



Asia-Pacific Student  
Case Competition 2019  
Top 10 Case Submissions

**Global Health**

**The New York Times**

 **APRU**



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**Note:** Essays have not been reviewed for grammatical and typographical inconsistencies, bar minor amendments, and appear in their original form.

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# About APRU and The New York Times

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**APRU** is a network of 51 leading universities connecting the Americas, Asia and Australasia. Chaired by UCLA Chancellor Gene Block, we bring together thought leaders, researchers, and policy makers to collaborate on effective solutions to the challenges of the 21st century.

As the voice of knowledge and innovation for the Asia-Pacific region, we have the responsibility to understand the risks of air pollution and the ways that universities can contribute to healthy outcomes.

Through the APRU Global Health Program hosted by the University of Southern California, APRU is committed to contributing to United Nations Sustainable Development Goal (SDG) 3, focused on health: “Ensure healthy lives and promote well-being for all at all ages.”

**The New York Times Company** is a global media organization dedicated to enhancing society by creating, collecting and distributing high-quality news and information.

Whether in print, with convenient home delivery of The New York Times or The New York Times International Edition, on the go with an array of apps for smartphones and tablets, or online with access to our award-winning website, NYTimes.com, The New York Times delivers excellence in journalism and rich, interactive multimedia storytelling to readers around the world.

Through live events and conference offerings year-round, The Times brings its curatorial expertise and editorial excellence to life, connecting audiences with journalists, like-minded communities and industry leading figures for unrivaled experiences.

For advertisers, The Times offers international publishing alliances, sponsorship and innovative advertising opportunities that enable them to reach new audiences, extend their brand and affiliate their business with the standard-bearing reputation of one of the world’s premier news media companies.

# Introduction

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Just 20 fossil fuel companies (we know their names) can be linked to more than one-third of all greenhouse gas emissions in the modern era. These companies knew about their environmental impact from the late 1950s, if not before<sup>1</sup>, and ‘...more than half the carbon exhaled into the atmosphere by the burning of fossil fuels has been emitted in the past three decades’<sup>2</sup>.

This means humans have done as much damage knowingly to the fate of the planet and its ability to sustain human life as we ever managed in ignorance.

As a result, air pollution has hit dangerous levels in many cities in Asia Pacific, home to the highest mortality rate in the world attributed to household and ambient air pollution, at 130 deaths per 100,000 population<sup>3</sup>. Consequently, leaders in government and industry are urged, more than ever before, to work together to mitigate the risks of air pollution through effective regulation and innovative policies.

APRU, in partnership with The New York Times, has challenged student competitors in the 2019 Asia-Pacific Student Case Competition to evaluate the global health policy ecosystem in the Asia-Pacific region. How best to address UNSDG 3: Ensure healthy lives and promote well-being for all at all ages?

Over one hundred students from 26 universities in 14 economies have submitted their entries.

The competition required students to write an 800-word policy brief to a leader in an economy in the Asia-Pacific region (government, philanthropy, business, NGO, etc.) discussing the threats to health from air pollution and to promote practical solutions.

I wish to congratulate:

- the winning team of the Hong Kong University of Science and Technology, Cherie Hiu Yu Leung and Veronica Qin Ting Li;
- the runners-up from the University of British Columbia, Candice Chan and Feifei Zhang;
- and, in third place, the team from Yale-NUS College, Ng Yi Ming, Lucy Kuo and Damon Lim Wei Da.

I also wish to acknowledge the efforts of all the contestants. Many came up with insightful solutions.

We are most grateful to The New York Times for its partnership and for publishing extracts from the winner’s article in its International Edition.

I would also like to thank the judges from The Times’s award-winning newsroom, Philip Traynor and Jim Hollander, and academic judges from the APRU network: Professor Keiji Fukuda MD, Director and Clinical Professor, Division of Community Medicine and Public Health Practice, The University of Hong Kong; and Professor Mellissa Withers, Program Director, APRU Global Health Program and Associate Professor of Clinical Preventive Medicine, Department of Preventive Medicine, University of Southern California.

While the challenges of pollution and climate change appear overwhelming, we have a chance if we act now and act together. These students have shown us how.

## **Christopher Tremewan**

Secretary General

APRU

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<sup>1</sup> Matthew Taylor and Jonathan Watts, ‘Revealed: the 20 firms behind a third of all carbon emissions’, *The Guardian*, October 9, 2019.

<sup>2</sup> p.4, David Wallace-Wells, *The Uninhabitable Earth – A Story of the Future* (London: Allen Lane) 2019.

<sup>3</sup> United Nations ESCAP, *Asia and the Pacific SDG Progress Report, 2019, Data Portal* (Bangkok, Thailand, 2019), <http://data.unescap.org/sdg/>

**Winner**

**1st Runner-up**

**2nd Runner-up**

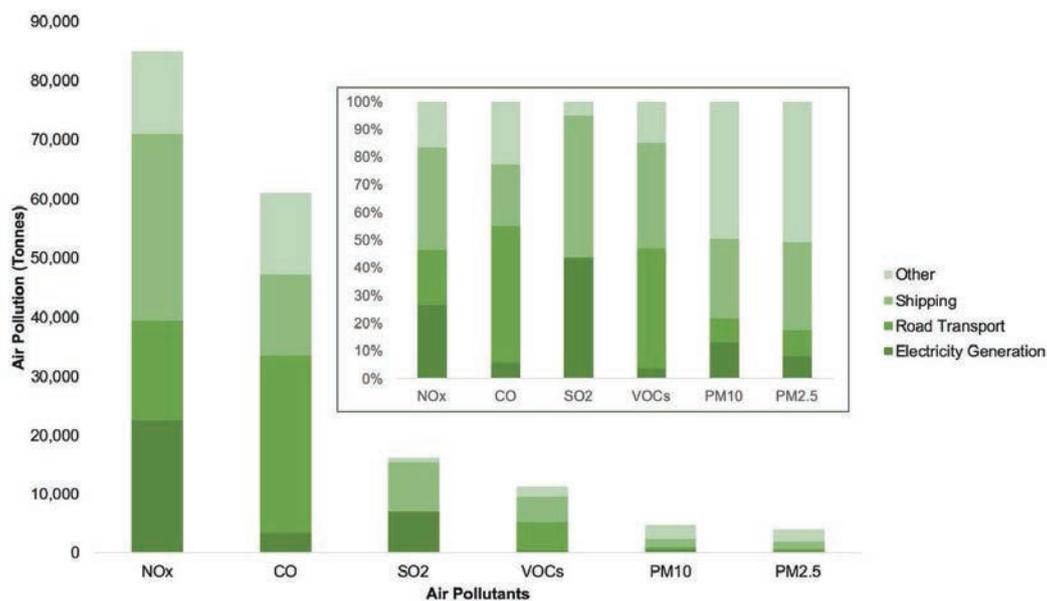
## Winner

# Air Pollution in Hong Kong: A Market-Based Approach to Infrastructural Change

**The Hong Kong University of Science and Technology**

Cherie Hiu Yu Leung, Veronica Qin Ting Li

Air pollution poses a significant threat to Hong Kong's economy. Over 3,000 premature deaths and 39 billion HKD in losses were attributed to air pollution in 2012 [1]. Shipping, road transport and fossil-fuel based electricity generation are the major sources of Hong Kong's air pollution (see Figure 1) [2]. Pollutants such as nitrous oxides (NO<sub>x</sub>) and particulate matter not only affect the respiratory health of Hong Kong citizens, but may also be linked to increased risks to mental health and cognitive impairment [3-4].



**Figure 1:** Hong Kong air pollution by sector, 2017 [5].

These consequences of increased healthcare expenditures and a weakened workforce can be avoidable with more proactive regulations. We recommend the following strategies for the HKSAR government to reduce air pollution in Hong Kong:

- 1) **Increase market penetration of less polluting alternatives for shipping and road transport.** Despite past efforts to reduce transport emissions in Hong Kong [6-7], shipping and road transport are still two of the most significant sources of air pollution in the city (see Figure 1). Traffic

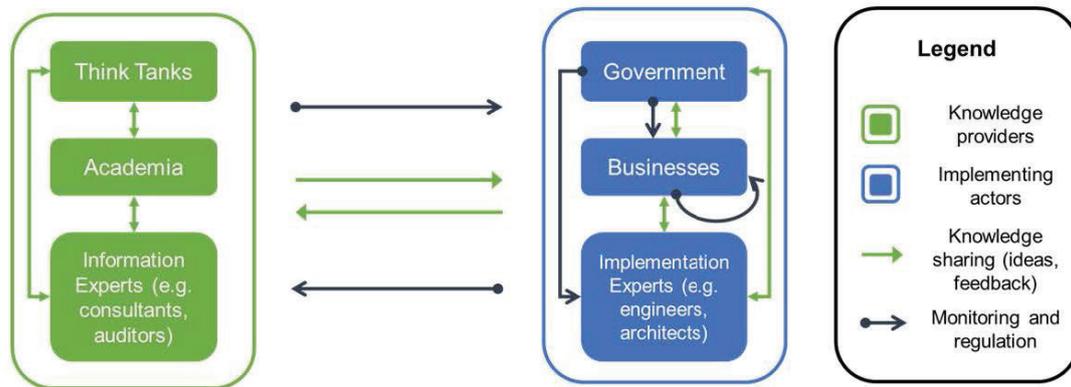
congestion in particular leads to air pollutant levels far exceeding World Health Organization safety limits [8]. Ultimately, the government should aim to eliminate air pollution from transportation altogether by transitioning to zero-emission fuels.

For ocean vessels, the Hong Kong government should offer tax rebates to shipping companies with ocean-going vessels that use fuels well below the mandatory 0.5% sulphur content limit [9]. For road transport, the government should subsidize charging facilities for private and public electric vehicles. All fossil-fuel based public buses and minibuses should be replaced by less polluting models, such as electric and supercapacitor buses, within the following decade. Finally, the Hong Kong government should increase its renewable energy target for its fuel mix, to further reduce the air pollution from burning fossil fuels for transport.

- 2) **Encourage urban greening.** 1 m<sup>2</sup> of plants removes 100g PM/year [10], and boosts a host of psychological and physical benefits [11-12]. Besides encouraging efficient ventilation systems, thoughtful designing of vegetation areas into urban areas can alleviate streetside and indoor air pollution [13-14].

Currently, Hong Kong benefits from green building guidelines, which require 20% or more of the building site to have vegetation areas [15]. Since ground space is limited in Hong Kong, a simple way to further incentivise greening for the commercial and non-governmental sectors would be a rebate program for constructing new green roofs or walls [16]. Estimations of green roof costs in Hong Kong range from 5-13 USD/m<sup>2</sup>, with prices predicted to drop as installations increase [17-18]. Additionally, the government should dedicate part of the Innovation and Technology Fund [19] to address under-researched issues, such as suitable plant species, extensive, low-input gardens [17], piloting implementations on different roadscapes, and retrofitting schemes. Emphasis should be on finding solutions that are appropriate to Hong Kong's opportunities and limitations.

- 3) **Impose an air pollution tax on the commercial, industrial and transport sectors.** Implementing a tax on the most potent air pollutants would ensure that polluters pay for their share of emissions. Based on a study conducted on China's Environmental Protection Tax, the government should set a tax of 10 HKD/kg of pollutants, which would correspond to nearly a 10% reduction in major pollutants such as SO<sub>2</sub> and NO<sub>x</sub> [20]. The tax should be raised over time to continually encourage companies to reduce emissions. Companies who reach ambitious abatement targets would be eligible for tax refunds proportional to its efforts. For equity considerations, part of the collected taxes should be distributed to lower-income households to help them bear the resulting rising domestic prices.
- 4) **Establish a cross-sector network on air pollution.** The network would connect economic and scientific experts with knowledge on green solutions, with key decision-makers in business, government and other organisation (see Figure 2). Services would range from regular meetings, auditing, consultations, or schemes such as in-house placements or internships to exchange ideas for reducing air pollution. Cross-sector communication and knowledge transfer aid the formation of collectively decided goals and targets for abatement. Frequent communication with field experts to review and update knowledge and data is imperative for controlling incentive programs to reward the correct behaviours. A monitoring system within the network would also allow for increased transparency and accountability over emissions, encouraging better development of measures suitable for different businesses.



**Figure 2:** Diagram of the proposed cross-sector network.

In summary, the Hong Kong government should combine market-based mechanisms with network facilitation to prompt infrastructural changes for air pollution reduction. In doing so, Hong Kong can grow a stronger economy founded on the promises of cleaner air and improved health.

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## 1st Runner-up

# A Multidimensional Approach to Solving Air Pollution Threats to Health in Canada

University of British Columbia

Candice Chan, Feifei Zhang

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### Introduction

Air pollution puts Canada into varying levels of health risks and financial loss.<sup>1</sup> The emission of fine particulate matter with an aerodynamic diameter of less than 2.5 micrometers (PM<sub>2.5</sub>) has been considered the most impactful to human health, causing 8.7% of deaths in 2017 and 14,600 premature deaths per year in Canada.<sup>2</sup> The problem in Canada disproportionately affects some Canadians more than others, especially marginalized communities.<sup>3</sup>

There is a clear need for targeted solutions that can be implemented in different municipalities and provinces. This brief aims to demonstrate three recommendations from the holistic, vertical and horizontal perspective that seek to serve all Canadians (Figure 1),

1. Emission Trading System to control emission pollution.
2. Development of vertical communication among municipal, provincial, and federal government.
3. Development of interdepartmental data transparency with the re-establishment of a roundtable.

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1 National Round Table on the Environment and the Economy, *Developing Ambient Air Quality Objectives for Canada: Advice to the Minister of the Environment* (Library and Archives Canada), 2008, 11. <http://neia.org/wp-content/uploads/2013/04/ambient-air.pdf>

2 Aaron J Cohen et al., "Estimates and 25-Year Trends of the Global Burden of Disease Attributable to Ambient Air Pollution: an Analysis of Data from the Global Burden of Diseases Study 2015," *The Lancet* 389, no. 10082 (2017): pp. 1907-1918, [https://doi.org/10.1016/s0140-6736\(17\)30505-6](https://doi.org/10.1016/s0140-6736(17)30505-6). ;Health Canada, "Government of Canada," Canada.ca (Government of Canada, August 6, 2019), <https://www.canada.ca/en/health-canada/services/air-quality/health-effects-indoor-air-pollution.html>.

3 "Canada," Institute for Health Metrics and Evaluation, September 18, 2017, <http://www.healthdata.org/canada>.

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**(Figure.1:** Three recommendations proposed to solve the issue of air pollution threats from multi-dimensions)

### **Recommendation 1: Emission Trading System to control the emission of pollutants**

Increasing emissions from industrial processes are considered as a major cause of the rising PM<sub>2.5</sub> levels.<sup>4</sup> According to recent reports, it has been estimated that Canada will need to impose a total carbon tax of \$102 per tonne if it wishes to achieve reduction as agreed in the Paris Agreement emissions target by 2030.<sup>5</sup> However, the future of carbon pricing is contentious as carbon tax is estimated to reduce Canada's real GDP by 0.35%.<sup>6</sup> This has also been noted by Canadians to be a difficult target.<sup>7</sup> With feasibility, effectiveness, and long-term effects in mind, we propose to implement an emission trading system that would incentivize companies to innovate for more efficient use of energy, utilizing the nature of free market competition.

The Emission Trading System converts the quota for emission into permits. The government body sells a limited number of permits and polluters need to hold permits equal to their emission level. Industrial companies wishing to increase their emission levels will have to purchase permits from other companies that are willing to sell them. The permits will create an emission market in Canada in which companies are motivated to constantly strive for a more efficient use of energy to cut down production costs. The federal government in Canada can also utilize the revenue generated from this system for future air pollution reduction programs.

<sup>4</sup> Government of Ontario, Ministry of the Environment, "Fine Particulate Matter," (Government of Ontario, Ministry of the Environment), accessed September 23, 2019, <http://www.airqualityontario.com/science/pollutants/particulates.php>.

<sup>5</sup> David Stevens and Stan Fedun, "Canada's Carbon Pricing Strategy Falls Short of Paris Agreement Target," Aird Berlis, <https://www.airdberlis.com/insights/blogs/energyinsider/post/ei-item/canada-s-carbon-pricing-strategy-falls-short-of-paris-agreement-target>.

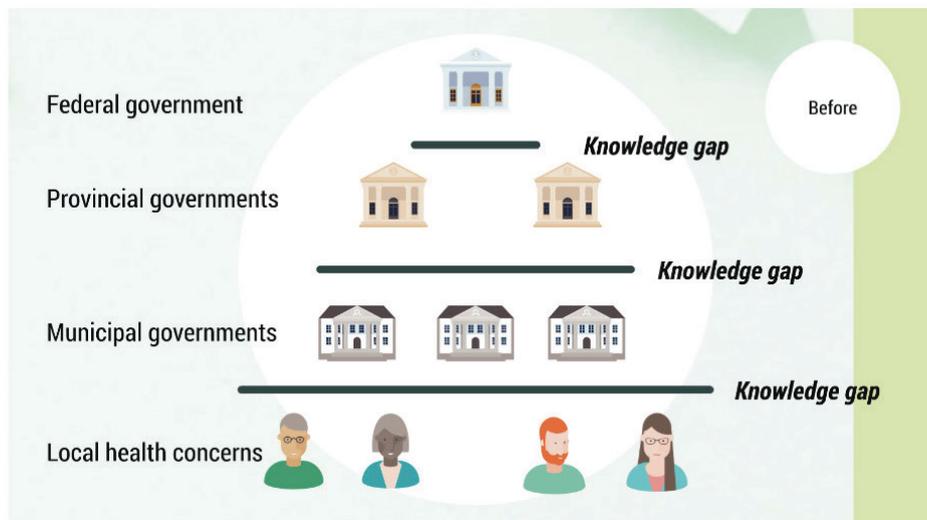
<sup>6</sup> Philip Bagnoliand Raphaël Liberge-Simard, "Closing the Gap: Carbon pricing the Paris target," Office of the Parliamentary Budget Officer, June 13 2019 [https://www.pbo-dpb.gc.ca/web/default/files/Documents/Reports/2019/Paris\\_Target/Paris\\_Target\\_EN.pdf](https://www.pbo-dpb.gc.ca/web/default/files/Documents/Reports/2019/Paris_Target/Paris_Target_EN.pdf)

<sup>7</sup> Ian Austen, "Canada Announces Goals for Reducing Emissions," the New York Times, April 27, 2017. [https://www.nytimes.com/2007/04/27/businessworldbusiness27green.html?ref=collection%2Ftimestopic%2FAir%20Pollution&action=click&contentCollection=science&region=stream&module=stream\\_unit&version=search&contentPlacement=6&pgtype=collection](https://www.nytimes.com/2007/04/27/businessworldbusiness27green.html?ref=collection%2Ftimestopic%2FAir%20Pollution&action=click&contentCollection=science&region=stream&module=stream_unit&version=search&contentPlacement=6&pgtype=collection)

## Recommendation 2: Vertical government communication platform

Air pollution is a main concern among Canadians.<sup>8</sup> However, air pollution is not the top priority among and often dismissed by municipal, provincial, and federal governments.<sup>9</sup> A knowledge gap between health concerns and policies enforced by the government exists. The unique problems faced by different municipalities are ignored by the provincial government, and federal government remain ignorant of the diverse problems faced by provinces. One of the causes is the lack of effort in creating representative consultation groups within communities, often resulting in alienating social groups including First Nations communities.<sup>10</sup>

We recognize the slow process of changing government priorities within communities to promote effective communication between Canadians and the governments, and among the different levels of governments. We thus propose outsourcing data collection to local non-governmental organisations (NGO). NGOs, unlike the hierarchical and bureaucratic nature of governments, are able to effectively monitor the implementation of policies since they are experts in dealing with local communities and have a well understanding of their needs.<sup>11</sup> By outsourcing data collection to local NGOs, we are fostering growth of organisations that promote positive connections among community, and providing a holistic view of the community to the provincial and federal government. (Figure 2 and Figure 3) NGOs will comprise a report consisting of most relevant and pressing problems, and the different levels of government can better tailor solutions to respective communities.



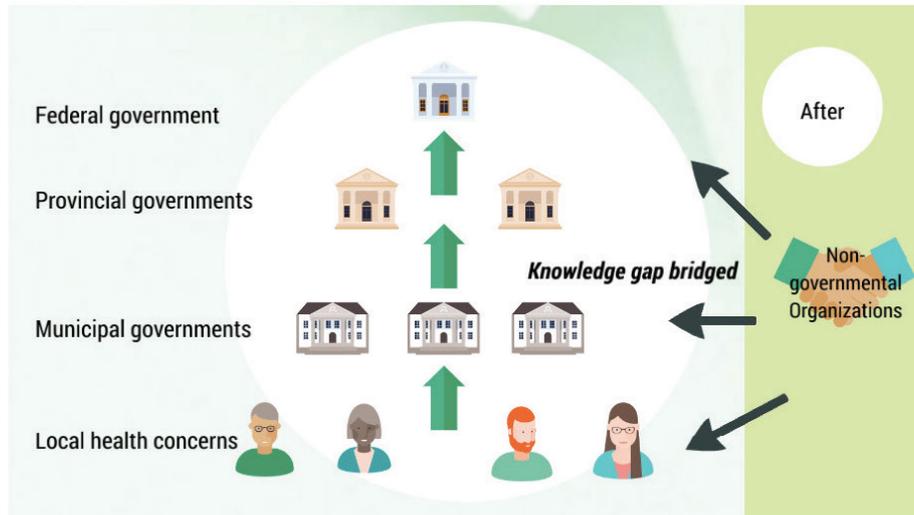
(Figure 2: Image demonstrating problem of knowledge gaps between levels of government)

<sup>8</sup> "Regulatory Framework for Air Emissions," Minister of Environment, 2007. [https://www.ec.gc.ca/doc/media/m\\_124/report\\_eng.pdf](https://www.ec.gc.ca/doc/media/m_124/report_eng.pdf)

<sup>9</sup> Ian Austen, "In Internal Canadian Documents, a Warning on Oil Sands," *the New York Times*, December 22, 2011.

<sup>10</sup> Hiliary Beaumont, "More than half of First Nations communities in Canada are affected by industrial pollution," *Vice*, September 6, 2017.

<sup>11</sup> Susan Cotts Watkins, Ann Swidler, and Thomas Hannan, "Outsourcing Social Transformation: Development NGOs as Organizations," *Annual Review of Sociology* 38 (2012): 285-315. <http://www.jstor.org.ezproxy.library.ubc.ca/stable/23254597>.



(Figure 3: Image demonstrating the use of NGOs in bridging knowledge gaps)

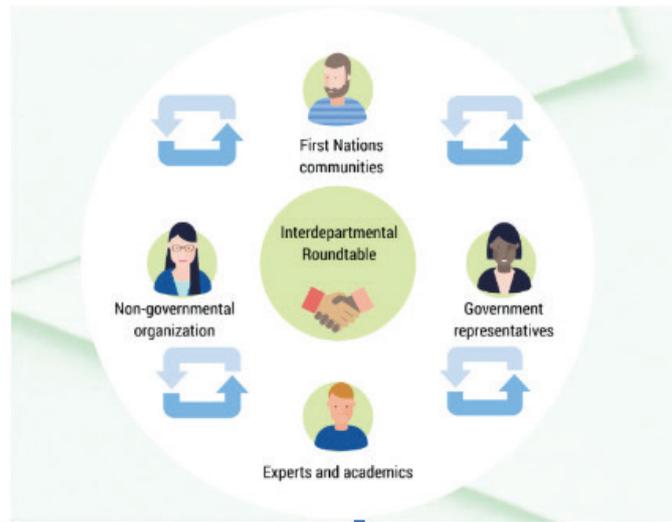
### Recommendation 3: Interdepartmental roundtable

We also see a problem of overlapping responsibilities among federal government departments in Canada.<sup>12</sup> This is especially a matter of concern for geographically widely spread problems such as air pollution across the country. There is a need for data transparency and clear directions for each department to maximise efficiency, thus we propose re-establishing an interdepartmental roundtable.

Until 2013, the Canadian government had a roundtable that focus on air pollution, National Round Table on the Environment and the Economy.<sup>13</sup> It was comprised of experts in the field and departmental representatives. They have written a number of literature on air pollution and acted as great reference for Members of Parliament in policy and decision making. With the problem of air pollution resurfacing, we see the need to reintroduce the roundtable, and include previously neglected communities including First Nations communities (Figure 4). Similarly to recommendation 2, they will act as advisors to the federal government, and promote communication across the board of departments in Ottawa, promoting horizontal communication.

<sup>12</sup> Gordon R. Brown, "Canadian Federal-Provincial Overlap and Presumed Government Inefficiency," *Publius* 24, no. 1 (1994): 21-37. <http://www.jstor.org/stable/3330702>.

<sup>13</sup> Newfoundland and Labrador Environment Industry Association, "Reports Produced by the National Round Table on the Environment and the Economy (NRTEE): NEIA - Newfoundland and Labrador Environmental Industry Association," NEIA, August 21, 2013, <http://neia.org/national-round-table-on-the-environment-and-the-economy-reports/>



(Figure 4: Image demonstrating the relationship among stakeholders in roundtable)

## Conclusion

We believe these 3 recommendations, once implemented, would combine efforts from state and non-state, provincial and federal, enterprise and concerned parties to maximize efficacy to increase the quality of life of Canadians.

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- Watkins, Susan Cotts, Ann Swidler, and Thomas Hannan. "Outsourcing Social Transformation: Development NGOs as Organizations." *Annual Review of Sociology* 38 (2012): 285-315. <http://www.jstor.org.ezproxy.library.ubc.ca/stable/23254597>.

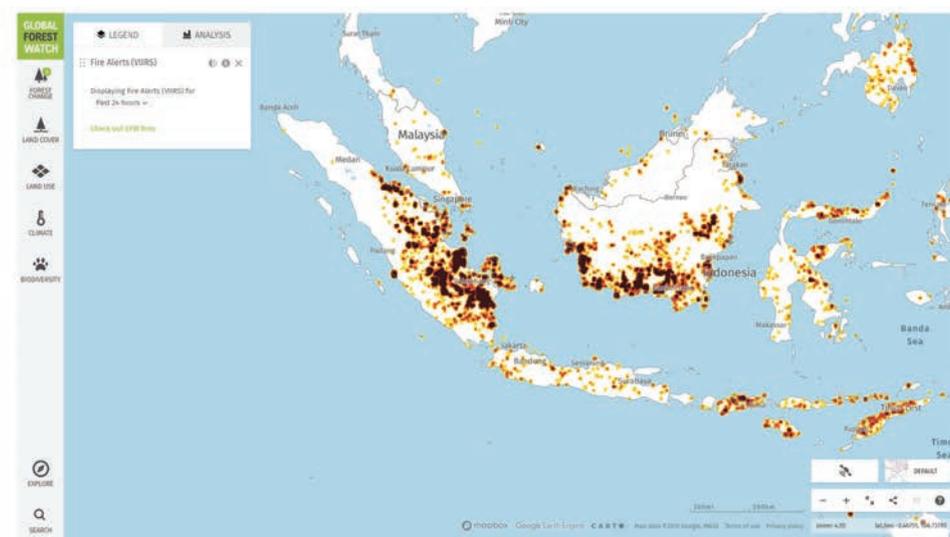
## 2nd Runner-up

# The GreenProduct Tax: A Sustainable Goods Tax to clear ASEAN's Hazy Skies

**Yale-NUS College**

Ng Yi Ming, Lucy Kuo, Damon Lim Wei Da

Since August 2019, 5 Southeast Asian nations have been suffering from a severe air pollution crisis – the persistently-recurring toxic haze from Indonesia's annual forest fires.<sup>i, ii, iii</sup> Air quality in neighboring Singapore reached 'unhealthy' levels,<sup>iv</sup> the worst in 3 years, while the PM10 Pollutant Standards Index in Indonesia's Pekanbaru climbed beyond 700, breaking the previous record in 2015.<sup>v</sup>



**Figure 1:** Forest fire map for Indonesia and Malaysia on 22 Sept 2019.

Source: GlobalForestWatch

The United Nations warns that 10 million children are at risk; with 100 million residents in affected regions, Southeast Asia needs a long-term solution.<sup>vii, viii</sup> The haze compounds respiratory conditions like asthma, pneumonia, and bronchitis, and a million Indonesians face potential lifelong health problems.<sup>ix, x</sup> A Harvard-Columbia study found that the 2015 haze likely caused 100,000 premature deaths in Indonesia, Malaysia, and Singapore.

## Root Cause

The main driver of the fires is the irresponsible business practices of multinational corporations (MNCs). Greenpeace reports that 80% of forest fires were intentionally set for palm and pulpwood plantations.<sup>xii, xiii</sup> Global consumer brands like Nestlé and Unilever were found to purchase from rogue producers<sup>xiv</sup> who engage in slash-and-burn practices on protected land.<sup>xv</sup>

The problem has persisted due to a structural absence of effective policies that spur MNCs to address environmental externalities. The Indonesian government has sought to regulate slash-and-burn but weak law enforcement and a failure to collect fines have done little to deter repeat offenders.<sup>xvi, xvii</sup> A lack of manpower to tackle forest fires also compounds the problem.<sup>xviii</sup>

## Existing Efforts

Singapore, a major consumer of palm oil and pulp-derived products, has an eco-certification scheme for environmentally-friendly consumer products called the Singapore GreenLabel Scheme (SGLS).<sup>xix</sup> This is administered by the Singapore Environment Council (SEC)<sup>xx</sup> and one category of the SGLS requires that products are not derived from forest fires. To get a green certification, companies have to fully disclose a product's supply chain, meet land and fire management requirements, and commit to zero-burning.<sup>xxi</sup> This is enforced via regular ground surveillance audits and reference checks on forestry practices.<sup>xxii</sup>

One success story – during the 2015 haze, the SEC suspended the GreenLabel previously granted to an Indonesian company, Asia Pulp and Paper (APP), leading supermarkets to remove its products from shelves.<sup>xxiii</sup> This spurred the company to adopt better fire management strategies and APP was re-awarded the GreenLabel in May 2019.<sup>xxiv</sup>

However, the SGLS is a voluntary scheme – companies sign up and pay a fee (US\$1000 to US\$3000) for eco-certification.<sup>xxv</sup> It is also merely advisory in nature, at best recommending consumers to patronize sustainable producers.<sup>xxvi</sup> These measures are insufficient in changing firms' behavior as the environmental costs of doing business are not explicitly priced into the market.

## Recommendation: GreenProduct Tax

We propose the GreenProduct tax, a market-based mechanism that accounts for the environmental costs of production. This tax harnesses the existing SGLS scheme to tax businesses contributing to forest fires and environmental degradation. Specifically, we recommend that National Environment Agency (NEA) impose mandatory SGLS certification for all palm oil and pulp-derived consumer products sold in Singapore. Companies not awarded the GreenLabel would be levied an excise tax, for instance 20% on the product's price, paid when purchases are made on their consumer goods.<sup>xxvii</sup>

By raising the consumer cost of non-ecofriendly goods, our recommendation creates market incentives for greener supply chains.<sup>xxviii</sup> The GreenProduct tax is thus a market-based complement to its legal counterpart, Singapore's Transboundary Haze Pollution Act, enacted in 2014 to criminalize and fine haze-causing companies.<sup>xxix</sup> As a major commerce hub with strong governance, Singapore can effect change beyond its borders by levying this tax on cross-border supply chains.

Implementation-wise, many excise duties on goods already exist (tobacco products), while NEA administered Singapore's first carbon tax.<sup>xxxii</sup> NEA should aim for a transparent and comprehensively communicated green tax to help firms adjust their supply chains accordingly.<sup>xxxiii</sup> We also recommend that the implementation of GreenProduct tax be coupled with enhanced public awareness campaigns on the SGLS certification and taxation scheme to maximize consumer demand pressure.<sup>xxxiii</sup>

The biggest obstacle to address is the SGLS's capacity given the significant increase in monitoring required. We further propose that the GreenProduct tax revenue be rechanneled back into the SGLS programme to allow it to strengthen its monitoring and auditing capacities. Crucially, this will help move the programme towards financial self-sufficiency.



**Figure 2:** GreenProduct Tax Policy Framework

Thus, the GreenProduct tax solves the root cause of the transboundary haze problem – the lack of incentives for companies to be eco-friendly – and also ensures that eco-monitoring becomes through and financially-sustainable.

## Conclusion

The GreenProduct Tax represents the possibilities of tempered capitalism via harnessing market incentives and consumer awareness to spur businesses to green their supply chains. With immense potential for diversifying coverage to more countries, products, and environmental aspects, the GreenProduct tax gives Singapore the opportunity to pioneer a new global model for green capitalism and safeguard healthy lives.



## **Other Entrants**

# Fire Alert: How to Improve Public Health with Fire Management

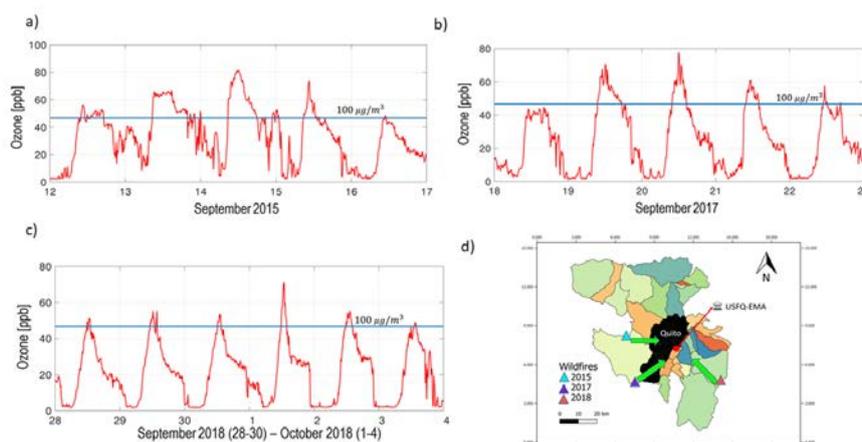
Universidad San Francisco de Quito

Eliana Cadena

## Introduction

According to the United Nations Environment Program, air pollution causes 7 million deaths annually (1). Quito, owns and runs a network of atmospheric monitoring with 9 stations to measure criteria pollutants such as ozone (2). High concentrations of ground level ozone (GLO) are associated with serious health problems (3) (4). Even though Quito is an urban environment with abundant UV light, GLO values usually comply with the established air quality standard imposed by Ecuadorian Legislation (5), except for recent episodes of high ozone.

To better understand this behavior, we analyzed 10-minute daily data of high ozone episodes, which occurred in 2015, 2017 and 2018, from measurements taken at the Atmospheric Measurement Station (EMA, Spanish acronym) at USFQ (6). We found 3 surges of GLO above the World Health Organization (WHO) guideline ( $100 \mu\text{g}/\text{m}^3$ ) and the Ecuadorian standard (Figure 1). These episodes took place at times when major wildfires impacted the city's surroundings. We presume the high ozone events are associated with wildfires due to the advection of volatile organic compounds (VOC), such as carbon monoxide and other gases, into the city. VOCs, nitrogen oxides (NOx) and UV light trigger ozone formation. Previous work at EMA shows that Quito's atmosphere is rich in NOx, which means that incremented VOCs would produce increased ozone (7). Further literature search showed that the emissions of VOCs in the atmosphere during the wildfire of September 2015 were 50 times higher compared to a normal working day (8) and it is possible that the ratio NO<sub>2</sub> to NO shifted.



**Figure 1. High ozone events and wildfires map.**

a) GLO concentration 12-17 September 2015

b) GLO concentration 18-23 September 2017

c) GLO concentration 28-30 September & 1-4 October 2018

d) Map of Quito. Wildfires are marked with a triangle where color corresponds to the year of the episode (light blue, 2015; purple, 2017; red, 2018). Green arrows on the map correspond to the wind directions the day of each wildfire.

Wildfire occurrence rates have generally increased in recent years possibly due to changes in climate (9). In fact, this July and August, this rate increased 76% in Quito compared to 2018 (10).

This document proposes three strategies to minimize wildfire associated high ozone episodes in Quito and to contribute to manage associated risks during these events.

### 1. Surface wind maps

We propose to expand the anemometer network throughout the city surroundings. Collecting abundant observations would help develop seasonal surface wind maps. Thus, maps would complement current efforts made by Quito's Secretary of Risk Management in determining areas that pose high wildfire risk (11). Although wind velocity and direction are difficult to predict, measurements from EMA at USFQ have shown observable seasonal patterns in the area (12). Estimating these patterns in the entire region on surface wind maps is key to improving risk assessment in a more holistic manner, as the influence of wind speed and direction in wildfire propagation would be taken into account (13). Academia and the government should work together to interpret results and develop efficient solutions to local issues.

### 2. Social awareness about potential surges in GLO

Quito inhabitants are not familiar with GLO risks as this contaminant is usually within WHO guidelines. We propose to develop an educational campaign to raise awareness of the potential emergence of ozone as an air pollutant in Quito. The campaign should cover:

#### a. What is ozone?

Ozone is a gas that is formed through a set of atmospheric chain reactions involving VOCs, NO<sub>x</sub> and UV light.

#### b. What produces ozone in urban environments?

Emissions from vehicles, solvent use, and power generation plants are among the main sources of VOCs and NO<sub>x</sub> in urban environments (14). Moreover, since Quito is located on the equator it receives abundant UV radiation specially during September. Wildfires, as explained earlier, may trigger ozone formation (7).

#### c. Why is ozone a threat to human health?

Ozone can produce damage in the respiratory system (4). Furthermore, at Quito's altitude in the Andes, there is less oxygen in mass per unit volume of air, which affects further vulnerable groups during pollution events.

#### d. What to do in case of an increased ozone concentration in the environment?

Stay calm and take action to reduce risks. Some recommendations are shown below.



### 3. Regulations on burning waste

Anthropogenic activities are the main cause of wildfires in Quito (15). Therefore, any type of activity that involves burning should be prohibited in particular in July, August and September.

Current campaigns developed by the City should continue to be reinforced. Since occasionally agriculturists practice slash and burn farming, we propose to develop policies with input of local governments, academia and agriculturists, that would help farmers adopt more sustainable practices.

### Summary

It has been observed that ozone is emerging as an episodic air contaminant in Quito due to an increase in frequency of wildfires around the city, in particular during summer months. To address this potential health risk, we propose to expand wind monitoring to develop surface wind maps, to raise awareness about GLO formation, and to regulate burning practices around the city.



### Conclusion

Wildfires should be considered in public policy regarding air quality since they are causing extreme levels of ozone in Quito. This memo proposes 2 straightforward recommendations to prevent wildfires around MDQ and tackle this issue from the source.

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# Air pollution India: An alarming crisis

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Dr Ruma Bhargawa

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## Summary

Air pollution is responsible for one out of every eight deaths in India<sup>1</sup>. Lack of real time air quality monitoring and failure to enforce regulations are some of the reasons for rising pollution levels. The answer lies in having a multi-pronged approach encompassing national policies and state-specific multi-sectoral Plans.

## Background

India has nine of the world's 10 most polluted cities according to WHO estimate (Illustration-1), with polluted air killing 1.24 million people in 2017<sup>2</sup> and 100,000 children under five years of age annually.<sup>3</sup>

India faces the dual challenge of exposures from both ambient (coal burning for thermal power production, industry emissions, construction activity, transport vehicles, road dust, biomass burning, agricultural stubble burning, and diesel generators) and household air pollution<sup>4</sup> (Illustration-2). The presence of particulate matter PM2.5 and PM10 in air causes deleterious health outcomes (Illustration-3), however 76.8% of the Indian population is exposed to levels of PM2.5 greater than those recommended by National Ambient Air Quality Standards<sup>1</sup>.

## HEALTH HAZARDS OF AIR POLLUTION<sup>1</sup>

Air pollution contributes to more disease burden in India than tobacco use, primarily through causing lower respiratory infections, chronic obstructive lung disease, heart attacks, stroke, diabetes, and lung cancer.

The average life expectancy in India would be 1.7 years higher if the air pollution level was less than the minimum level.

- 1 Balakrishnan, K., Dey, S., Gupta, T., Dhaliwal, R. S., Brauer, M., Cohen, A. J., ... & Sabde, Y. (2019). The impact of air pollution on deaths, disease burden, and life expectancy across the states of India: The Global Burden of Disease Study 2017. *The Lancet Planetary Health*, 3(1), e26-e39
  - 2 Habib, M., & Kumar, H. (2019). India Finally Has Plan to Fight Air Pollution. Environmentalists Are Wary. *The New York Times*. Retrieved from <https://www.nytimes.com/2019/01/11/world/asia/india-air-pollution.html> [Accessed 23 Sep. 2019].
  - 3 The Hindu Business Line. (2019). 1 lakh kids under 5 years of age in India die due to air pollution each year: Study. Retrieved from [https://www.business-standard.com/article/current-affairs/toxic-air-killed-over-100-000-kids-aged-below-5-years-in-india-in-2016-who-118102901293\\_1.html](https://www.business-standard.com/article/current-affairs/toxic-air-killed-over-100-000-kids-aged-below-5-years-in-india-in-2016-who-118102901293_1.html) [Accessed 23 Sep. 2019].
  - 4 Balakrishnan, K., Cohen, A., & Smith, K. R. (2014). Addressing the burden of disease attributable to air pollution in India: the need to integrate across household and ambient air pollution exposures.
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## Reasons

The reasons why we have failed to tackle this menace are:

1. **Not monitoring air quality real time:** Only 29 cities are monitored real time by Central Pollution Control Board, while 573 still monitored manually<sup>5</sup>.
2. **City data of sources of pollution is unavailable:** 2008 was when data on pollution sources was last collected in cities.
3. **Governments fail to enforce:** Seriousness to enforce air quality standards lacks in city administration.
4. **Ignoring health risks:** Health-care fees and productivity losses from pollution cost India 8.5% of GDP<sup>6</sup>. Yet it's not an urgency.
5. **Irresponsiveness of citizens:** Do not take public transport, pollution isn't a priority.

## Present policies

The govt unveiled the National Clean Air Program, a 5-year plan to reduce 102 worst-affected cities in the country by 20- 30% by 2024<sup>7</sup>. However, the plan lacks clear mechanisms and funding to achieve its aims.

## Recommendation

Cities are engines of growth and equity but they have to be sustainable. Hence, this is a defining moment and we must scale up action to urgently respond to this challenge.

Although control of air pollution is needed all over India, the heterogeneity between states should be taken into account in designing policies and interventions consistent with the magnitude and sources of pollution in each state.

## Implementation

An amalgamation of national level and multi-sectoral collaborations are needed to mitigate the impact of pollution. It's the collective responsibility of the government, citizens, think tanks, international development agencies and academia to work together and weave overarching strategies. The following strategies can be taken into consideration:

5 Nandi, J. (2016). *Delhi Today, Your City Tomorrow*. *The Times Of India*. Retrieved from <http://epaperbeta.timesofindia.com/Article.aspx?eid=31808&articlexml=Delhi-Today-Your-City-Tomorrow-06112016010005&Mode=> [Accessed 23 Sep. 2019].

6 Marlow, I. (2018). *World's fastest growing economy has the world's most toxic air*. *The Economic Times*. Retrieved from <https://economictimes.indiatimes.com/news/politics-and-nation/worlds-fastest-growing-economy-has-the-worlds-most-toxic-air/articleshow/66310288.cms> [Accessed 23 Sep. 2019].

7 *Government launches National Clean Air Programme (NCAP)*. (2019). Retrieved 23 September 2019, from <https://pib.gov.in/newsite/PrintRelease.aspx?relid=187400>

## Multi-Pronged Approach

### National Level Strategies

- Satellite technology for monitoring city wise air pollution.
- Make National Ambient Air Quality Standards legally binding across the country.
- Evidence and credible data on public health effects of air pollution to take informed decisions.
- Increased funding for pollution control measures.

### Multi Sectoral Strategies

S. NO	Sector	Strategy	Impact	Responsible Agencies
<b>Govt of India, State and District govt will be the stewards. Additionally, collaboration with following agencies is required for implementing each strategy</b>				
I	Transport	<ul style="list-style-type: none"> <li>➤ Strengthening of Public transport system and its conversions to CNG</li> <li>➤ Ban on old commercial vehicles (10 year)</li> <li>➤ By-passing of trucks through peripheral ring roads</li> <li>➤ Fiscal incentives for hybrid /electric vehicles</li> <li>➤ Ensure alternative fuels - ethanol, bio-diesel</li> <li>➤ Encourage non-motorized transport- Pedestrian friendly walkways</li> </ul>	Reduced vehicular pollution	Transport department
II	Road dust	<ul style="list-style-type: none"> <li>➤ Better road paving technology – pavement to be wall to wall</li> <li>➤ Vacuum cleaning of roads</li> </ul>	Reduced suspended dust in air	Public Works Department
III	Industries	<ul style="list-style-type: none"> <li>➤ Fuel shift to cleaner fuels</li> <li>➤ Industrial zones may be developed outside the city</li> <li>➤ Strengthening of enforcement mechanism for pollution control</li> </ul>	Reduced industrial emissions	Department of Industries and Commerce
IV	Construction	<ul style="list-style-type: none"> <li>➤ Enforcement of Green Building concepts</li> </ul>	Reduced dust from construction sites	Public Works Department, Construction associations

<b>V</b>	Domestic fuel	➤ Ensure 100% replacement of kerosene and wood stoves to CNG/PNG	Reduced indoor pollution	Citizens forums
<b>VI</b>	Bio mass/ trash burning	➤ Ensure ban on crop residue burning	Reduced suspended dust and haze	Food and supplies department, Famers association
<b>VII</b>	Encourage electric crematorium	➤ Active advocacy amongst citizens ➤ No cost charged for using	No pyre emission	NGOs/CBOs
<b>VIII</b>	Information, Education and Communication (IEC)	➤ Sensitization programmes for all levels of stakeholders	Increased awareness	Schools/Colleges, CBOs/NGOs

## Conclusion

A clean and healthy environment is the single most important precondition for ensuring good health. It's time we break up the complacency around these premature preventable deaths. As Dr. Tedros, DG of WHO says "The world has turned the corner on tobacco. Now it must do the same for the 'new tobacco': the toxic air that billions breathe."<sup>8</sup>

<sup>8</sup> Schultz, K., Gettleman, J., Kumar, H., & Venkatraman, A. (2018). *As World's Air Gets Worse, India Struggles to Breathe*. *The New York Times*. Retrieved from <https://www.nytimes.com/2018/10/30/world/asia/india-air-pollution.html> [Accessed 23 Sep. 2019].

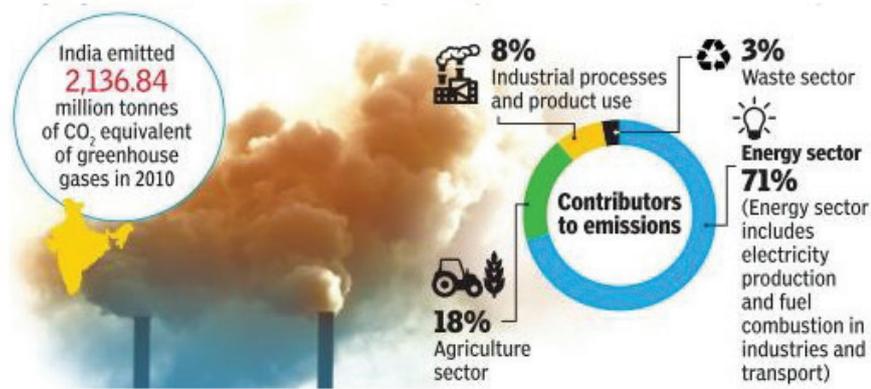
### Illustrations

#### Illustration - 1



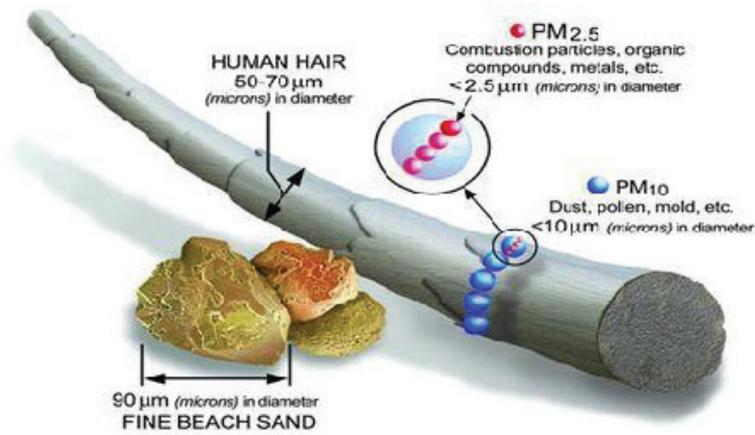
Source- <https://www.mapsofindia.com/my-india/cities/10-most-polluted-cities-of-india>

**Illustration – 2**



Source: India's Biennial Update Report (BUR) to UN Climate body

**Illustration – 3**



Source: US EPA

# Resolving Transnational Haze Caused by the Palm Oil Industry

**The University of Hong Kong**

Kevin Yap, Tan Zhi Qing

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## **1. Background**

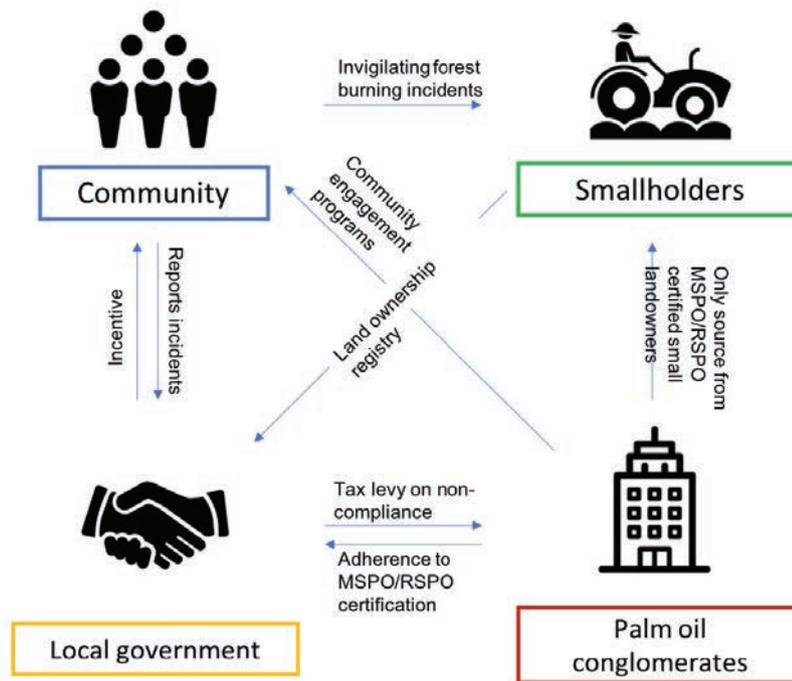
The current haze caused by ‘slash-and-burn’ practices in Indonesia, often occur within land concessions and sub-contractors linked to Malaysian palm oil conglomerates (Paddock & Suhartono, 2019). Conservative estimates indicate that the healthcare costs to treat haze-related illnesses in Malaysia in 2013 was approximately USD100 million alone and was directly linked to a spike in respiratory disease symptoms in the local population (Ab Manan, Manaf & Hod, 2018). Moreover, these unsustainable agricultural techniques have led to the European Union’s phasing out and eventual ban on palm oil biofuels which threatens the livelihood of 650,000 farmers in Malaysia (Terazono, 2019).

## **2. Policy Gaps**

While the Malaysian Government has attempted to expedite the adoption of the Roundtable for Sustainable Palm Oil (RSPO) certification, two policy gaps exist. The first is a lack of transparency and visibility in the complex supply chain of palm oil companies. The second is the inability to prosecute Malaysian palm oil companies for unsustainable farming techniques practiced by smallholder subcontractors in Indonesia.

## **3. Recommendation**

We therefore propose the Industrial Change Model which drives interactional change between different stakeholders involved in the production, commercialization and regulation of the palm oil industry. Close partnership between the Malaysian government and Indonesian local authorities in evidence sharing and reporting of regulatory violations is required. This enables the prosecution of perpetrators in Malaysia for unsustainable practices by their subcontractors under the legal principal of vicarious liability.



**Figure 1.** Visualization of Industrial Change Model

i) Community and local authorities

The Malaysian government should partner with Indonesian local authorities to finance the expansion of 'Fire Free Village Programs' (APRIL, 2015) in recurring hotspots in Indonesia. These financial incentive programs aim to promote sustainable practices by financially rewarding communities that are able to prevent and mitigate man-made forest fires in nearby palm oil plantations.

ii) Community and smallholders

By integrating local communities in close proximity with plantation concessions into forest fire prevention programs locals are incentivized to inspect, report and immediately respond to man-made forest fires initiated in nearby smallholding plantations. This is particularly effective especially since these communities suffer the brunt of the health consequences of the haze.

iii) Community and palm oil conglomerates

Malaysian palm oil companies should be mandated by the Government to incorporate community engagement programs highlighting the benefits of sustainable farming practices into its corporate strategy and operations. The effectiveness of these programs will be used as an additional metric in the RSPO certification of palm oil companies.

iv) Local authorities and palm oil conglomerates

The Government should impose an export tax levy to Malaysian domiciled companies who are unable to verify sources of palm oil kernels and/or regularly fail sustainability audits. This would deter producers from striving to export cheaper but unsustainable palm oil to emerging markets with weaker sustainability standards (e.g. India).

v) Palm oil conglomerates and smallholders

Palm oil companies should be prohibited from sourcing palm oil kernels from smallholder plantations that have not obtained RSPO certification and maintain a detailed record of all such inbound delivery to its milling plants. Failing that, its RSPO certification will be revoked and the abovementioned tax levy will be imposed.

vi) Smallholders and local authorities

All smallholders should register their land holdings with the local government and report their contractual relationship with larger palm oil companies. In return, the Malaysian government and local authorities will co-finance RSPO certification costs and provide support in transitioning to RSPO best practices.

#### **4. Potential Impact**

i) Environment

By promoting a system of checks and balances within the palm oil industry's supply chain, we anticipate a significant decline in man-made forest fires, thereby reducing the risk of serious hazes. This in turn reduces the risk of respiratory illnesses amongst communities in Malaysia and Indonesia while effectively improving the quality of life.

ii) Economy

Apart from the reduction of healthcare costs and productivity losses during serious haze episodes, promoting sustainability and transparency in upstream palm oil producers will weaken global anti-palm oil movements. This enables Malaysia's continued access and growth in the global plant-based oil market which in turn preserves the livelihood of 650,000 farmers.

#### **5. Barriers and Limitations**

Financing incentive programs and launching engagement campaigns incur financial costs. However, the implementation costs incurred by the Malaysian government is offset by the increased productivity of a healthy economy and tax revenues from a thriving sustainable palm oil export segment. Moreover, as increased operational costs are spread across a large production volume, any price increases felt by palm oil buyers would be marginal.

## 6. Conclusion

Hence, we believe that the successful implementation of the Industrial Change Model will not only reduce environmental air pollution via improved transparency within the palm oil industry, but also increase consumer confidence in the sustainability of palm oil derivatives which in turn benefits smallholder growers in Malaysia.

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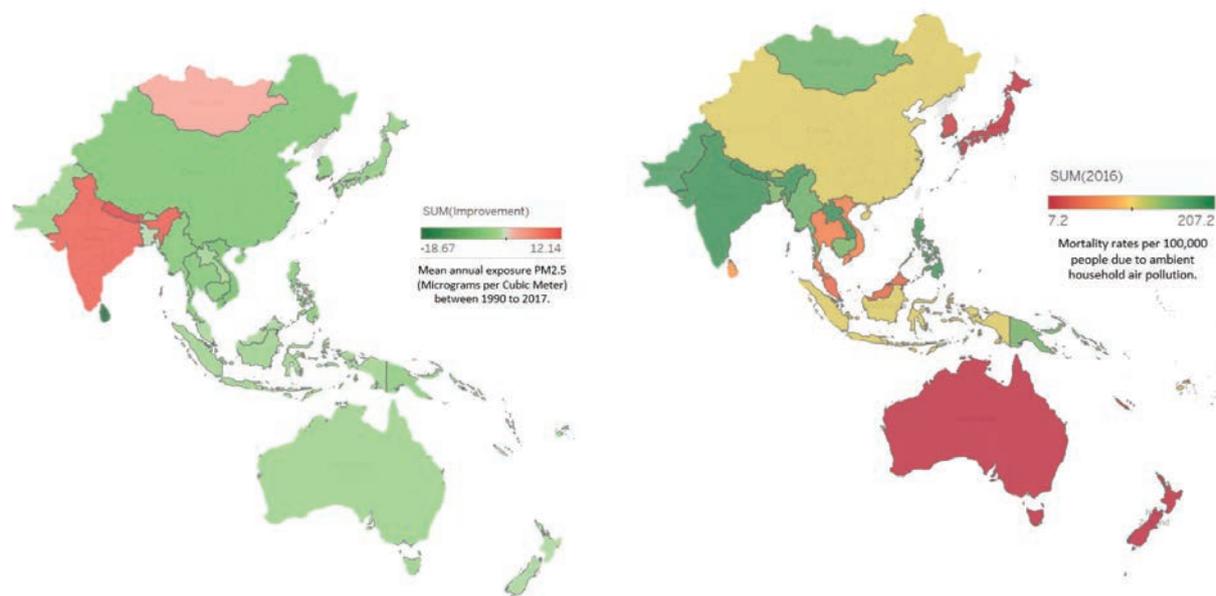
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# Cleaner Air Through Performance-Based Sustainability, Investment Ecosystems and Levied Decongestion

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Australia's mortality rates as a result of ambient air pollution relative to its neighbouring countries are some of the lowest across the Asia-Pacific region, with significant improvements in reducing PM2.5 exposures from 1990 to 2017 (see Figures 1a and 1b). Mortality rates in 2016 were at 8.4 deaths per 100,000, compared with the next highest country (excluding North Korea) being Nepal at 193.8 deaths per 100,000 people.



**Figure 1a:** (Left) World Bank Database 2019, annual PM2.5 exposure per person across the Asia-Pacific region, available: <https://data.worldbank.org/indicator/EN.ATM.PM25.MC.M3>.

**Figure 1b:** (Right) World Bank Database 2016 figures for mortality rates per 100,000 individuals due to ambient air pollution, available: <https://data.worldbank.org/indicator/SH.STA.AIRP.P5>.

Figures exclude the Americas and the Russian Federation. Tableau software used for geographical colour coding.

Different countries will have unique priorities for their populations and institutional strengths. For example, India's population largely places priority for necessities over environmental actions (Schultz 2019) resulting in annual PM2.5 exposures of 89.7  $\mu\text{g}/\text{m}^3$  and 184.3 deaths per 100,000 people in 2016, and corruption in China has led to greater pollution levels (Lague 2006).

Licensing from the Australian government continues to permit pollution beyond safe levels with prosecutions inadequately enforced for violations, encouraging communities to take civil action for caused harm (Dobbie & Green 2015). Consequently, two factors arise. Firstly, this underscores the ineffectiveness of Australia's current command-and-control methods due to its failure to protect communities. Secondly, stakeholders are more likely to become involved in environmental initiatives if they have a stake in the problem. As a result, a solution that supports rather than enforces companies to reduce pollution-emitting activities, and encourages active communal involvement, is needed. Three solutions are proposed to address this:

- 1) Points-based tax saving scheme incentivising companies to reduce air pollution
- 2) Emissions investment schemes between councils and businesses
- 3) Levying businesses out of pollution hotspots

### Proposal 1: PM2.5 Performance Tax Reduction Scheme

A formula is devised to maximise the reduction in PM2.5 air pollution at the source while minimising negative repercussions on profits and the labour force. This ensures sustainable activities are maximised while negative economic ramifications are minimised. The company tax rate of 30% is deducted off the percentage improvement in reducing PM2.5 emissions across the company's operations (which the government could cap the maximum reduction permissible to safeguard taxation revenue). A multiplier (B) may also be applied to emphasise sustainability performance improvements for certain industries (for example the mining industry).

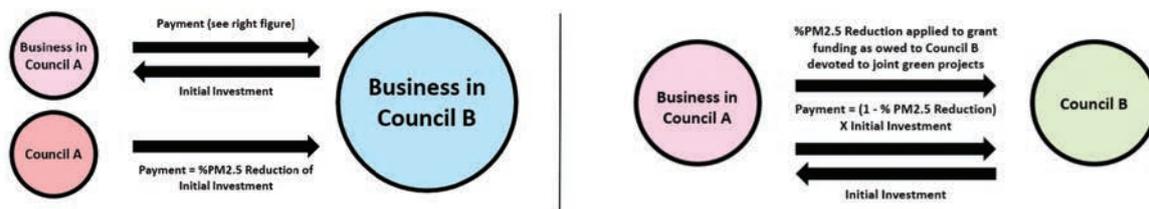
$$\begin{array}{c}
 \text{PM2.5 TAX REDUCER} \\
 \hline
 \begin{array}{ccc}
 \text{PM2.5 Reduction} & \times & \text{Company Labour Force} & \times & \text{Company Profit with Reduction} \\
 \text{PM2.5 Before Reduction} & \times & \text{Company Labour Force without Reduction} & \times & \text{Company Profit without Reduction}
 \end{array}
 \end{array}
 = A \left| \text{TR}(\%) - \left[ B \left[ \frac{1-A}{A} \times 100 \right] \right] \right.$$

**Figure 2:** Proposed Air Pollution Tax Deduction Formula

An equation of this sort requires government adoption and support. With effective PM2.5 monitoring systems in place at the source and accounting principles that audit the sustainability performance of a firm, this would incentivise companies to closely collaborate with rather than evade governments to achieve tax savings on their performance. This would circumvent the ineffectiveness of command-and-control policies and support competitive PM2.5 reduction schemes for Australian companies.

### Proposal 2: Emissions Investment Scheme

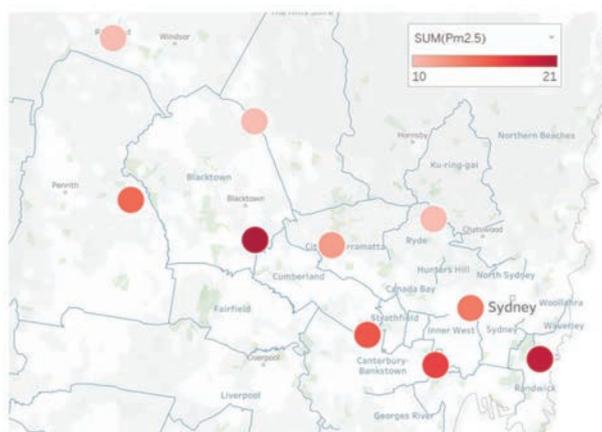
PM2.5 exposure levels across Australia are shown to be concentrated around operation sites (Dobbie & Green 2015). Carbon emission trading schemes have demonstrated improved engagement between internal stakeholders of businesses (Wang et al. 2018). A scheme where communities are incentivised to reduce the amount of  $\mu\text{g}/\text{m}^3$  exposure to populations is needed. A proposal would be to create an ecosystem where councils and businesses can invest in a stable company's operations to minimise  $\mu\text{g}/\text{m}^3$ . With currently available systems to monitor air pollution levels across the Sydney region, cutting  $\mu\text{g}/\text{m}^3$  will be an easily implementable solution strengthening community ties and reducing air pollution.



**Figure 3:** Ecosystem model of investing in stronger communal collaboration and sustainability.

### Proposal 3: Dispersion Levy

Local councils generate revenue through a variety of tools. One tool is through levies. Levying businesses in highly congested regions can discourage new companies from forming clusters where air pollution becomes harmful for nearby communities. For example, businesses outside of levy zones will be exempt, but will be levied if not. This will disperse business away from each other and encourage relocation into spots with lower congestions.



**Figure 4:** PM2.5 air quality data within Sydney region as of 12th July 2019. Accessed: <https://www.environment.nsw.gov.au/aqms/hourlydata.htm>.

Data converted to geo format.

$$\frac{\begin{array}{|c|} \hline \text{Additional Land} \\ \text{Purchased} \\ \hline \end{array} \quad \begin{array}{|c|} \hline \text{Total Emissions} \\ \text{by Company} \\ \hline \end{array}}{\begin{array}{|c|} \hline \text{Free Land Available} \\ \text{for a Zone} \\ \hline \end{array} \quad \begin{array}{|c|} \hline \text{Total Emissions} \\ \text{for Zone} \\ \hline \end{array}} \times 100\% = \text{Dispersion Levy}$$

**Figure 5:** Dispersion levy to reduce pollution concentration.

### Conclusion:

A 10% reduction in PM<sub>2.5</sub> 2007 levels by 0.6 µg/m<sup>3</sup> over ten years would reduce the number of deaths in Sydney by about 650 per 6.82 million people for the period (Broome et al. 2015), and an extrapolated total across Australia of about 1,974 people. The need to incentivise businesses to reduce air pollution is now more important than ever, where action is needed today for cleaner air tomorrow.

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# Threat to Health: How to Eliminate the Impact of Air Pollution

**The Hong Kong University of Science and Technology and The University of Hong Kong**  
Cheung Kit Shan and Wong Wing Yin

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Soaring pollutant emissions increase the risk of respiratory diseases and harm fetal cognitive development. More than 1500 people die prematurely in Hong Kong (HK) due to respiratory diseases every year<sup>1</sup>, highest among the other Great Bay Area provinces.

Every year, the deaths and shrinking labour forces brought by air pollution carry a quantifiable economic cost to global society as a loss of 2.6 trillion USD<sup>2</sup> and over 15 billion HKD in Hong Kong.<sup>3</sup>

Despite the Hong Kong government (HKG) claims there is a decreasing emission trend of air pollutants as a result of implementing internal Air Quality Guidelines (AQGs), HK's contemporary regulatory policy of air pollution is far too loose in which the AQG of SO<sub>2</sub> is 5 times higher than that of WHO. Moreover, it is reviewed once every five years which could not reflect the current situation effectively.

Nevertheless, a misleading and deceiving proposal that tightens up SO<sub>2</sub> and PM2.5 emissions, but simultaneously relaxes the allowable exceedance significantly from 9 times to 35 times, was suggested by the HKG. With substantially higher permitted emissions, it harms global well-being and economy.

HK, being a strong economy in Asia, has an inevitable responsibility to enforce effective policies and cooperate with nearby regions to relieve air pollution. Therefore, we recommend a holistic solution - set up an Air Pollution Control Commission with a goal of ensuring citizens' well-being and achieving a more sustainable future for both HK and the Asia-Pacific region. (Figure 1)

The Commission focuses on inspecting and tackling the current air-related policies in three main aspects: (1) imposition of progressive systems on carbon footprint (2) Provide a platform for science and innovative ideas (3) Cross-border cross-sector policy conference.

## **(1) Imposition of progressive systems on carbon footprint**

Capital is a powerful tool to alter corporations' behaviour in HK. Thus, a monetary incentive can reduce the carbon footprint and encourage companies to invest in clean air alternatives.

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<sup>1</sup> Hedley Environmental Index. School of Public Health of the University of Hong Kong. Retrieved from <http://hedleyindex.hku.hk/historical>

<sup>2</sup> OECD (2016). *The Economic Consequences of Outdoor Air Pollution*. OECD Publishing. Retrieved from <https://doi.org/10.1787/9789264257474-en>

<sup>3</sup> Hedley Environmental Index. School of Public Health of the University of Hong Kong. Retrieved from <http://hedleyindex.hku.hk/historical>

Public support has been shown since 2012, with almost 80% of respondents willing to pay for carbon tax following the equity and polluter pays principle.<sup>4</sup>

By comparing the carbon system in Britain and California, the key to an effective system in California is a high initial carbon price.<sup>5</sup> Therefore, a strict progressive Carbon Tax (CT), which imposes a levy on emissions exceeding the permitted level, should be adopted in HK. Meanwhile, to promote the reduction of carbon footprint, the reward system awards those with low emissions. (Figure 2)

To eliminate understatement of total health impact, different pollutants such as SO<sub>x</sub>, NO<sub>x</sub> and PM<sub>2.5</sub> are converted to the same measurement - CO<sub>2</sub> equivalent - in the calculation of emissions.

The CT will start from large-scale companies, followed by a larger population in the long term. (Figure 3) The Commission will adjust the tax system by considering the overall health condition of citizens, science-technology research and provides certain guidelines for the companies and individuals to improve air quality.

## **(2) Annual Air Product Release - a platform for innovative ideas**

Science and technological parties can contribute to the future development of relevant policies by focusing on radical, future technology and market development as integrated strategies for sustainability. An annual conference (ICTSI2019) was held in Thailand with 40 top Asia institutes for publishing their latest research.<sup>6</sup> Instead of technological research, the Commission gathers the air quality-related innovations by holding an annual product release. Companies with great inventions could apply to introduce their products and attract potential investors worldwide. Students are encouraged to participate as it bridges their future careers with the new challenging socio-technical environment. Shortlisted inventions would be introduced on the release day. If the interventions are qualified, monetary investments, technical and marketing support will be offered.

Not only should the inventors and investors pay attention to the latest showcase, but also the public has to emphasize the improvement of air quality. To increase public engagement, the release would be broadcast on mainstream TV channels and social media.

## **(3) Cross-border cross-sector policy conference**

HK can raise its socio-technological influences by holding international air quality conferences. The Commission connects sustainable behavior and broader societal levels including technology, institutions, cooperation and government sectors. (Figure 1)

<sup>4</sup> Ho, L. S. (2012). *Implementation of carbon taxes in Hong Kong: Level of intention and willingness to pay among undergraduate students in City University of Hong Kong*. City University of Hong Kong, City U Institutional Repository. Retrieved from <http://lbms03.cityu.edu.hk/oaps/sa2012-4601-hls388.pdf>

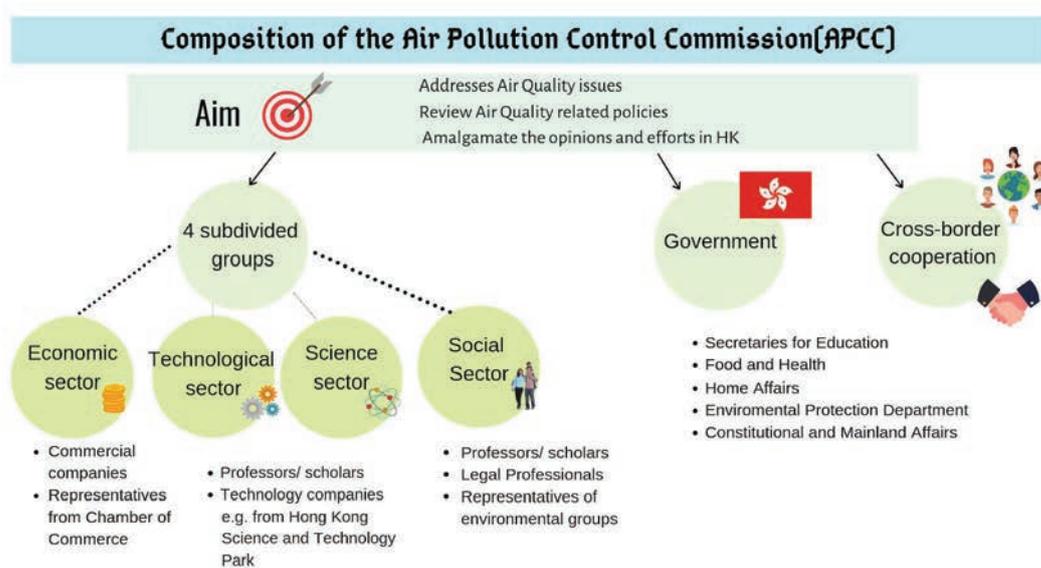
<sup>5</sup> Plumer, B., & Popovich, N. (2019, April 2). *These Countries Have Prices on Carbon. Are They Working?* *The New York Times*. Retrieved from <https://www.nytimes.com/interactive/2019/04/02/climate/pricing-carbon-emissions.html>

<sup>6</sup> *International Conference on Technological and Social Innovations 2019 (ICTSI2019)*. Retrieved from <http://conf.e-jikei.org/ICTSI2019/>

Discussion among sectors facilitates the interaction and exchange of opinions of stakeholders which fully reflects their vested interests.

The future vision and strategic direction of the conference would be determined every three years for guiding the work of the Commission and quality control. We anticipate to connect different economies and groundbreaking ideas could be raised effectively in the conference.

With a rising global population, immediate rectification of policies should be imposed to maintain our well-being. The socio-technological Commission is a good kickoff for HKG to address the current salient air quality crisis. As inclusive professions and stakeholders are engaged, the recommendations could become more diverse, comprehensive and reliable.



**Figure 1.** Composition of the Air Pollution Control Commission (APCC)

### PROPOSED PROGRESSIVE SYSTEMS

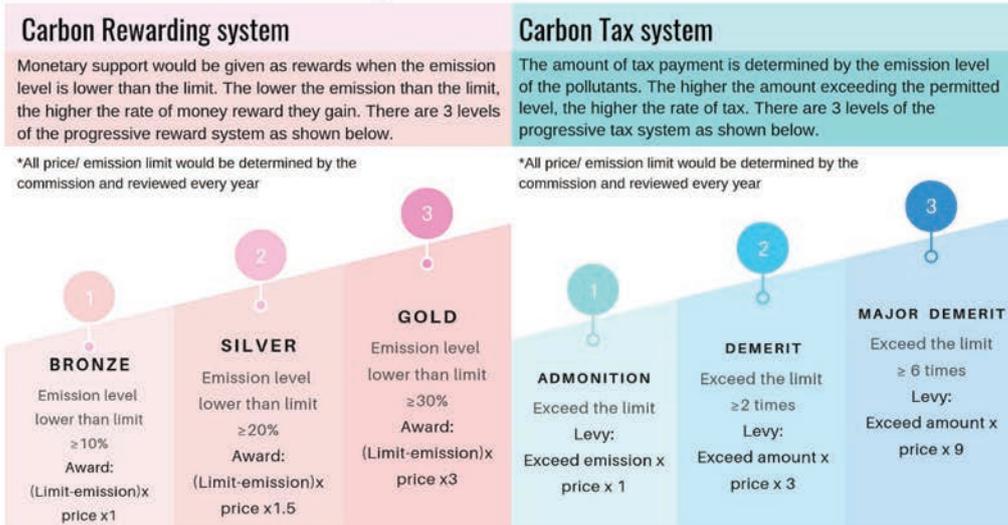


Figure 2. Proposed Progressive Systems

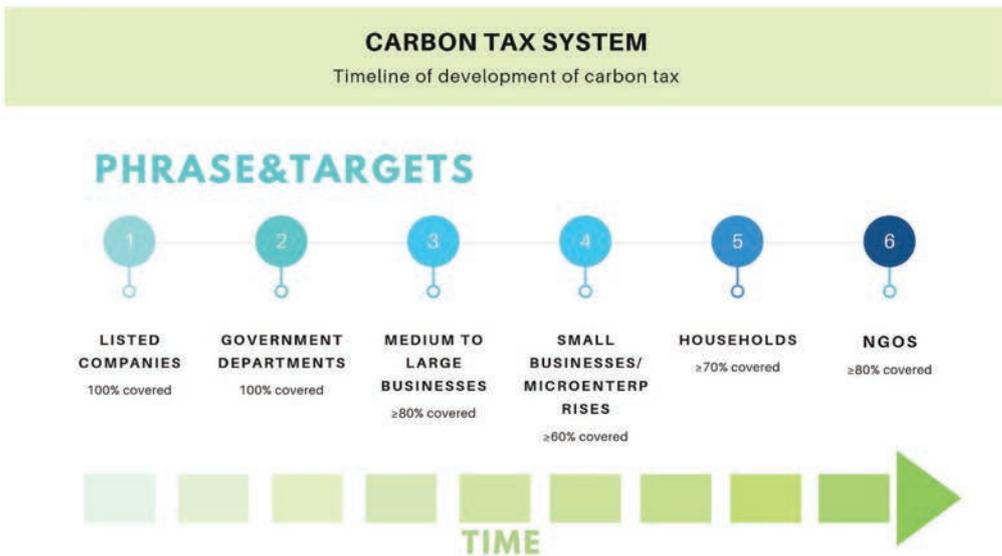


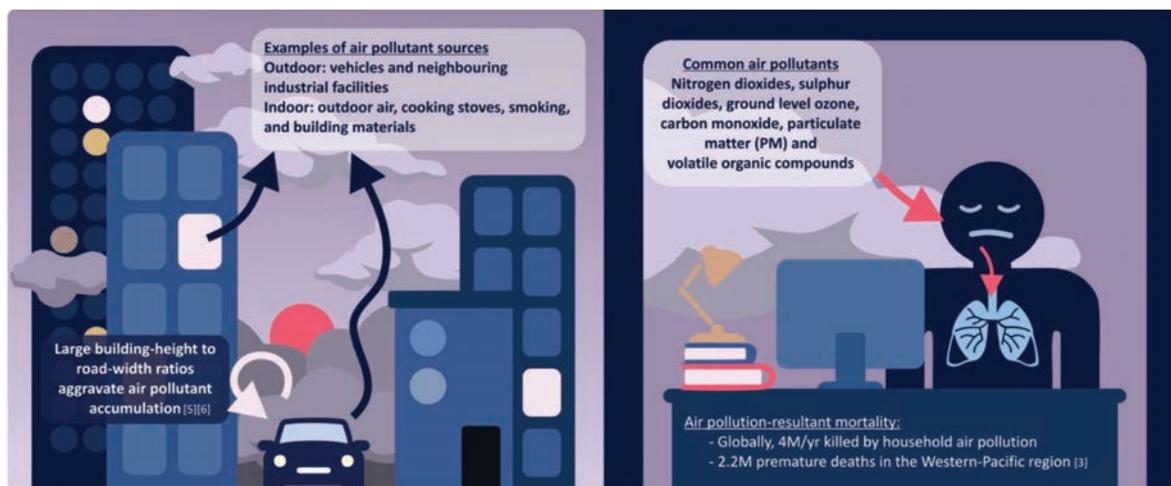
Figure 3. Phrases of development of carbon tax

# Harnessing Plant Biotechnology for the Improvement of Air Quality

The Hong Kong University of Science and Technology

Keira Lee Rice

Modern metropolises exhale a concoction of air contaminants that become trapped within a maze of towering skyscrapers, deep street canyons and tight dwellings. The design of our concrete habitats thus acts to impede airflow and favour the accumulation of air pollutants[1,2]. Indoor or outdoor, toxic air is being condensed into a constant haze and urban populations are becoming increasingly vulnerable to the many hazards it presents (Figure 1). Whilst the health effects of deteriorating air quality are reflected in the rising prevalence of lung cancer, heart conditions and respiratory diseases[4], the negative impacts of air pollution on fertility and embryonic development are also taking a toll on our future generations[5,6]. Therefore, despite promising advancements in healthcare, economies will suffocate in the thickening smog if measures to curb emissions and reduce exposure are not enforced. By leveraging on breakthroughs in plant biotechnology and working synergistically with trends in 'green' and 'smart' cities, this policy memo puts forth air phylloremediation as a sustainable and ubiquitous solution for the improvement of air quality.

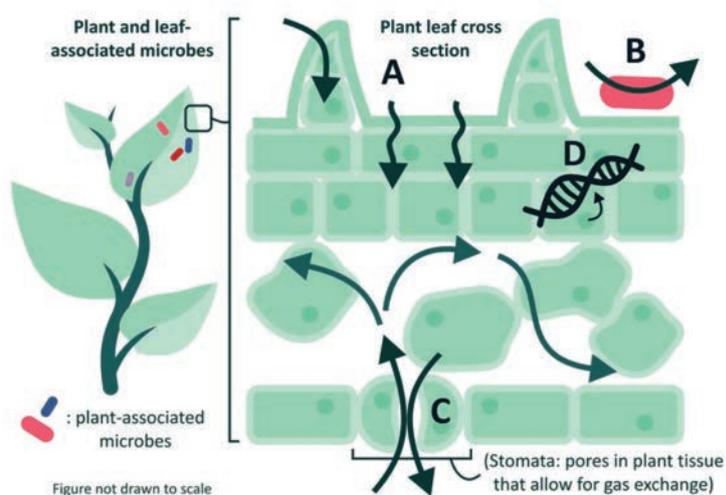


**Figure 1:** Infographic showing examples of air pollutant sources and components as well as their effects in urban environments.

Reports demonstrating the positive impacts of commercial air purifiers on human health suggest that air remediation may serve as an effective countermeasure to harmful air exposure [4,7]. However, ownership of air filtration systems remains limited to one tenth of the population in China[8]. Affordability,

aesthetic appeal, spatial requirements and energy consumption are some factors that limit their large-scale adoption[9]. Much like air purifying appliances, plant surfaces assimilate air pollutants and their internal components work to transform harmful compounds to less toxic or nontoxic products. Together with the microbes that colonize plant surfaces, air phylloremediation describes the potential of exploiting plant leaves and their associated microbes to improve air quality (Figure 2)[9-12].

To take advantage of nature's abundant, low-cost and sustainable air purifiers, (I) funding research and development (R&D) in plant science and biotechnology is necessary. This will support ongoing studies that are working to understand the biological mechanisms underlying air phylloremediation, the heterogeneity of plant and microbial species in these processes and their efficacy in sequestering the pollution mixtures of urban environments[9,11,12]. By building on these research outputs with new tools in synthetic biology, plant biotechnologists can optimize biochemical and physical parameters to engineer plants with greater functionality and/or commercial viability[13,14]. Moreover, the emerging role of plant-associated microbes in air remediation could lead to the development of biofertilizers to enhance the performance of existing urban greenery[11,12]. Altogether, research will help to produce scientific criteria that may be applied in the selection of plants and microbes to combat the air pollution threats of various metropolitan niches (figure 3).



**Figure 2:** Plant leaf anatomy showing the mode of action of air phylloremediation. (A) Passive accumulation into the leaf surface.

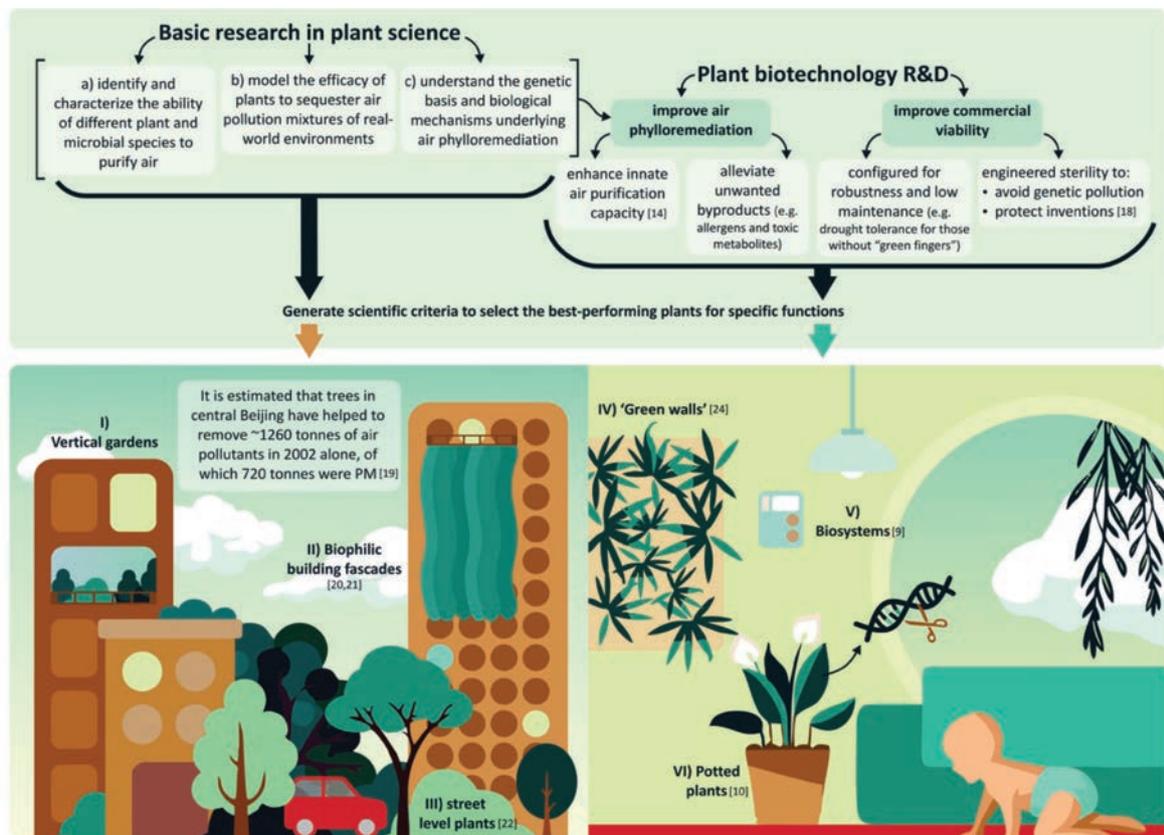
(B) Active removal of air pollutants by leaf-associated microbes. (C) Air pollutant uptake through stomatal absorption is followed by active biochemical degradation. (D) Within each cell, genetic information acts as a blueprint for plant morphology (e.g. leaf surface area) and coordinating

cellular machinery (e.g. detoxification enzymes) in the metabolism of absorbed compounds. Aside from ventilation and light intensity, these traits act to determine the capacity of different plant species to detoxify air. Figure modified from Brill et al., 2018.

However, the success of air phylloremediation in reducing harmful air exposure is hindered on the implementation and adoption of plantscaping measures. To achieve this goal, the (IIa) initiation of cross-disciplinary summits to bridge knowledge transfer between architects, civil engineers and researchers is recommended for efficient urban design. Secondly, just as Alibaba's "Ant Forest" afforestation project helped to plant ~100 million trees in rural China through a public mobile app[15], (IIb) mobilizing private enterprises may achieve similar successes in the creation of urban forests. At the same time, this will serve to (IIc) engage the general public through greening projects within their own cities to educate and raise awareness concurrently. While this works to improve air quality outdoors, the commercialization of indoor air purifying plants relies on (IId) support for bioentrepreneurship to aid biotechnology startups in the development and distribution of bioproducts. Lastly, the (IIe)

establishment of appropriate legal frameworks pertaining to the products of biotechnology is key to encouraging innovation and protecting inventors in a manner that does not compromise bioethics[16].

In conclusion, the air-purifying capabilities of plants present an underexploited solution to meet the Sustainable Development Goal of “ensur[ing] healthy lives and promot[ing] well-being for all at all ages”[17]. It is by investing in plant biotechnology R&D and fostering a conducive business and legal environment for their outputs that air phylloremediation may exert a sustainable and universal role in the cities of tomorrow.



**Figure 3:** Infographic showing how research in plant science and biotechnology can be translated into the creation of ‘urban forests’ for air phylloremediation. The flow chart illustrates examples of key research topics and potential targets for plant biotechnology. I)-III) and IV)-VI) are examples of ‘urban forest’ components outdoors and indoors, respectively. I)&II) Biophilic building design could help to detoxify the air surrounding flats and office blocks[20][21]. III) Street level plants may function as efficient pollution filters in street canyons[22]. Of significance to urban populations who spend 87% of their time indoors[23], botanical installations for homes and offices provide a promising market opportunity: IV) ‘Green walls’ present a space-saving and aesthetic means for air purification[24]. V) ‘Biosystems’ comprising computerized lighting and ventilation systems have the potential to optimize phylloremediation and achieve energy conservation concurrently[9]. VI) Studies by NASA in the 1980s demonstrated the efficacy of potted plants in reducing the concentration of various air pollutants[10]. Along with advancements in selective breeding and genetic engineering, popular household varieties could be optimized for air phylloremediation, aesthetic appeal and maintenance requirements.

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# Amending Taiwan's Air Quality Standards

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Taiwan's Air Quality Standards (AQS) has remained unchanged since the last amendments in 2012. Amendments proposed by the Environmental Protection Administration (EPA) this May still lag behind the World Health Organisation's (WHO) Air Quality Guidelines (AQGs). Such obsolete standards can lead to misperceptions of health risks among the public. The AQS should thus be amended to reflect such risks based on the AQGs and latest scientific findings to fulfil its role in Taiwan's air pollution management and climate change mitigation strategies.

## Background

According to the Air Pollution Control Act (APCA)<sup>1</sup>, all of Taiwan's special municipalities, cities, and counties are categorised into three classes of Air Pollution Control Regions: Class 1 consists of national parks and conservation areas, while Classes 2 and 3 are all others that either meet or do not meet the AQS, respectively. 2018 amendments further require an AQS review every four years to reflect changing pollution sources.

Enacted in 1992, AQS covers seven major pollutants. Table (1) compares the current standards to the proposed amendments and WHO's AQGs :

Pollutant	Averaging Time	Current standards (2012)	Proposed amendments (2019)	WHO AQGs (2018)
PM10 ( $\mu\text{g}/\text{m}^3$ )	Annual	65	50	20
	24-hr	125	100	50
PM2.5 ( $\mu\text{g}/\text{m}^3$ )	Annual	15	15	10
	24-hr	35	35	25
SO <sub>2</sub> (ppb)	Annual	30	20	(x)
	24-hr	100	(x)	20
	Hourly	250	75	(x)
O <sub>3</sub> (ppb)	8-hr	0.060	0.060	0.0509
	Hourly	0.120	0.120	(x)
NO <sub>2</sub> (ppb)	Annual	50	30	40
	Hourly	250	100	200
CO (ppb)	8-hr	9000	9000	(x)
	Hourly	35000	35000	(x)

**(Table 1:** Comparison among current standards, proposed amendments, and WHO AQGs)

<sup>1</sup> Air Pollution Control Act, art. 5. <https://law.moj.gov.tw/ENG/LawClass/LawAll.aspx?pcode=00020001>

<sup>2</sup> "Ambient (Outdoor) Air Quality and Health." World Health Organization. World Health Organization, May 2, 2018. [https://www.who.int/en/news-room/fact-sheets/detail/ambient-\(outdoor\)-air-quality-and-health](https://www.who.int/en/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health).

## Analysis

The EPA has cited current pollution-prevention technologies and difficulties to meet standards as reasons for the lack of drastic changes—the annual PM2.5 average for all regions in Taiwan was 17.5 µg/m<sup>3</sup> in 2018, only eastern rural regions passed<sup>3</sup>.

But the legislative rationale is to safeguard public health—neither the current state nor the proposed updates fulfil that. These loose standards have two main implications:

1. In a region with emissions levels close to the boundary citizens can sometimes develop false perceptions of better air quality while they are still prone to similar health risks.
2. The amount of air pollution control fee polluters pay also differs according to the status of the regions in which they operate. Heavy polluters that barely meet the AQS can thus avoid higher fees without any improvement.

A National Health Research Institute (NHRI)<sup>4</sup> research suggests that regulatory strategies built upon emissions levels are not indicative of the relationship between pollutants and general health conditions. Hence more respiratory-related diseases in recent years despite declining PM2.5 levels.

## Recommended Actions

1. Halt proposed amendments

The NHRI report was released after the EPA proposal. The EPA should suspend the planned schedule and conduct a robust review of current failures to reflect corresponding health risks, considering the new findings and suggestions of the report.

2. Follow WHO guidelines

The NHRI report and studies conducted in the United States<sup>5</sup> suggest that, even at modest levels, pollutants like PM2.5 significantly influence health conditions. Changes to the standards should thus align with WHO guidelines, if not stricter.

3. Consult Scientific Committee in Reviews

A committee consisting of scientists should be consulted in the required AQS reviews to ensure a degree of rigour in the AQS in terms of reflecting public health implications.

4. Integrate with climate policies

Activities that affect air quality and contribute to climate change often overlap and should be considered together systematically instead of being separated as they are. A plausible first step is to add GHGs like CO<sub>2</sub> to the AQS.

3 周好靜 “「我們等了七、八年，終於有了檢討 PM2.5 標準的機會」 空品標準修正 環團要求比照 WHO。” 台灣環境資訊協會-環境資訊中心, July 9, 2019. <https://e-info.org.tw/node/218952>.

4 “懸浮微粒特徵對民眾健康影響之研究。” 政府研究資訊系統 GRB. 財團法人國家衛生研究院, July 23, 2019. <https://www.grb.gov.tw/search/plan/Detail?id=13154959&fbclid=IwAR3KPh6bh5FocV-MZaOdtAogu0AjBknwGd8y-7tLrI6NYG40isKWnN0-W4A>.

5 Bakalar, Nicholas. “The Deadly Toll of Air Pollution.” *The New York Times*. *The New York Times*, August 27, 2019. <https://www.nytimes.com/2019/08/27/well/live/air-pollution-deaths.html>.

**Policy Implications**

Recommendations (1) and (2) deal primarily with the short-term.

- These will likely realise the EPA concern that regions would not be able to meet the standards.
- However, the purpose of AQS is not to ensure that local governments can to pass set thresholds but public wellbeing.
- Stricter standards can incentivise new pollution-prevention technologies to develop.
- Adopting WHO guidelines before most nations can boost Taiwan's international reputation in public health after having been barred from attending the World Health Assembly (WHA) since 2016.

Implications of recommendations (3) and (4) are in the long-term.

- Disagreements may emerge among the scientific community on how best to extract policymaking implications.
- Constant input from scientific communities plus a climate-policy integration can avoid outcomes of one department from discounting those of the other, for example, the promotion of diesel vehicles to reduce CO<sub>2</sub> emissions backfiring by increasing No<sub>x</sub> and PM.

Asia-Pacific Student Case  
Competition 2019

# Thank You

We would like to give a special thank you to all the university staff and faculty, students and judges who took part in this year's competition. With your support, the competition was a success.

The judges:

**Philip Traynor**

Staff Editor, The New York Times

**Jim Hollander**

Staff Editor, The New York Times

**Professor Keji Fukuda**

MD Director and Clinical Professor, Division of Community  
Medicine and Public Health Practice

The University of Hong Kong

**Professor Mellissa Withers**

Program Director, APRU Global Health Program

Associate Professor of Clinical Preventive Medicine, Department  
of Preventive Medicine

University of Southern California

# Case Competition Task

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## Global Health

Mortality attributed to household and ambient air pollution in the Asia-Pacific region is higher than in the rest of the world, at 130 deaths per 100,000 population.

Write an 800-word policy brief to a leader in your economy (government, philanthropy, business, NGO, etc.) discussing the threats to health from air pollution. What are the solutions you promote? What are the resources necessary? What are the ways that this solution will make an impact?

Using resources from The New York Times and beyond, describe the ways that air pollution threatens a healthy economy and promote a solution that would advance the third United Nations Sustainable Development Goal (SDG), focused exclusively on health: “Ensure healthy lives and promote well-being for all at all ages.”

SDG 3 calls for dramatic and inspiring achievements, including ending the epidemics of infectious diseases, preventing premature mortality, reducing maternal and infant mortality, and achieving universal health coverage, all of which will require significantly greater investments in global health. The SDGs have the potential to catalyze further transformations in global health and there are endless strategies to achieve results.

# Judging Criteria

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## **Accuracy (20%)**

- 1 Demonstration of knowledge of the subject matter under discussion, and coherence of the argument.
- 2 The use of accurate information or data to support arguments, with proper citation and definition of major terms.

## **Relevance (30%)**

- 1 Appropriate use of theories, concepts, or external data to justify the arguments.
- 2 The proposal of a practical and feasible solution or action with proper justification on the costs or tradeoffs involved.
- 3 Evidence of relevance or applicability of external data, field data, foreign research or method to the local environment.

## **Clarity (20%)**

- 1 Well-defined problem followed by a structured and organized presentation of data, ideas, and solutions.
- 2 Writing with clarity, style and professionalism, free of grammatical and spelling mistakes.

## **Originality (30%)**

- 1 The proposal of an original and innovative solution adequately addressing the case prompt.
- 2 Demonstration of independent thoughts and critical reflection on the specific circumstances of the situation involved.
- 3 Directness and magnitude of the impact created by the solution. (Who will benefit and how many of them? What could be the costs and benefits?)

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The Hong Kong University of Science and Technology  
The University of Hong Kong  
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University of Chinese Academy of Sciences  
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