating illnesses. Furthermore, it affects economic growth since it decreases the productivity of both high and low-skilled workers, decreases crop yields, and increases health expenditures.

Air quality remains a key concern in most countries around the world. Northeast Asia, comprising Japan, Korea and the People's Republic of China (hereafter "China"), is particularly concerned with improving air quality given the high population density in several regions. Despite recent improvements across most regions of Japan and in the entire territory of Korea and China, average fine particle concentrations remain above the guideline levels of 10µg per cubic metre indicated by the World Health Organisation.

As air pollutants travel across borders, international co-operation is essential for addressing its cost effectively. Country-specific policy action increases air quality up to a point but international co-operation would significantly increase air quality in the region besides reducing the implementation cost of implementing such policies.

This Policy Highlights summary is based on the Working Paper "The economic benefits of international co-operation to improve air quality in Northeast Asia", which focuses on the benefits from internationally coordinated policy action on air pollution in Korea, Japan and China with time horizon to 2050.

Figure 1. **CONCENTRATIONS OF FINE PARTICULATE MATTER ($PM_{2.5}$)**
2019, Annual average concentrations of $PM_{2.5}$, µg/m^3, 2019.



Note: Concentrations include both anthropogenic and natural sources.
Source: OECD Environment Statistics database (2021), using Global Burden of Disease concentration estimates (IHME GBD, 2020[17]).

Main messages

- Without more stringent policies, emissions of several pollutants are projected to slowly decrease over time in Northeast Asia but this will not be enough to bring $PM_{2.5}$ concentrations in line with the Guidelines of the WHO (i.e. 10 $\mu g/m^3$) by 2050.
- If countries were to introduce ambitious policies unilaterally, air quality would substantially improve. In China, average $PM_{2.5}$ concentrations would halve compared to the projected level for 2050 under current policies. Concentration of $PM_{2.5}$ would be between 22% and 25% lower than in the current policies scenario in Korea and Japan.
- Coordinated policy reforms in Korea, Japan and China would bring substantial benefits by 2050. Average concentrations of $PM_{2.5}$ are projected to remain below the WHO guidelines of 10$\mu g/m^3$ annual concentrations in Japan while in Korea most regions are projected to have concentration levels in line with the WHO air quality guideline interim target-3 of 15 $\mu g/m^3$. In China, areas with severe air pollution levels (exceeding WHO interim target-1 of 35 $\mu g/m^3$), would shrink to regions with high natural dust contributions (North/Northwest China) and small patches in the most polluted areas of the Hebei province, with 97% of the population being under 35 $\mu g/m^3$.
- Better air quality would save numerous lives. If each country acted on its own, premature deaths would decrease, by 20% in Korea, 10% in Japan and 25% in China, while regionally coordinated policy action would save an additional 7750 lives. In China alone, unilateral policy action would avoid one in four deaths due to air pollution, amounting to around 340 thousand lives saved, with an additional 1400 lives saved in case of regionally coordinated action.
- The economic cost of saving these lives would be almost zero. The yearly macroeconomic costs of environmental policies are offset by macroeconomic benefits for Japan and China in all scenarios. For Korea, the costs are slightly higher than the benefits in the unilateral policy action scenario but not when policies are regionally coordinated. The cost of more stringent air quality policies decreases as more countries reform their air quality policy frameworks due to economy of scale in abatement technologies and a level playing field in international trade. Therefore, the global policy action scenario provides the highest macroeconomic benefits for all countries.
- The aggregate welfare benefits, which are an estimate of the economic value of lower mortality and avoided illnesses, are projected to exceed USD 900 billion and for regionally coordinated policy action by 2050 with an extra USD 100 billion with globally coordinated policy action. In case of unilateral action, yearly per capita welfare benefits are projected to be around 360 USD in Japan and 230 in Korea, and reach 600 USD in China. Regionally coordinated action would further increase per capita gains to 500 USD in Japan and 415 USD in Korea, whereas in China they are projected to range between 600 USD and 680 USD. Global coordinated policy action would further increase the per capita welfare benefits, with projections of a per capita benefit of 550 USD in Japan, 515 USD in Korea and 690 USD in China by 2050.

How to model the economic benefits of air quality improvements

The economic benefits of air quality improvements are quantified using the OECD ENV-Linkages model, with inputs from the GAINS (Greenhouse gas – Air pollution INteractions and Synergies) model developed by the International Institute for Applied Systems Analysis (IIASA) and the TM5-FASST model of the European Commission's Joint Research Centre (EC-JRC).

This suite of models is used following a step-wise procedure (Figure 3), which starts by linking economic activities to emissions of a wide range of air pollutants: sulphur dioxide (SO_2), organic carbon (OC), nitrogen oxides (NO_x), non-methane volatile organic compounds (NMVOCs), black carbon (BC), carbon monoxide (CO) and ammonia (NH_3). Emission of these gases lead to higher atmospheric concentrations of fine particulate matter ($PM_{2.5}$) and ground-level ozone (O_3), which are the drivers of the impacts of air pollution on human health and agriculture. These impacts have economic consequences (Figure 4),resulting from air pollution-driven changes in labour productivity, crop yields, and health expenditures.

ENV-Linkages can provide projections of the macroeconomic benefits of air pollution policies, resulting from higher labour and agricultural productivity and lower health expenditures. In the model, these benefits are weighted against the macroeconomic costs that follow investments in the best available techniques (BATs) to reduce air pollution. Additionally, the welfare costs related with mortality and morbidity are calculated using results of valuation studies, specifically the OECD's values of a statistical life.[1]

Figure 2. **STEPS TO STUDY THE ECONOMIC CONSEQUENCES OF AIR POLLUTION**

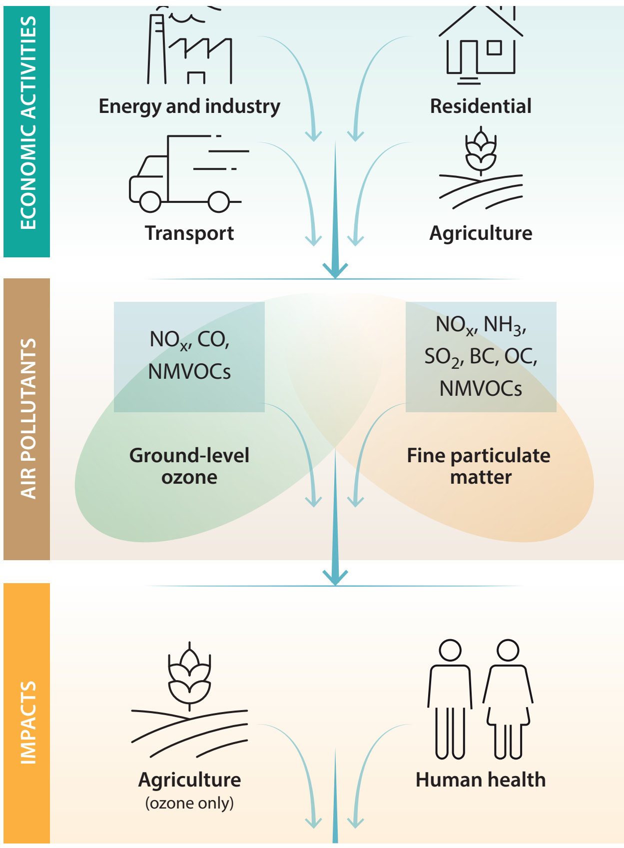
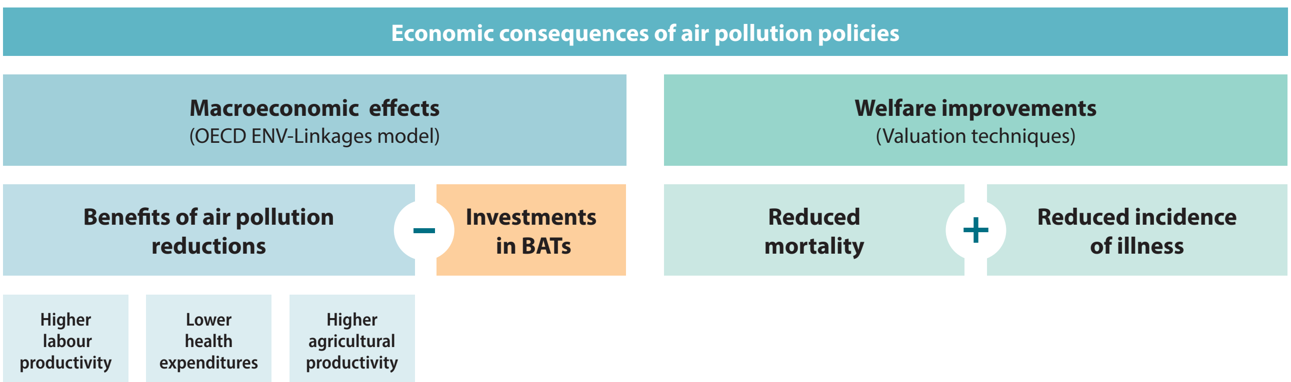


Figure 3. **COST CATEGORIES CONSIDERED IN THE ANALYSIS**



1. https://www.oecd.org/env/tools-evaluation/env-value-statistical-life.htm

Policy scenarios

This OECD study projects the health and economic consequences of air pollution under six different scenarios, which differ in relation to the number of countries taking action to address air pollution (see Table 1).

First, the consequences of current policies are modelled in the current policy scenario. Then, three single-country policy action scenarios depict the health and economic consequences of introducing more stringent air policies in Korea, Japan and China separately. A fifth scenario considers the impact of coordinated policy action between Korea, Japan and China. Finally, the global policy action scenario reflects on consequences of concerted efforts to address air pollution around the world.

Emissions of a number of pollutants that contribute to the formation of particulate matter and ground level ozone are modelled in the different scenarios, including SO_2, OC, NOx, NMVOCs, BC, CO, and NH_3, a well as CH_4.

Table 1. **OVERVIEW OF THE SIX SCENARIOS**

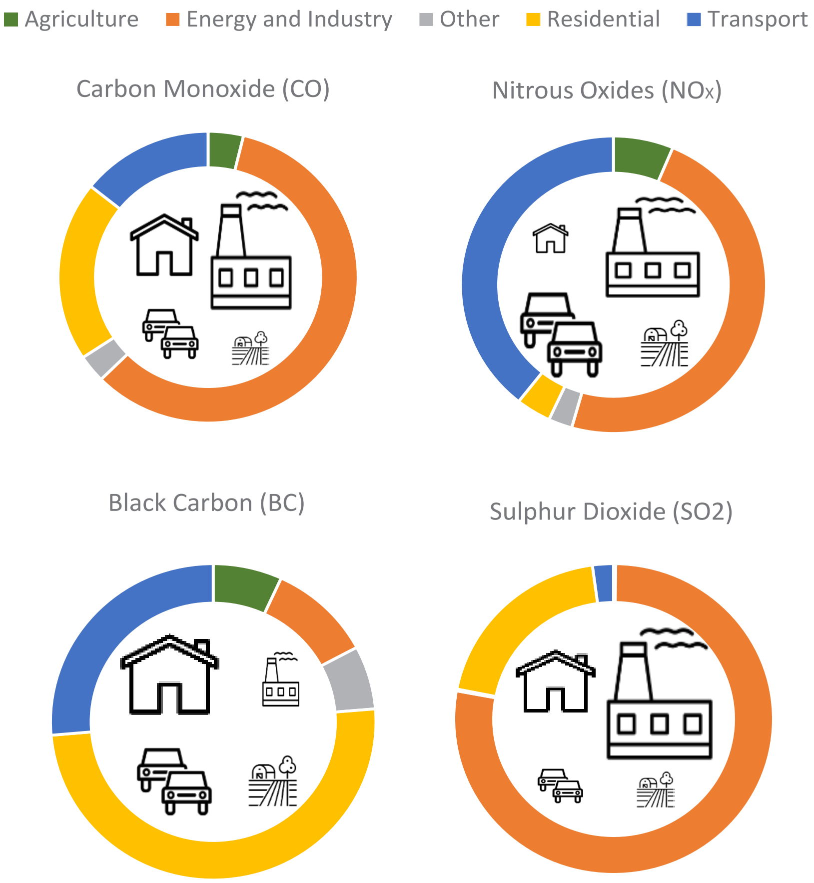
Scenario name	Policy reforms introduced in	Main Assumption
Current Policies (Baseline)	No country	Current policies
Japan Policy Action (JPA)	Japan	Policy action that stimulate the deployment of the best available techniques (BATs) to control air pollution in acting countries and current policies in non-acting countries
Korean Policy Action (KPA)	Korea	
China Policy Action (CPA)	China	
North East Asia Policy Action (NEAPA)	Japan, Korea and China	
Global Policy Action	All countries, at global level	All countries introduce policy action and deploy BATs to control emissions

Emission sources

Emissions of pollutants differ by sector in Japan, Korea and China (see Figure 4). The energy and industry sector contributes a large share of emissions of sulphur dioxide, and precursor emissions to ground-level ozone such as, nitrous oxides and methane. The residential sector has a high share of black carbon and organic carbon emissions.

The transport sector also plays a key role in the emissions of several pollutants including nitrous oxides and black carbon. Land transport accounts for 90% of transport emissions of NOx and in Japan and Korea accounts for half of overall black carbon emissions. The agriculture sector is a key contributor to NH_3 emissions, which is due to livestock and mineral nitrogen fertiliser.

Figure 4. **SECTORAL EMISSION SHARES IN NORTHEAST ASIA IN 2020**



Note: Other emissions and their sources considered in the analysis include NH_3, CH_4, NMVOCs, $PM_{2.5}$ and OC. 2020 values are estimates. "Other" includes emissions from the waste sector (except agricultural waste, which is included in "Agriculture").
Source: IIASA's GAINS model.

Emission reductions

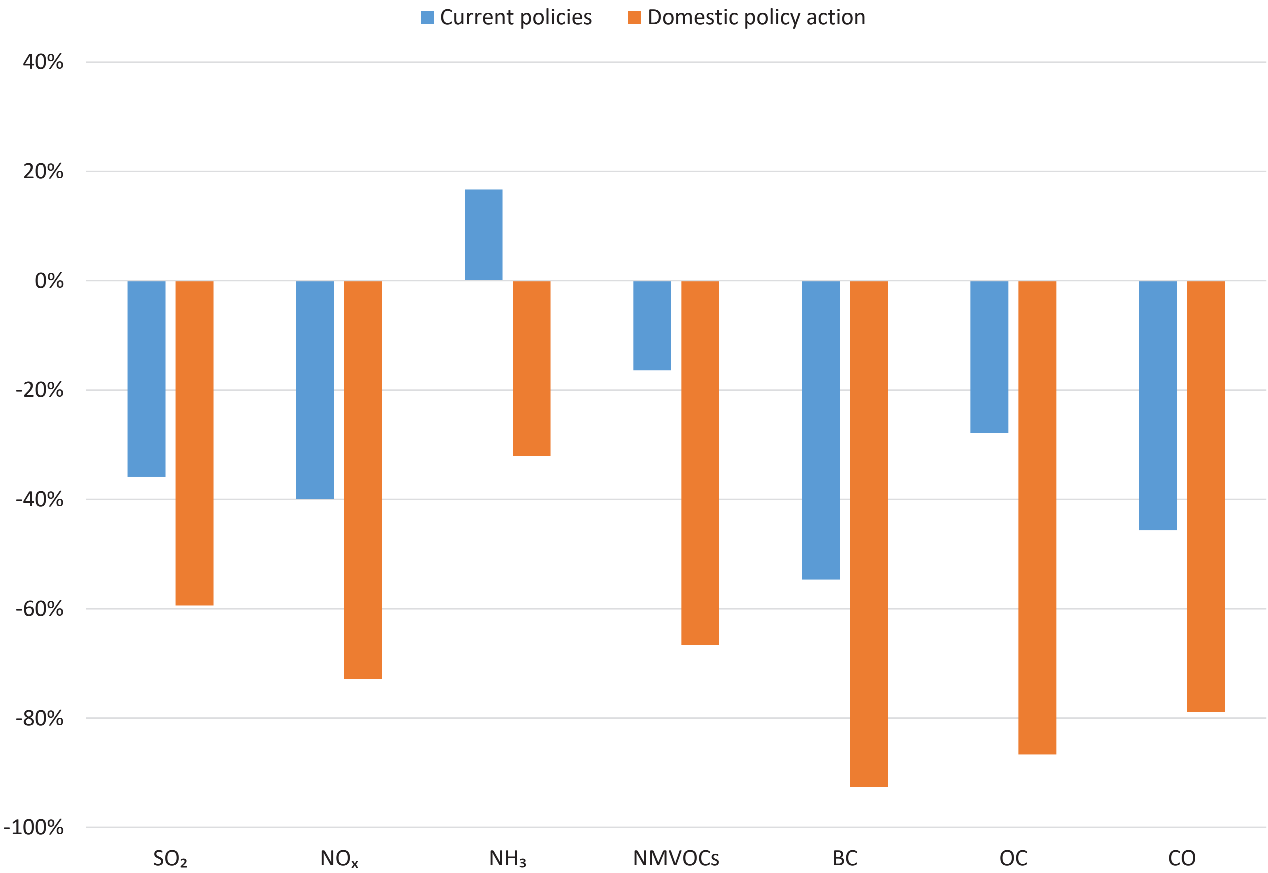
In the current policy scenario (CP), emissions of almost all pollutants are projected to slowly decrease over time with the exception of NH_3 emissions (Figure 5). The continued growth in application of chemical fertilizers, especially in China, and the livestock sector are the key drivers of this increase.

Introducing more stringent environmental policies would accelerate and deepen the projected emissions reduction. $PM_{2.5}$ emissions would be 80% lower than 2020 levels in 2050 across all Northeast Asian countries, with the largest reductions taking place in China.

Emissions of SO_2, NOX, NMVOCs, and CO would be on average less than half the 2020 levels by 2050. The growth trend of NH_3 emissions would be reversed, and emissions would be around 30% lower than the 2020 level by 2050. Importantly, our modelling assumes that countries introduce the same reforms in all policy action scenarios, thus emission reductions in each country would be the same in the single-country, regional and global policy action scenario.

Figure 5. **PROJECTED CHANGES IN EMISSIONS IN THE CURRENT POLICIES AND POLICY ACTION SCENARIOS IN NORTHEAST ASIA**

Percentage change in emissions by 2050, compared to 2020.



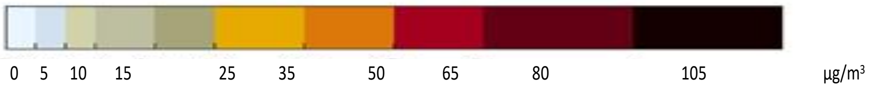
Source: IIASA's GAINS model.

Air quality benefits

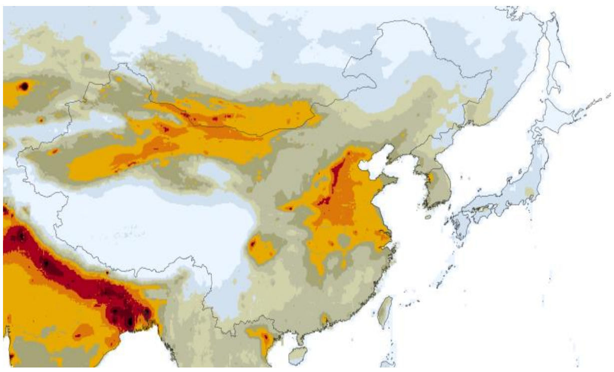
Emission reductions result in air quality improvements and lower concentrations of both $PM_{2.5}$ (Figure 6) and ground level ozone. In China the adoption of best available techniques is projected to halve average $PM_{2.5}$ concentrations compared to current policy levels. In Japan and Korea, concentrations of $PM_{2.5}$ would be between 22% and 25% lower than in the current policy scenario, respectively, and further decreasing by 28% in both countries with co-ordinated policy action compared to current policy. Concentration levels of ground-level ozone in the current policy scenario are projected to remain high in the coming decades in Northeast Asia. Compared with $PM_{2.5}$, ground-level ozone heavily depends on historical emissions, weather conditions and emissions from neighbouring countries. For these reasons regional and global policy action can provide substantial reduction in ground-level ozone concentration. This would be particularly beneficial to West China, where concentrations are projected to be the

Figure 6. **PROJECTED CONCENTRATIONS OF $PM_{2.5}$ IN THE CP AND NEAPA SCENARIOS**

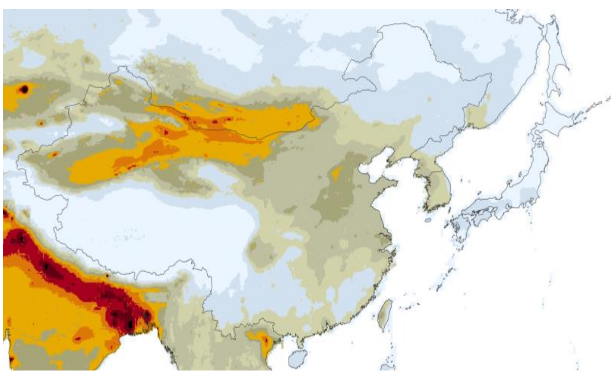
2050, Annual average $PM_{2.5}$ concentrations, μg/m³, 2050.



Panel A. Current policy (CP) scenario



Panel B. Northeast Asia Policy Action (NEAPA) scenario

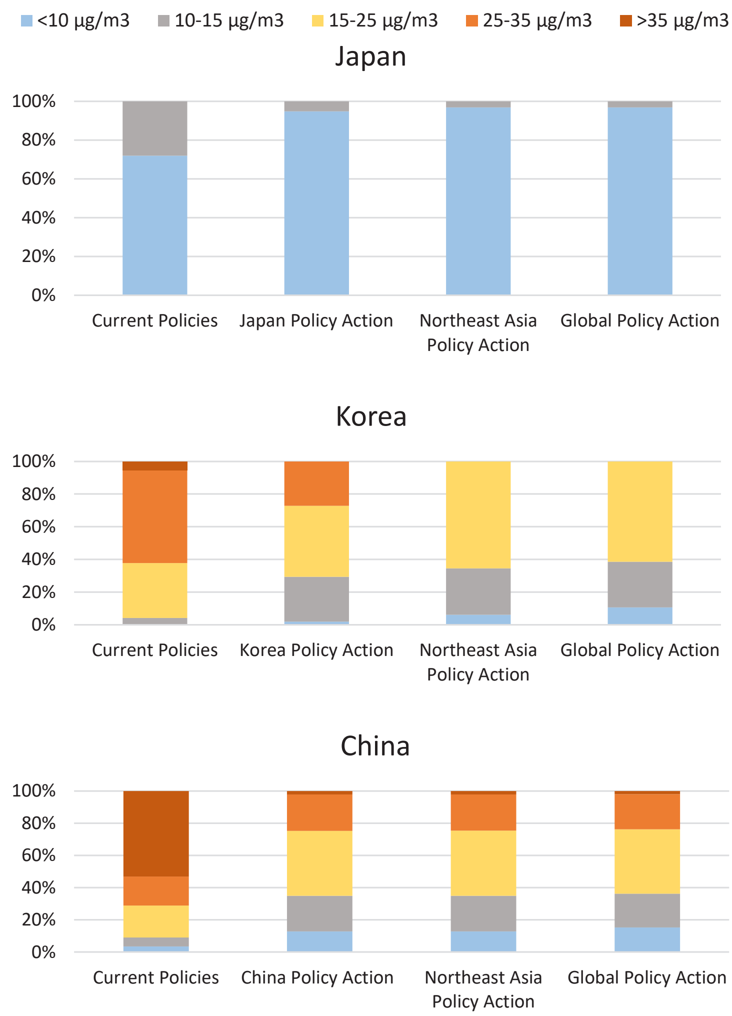


Source: IIASA's GAINS model.

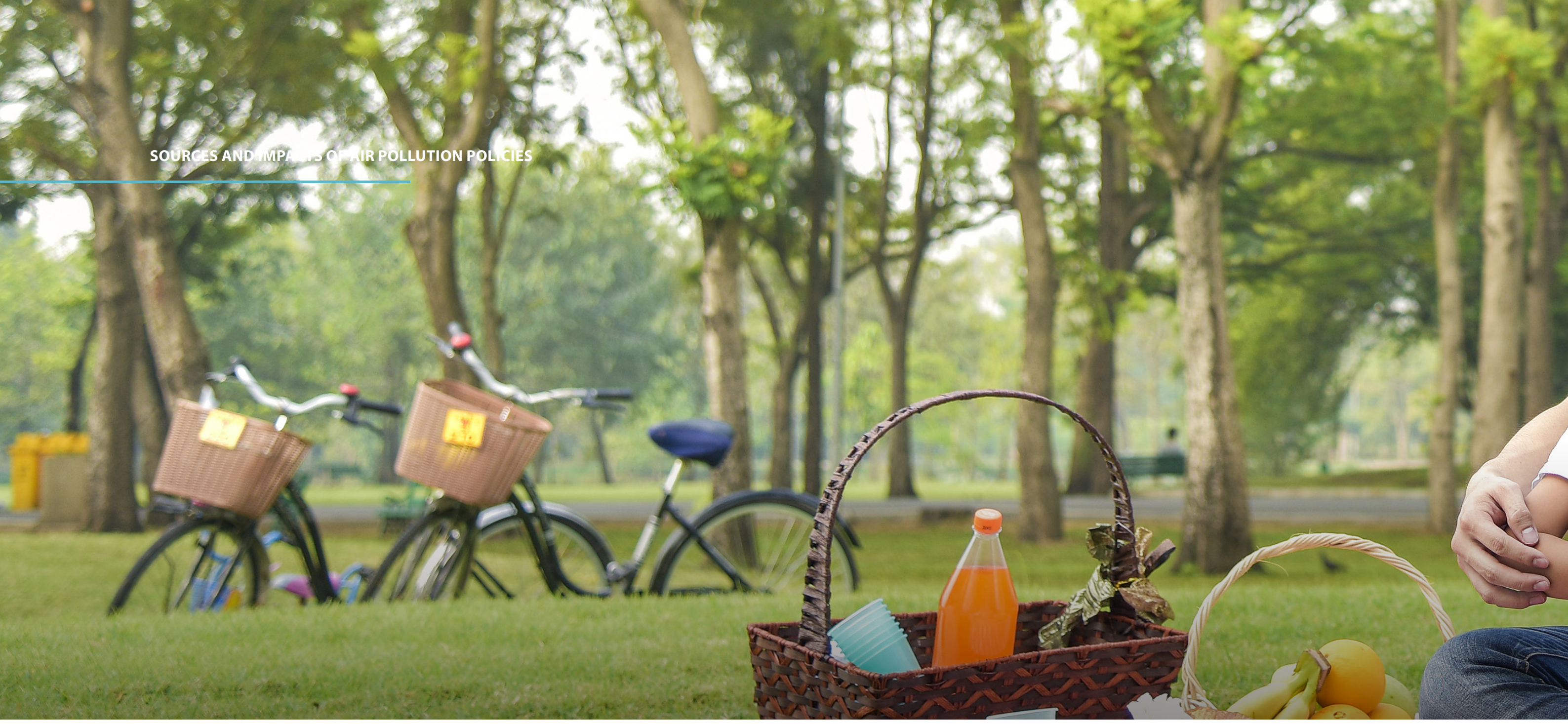
highest under the current policy scenario. Thanks to lower concentrations, exposure to air pollution is also projected to decrease (Figure 7). Overall, the number of people in Northeast Asia exposed to a $PM_{2.5}$ concentration above $10 \mu g/m^3$ in 2050, would decrease by 160 million people in the Northeast Asia coordinated policy action scenario compared to current policy and further decrease by 40 million in the global policy action scenario.

Figure 7. **POPULATION EXPOSURE TO AVERAGE $PM_{2.5}$ CONCENTRATIONS LEVELS**

Share of population exposed to various concentrations.



Source: IIASA's GAINS model.



Health benefits

With the current policies in place, yearly air pollution-related deaths in Northeast Asia are projected to increase from 1.2 million in 2025 to 1.4 million in 2050.

Domestic policy action would accelerate the reduction in premature deaths in Japan and Korea, which will respectively be 20% and 10% lower than the projected levels in the current policies scenario in 2050. In China, the benefits would be even larger with a 25% reduction in premature deaths.

If Northeast Asian countries act jointly, an additional 6 thousand lives could be saved in Japan and in Korea, while a further 1 400 lives would be saved in China, compared to domestic policy action. Global policy action would avoid additional 400 thousand deaths in benefits.

Figure 8. **PROJECTING NUMBER OF LIVES SAVED WITH POLICY ACTION COMPARED TO CURRENT POLICIES, 2050**

Source: OECD ENV-Linkages model projections, based on Global Burden of Disease (GBD, 2017; GBD, 2016).

Furthermore, the incidence of air pollution related illnesses would decrease (Figure 9). The impact of illnesses would be on average around 25% lower across the three countries in the regional coordinated policy action scenario compared to the current policy scenario. Global policy action provides few additional benefits, mostly in relation to lower hospital admissions.

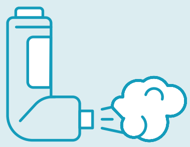
Figure 9. **COORDINATED POLICY ACTION CAN SIGNIFICANTLY REDUCE AIR POLLUTION-RELATED ILLNESSES IN NORTHEAST ASIA**
Comparison between Northeast Asia policy action and current policy scenario, 2050.

Bronchitis in adults

Japan: **10 thousand**
Korea: **3 thousand**
China: **210 thousand**

Cases avoided with coordinated action

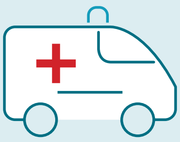
Asthma in children (aged 5-19)



Japan: **333 thousand**
Korea: **129 thousand**
China: **7 million**

Symptomatic days avoided with coordinated action

Hospital admissions



Japan: **11 thousand**
Korea: **4 thousand**
China: **399 thousand**

Cases avoided with coordinated action

Restricted activity days

Japan: **14 million**
Korea: **5 million**
China: **299 million**

Avoided restricted activity days with coordinated action

Source: OECD ENV-Linkages model projections, based on OECD Value of a Statistical Life (VSL) values (OECD, 2020) and Holland (2014).

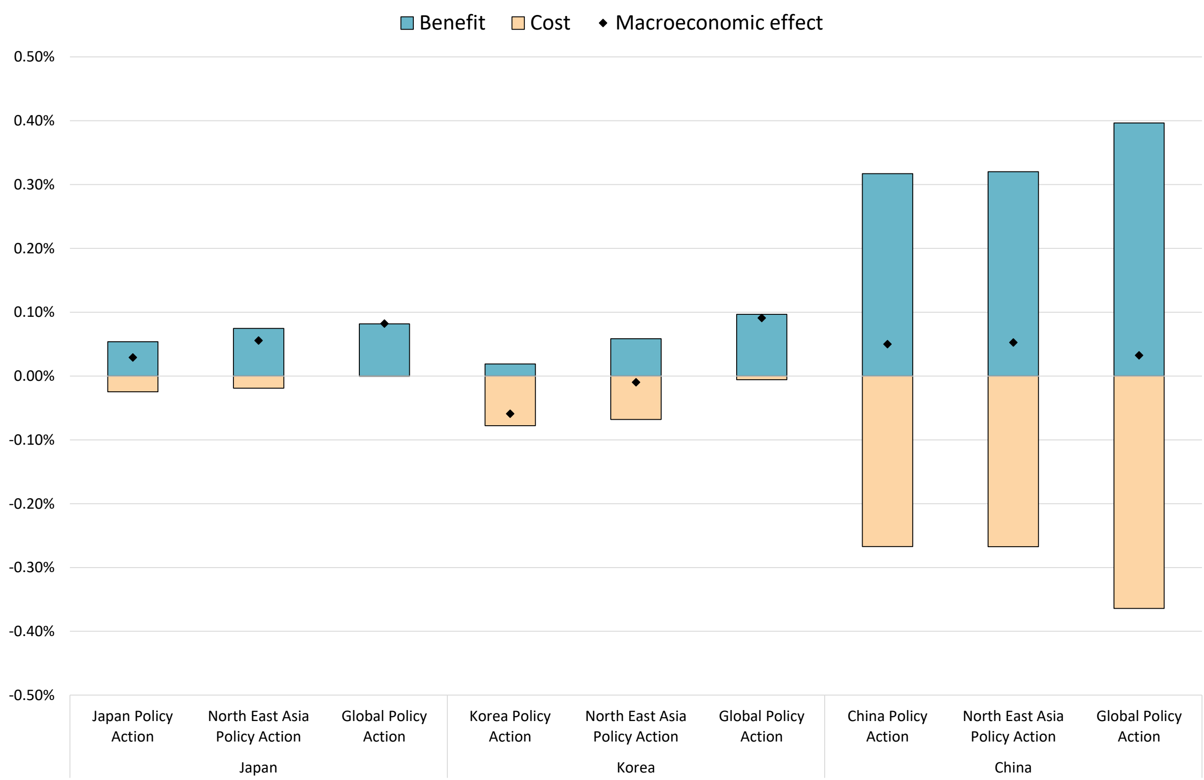
Economic consequences

Better air quality provides a number of economic benefits, including higher labour productivity, lower health expenditures and higher agricultural yields. At the same time, the adoption of more environmental friendly technologies may represent a cost for the economy in the short term, especially if it leads to competitive disadvantage due to an unlevelled playing field in global trade.

Our modelling shows that macroeconomic benefits and costs are relatively small in size and tend to cancel out (Figure 10). Slightly overall positive macro-economic consequences can be observed in Japan and Korea in case of global coordinated policy action thanks to less transboundary air pollution and a levelled trade playing field. However, when acting alone Korea is projected to incur macroeconomic costs that are slightly higher than the benefits by 2050. In China, where air pollution issues are the most serious, both costs and benefits are higher than in the other two countries across all scenarios because of the larger potential benefits of pollution reduction and relative higher investments needed to achieve these gains.

Figure 10. **THE ECONOMIC COSTS AND BENEFITS OF POLICY ACTION CANCEL EACH OTHER OUT**

Projected change in regional Gross Domestic Product in the policy scenarios in 2050, compared to the current policies scenarios.



Source: OECD ENV-Linkages model

Policy co-operation to increase air quality in Northeast Asian countries would result in higher economic benefits.

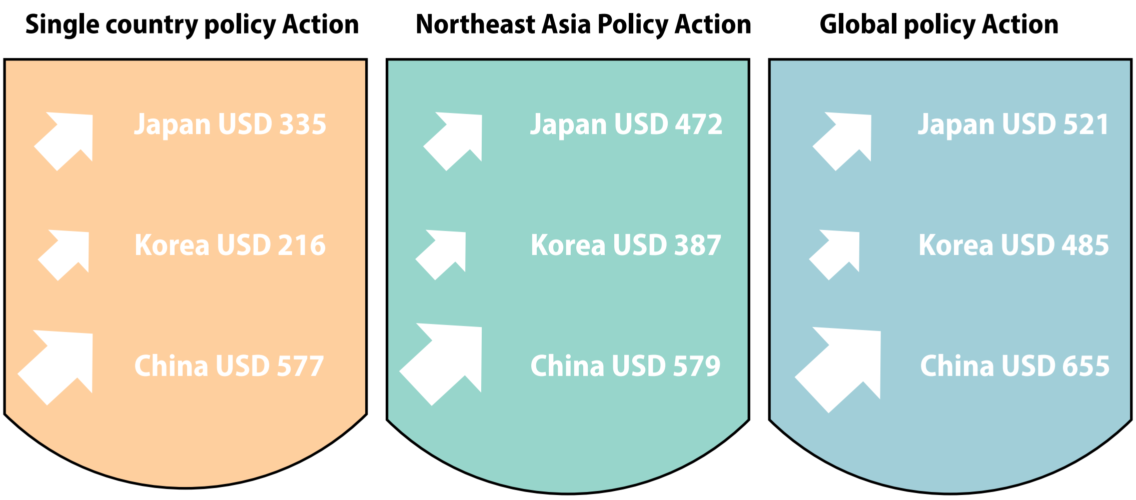
Welfare benefits

The impacts of lower mortality and lower incidence of illness are not included in our estimations of economic consequences but can be quantified in terms of welfare benefits (Figure 11).

The yearly welfare benefits of lower mortality for the whole region would exceed USD 850 billion by 2050 in the regional co-ordinated policy action scenario and USD 950 billion in the global policy action scenario. Additionally, the yearly benefits from avoided illnesses are projected to reach around USD 48 billion by 2050 in the NEAPA scenario, and USD 49 billion by 2050 in the GPA scenario. If the yearly benefits from both reduced mortality and morbidity are computed on a per capita terms, they would amount to USD 360 in Japan, USD 230 in Korea and almost USD 600 in China by 2050 in the single-country policy action scenarios. As countries increase coordination, the per capita benefit would grow substantially reaching USD 500 in Japan, USD 410 in Korea and almost reach around USD 700 in China by 2050 in case of regional cooperation. Across all scenarios, China is the country that would benefit the most from reduced impacts in per capita terms.

Importantly, a number of additional welfare benefits due to lower air pollution, such as higher fertility and better school performance, are not considered, thus this is a lower bound estimate.

Figure 11. **COORDINATED POLICY ACTION RESULTS IN WELFARE BENEFITS**
Welfare savings of reduced mortality, USD per capita, 2017 PPP exchange rates, w.r.t to Current Policy, 2050.

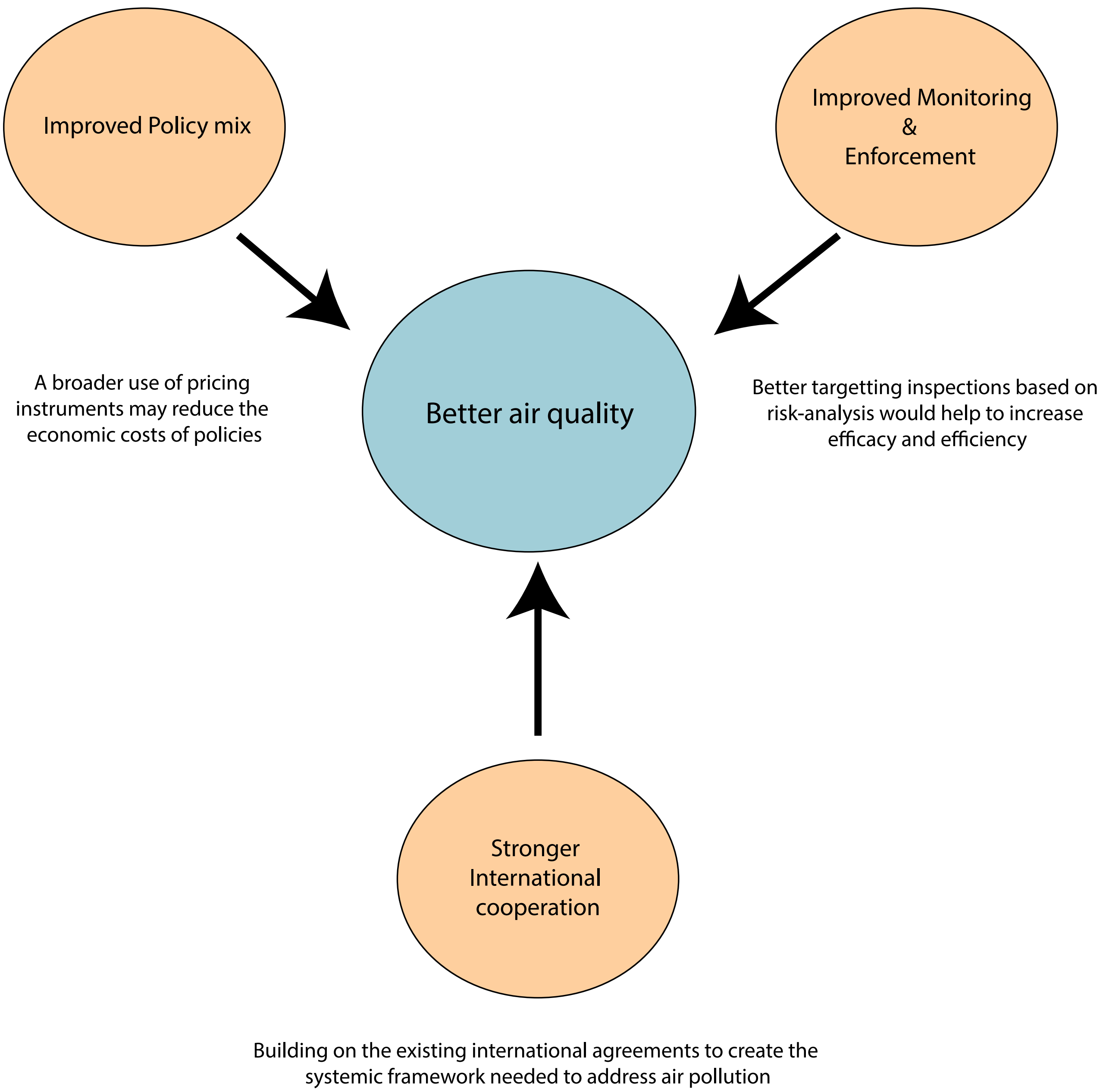


Source: OECD ENV-Linkages, based on OECD Environment Database; Mortality and welfare cost from exposure to air pollution and Holland (2014).

Policy synergies

Better air quality in Northeast Asia would require countries in the region to focus their efforts on three complementary actions: improving the domestic mix of policies to control emissions, increasing the efficiency and efficacy of monitoring and enforcement activities, and engaging in mutual beneficial cooperation (Figure 12).

Figure 12. **POLICY ACTIONS FOR BETTER AIR QUALITY**



FOR FURTHER INFORMATION

OECD (2021), The economic benefits of international co-operation to improve air quality in Northeast Asia: A focus on Japan, Korea and China, OECD Publishing, Paris. https://doi.org/10.1787/5c5ee1a3-en

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This Policy Highlights summary is based on the OECD publication " The economic benefits of international co-operation to improve air quality in Northeast Asia: A focus on Japan, Korea and China".

The findings in the report call for ambitious policy action to reduce air pollution in Northeast Asian countries, highlighting the environmental, health, and economic benefits from policy action and, specifically, from internationally coordinated action.

The Northeast Asia region is highly populated, implying that air pollution affects large amounts of people. Despite important improvements in the past years, concentrations of particulate matter and ozone in the regionis expected to remain at dangerous levels for human health over the coming decades in several areas.

If Japan, Korea and China were to implement more ambitious policy action to improve air quality by reducing a wide range of air pollutants, they would obtain a positive effect on health and the environment throughout their territory. These benefits would be even larger with coordinated policy action.

To access the full report, visit: **oe.cd/4DY**

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