Institution: University of York		
Unit of Assessment: 7 - Earth Systems and Environmental Sciences		
Title of case study: Advising government policies for integrated air quality and climate change mitigation strategies in Asia, Africa and Latin America		
Period when the underpinning research was undertaken: 2012 – 2020		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s):	**Role(s) (e.g. job title):**	**Period(s) employed by submitting HEI:**
Johan Kuylenstierna	Reader	Mar. 1986 - present
Kevin Hicks	Senior Researcher	Oct. 1997 - present
Lisa Emberson	Professor	Feb. 1997 - present
Harry Vallack	Senior Researcher	Oct. 1982 - Sep. 2019
Chris Malley	Senior Researcher	Sep. 2015 - present
Period when the claimed impact occurred: Sep. 2014 to Oct. 2020		
Is this case study continued from a case study submitted in 2014? N		

1. Summary of the impact (indicative maximum 100 words)

Research carried out within the Department of Environment and Geography by the York Centre of the Stockholm Environment Institute (SEI York) has been used to drive national agendas to include mitigation of Short-Lived Climate Pollutants (SLCPs). This builds on our contribution to a UN Environment (UNEP) and World Meteorological Organisation (WMO) global assessment on black carbon and tropospheric ozone and formation of the Climate and Clean Air Coalition (CCAC). Our researchers have informed development of integrated air quality and climate strategies in 16 countries resulting in high-level political endorsement of national action plans to reduce SLCPs in Nigeria, Côte d'Ivoire, Mexico, Bangladesh, Maldives, Colombia and Togo. In addition, Chile and Mexico have adopted black carbon targets in their Nationally Determined Contributions (NDCs) to mitigate climate change; and Bangladesh and Dominican Republic have acknowledged the support given by our researchers in their revised NDCs. Our research is cited by the Intergovernmental Panel on Climate Change (IPCC) in support of their demand that the global response to climate change must be strengthened.

2. Underpinning research (indicative maximum 500 words)

Since 2012, the York Centre of the Stockholm Environment Institute (SEI York), based in the Department of Environment and Geography at the University of York, has been at the forefront of research into SLCPs. SEI York research has provided evidence that SLCPs, such as black carbon (aka soot), methane, ground-level ozone and hydrofluorocarbons (HFCs), not only have a potent impact on climate change, but all except HFCs also impact on human health through people's exposure to polluted air. SEI York's body of research provides evidence, often for the first time, of the global extent of the harms which air pollution causes to health as well as its impact on climate change, and outlines the practical steps which governments and policy-makers can take to mitigate detriment to both. The SEI York team's research (3.1) was instrumental in demonstrating the most effective strategies for mitigating SLCPs, simultaneously improving health and reducing harmful climate effects in the near-term. This highlighted that if the 16 measures were applied globally between 2010- 2030 to reduce emissions of methane and black carbon and co-pollutants, that the rate of warming could be halved by 2050. These mitigation measures would result in the avoidance of millions of premature deaths from air pollution in 2030 and subsequent years, and the avoidance of tens of millions of tonnes of crop losses from reduced ozone formation.

SEI's initiative on Low Emission Development Pathways is designed to help policy-makers and planners to develop mitigation scenarios informed by quantitative assessments of SLCPs, Greenhouse Gases (GHGs) and air pollutant emission scenarios, and their impacts on health, crop yields and climate (3.2). Kuylenstierna, Hicks, Malley and Vallack developed a new application of the widely used energy and climate planning research tool: the Low Emissions Analysis Platform system (LEAP), by adding: i) air pollution scenario estimation capabilities; ii) non-energy emission sources; and iii) the development of an Integrated Benefits Calculator

(IBC) that can estimate $PM_{2.5}$ (fine particulate matter which is inhaled deeply into the lungs and causes significant health detriment) and ozone concentrations, that have subsequent impacts on premature mortality and crop losses (3.2).

The research provided evidence to promote mitigation of SLCPs in countries (3.3) by developing the first global assessment of the effect of exposure to $PM_{2.5}$ air pollution on the extent of preterm births (< 37 weeks of gestation) around the world, which is a major cause of postnatal death and a significant cause of long-term loss of human potential. The research estimated that between 13-24% of preterm births were associated with maternal $PM_{2.5}$ exposure and provided robust and politically relevant evidence for the health benefits of reducing exposure to indoor pollutants.

Following the 2015 revelations that automotive manufacturers had been using 'defeat devices' to hide the true extent of nitrogen oxide (NOx) emissions from diesel vehicles, SEI York researchers published a study (3.4) which was the first to quantify the effects of excess NOx emissions related to the 'defeat devices' (software deliberately misleading regulatory testing of emissions) on both public health (global mortality estimates) and the environment. The study examined 11 major vehicle markets, representing >80% of new diesel vehicle sales in 2015, finding that the hidden excess emissions amounted to 4.6m tons (53% higher than the expected emissions), associated with 38,000 premature deaths in 2015 alone.

Later research (3.5) built on their earlier findings to examine the influence of ambient air pollution on asthma: they were able to demonstrate the global asthma burden attributable to the effect of ozone and $PM_{2.5}$, for the first time, estimating that 9,000,000 - 23,000,000 and 5,000,000 - 10,000,000 annual asthma emergency room visits in 2015 were as a result of the influence of ozone and $PM_{2.5}$, representing 8-20% and 4-9% of the annual number of global visits, respectively.

The SEI York team synthesised the results of their research on the health and climate effects of SLCPs in a 2017 paper (3.6), which presents an ambitious yet achievable pathway towards reducing mean global warming by 50% by 2042 through reducing emissions of SLCPs and eliminating hydrofluorocarbons. The paper speaks directly to governments seeking to meet their commitments to both the Paris Climate Agreement and the UN's Sustainable Development Goals, and is referred to by the IPCC (section 4). The paper builds on (3.1) to further develop the concept of SLCPs, which have now been included in various countries' NDCs under the UN Framework Convention on Climate Change (UNFCCC) (e.g. in Ghana quote in Section 4, and Nigeria testimonial - 5.3a).

3. References to the research (indicative maximum of six references) **(York researchers in bold)**

3.1. D. Shindell, **J. C. I. Kuylenstierna**, G. Faluvegi, G. Milly, **L. Emberson, K. Hicks**, et al. Simultaneously mitigating near-term climate change and improving human health and food security. *Science* 335 (6065): 183-189 (2012) https://doi.org/10.1126/science.1210026. *Peer reviewed*

3.2. **J. C. I. Kuylenstierna,** C. G. Heaps, T. Ahmed, **H. W. Vallack**, **K. Hicks**, M. R. Ashmore, **C. S. Malley**, et al Development of the Low Emissions Analysis Platform – Integrated Benefits Calculator (LEAP-IBC) tool to assess air quality and climate co-benefits: Application for Bangladesh. *Environment International*, 145, 106155 (2020) https://doi.org/10.1016/j.envint.2020.106155. *Peer reviewed*

3.3. **C. S. Malley, J. C. I. Kuylenstierna,** M. Ashmore, M. Rutherford, **H. W. Vallack,** H. Blencowe, D. Henze. Preterm birth associated with maternal fine particulate matter exposure: A global, regional and national assessment *Environment Internationa*l, 101, 173-182 (2017). http://dx.doi.org/10.1016/j.envint.2017.01.023. *Peer reviewed, output submitted to REF2021*

3.4. S. C. Anenberg, J. Miller, R. Minjares, L. Du, D. K. Henze, F. Lacey, **C. S. Malley**, **L. Emberson**, et al. Impacts and mitigation of excess diesel-related NOx emissions in 11 major vehicle markets. *Nature* 545(7655):467-471. (2017) https://doi.org/10.1038/nature22086. *Peer reviewed, output submitted to REF2021*

3.5. S. C. Anenberg, D.K. Henze, V. Tinney, P.L. Kinney, W. Raich, N. Fann, **C. Malley**, H. Roman, L. Lamsal, B. Duncan, R. V. Martin, A. van Donkelaar, M. Brauer, R. Doherty, J. H. Jonson, Y. Davila, K. Sudo, **J. C. I. Kuylenstierna**. Estimates of the global burden of ambient $PM_{2.5}$, ozone, and NO_2 on asthma incidence and emergency room visits. *Environmental Health Perspectives,* 126(10), 107004 (2018) https://doi.org/10.1289/EHP3766. *Peer reviewed, output submitted to REF2021*

3.6. D. Shindell,N. Borgford-Parnell, M. Brauer, A. Haines, **J. C. I. Kuylenstierna**, S. A. Leonard, V. Ramanathan, A. Ravishankara, M. Amann, L. Srivastava. A climate policy pathway for near- and long-term benefits. *Science* 356 (6337): 493-494 (2017) https://doi.org/10.1126/science.aak9521. *Peer reviewed*

4. Details of the impact (indicative maximum 750 words)

Given the importance of reducing SLCPs, both in terms of climate change and the impact of air pollution on human health, SEI York has undertaken significant work to translate its research findings to policy-influencing organisations and policy-makers in national governments, and is described by the former Chief Scientist of UNEP as "*one of the most effective and important institutions working in the world on cutting edge science-policy issues*" (5.1).

Prior to this REF period, SEI York worked closely with UNEP to persuade governments to act on its research (3.1), leading to the formation in 2012 of the international Climate and Clean Air Coalition (CCAC) which has a mission to work with state and non-state partners to reduce SLCPs. SEI was the first non-state partner to join CCAC and since August 2013 the SEI York team has continued to play a major role in the development of key initiatives, especially in relation to Supporting National Action and Planning (SNAP) and regional assessments. The Head of the CCAC Secretariat states that "*The SEI team at the University of York…is instrumental in the work that our initiative supporting the development of National Plans on short-lived climate pollutants is implementing in about 20 countries*" (5.2). As of November 2020 CCAC has 70 state partners and 76 non-state partners, and is described as "*one of the premier institutions worldwide catalysing actions that combat both air pollution and climate change simultaneously*" (5.1). Kuylenstierna and Emberson sit on the CCAC Scientific Advisory Panel, ensuring that SEI York research informs the strategic direction of the coalition.

As part of the SNAP initiative, SEI York researchers worked directly with governments, training them to use the LEAP-IBC tool to quantify emissions and model scenarios for reduced air pollution (5.2) and providing expert scientific and technical input into policy drafts to ensure the final plans are robust and achievable. The application of SEI York research has enhanced the capacity of national governments and institutions to assess air quality and climate impacts, generate mitigation scenarios and produce National Action Plans on SLCP mitigation using LEAP-IBC, with the following a quote from the Federal Ministry of Environment of Nigeria in their national SLCP planning document:

"The LEAP-IBC tool developed by SEI York researchers, and the training provided in August 2018 by the SEI York team to staff at the Federal Ministry of Environment in Nigeria and other national institutions has enabled us for the first time to:

(i) quantify emissions of air pollutants and SLCPs;
(ii) identify, evaluate and prioritize mitigation actions to improve air quality and mitigate climate change, and quantify the human health benefits of the mitigation measures by developing a Nigerian model for SLCPs in LEAP-IBC with support and training from SEI." (5.3a, similarly confirmed for other countries in 5.3b, c, d and e).

To date seven countries have officially endorsed National Action Plans for SLCP reduction (5.2): Nigeria (2018) (5.4a), Côte d'Ivoire (2020) (5.4b), Bangladesh (2020) (5.4c), the Maldives (2019) (5.4d), Mexico (2020) (5.4e), Togo (2019) (5.4f) and Colombia (2020) (5.4g). The SEI York team have successfully worked with a further nine countries: Ghana (2018) (5.5a), Argentina, Chile, Costa Rica, Dominican Republic, Mongolia (5.5b), Morocco, Peru and The Philippines, to advance their commitments to SLCP reduction and move towards the creation of endorsed National Action Plans. In addition, the national planning supported by our researchers has been referenced explicitly in the revised NDC submissions by Bangladesh and the Dominican Republic to the UNFCCC in December 2020 (5.5c and 5.5d).

The multidimensional assessments enabled by the LEAP-IBC tool, including energy planning, GHG mitigation scenarios and air quality assessment, enable governments to understand how policies affecting air quality cut across climate, and vice versa, promoting inter-departmental dialogue and joined-up policy planning:

"SEI researchers, as part of the Climate and Clean Coalition (CCAC), Supporting National Action Planning (SNAP) initiative have provided technical support through training activities using their Low Emissions Analysis Platform – Integrated Benefits Calculator (LEAP-IBC) tool to assist staff at the Ghana EPA and other national institutions in: quantifying emissions of SLCPs, air pollutants and GHGs; identifying, evaluating and prioritising mitigation actions to improve air quality and mitigate climate change and quantifying the human health benefits of the mitigation measures by developing a Ghana model for SLCPs in LEAP-IBC with support and training from SEI York; establishing a planning process to engage stakeholders and obtain a high-level political endorsement for the National Action Plan; training in the impacts of air pollution on human health. The discussion of the impacts has helped to increase the interest of stakeholders in Ghana to address air pollution; the integration of strategy development between air pollution and climate change, including strengthening linkages between different ministries, departments and agencies; reviewed and provided technical comments during the finalisation of Ghana's 2nd Biennial Update Report, submitted to the UNFCCC." (5.3b see also similar confirmation from other countries in 5.3a-e).

Impact on Policy Debate

In addition to the concrete impacts on government policy and practice listed above, SEI York research has provided robust evidence to back calls for strengthening both global and regional climate responses, with (3.1) alone being cited in 94 policy documents from around the world (5.6). Some of the most influential organisations who use SEI York research to inform policy positions include: The Intergovernmental Panel on Climate Change who cite (3.6) in support of their recommendation that countries should focus on pathways and policies which both improve air quality and reduce impacts of climate change (5.7 at p.268), and; The World Health Organization (WHO) which cites (3.1) in six publications from November 2014 – March 2018 (5.6), including the WHO indoor air quality guidelines on household fuel consumption.

In summary, our research has outlined a global pathway to achieve the 1.5 degrees celsius target whilst also maximising the sustainable development benefits through reducing air pollution exposure and its impact on human health. This pathway has been emphasised in global reports of the IPCC as being the only way by which we can achieve the temperature targets outlined in the Paris agreement. This research has been operationalised through the development of national-scale policy plans and strategies by developing country-specific roadmaps that contribute to reducing the country's contribution to climate change whilst maximising the benefits to the health of their citizens through reducing the exposure to health-damaging air pollution. Specifically, this research has resulted in the development of eight climate change commitments submitted to the UNFCCC that incorporate this pathway of simultaneous climate and air pollution reductions as well as eight additional national action plans that have been endorsed at ministerial or cabinet levels to identify how these climate and air pollution targets can be achieved.

5. Sources to corroborate the impact (indicative maximum of 10 references)

5.1. Testimonial from former Chief Scientist of UNEP (2020)
5.2. Testimonial from Head of the CCAC Secretariat (2020)
5.3. Country Testimonials: a) Nigeria (2020); b) Ghana (2020); c) Republic of Maldives (2020); d) Bangladesh (2020); e) Côte d'Ivoire (2020)
5.4. National Action Plans: a) Nigeria National Action Plan (2018); b) Côte d'Ivoire National Action Plan (2020); c) Bangladesh National Action Plan (2020); d) Maldives National Action Plan (2019); e) Mexico National Action Plan (in Spanish) (2020); f) Togo National Action Plan (in French) (2019); g) Colombia (in Spanish) (2020)
5.5. A) Ghana National Action Plan (2018); b) Mongolia (2020); c) Bangladesh Nationally Determined Contribution (2020); d) Gobierno de la República Dominicana Contribución Nacionalmente Determinada (in Spanish) (2020)
5.6. Search results for policy documents citing output 3.1 from Overton
5.7. Chapter 3 of IPCC Special Report *Global Warming of 1.5°C* (2018)