Short-lived Climate Pollutant Research Digest

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Short-Lived Climate Pollutants (SLCPs)

Description: This is a cross-cutting section which includes articles which specifically focus on SLCPs as a category of emissions and/or measures

Climate policy for short- and long-lived pollutants

The current focus on the long-term global warming potential in climate policy-making runs the risk of mitigation options for short-lived climate pollutants being ignored, and tipping points being crossed. We outline how a more balanced perspective on long- and short-lived climate pollutants could become politically feasible.

Fesenfeld, Lukas P., Tobias S. Schmidt, and Alexander Schrode. "Climate policy for short-and long-lived pollutants." Nature Climate Change (2018): 1.

Multiple Benefits/Impacts & Crosscutting

Description: This section includes articles addressing the multiple benefits of action to address SLCPs and implement SLCP measures.

Co-benefits of climate mitigation on air quality and human health in Asian countries

Climate change mitigation involves reducing fossil fuel consumption and greenhouse gas emissions, which is expensive, particularly under stringent mitigation targets. The co-benefits of reducing air pollutants and improving human health are often ignored, but can play significant roles in decision-making. In this study, we quantified the co-benefits of climate change mitigation on ambient air quality and human health in both physical and monetary terms with a particular focus on Asia, where air quality will likely be degraded in the next few decades if mitigation measures are not undertaken. We used an integrated assessment framework that incorporated economic, air chemistry transport, and health assessment models. Air pollution reduction through climate change mitigation under the 2 °C goal could reduce premature deaths in Asia by 0.79 million (95% confidence interval: 0.75–1.8 million) by 2050. This co-benefit is equivalent to a life value savings of approximately 2.8 trillion United States dollars (USD) (6% of the gross domestic product [GDP]), which is decidedly more than the climate mitigation cost (840 billion USD, 2% of GDP). At the national level, India has the highest potential net benefit of 1.4 trillion USD, followed by China (330 billion USD) and Japan (68 billion USD). Furthermore, in most Asian countries, per capita GDP gain and life value savings would increase with per capita GDP increasing. We robustly confirmed this qualitative conclusion under several socioeconomic and exposure-response function assumptions.

Xie, Yang, et al. "Co-benefits of climate mitigation on air quality and human health in Asian countries." Environment international 119 (2018): 309-318.

Integrating synergistic effects of air pollution control technologies: More cost-effective approach in the coal-fired sector in China

A strategy of controlling individual pollutants without considering synergistic effects and ancillary benefit/cost has been followed in the course of air pollution control in China. This policy orientation could lead to divided and costly technology pathways. In this paper, the coal-fired power sector is used as a representative case to investigate the technology schemes and assess their cost effectiveness, so as to provide empirical evidence of technology synergies' impacts on cost-effectiveness and to shed light on the future directions for pollution control strategies. The results indicate that more pollution damage caused by particulate matter and mercury, could be avoided at less cost if the proposed technology schemes can be used more instead of the current mainstream scheme in this sector at the beginning of air pollution regulation. It implies that more detailed evaluation of technology schemes is needed to better control multiple pollutants and alleviate various negative

health endpoint effects. The transformation of strategy will rely on a combination of technological developments and policy changes. The lessons learned from coal-fired power sector can contribute to policy-making across sectors within the industry.

Wu, Dan, Xunzhou Ma, and Shiqiu Zhang. "Integrating synergistic effects of air pollution control technologies: More cost-effective approach in the coal-fired sector in China." Journal of Cleaner Production (2018).

The need for policies to reduce the costs of cleaner cooking in low income settings: Implications from systematic analysis of costs and benefits

Inefficient household cooking in less-developed countries harms health and productivity, the environment, and the global climate. Interventions to encourage adoption of cleaner and more fuel-efficient stoves are being implemented widely to reduce these burdens, but sustained use has proven elusive. This study develops a data-driven simulation approach to investigate the potential costs and benefits of cleaner stoves, informed by recent empirical studies. The results suggest that the private case for adoption of technologies other than charcoal ICS is often unclear; that is, households' private benefits do not usually outweigh the costs of these improvements. Overall social benefits, in contrast, are typically positive and large for nearly all such improved technologies. We investigate how economic benefits vary with intensity of use, and find that higher use does not unambiguously translate into greater private benefits. Analyzing the effects of different subsidies, we further find that fuel subsidies for purchased fuels could substantially improve private net benefits, but that even these may be insufficient to make cleaner cooking attractive to many households; stove subsidies meanwhile tend to modestly improve private outcomes. To capture the social benefits of cleaner cooking, new and effective incentives may be needed to support household use of efficient stoves.

Jeuland, Marc, Jie-Sheng Tan Soo, and Drew Shindell. "The need for policies to reduce the costs of cleaner cooking in low income settings: Implications from systematic analysis of costs and benefits." Energy policy 121 (2018): 275-285.

Greenhouse gas emissions reduction in different economic sectors: Mitigation measures, health co-benefits, knowledge gaps, and policy implications

To date, greenhouse gas (GHG) emissions, mitigation strategies and the accompanying health co-benefits in different economic sectors have not been fully investigated. The purpose of this paper is to review comprehensively the evidence on GHG mitigation measures and the related health co-benefits, identify knowledge gaps, and provide recommendations to promote further development and implementation of climate change response policies. Evidence on GHG emissions, abatement measures and related health co-benefits has been observed at regional, national and global levels, involving both low- and high-income societies. GHG mitigation actions have mainly been taken in five sectors: energy generation, transport, food and agriculture, household and industry, consistent with the main sources of GHG emissions. GHGs and air pollutants to a large extent stem from the same sources and are inseparable in terms of their atmospheric evolution and effects on ecosystem; thus, GHG reductions are usually, although not always, estimated to have cost effective co-benefits for public health. Some integrated mitigation strategies involving multiple sectors, which tend to create greater health benefits. The pros and cons of different mitigation measures, issues with existing knowledge, priorities for research, and potential policy implications were also discussed. Findings from this study can play a role not only in motivating large GHG emitters to make decisive changes in GHG emissions, but also in facilitating cooperation at international, national and regional levels, to promote GHG mitigation policies that protect public health from climate change and air pollution simultaneously.

Gao, Jinghong, et al. "Greenhouse gas emissions reduction in different economic sectors: Mitigation measures, health co-benefits, knowledge gaps, and policy implications." Environmental pollution 240 (2018): 683-698.

Potential health and economic benefits of banning diesel traffic in Dublin, Ireland

Air pollution has been linked to 491,000 deaths in Europe annually and diesel vehicles are one of the major sources of two deadly air pollutants, PM2.5 (Particulate Matter) and NOx (Oxides of Nitrogen). Ireland has the

highest number of newly registered diesel vehicles in Europe with a share of 43.57% in the overall fleet which is expected to increase to 73.9% by 2025. This will have significant health and financial impacts, especially in the urban areas. The present study quantifies the environmental, financial and health burdens from cars, Light Commercial Vehicles (LCVs) and buses in Dublin under the existing conditions and estimates the potential impact of the increasing numbers of diesel cars, LCVs and buses following the current trend projected over the next decade. As a preventative measure, the present study examines the impact of banning diesel vehicles older than 20 years from 2018 through the initiation of a phase-out policy. Furthermore, the impacts of a policy to ban new diesel vehicle sales from the year 2025 is also estimated. In both future scenarios, the preventative measures show significant savings in terms of reductions in NOx and PM2.5 emissions which were found to be 47% and 52% respectively in the year 2030 compared to the year 2015 levels. Additionally, this reduction will amount to savings of 300 DALYs and €43.8 million. Consequently, the results of this study make a strong case for policies and investments aimed at reducing the environmental impact caused by urban transportation and improving public health.

Dey, Shreya, Brian Caulfield, and Bidisha Ghosh. "Potential health and economic benefits of banning diesel traffic in Dublin, Ireland." Journal of Transport & Health (2018).

Methane

Description: This section includes articles addressing methane source apportionment, emissions factors, impacts and emissions trends.

Methane correction factors for estimating emissions from aerobic wastewater treatment facilities based on field data in Mexico and on literature review

Wastewater treatment (WWT) may be an important source of methane (CH4), a greenhouse gas with significant global warming potential. Sources of CH4 emissions from WWT facilities can be found in the water and in the sludge process lines. Among the methodologies for estimating CH4 emissions inventories from WWT, the more adopted are the guidelines of the Intergovernmental Panel on Climate Change (IPCC), which recommends default emission factors (Tier 1) depending on WWT systems. Recent published results show that well managed treatment facilities may emit CH4, due to dissolved CH4 in the influent wastewater; in addition, biological nutrient removal also will produce this gas in the anaerobic (or anoxic) steps. However, none of these elements is considered in the current IPCC guidelines. The aim of this work is to propose modified (and new) methane correction factors (MCF) regarding the current Tier 1 IPCC guidelines for CH4 emissions from aerobic treatment systems, with and without anaerobic sludge digesters, focusing on intertropical countries. The modifications are supported on in situ assessment of fugitive CH4 emissions in two facilities in Mexico and on relevant literature data. In the case of well-managed centralized aerobic treatment plant, a MCF of 0.06 (instead of the current 0.0) is proposed, considering that the assumption of a CH4-neutral treatment facility, as established in the IPCC methodology, is not supported. Similarly, a MCF of 0.08 is proposed for biological nutrient removal processes, being a new entry in the guidelines. Finally, a one-step straightforward calculation is proposed for centralized aerobic treatment plants with anaerobic digesters that avoids confusion when selecting the appropriate default MCF based on the Tier 1 IPCC guidelines.

Noyola, A., et al. "Methane correction factors for estimating emissions from aerobic wastewater treatment facilities based on field data in Mexico and on literature review." Science of The Total Environment 639 (2018): 84-91.

Assessment of methane emissions and energy recovery potential from the municipal solid waste landfills of Delhi, India

Rising rate of MSW generation and unscientific disposal in the open dumping sites are responsible for emission

of high concentrations of methane in developing countries. IPCC Default method (DM), First-order decay (FOD) and LandGEM were used to estimate methane emissions from the unengineered landfill sites of Delhi-Okhla, Bhalswa and Ghazipur between 1984 and 2015. During the period, the total CH4 emissions was found to be 1288.99, 311.18, 779.32 Gg from the 3 landfill sites of Delhi as predicted by DM, FOD and LandGEM respectively. The energy generation potential from methane for the year 2015 was found to vary from 4.16 × 108 to 9.86 × 108 MJ for Ghazipur, 2.08 × 108 to 4.06 × 108 MJ for Okhla and 3.42 × 108 to 8.11 × 108 MJ for Bhalswa. Efficient utilization of methane from the landfills as an energy source can be a sustainable waste management option.

Ghosh, Pooja, et al. "Assessment of methane emissions and energy recovery potential from the municipal solid waste landfills of Delhi, India." Bioresource technology (2018).

Methane emissions from small residential wood combustion appliances: Experimental emission factors and warming potential

Methane emission factors (g/GJ) were determined testing residential heating biomass appliances (6–11 kW) under real-world operating conditions. User behavior for manually load appliances was simulated following a loading scheme starting from the cold start conditions, followed by two nominal batches and a final batch either with the nominal load of the appliance or by over loading the firebox (closing the air valves) and lasted until burn out. The results were analyzed both on batch-per-batch basis and for total combustion cycle from cold start to burn out in order to determine the critical situations causing high methane emissions. For comparison two automatic pellet appliances (8–25 kW) were also tested. Emission factors (EFs) for these automatic appliances are more than an order of magnitude lower with respect to batch-working room heaters. For the latter the average EFs ranged from 142 g/GJ to 238 g/GJ and showed both batch-to-batch and inter-appliance variability; however, many of the observed differences were not statistically significant. The results highlighted the importance of the user behavior to avoid high methane emissions. The climate relevance of methane emission levels has been assessed using global warming potential (GWP) taken from the literature, comparing CO2equivalent emissions with that of N2O and other near-term climate forcers (CO, NOx, VOC, black carbon) emitted by the same appliances. The results show that the warming impact of CH4 is lower than that of BC and CO (compounds emitted in relevant levels in small appliances burning wood), but is still an important portion of the CO2 avoided for the substitution of fossil fuels with biomass. Although the uncertainties associated with GWP are large and EFs are based on a limited number of appliances and fuel types, the results show that in the short term (i.e., 20-year period) CO2eq for all the non-CO2 forcers offset the CO2 benefits of biomass use.

Ozgen, Senem, and Stefano Caserini. "Methane emissions from small residential wood combustion appliances: Experimental emission factors and warming potential." Atmospheric Environment 189 (2018): 164-173.

Black Carbon

Description: This section includes articles addressing black carbon source apportionment, emissions factors, impacts and emissions trends.

Assessment of Indoor & Outdoor Black Carbon emissions in rural areas of Indo-Gangetic Plain: seasonal characteristics, source apportionment and radiative forcing

Black Carbon (BC) has been widely recognized as the second largest source of territorial and global climate change as well as a threat to human health. There has been serious concern of BC emission and its impact in Indo-Gangetic Plains (IGP) due to the use of biomass and fossil fuels for cooking, transportation and industrial activities. An attempt has been made to study indoor (Liquefied Petroleum Gas- LPG & Traditional cookstoves users households) and outdoor concentrations; seasonal characteristics; radiative forcing and source of apportionment of BC in three districts (Sitapur, Patna and Murshidabad) of IGP during January to December 2016. The seasonal concentrations of BC in LPG (traditional cookstoves) users households were

3.79 ± 0.77 µgm−3 (25.36 ± 5.01 µgm−3) during the winter; 2.62 ± 0.60 µgm−3 (16.36 ± 3.68 µgm−3) during the pre-monsoon; 2.02 ± 0.355 µgm−3 (8.92 ± 1.98 µgm−3) during the monsoon and 2.19 ± 0.47 µgm−3 (15.17 ± 3.31 µgm−3) during the post-monsoon seasons. However, the outdoor BC concentrations were 24.20 ± 4.46, 19.80 ± 4.34, 8.87 ± 1.83, and 9.14 ± 1.84 µgm−3 during winter, pre-monsoon, monsoon and post-monsoon seasons respectively. The negative radiative forcing (RF) at the surface suggests a cooling effect while a warming effect appears to be occurring at the top of the atmosphere. The atmospheric forcing of BC and aerosols also show a net warming effect in the selected study areas. The analysis of BC concentrations and fire episodes indicated that the emissions from biomass burning increases the pollution concentration. The backward trajectory analysis through the HYSPLIT model also suggests an additional source of pollutants during winter and pre-monsoon seasons from the northwest and northern region in the IGP.

Arif, Mohammad, et al. "Assessment of Indoor & Outdoor Black Carbon emissions in rural areas of Indo-Gangetic Plain: seasonal characteristics, source apportionment and radiative forcing." Atmospheric Environment 191 (2018): 227-240.

Characteristics and source apportionment of black carbon in the Helsinki metropolitan area, Finland

This study shows that exposure to air pollutants from indoor cooking fuel combustion may be associated with elevated Diastolic Blood Pressure (DBP), Systolic Blood Pressure (SBP), Heart rate and Body mass index (BMI) in rural women of India. 60 premenopausal women (using solely agriculture residues, wood, dung, straw, leaf) and 30 women (solely using clean fuel, LPG) were recruited for this study. An ethically approved questionnaire was used in the study and health parameters were measured by standard instruments. Eight pollutants were measured by calibrated instruments, applied both in the living room as well as kitchens of test-subjects. The Test-subjects were divided into two groups, LPG users, and biomass users, and the toxicological risk was assessed by measurement of PM2.5 levels in the given indoor environments. The concentrations of all the pollutants were significantly ($p < 0.001$) higher in biomass users than in LPG using households, except in the case of O3 ($p < 0.403$) at the time of cooking. Results highlighted that DBP ($p < 0.070$), SBP ($p < 0.143$), Heart rate ($p < 0.002$) and BMI ($p < 0.052$) were varied in the two fuel user groups. In the case of biomass fuel user toxicological risk was higher (5.21) than LPG users (0.69). Moreover, Symptoms like asthma (25%), cough (76.67%), dizziness (36.67%), eye irritation (88.33%), and shortness of breath (43.33%) were highly prevalent among biomass users than in LPG users. The study highlighted that Biomass using women are more prone to cardiovascular disease and policies should be formulated for their sustainable health.

Chakraborty, Deep, and Naba Kumar Mondal. "Hypertensive and toxicological health risk among women exposed to biomass smoke: A rural Indian scenario." Ecotoxicology and Environmental Safety 161 (2018): 706-714.

Tropospheric Ozone

Description: This section includes articles addressing tropospheric ozone impacts and important trends in precursor emissions.

Seasonal variation in surface ozone and its regional characteristics at global atmosphere watch stations in China

We investigated the seasonal and spatial ozone variations in China by using three-year surface ozone observation data from the six Chinese Global Atmosphere Watch (GAW) stations and tropospheric column ozone data from satellite retrieval over the period 2010–2012. It is shown that the seasonal ozone variations at these GAW stations are rather different, particularly between the western and eastern locations. Compared with western China, eastern China has lower background ozone levels. However, the Asian summer monsoon (ASM) can transport photochemical pollutants from the southern to the northern areas in eastern China, leading to a northward gradual enhancement of background ozone levels at the eastern GAW stations. Over China, the

tropospheric column ozone densities peak during spring and summer in the areas that are directly and/or indirectly affected by the ASM, and the peak time lags from the south to the north in eastern China. We also investigated the regional representativeness of seasonal variations of ozone at the six Chinese GAW stations using the yearly maximum tropospheric column month as indicator. The results show that the seasonal variation characteristics of ozone revealed by the Chinese GAW stations are typical, with each station having a considerable large surrounding area with the ozone maximum occurring at the same month. Ozone variations at the GAW stations are influenced by many complex factors and their regional representativeness needs to be investigated further in a broader sense.

Liu, Ningwei, et al. "Seasonal variation in surface ozone and its regional characteristics at global atmosphere watch stations in China." Journal of Environmental Sciences (2018).

Hydrofluorocarbons (HFCs)

Description: This section includes articles addressing hydrofluorocarbon emissions, relevant new information about use sectors, alternative refrigerants and relevant analysis of energy efficiency.

Transcritical R744 refrigeration systems for supermarket applications: Current status and future perspectives

Visible signs of climate change call for urgent actions on food retail industry, since such a sector is characterized by an abundant carbon footprint. Being CO2 (or R744) recognized across the world as the most promising working fluid for supermarket applications, commercial transcritical R744 refrigeration systems have emerged as leading hydrofluorocarbon (HFC)-free technologies. This study is intended to implement an in-depth review study covering the most important aspects related to the state-of-the-art pure R744 refrigeration plants for food retail applications, including the evolution of system architectures, some field measurements, the main available results from an energy, environmental and economic perspective as well as the indispensable future investigations. It could be concluded that, in spite of some persisting barriers which still prevent such technologies from a wider adoption, the usage of R744 as the only refrigerant in supermarkets is no longer open to dispute, even in warm locations.

Gullo, Paride, Armin Hafner, and Krzysztof Banasiak. "Transcritical R744 refrigeration systems for supermarket applications: Current status and future perspectives." International Journal of Refrigeration (2018).

Biomass Burning & Household Energy

Description: This section includes articles primarily addressing SLCP measures and innovations related to the household energy initiative, open burning of agricultural residue, and SLCP emissions in relevant sectors. Solid waste burning is covered in the waste section.

Field measurements of solid-fuel cookstove emissions from uncontrolled cooking in China, Honduras, Uganda, and India

Cookstoves have wide-reaching impacts on human health, air quality, and the climate. We measured emissions from uncontrolled cooking in 41 households in China, Honduras, Uganda, and India using a portable sampler. Test sites were chosen to cover a range of stove types (traditional and “improved”), fuels (wood, charcoal and coal), and cooking practices. We report test-integrated fuel-based emission factors (EFs) of fine particulate matter (PM2.5) mass, organic carbon (OC), elemental carbon (EC), as well as real time EFs of carbon monoxide (CO), black carbon (BC), total particle number, and particle size distributions. There was substantial house-to-

house variability in emissions; the distribution of EFs were also highly positively skewed by several "superemitter" stoves in China (those with PM2.5 EFs 5–20 times greater than the median value). The highest PM2.5 mass emission factors were measured in China (median:10.3 g/kg-fuel), and the lowest in Uganda (median: 1.7 g/kg-fuel). The median PM2.5 mass EFs in wood-burning stoves in Honduras and India were similar: 3.7 g/kg-fuel and 4.1 g/kg-fuel, respectively. However, Indian stoves had higher EC EFs then Honduran stoves, demonstrating that emissions depend on more that fuel type; regional differences, such as cooking styles and stove design, may influence aerosol properties as well. Coal and charcoal stoves had higher OC:EC than wood stoves. The differences between the CO, PM2.5, and OC:EC ratios of "improved" and traditional stoves in India and Honduras were not statistically significant. To the best of our knowledge, we report the first cookstove source size distributions measurements from uncontrolled in-home cooking. These distributions varied between countries, which will influence local radiative effects. Particle size distributions from stoves tested in China, Honduras, and India were unimodal in the size range measured, with geometric mean diameters (GMDs) of 66 nm, 48 nm, and 76 nm, respectively. The median GMD of particles emitted from Ugandan charcoal stoves was 39, and when all tests are averaged, the resulting distribution appears tri-modal, with modes near 15, 30, and 100 nm. Real-time emissions data reveal high BC and particle number emissions during startup and fuel additions, which can be seen in the positively skewed distributions. Emissions of BC were most skewed, indicating that they were highly event-driven, followed by total particle number. CO emissions were more evenly spread across cooking events.

Eilenberg, S. Rose, et al. "Field measurements of solid-fuel cookstove emissions from uncontrolled cooking in China, Honduras, Uganda, and India." Atmospheric Environment 190 (2018): 116-125.

Use of cleaner-burning biomass stoves and airway macrophage black carbon in Malawian women

Exposure to particulate matter (PM) from burning of biomass for cooking is associated with adverse health effects. It is unknown whether or not cleaner burning biomass-fuelled cookstoves reduce the amount of PM inhaled by women compared with traditional open fires. We sought to assess whether airway macrophage black carbon (AMBC) - a marker of inhaled dose of carbonaceous PM from biomass and fossil fuel combustion - is lower in Malawian women using a cleaner burning biomass-fuelled cookstove compared with those using open fires for cooking. AMBC was assessed in induced sputum samples using image analysis and personal exposure to carbon monoxide (CO) and PM were measured using Aprovecho Indoor Air Pollution meters. A fossil-fuel exposed group of UK women was also studied. Induced sputum samples were obtained from 57 women from which AMBC was determined in 31. Median AMBC was 6.87 µm2 (IQR 4.47–18.5) and 4.37 µm2 (IQR 2.57–7.38) in the open fire (n = 11) and cleaner burning cookstove groups (n = 20), respectively (p = 0.028). There was no difference in personal exposure to CO and PM between the two groups. UK women (n = 5) had lower AMBC (median 0.89 µm2, IQR 0.56–1.13) compared with both Malawi women using traditional cookstoves (p < 0.001) and those using cleaner cookstoves (p = 0.022). We conclude that use of a cleaner burning biomass-fuelled cookstove reduces inhaled PM dose in a way that is not necessarily reflected by personal exposure monitoring.

Whitehouse, Abigail L., et al. "Use of cleaner-burning biomass stoves and airway macrophage black carbon in Malawian women." Science of The Total Environment 635 (2018): 405-411.

Agriculture and Livestock

Description: This section includes articles primarily addressing SLCP measures and innovations related to the Agriculture initiative and SLCP emissions in relevant sectors

Potentials to mitigate greenhouse gas emissions from Swiss agriculture

There is an urgent need to identify and evaluate management practices for their biophysical potential to maintain productivity under climate change while mitigating greenhouse gas (GHG) emissions from individual cropping systems under specific pedo-climatic conditions. Here, we examined, through DayCent modeling, the long-term impact of soil management practices and their interactions on soil GHG emissions and GHG intensity

from Swiss cropping systems. Based on experimental data from four long-term experimental sites in Switzerland (Therwil, Frick, Changins, and Reckenholz), we robustly parameterized and evaluated the model for simulating crop productivity, soil C dynamics and soil N2O emissions across a range of management practices and pedo-climatic conditions. Net soil GHG emissions (NSGHGE) were derived from changes in soil C, N2O emissions and CH4 oxidation. Soils under conventional management acted as a net source of soil GHG emissions (1361–1792 kg CO2eq ha−1 yr−1) and NSGHGE were dominated by N2O (50–63%). Reduced tillage and no-tillage reduced long-term NSGHGE by up to 31 and 58%, respectively. Organic farming, represented by organic fertilization, reduced NSGHGE by up to 31% compared to systems based solely on mineral fertilization. Replacement of slurries with a composted FYM led to an additional reduction in NSGHGE by 46%, although our approach considered only soil GHG emissions and thus did not take into account GHG emissions from the composting process. Cover cropping did not significantly influence NSGHGE, however vetch tended to reduce NSGHGE (-19%). The highest mitigation potential was associated with organic farming plus reduced tillage management, it reduced long-term NSGHGE by up to 128%. Soil C sequestration accounted, on average, for 89% of GHG mitigation potentials, consequently N2O dominated NSGHGE across all treatments and sites (60 − 80%). This indicates that these mitigation potentials are time limited and reversible, if the management is not maintained, in contrast to the reduction in N2O emissions, which is considered permanent. Not all the management practices sustained crop yields. Nevertheless, composting of organic manures, reduced tillage and no-tillage effectively reduced NSGHGE and GHG intensity without a noticeable yield reduction. Our results suggest that implementation of the above soil management practices in Swiss cropping systems have a considerable potential for climate change mitigation, although time-limited.

Necpalova, Magdalena, et al. "Potentials to mitigate greenhouse gas emissions from Swiss agriculture." Agriculture, Ecosystems & Environment 265 (2018): 84-102.

Achieving low methane and nitrous oxide emissions with high economic incomes in a rice-based cropping system

Rice cultivation faces increasing challenges to enhance the net ecosystem economic budget (NEEB), which is the balance between economic benefits and environmental costs. Plastic film mulching cultivation (MC) was evaluated for its ability to decrease the global warming potential (GWP) while increasing economic benefits relative to rainfed (RF) and traditional irrigation (TI). To comprehensively assess the effect on NEEB, the CH4 and N2O emissions and grain yields in a rice-based cropping system were measured from 2010 to 2014. The effects of urease and nitrification inhibitors (UNIs) and controlled release fertilizer (CRF) were also estimated. Shifting the field management from RF to MC had unclear impact on CH4 emissions, but increased N2O emissions by 77%. In contrast, switching TI to MC caused a significant reduction (45–85%) in CH4 emissions, producing a strong decrease in GWP, although N2O emissions substantially increased (206–1153%). The decrease in CH4 emissions was attributed to the reduced dissolved organic carbon and CH4 production, whereas the increase in N2O emissions might have resulted from the higher NH4+ concentrations and more favorable soil water content. Integrated assessment showed that MC significantly enhanced NEEB by 6136–8362 CNY ha−1 y−1 relative to RF as the yields increased and input costs reduced. Although MC reduced the yields, the much lower input and GWP costs led to a substantial increase in NEEB (2607–5593 CNY ha−1 y−1) relative to TI. Under MC conditions, applying UNIs and CRF obviously increased input costs though it always tended to enhance grain yields, thus decreasing NEEB by approximately 490–960 CNY ha−1 y−1, except CP addition, which had a positive effect on NEEB. The results demonstrate that MC, particularly MC + CP, are effective management strategies to reduce the environmental costs and increase the economic benefits of rice fields suffering from a lack of water supply.

Zhang, Guangbin, et al. "Achieving low methane and nitrous oxide emissions with high economic incomes in a rice-based cropping system." Agricultural and Forest Meteorology 259 (2018): 95-106.

Lime application lowers the global warming potential of a double rice cropping system

Liming is a common practice to alleviate soil acidification in agricultural systems worldwide. Because liming affects soil microbial activity and soil carbon (C) input rates, it can affect soil greenhouse gas (GHG) emissions as well. However, little is known about the effect of liming on GHG emissions from rice agriculture, one of the main sources of anthropogenic methane (CH4). Here, we report on the first experiment to measure the effect of liming

on GHG emissions from rice paddy fields. We studied a double rice cropping system in an acid paddy for two years and measured the impacts of liming on GHG emissions and rice growth with or without straw incorporation. We found that liming reduced CH4 emissions in the early rice season, but it did not affect nitrous oxide (N2O) emissions. Over the two-year study, lime application reduced total CH4 emissions by 12.5% and 15.4% in plots without and with straw incorporation, respectively. Lime application significantly enhanced rice aboveground biomass, while reducing the area- and yield-scaled global warming potential of CH4 and N2O emissions. Lime application stimulated soil respiration during the fallow season and reduced the abundance of methanogens during the early rice growing season. Together, these results suggest that liming reduces CH4 emissions by promoting the decomposition of organic matter during the fallow season, thereby reducing C availability for methanogens. We conclude that in the short term, liming is an effective practice to reduce greenhouse gas emissions from acidic paddy soils.

Jiang, Yu, et al. "Lime application lowers the global warming potential of a double rice cropping system." Geoderma 325 (2018): 1-8.

Transportation

Description: This section includes articles primarily addressing SLCP measures and innovations related to the Diesel initiative and SLCP emissions in relevant sectors

Mobile source contributions to ambient ozone and particulate matter in 2025

The contribution of precursor emissions from 17 mobile source sectors to ambient ozone and fine particulate matter levels across the U.S. were evaluated, using the CAMx photochemical model, to identify which mobile source sectors are projected to have the largest impacts on air pollution in 2025. Both onroad and nonroad sectors contribute considerably to projected air pollution across much of the country. Summer ozone season ozone contributions between 2 and 5 ppb, which are among the highest levels presented on the maps of mobile source sectors, are largely found in the southeast United States from the onroad sectors, most notably light-duty and heavy-duty vehicles, and along the coastline from the Category 3 (C3) marine sector. Annual average PM2.5 contributions between 0.5 and 0.9 µg/m3, which are among the highest levels presented on the maps of mobile source sectors, are found throughout the Midwest and along portions of the east and west coast from onroad sectors as well as nonroad diesel and rail sectors. Additionally, contributions of precursor emissions to ambient ozone and PM2.5 levels were evaluated to understand the range of impacts from precursors in the various mobile source sectors. For most mobile source sectors, in most locations, NOX emissions contributed more to ozone than VOC emissions, and secondary PM2.5 contributed more to ambient PM2.5 than primary PM2.5. The largest ozone levels on the maps showing contributions from mobile source NOX emissions tended to be between 2 and 5 ppb, while the largest ozone levels on the maps showing contributions from mobile source VOC emissions tended to be between 0.9 and 2 ppb, except for southern California where ozone contributions from VOC emissions from onroad light duty vehicles were between 2 and 5 ppb. The largest contributions to ambient PM2.5 on the maps showing primary and secondary contributions from mobile source sectors tended to be between 0.1 and 0.5 µg/m3. The contribution from primary PM2.5 extended over localized areas (urban-scale) and the contribution from secondary PM2.5 extended over more regional (multi-state) areas.

Zawacki, Margaret, et al. "Mobile source contributions to ambient ozone and particulate matter in 2025." Atmospheric Environment (2018).

Can urban rail transit systems alleviate air pollution? Empirical evidence from Beijing

Improving air quality across mainland China is an urgent policy challenge, while rapidly increasing use of vehicles poses a great menace to the urban population and air quality. Public transportation has received increasing attention as emissions friendly transport options, but whether the urban rail transit system has a significant effect on curbing air pollution has been unclear, and there is a lack of explicit case studies in mainland China.

Therefore, the effects of the opening of the Beijing Metro on air pollutants emissions in Beijing were quantified through a regression discontinuity design. Beijing has seen a brisk growth in its rail transit infrastructure and a downward trend of air pollution index since 2005. The regression results show that the operation of the rail transit system was observed to have a significant effect on reducing most of the air pollutants concentrations (PM2.5, PM10, SO2, NO2, and CO) but had little effect on ozone pollution. The results obtained were highly robust across a variety of tests. This study contributes to empirical evidence on the air pollutants associated with the opening of rail transit and traffic-related pollution control policy making in Beijing.

Guo, Shihong, and Liqiang Chen. "Can urban rail transit systems alleviate air pollution? Empirical evidence from Beijing." Growth and Change.

Waste and Waste Management

Description: This section includes articles primarily addressing SLCP measures and innovations related to the solid waste initiative and SLCP emissions in relevant sectors

Reduction of greenhouse gases (GHGs) and short-lived climate pollutants (SLCPs) from municipal solid waste management (MSWM) in the Philippines: Rapid review and assessment

Municipal solid waste management (MSWM) is considered one of the serious environmental issues in the Philippines, with corresponding linkages to the climate change and Sustainable Development Goals (SDGs). However, methane (CH4) linked with indiscriminate dumping of municipal solid waste has received the much attention with regard to public health and climate change. The impacts of black carbon (BC) are less documented and understood. This paper aims to review the status of MSWM in the Philippines and makes efforts to assess the scale of short-lived climate pollutants (SLCPs), including both CH4, and BC, associated with the country's waste sector. Utilising available national level data and following a life-cycle assessment (LCA) approach, the paper offers preliminary projections of SLCP emissions resulting from present MSWM practices. In addition, it examines model mitigation scenarios based on priority actions identified within the country's national policy on waste management, Republic Act 2003 (RA 9003). Data analysis was conducted using an Emission Quantification Tool (EQT) developed by the Institute for Global Environmental Strategies (IGES) through its work under the Climate and Clean Air Coalition (CCAC) – Municipal Solid Waste Initiative (MSWI). Following a summary of key findings, the paper affirms that control of methane from disposal practices and of BC from waste collection and open burning requires urgent attention in the Philippines. Continued awareness raising, institutionalising regulatory policies on SLCPs, and further enhancing data collection and capacity building on waste-related BC emissions remain key priorities for the country.

Premakumara, Dickella Gamaralalage Jagath, et al. "Reduction of greenhouse gases (GHGs) and short-lived climate pollutants (SLCPs) from municipal solid waste management (MSWM) in the Philippines: Rapid review and assessment." Waste Management 80 (2018): 397-405.

Estimating emissions from open burning of municipal solid waste in municipalities of Nepal

Open burning of municipal solid waste (MSW) is a poorly-characterized and frequently-underestimated source of air pollution in developing countries. This paper estimates the quantity of MSW that was burned in five erstwhile municipalities of the Kathmandu valley, Nepal. A household survey, a transect walk survey, an experiment to measure the fraction of waste that is combustible, a survey on fraction of population burning waste outside their houses, and a survey of the fraction of MSW burned at dump sites were performed in this study, whereas burning/oxidation efficiency, municipal populations, MSW generation rates, and emission factors were derived from the literature. The total mass of MSW burned during 2016 is estimated to be 7400 tons (i.e., 20 tons/day), which was of 3% of the total MSW generated in the valley municipalities that year. This exceeds Government estimates by a factor of three. Multiplying the burned MSW mass by emission factors, the air pollutant emissions are estimated as PM2.5 55 tons (OC 42 tons and EC 1.4 tons), PM10 60 tons, BC 25 tons,

CO2 11,900 tons, CH4 30 tons, SO2 5.0 tons, NOx 19.2 tons, CO 630 tons, NMVOC 112 tons, and NH3 5.7 tons per year. Open burning of MSW can trigger health impacts such as acute and chronic respiratory disease, heart diseases, and allergic hypersensitivity, in addition to impacts on local climate. Improved waste-segregation practices at the source and waste-collection systems throughout the valley are needed to mitigate this pollution source and its effects.

Das, Bhupendra, et al. "Estimating emissions from open burning of municipal solid waste in municipalities of Nepal." Waste Management 79 (2018): 481-490.

Evaluation of emission inventory for the emitted pollutants from landfill of Borujerd and modeling of dispersion in the atmosphere

Nowadays, air pollution is a serious problem in big cities, since municipal solid wastes contain high amounts of organic compounds. The aim of this study is to evaluate the emission inventory of the pollutants emitted from the municipal solid wastes landfill of the city of Borujerd, the capital of Borujerd County, Lorestan Province, in western part of Iran. First, all the necessary information, such as the amount of disposed solid waste in the landfill, analysis of the municipal solid wastes and the metrological data were collected. Then, the information was analyzed by the LandGEM model to estimate the amount of carbon dioxide, methane, and non-methane organic compounds emitted into the atmosphere from the Borujerd landfill. Next, the distribution of the pollutants emitted from the landfill was modelled using AERMOD software. The results showed that the majority of biogas is generated between 2015 and 2025. The maximum amount of biogas generation will be observed in 2020, which would be 12,900, 4600 and 200 tons for carbon dioxide, methane, and non-methane organic compounds, respectively. The Borujerd landfill has the potential to generate 4035 MW electricity in 2020.

Talaiekhozani, Amirreza, et al. "Evaluation of emission inventory for the emitted pollutants from landfill of Borujerd and modeling of dispersion in the atmosphere." Urban Climate 25 (2018): 82-98.

$PM_{2.5}$ and Air Pollution

Description: This section includes articles addressing PM2.5 and air pollution source apportionment, impacts and emissions trends.

Effects of the emergency control measures in Beijing on air quality improvement

Emergency air pollution control measures were successfully implemented in Beijing many times, such as during the Asia-Pacific Economic Cooperation (APEC) conference in 2014 and the Red Alert (RA) in 2015. Given that air quality was largely affected by wind speed, the efficiency of control measures and wind speed must be quantified to adjust the control measures under different wind speeds. During APEC and RA, source apportionment of organic carbon (OC) was conducted using chemical mass balance receptor model (CMB) with organic tracers to reveal PM2.5 source reductions caused by control measures. In the APEC control period, mobile sources contribution to organic carbon (OC) and dust contribution to PM2.5 decreased from 3.7 μg/m3 (63.7%) to 3.3 μg/m3 (38.8%) and from 5.1 μg/m3 (16.6%) to 3.8 μg/m3 (6.9%), respectively. For the RA day, coal combustion source contribution to OC decreased from 11.3 μg/m3 (53.2%) to 2.3 μg/m3 (6.2%), while mobile sources contribution changed from 8.9 μg/m3 (41.7%) to 14.7 μg/m3 (40.3%). These data suggest that the vehicle restriction rule was not truly implemented. Control measures should be announced in advance to achieve the expected result. In addition, the effectiveness of control measures would decrease with the increase of wind speed, and the critical wind speeds for sustaining an excellent PM2.5 level (35 μg/m3) and daily PM2.5 concentration standard of China (75 μg/m3) were determined by a power function as 11 km/h and 7 km/h, respectively. So wind speed should be considered before the selection of anthropogenic control measures.

Tian, Jingyu, et al. "Effects of the emergency control measures in Beijing on air quality improvement." Atmospheric Pollution Research (2018).

PM2.5 footprint of household energy consumption

Particulate matter 2.5 (PM2.5) as a major hazardous constituent is strongly associated with household energy consumption. In this paper, we investigate the PM2.5 footprint of household energy consumption in Beijing based on input–output analysis. An inventory of primary and secondary household energy consumption is developed to quantify the direct PM2.5 emissions. The household PM2.5 footprint is then traced through goods or services that ultimately consumed by households to unveil the indirect PM2.5 emissions triggered by economic activities. PM2.5 fingerprint is also proposed to describe the characteristic of household PM2.5 footprint. Results show that PM2.5 footprint of Beijing households in 2010 is 7831.36 kt, of which 92.61% is contributed by urban households. The source of direct PM2.5 emissions in urban area is diversified, which is composed of coal (42.07%), heat and electricity (32.83%), gasoline (21.29%), natural gas (3.04%) and liquefied petroleum gas (0.77%), while in rural area, coal (98.09%) plays a dominant role. The indirect PM2.5 accounts for 99.96% of the total footprint in urban area, about one third of which is contributed by sectors of “Food Processing and Production”, “Healthcare and Social Security”, and “Farming, Forestry, Animal Husbandry and Fishery”. The disparity between urban and rural households PM2.5 footprints is further evaluated with income levels. The PM2.5 footprint from living expenditures of urban households is found to be nearly twice as much as that of rural households. Such inventory of PM2.5 footprint and examination of drivers for PM2.5 emissions may be essential for urban pollution mitigation policy.

Yang, Siyuan, et al. "PM2. 5 footprint of household energy consumption." Applied Energy 227 (2018): 375-383.

Source apportionment of PM10 and PM2.5 air pollution, and possible impacts of study characteristics in South Korea

Studies of source apportionment (SA) for particulate matter (PM) air pollution have enhanced understanding of dominant pollution sources and quantification of their contribution. Although there have been many SA studies in South Korea over the last two decades, few studies provided an integrated understanding of PM sources nationwide. The aim of this study was to summarize findings of PM SA studies of South Korea and to explore study characteristics. We selected studies that estimated sources of PM10 and PM2.5 performed for 2000–2017 in South Korea using Positive Matrix Factorization and Chemical Mass Balance. We reclassified the original PM sources identified in each study into seven categories: motor vehicle, secondary aerosol, soil dust, biomass/field burning, combustion/industry, natural source, and others. These seven source categories were summarized by using frequency and contribution across four regions, defined by northwest, west, southeast, and southwest regions, by PM10 and PM2.5. We also computed the population-weighted mean contribution of each source category. In addition, we compared study features including sampling design, sampling and lab analysis methods, chemical components, and the inclusion of Asian dust days. In the 21 selected studies, all six PM10 studies identified motor vehicle, soil dust, and combustion/industry, while all 15 PM2.5 studies identified motor vehicle and soil dust. Different from the frequency, secondary aerosol produced a large contribution to both PM10 and PM2.5. Motor vehicle contributed highly to both, whereas the contribution of combustion/industry was high for PM10. The population-weighted mean contribution was the highest for the motor vehicle and secondary aerosol sources for both PM10 and PM2.5. However, these results were based on different subsets of chemical speciation data collected at a single sampling site, commonly in metropolitan areas, with short overlap and measured by different lab analysis methods. We found that motor vehicle and secondary aerosol were the most common and influential sources for PM in South Korea. Our study, however, suggested a caution to understand SA findings from heterogeneous study features for study designs and input data.

gon Ryou, Hyoung, Jongbae Heo, and Sun-Young Kim. "Source apportionment of PM 10 and PM 2.5 air pollution, and possible impacts of study characteristics in South Korea." Environmental Pollution (2018).

Numerical simulations for the sources apportionment and control strategies of PM2.5 over Pearl River Delta, China, part II: Vertical distribution and emission reduction strategies

The contribution of various emission sources to the vertical structure of the PM2.5 concentration and the modeling of emission reduction strategies are emphasized in this study. Analysis of vertical distribution of PM2.5

concentration in the planetary boundary layer (PBL) reveals that strong diurnal cycle exists during the pollution episodes, with heavier surface pollution in nocturnal periods. Contributions from transportation and agriculture are mainly restricted to the surface, while contributions from industry and power are distributed in a relatively higher layer. In the northerly-controlled episodes, the contribution of local emissions mainly accumulates below 300 m and the impact of the emissions from surrounding cities can reach 500–600 m during nocturnal periods. The contributions outside of Guangdong are uniformly distributed within 1000 m altitude. In the daytime, the contribution of emissions is basically uniform throughout the PBL. In the southerly-controlled episodes, the contribution of local emission mainly concentrates below 400 m during the nocturnal periods. Emissions from surrounding cities can exert the influence below 1000 m height, and the contribution outside of Guangdong reaches even 1500 m. In the daytime, the contribution of emissions in the PBL is distributed evenly. The highest altitude of the contribution from different subdomains that can reach is closely related to the physical property of the PBL. The industrial and agricultural emissions are the most important contributors for the surface PM2.5 concentration. Results from emission reduction experiments show that PM2.5 reduces significantly near the pollution center. Although control efficiency decreases with the increasing reduction ratio, the efficiency differences between 30% and 50% reduction is limited. In particular, 10% reduction in industrial emission causes PM2.5 concentration to be slightly higher in the afternoon. Furthermore, below 200-m height, emission reduction experiments perform the effective reduction in PM2.5 concentration, and higher reduction ratio results in larger reduced PM2.5 concentration on almost all layers in the PBL.

Deng, Tao, et al. "Numerical simulations for the sources apportionment and control strategies of PM 2.5 over Pearl River Delta, China, part II: Vertical distribution and emission reduction strategies." Science of The Total Environment 634 (2018): 1645-1656.

A long-term source apportionment of PM2.5 in New York State during 2005–2016

The development and implementation of effective policies for controlling PM2.5 mass concentrations and protecting human health depend upon the identification and apportionment of its sources. In this study, the PM2.5 sources affecting 6 urban and 2 rural sites across New York State during the period 2005–2016 were determined. The extracted profiles were compared to identify state-wide common profiles. The source contributions provide detailed, long-term quantification of the emission sources across the state during the investigated period (2005–2016). Seven factors were common to all sites: secondary sulfate, secondary nitrate, spark-ignition emissions, diesel emissions, road dust, biomass burning, and pyrolyzed organic (OP) rich. The largest contributors were secondary sulfate, secondary nitrate, spark-ignition (gasoline), diesel, and OP-rich. Secondary sulfate concentrations ranged from 2.3 μg m−3 at Whiteface to 3.2 μg m−3 at Buffalo and the Bronx. The highest secondary sulfate fractional contributions were found at the rural sites (~46% of PM2.5 mass) also showed the highest OP-rich contributions (~19%). Secondary nitrate showed the highest concentrations at the urban sites representing ~17% of PM2.5 mass (1.6 ± 0.3 μg m−3 on average). Urban sites also showed the highest average spark-ignition concentrations (1.7 ± 0.2 μg m−3, ~18%) and diesel emissions (1.0 ± 0.2 μg m−3, ~10%). During this period, secondary sulfate concentrations declined likely related to the implementation of mitigation strategies for controlling SO2 emissions and the changing economics of electricity generation. Similarly, diesel and secondary nitrate showed decreases in concentrations likely associated with the introduction of emissions controls and improved quality fuels for heavy-duty diesel on-road trucks and buses. Spark-ignition concentrations showed an increase across the state during 2014–2016 associated with the increase of registered vehicles in New York State.

Squizzato, Stefania, et al. "A long-term source apportionment of PM2. 5 in New York State during 2005–2016." Atmospheric Environment 192 (2018): 35-47.

Socio-Economic impacts

Description: This section includes articles addressing the socio-economic impacts due to air pollutions and SLCP

Quantitative Assessment of Relationship between Population Exposure to PM2.5 and Socio-Economic Factors at Multiple Spatial Scales over Mainland China

Analyzing the association between fine particulate matter (PM2.5) pollution and socio-economic factors has become a major concern in public health. Since traditional analysis methods (such as correlation analysis and geographically weighted regression) cannot provide a full assessment of this relationship, the quantile regression method was applied to overcome such a limitation at different spatial scales in this study. The results indicated that merely 3% of the population and 2% of the Gross Domestic Product (GDP) occurred under an annually mean value of 35 μg/m3 in mainland China, and the highest population exposure to PM2.5 was located in a lesser-known city named Dazhou in 2014. The analysis results at three spatial scales (grid-level, county-level, and city-level) demonstrated that the grid-level was the optimal spatial scale for analysis of socio-economic effects on exposure due to its tiny uncertainty, and the population exposure to PM2.5 was positively related to GDP. An apparent upward trend of population exposure to PM2.5 emerged at the 80th percentile GDP. For a 10 thousand yuan rise in GDP, population exposure to PM2.5 increases by 1.05 person/km2 at the 80th percentile, and 1.88 person/km2 at the 95th percentile, respectively

Yao, Ling, et al. "Quantitative Assessment of Relationship between Population Exposure to PM2. 5 and Socio-Economic Factors at Multiple Spatial Scales over Mainland China." International journal of environmental research and public health 15.9 (2018): 2058.

Gridded emissions and land-use data for 2005–2100 under diverse socioeconomic and climate mitigation scenarios

Information on global future gridded emissions and land-use scenarios is critical for many climate and global environmental modelling studies. Here, we generated such data using an integrated assessment model (IAM) and have made the data publicly available. Although the Coupled Model Inter-comparison Project Phase 6 (CMIP6) offers similar data, our dataset has two advantages. First, the data cover a full range and combinations of socioeconomic and climate mitigation levels, which are considered as a range of plausible futures in the climate research community. Second, we provide this dataset based on a single integrated assessment modelling framework that enables a focus on purely socioeconomic factors or climate mitigation levels, which is unavailable in CMIP6 data, since it incorporates the outcomes of each IAM scenario. We compared our data with existing gridded data to identify the characteristics of the dataset and found both agreements and disagreements. This dataset can contribute to global environmental modelling efforts, in particular for researchers who want to investigate socioeconomic and climate factors independently.

Fujimori, Shinichiro, et al. "Gridded emissions and land-use data for 2005–2100 under diverse socioeconomic and climate mitigation scenarios." Scientific data 5 (2018): 180210.

Air pollution & Health Impacts

Description: This section includes articles primarily addressing linkages between air pollution exposure and health impacts

Air pollution associated with non-suicidal self-injury in Chinese adolescent students: A cross-sectional study

Non-suicidal self-injury (NSSI) is a frequent phenomenon in adolescents and is closely related to eventual suicide. Although the effect of air pollution on various diseases has been extensively investigated, no studies examined its effect on NSSI in young students. We investigated the effect of air pollution on NSSI in Chinese students. We investigated the incidence of NSSI in the past 12 months in 54 923 Chinese students with an anonymous

questionnaire. We assessed the air pollution exposure of each student by the air quality matched with their schools, which were calculated by the inverse distance weighting method from the environmental monitoring data. We discussed the association between ambient air pollutants and the incidence of NSSI using generalized additive mixed models. A 10 μg/m3 increase in the annual moving average concentration of particulate matter with diameters less than 2.5 μm (PM2.5) and ozone (O3) was associated with a 13.9 percent and a 10.5 percent increase in the odds ratio (OR) of NSSI, respectively. In addition, a 0.1 mg/m3 increase in the annual moving average concentration of carbon monoxide (CO) was associated with a 4.8 percent increase in the OR of NSSI. NO2 and SO2 were not related to NSSI. CO and O3 show non-linear effects on NSSI. Male students in high school are the most s to the effects of PM2.5 on NSSI. Our study suggests that increases in PM2.5, O3 and CO may increase the incidence of NSSI among adolescent students.

Liu, Weina, et al. "Air pollution associated with non-suicidal self-injury in Chinese adolescent students: A cross-sectional study." Chemosphere 209 (2018): 944-949.

The concentration-response between long-term PM2.5 exposure and mortality; A meta-regression approach

Long-term exposure to ambient fine particulate matter (⩽ 2.5 μg/m3 in aerodynamic diameter; PM2.5) is significantly associated with increased risk of premature mortality. Our goal was to provide an updated meta-analysis of all-cause and cause-specific mortality associated with exposure to PM2.5 and to better estimate the risk of death as a function of air pollution levels. We systematically searched all published cohort studies examining the association between long term exposure to PM2.5 and mortality. We applied multivariate linear random effects meta-analysis with random effects for cohort, and study within cohort. Meta-regression techniques were used to test whether study population or analytic characteristics modify the PM2.5 -mortality association and to estimate the shape of the concentration-response curve. A total of 53 studies that provided 135 estimates of the quantitative association between the risk of mortality and exposure to PM2.5 were included in the meta-analysis. There were 39 studies from North America, 8 from Europe, and 6 from Asia. Since 2015, 17 studies of long-term air pollution exposure have been published, covering, wider geographic areas with a wider range of mean exposures (e.g. <12 or > 20 μg/m3). A penalized spline showed the slope decreased at higher concentrations but appeared to level off. We found that the inverse transform of average PM2.5 well approximated that spline and provided a parametric estimate that fit better than a linear or logarithmic term for average PM2.5. In addition, we found that studies using space time exposure models or fixed monitors at Zip-code scale (as compared to land use regression method), or additionally controlling for area level socio-economic status, or with mean exposure less than 10 μg/m3 were associated with higher mortality effect estimates. This meta-analysis provides strong evidence for the adverse effect of PM2.5 on mortality, that studies with poorer exposure have lower effect size estimates, that more control for SES increases effect size estimates, and that significant effects are seen below 10 μg/m3. The concentration -response function produced here can be further applied in the global health risk assessment of air particulate matter.

Vodonos, Alina, Yara Abu Awad, and Joel Schwartz. "The concentration-response between long-term PM2. 5 exposure and mortality; A meta-regression approach." Environmental research 166 (2018): 677-689.

Exposure to household air pollution from biomass cookstoves and blood pressure among women in rural Honduras: A cross-sectional study

Growing evidence links household air pollution exposure from biomass cookstoves with elevated blood pressure. We assessed cross-sectional associations of 24-hour mean concentrations of personal and kitchen fine particulate matter (PM2.5), black carbon (BC), and stove type with blood pressure, adjusting for confounders, among 147 women using traditional or cleaner-burning Justa stoves in Honduras. We investigated effect modification by age and body mass index. Traditional stove users had mean (standard deviation) personal and kitchen 24-hour PM2.5 concentrations of 126 μg/m3 (77) and 360 μg/m3 (374), while Justa stove users' exposures were 66 μg/m3 (38) and 137 μg/m3 (194), respectively. BC concentrations were similarly lower among Justa stove users. Adjusted mean systolic blood pressure was 2.5 mm Hg higher (95% CI, 0.7-4.3) per unit increase in natural log-transformed kitchen PM2.5 concentration; results were stronger among women of

40 years or older (5.2 mm Hg increase, 95% CI, 2.3-8.1). Adjusted odds of borderline high and high blood pressure (categorized) were also elevated (odds ratio = 1.5, 95% CI, 1.0-2.3). Some results included null values and are suggestive. Results suggest that reduced household air pollution, even when concentrations exceed air quality guidelines, may help lower cardiovascular disease risk, particularly among older subgroups.

Young, Bonnie N., et al. "Exposure to household air pollution from biomass cookstoves and blood pressure among women in rural Honduras: A cross-sectional study." Indoor air (2018).

Current and Future Disease Burden From Ambient Ozone Exposure in India

Long-term ambient ozone (O3) exposure is a risk factor for human health. We estimate the source-specific disease burden associated with long-term O3 exposure in India at high spatial resolution using updated risk functions from the American Cancer Society Cancer Prevention Study II. We estimate 374,000 (95UI: 140,000–554,000) annual premature mortalities using the updated risk function in India in 2015, 200% larger than estimates using the earlier American Cancer Society Cancer Prevention Study II risk function. We find that land transport emissions dominate the source contribution to this disease burden (35%), followed by emissions from power generation (23%). With no change in emissions by 2050, we estimate 1,126,000 (95UI: 421,000–1,667,000) annual premature mortalities, an increase of 200% relative to 2015 due to population aging and growth increasing the number of people susceptible to air pollution. We find that the International Energy Agency New Policy Scenario provides small changes (+1%) to this increasing disease burden from the demographic transition. Under the International Energy Agency Clean Air Scenario we estimate 791,000 (95UI: 202,000–1,336,000) annual premature mortalities in 2050, avoiding 335,000 annual premature mortalities (45% of the increase) compared to the scenario of no emission change. Our study highlights that critical public health benefits are possible with stringent emission reductions, despite population growth and aging increasing the attributable disease burden from O3 exposure even under such strong emission reductions. The disease burden attributable to ambient fine particulate matter exposure dominates that from ambient O3 exposure in the present day, while in the future, they may be similar in magnitude.

Conibear, Luke, et al. "Current and future disease burden from ambient ozone exposure in India." GeoHealth (2018).

Women and girls in resource poor countries experience much greater exposure to household air pollutants than men: Results from Uganda and Ethiopia

Household Air Pollution (HAP) from burning biomass fuels is a major cause of mortality and morbidity in low-income settings worldwide. Little is known about the differences in objective personal HAP exposure by age and gender. We measured personal exposure to HAP across six groups defined by age and gender (young children, young males, young females, adult males, adult females, and elderly) in rural households in two sub-Saharan African countries. Data on 24-hour personal exposure to HAP were collected from 215 participants from 85 households in Uganda and Ethiopia. HAP exposure was assessed by measuring carbon monoxide (CO) and/or fine particulate matter (PM2.5) concentrations using five types of devices. 24 h PM2.5 personal exposure was highest among adult females with Geometric Mean (GM) and Geometric Standard Deviation (GSD) concentrations of 205 µg/m3 (1.67) in Ethiopia; 177 µg/m3 (1.61 GSD) in Uganda. The lowest PM2.5 exposures were recorded among young males GM (GSD) 30.2 µg/m3 (1.89) in Ethiopia; 26.3 µg/m3 (1.48) in Uganda. Young females had exposures about two-thirds of the adult female group. Adult males, young children and the elderly experienced lower exposures reflecting their limited involvement in cooking. There was a similar pattern of exposure by age and gender in both countries and when assessed by CO measurement. There are substantial differences in exposure to HAP depending on age and gender in sub-Saharan Africa rural households reflecting differences in household cooking activity and time spent indoors. Future work should consider these differences when implementing exposure reduction interventions. There was a strong agreement between optical and gravimetric devices measurements although optical devices tended to overestimate exposure. There is need to calibrate optical devices against a gravimetric standard prior to quantifying exposure.

Okello, Gabriel, Graham Devereux, and Sean Semple. "Women and girls in resource poor countries experience

much greater exposure to household air pollutants than men: Results from Uganda and Ethiopia." Environment international 119 (2018): 429-437.

Hypertensive and toxicological health risk among women exposed to biomass smoke: A rural Indian scenario

This study shows that exposure to air pollutants from indoor cooking fuel combustion may be associated with elevated Diastolic Blood Pressure (DBP), Systolic Blood Pressure (SBP), Heart rate and Body mass index (BMI) in rural women of India. 60 premenopausal women (using solely agriculture residues, wood, dung, straw, leaf) and 30 women (solely using clean fuel, LPG) were recruited for this study. An ethically approved questionnaire was used in the study and health parameters were measured by standard instruments. Eight pollutants were measured by calibrated instruments, applied both in the living room as well as kitchens of test-subjects. The Test-subjects were divided into two groups, LPG users, and biomass users, and the toxicological risk was assessed by measurement of PM2.5 levels in the given indoor environments. The concentrations of all the pollutants were significantly ($p < 0.001$) higher in biomass users than in LPG using households, except in the case of O3 ($p < 0.403$) at the time of cooking. Results highlighted that DBP ($p < 0.070$), SBP ($p < 0.143$), Heart rate ($p < 0.002$) and BMI ($p < 0.052$) were varied in the two fuel user groups. In the case of biomass fuel user toxicological risk was higher (5.21) than LPG users (0.69). Moreover, Symptoms like asthma (25%), cough (76.67%), dizziness (36.67%), eye irritation (88.33%), and shortness of breath (43.33%) were highly prevalent among biomass users than in LPG users. The study highlighted that Biomass using women are more prone to cardiovascular disease and policies should be formulated for their sustainable health.

Chakraborty, Deep, and Naba Kumar Mondal. "Hypertensive and toxicological health risk among women exposed to biomass smoke: A rural Indian scenario." Ecotoxicology and Environmental Safety 161 (2018): 706-714.

Ambient air pollution and completed suicide in 26 South Korean cities: Effect modification by demographic and socioeconomic factors

Air pollution has been recently associated with suicide mortality. However, limited studies have examined possible effect modification of the association by various demographic and socioeconomic factors, despite their crucial roles on suicide risk. In 73,445 completed suicide cases from 26 South Korean cities from 2002 to 2013, we studied the association of suicide risk with exposure to particles <10 μm (PM10), nitrogen dioxide (NO2), sulfur dioxide (SO2), ozone (O3), and carbon monoxide (CO), using a city-specific conditional logistic regression analysis with a case-crossover design. Random effects meta-analysis was used to pool the results. We considered a delayed effect of air pollution by constructing lags of up to 7 days. We explored effect modification by demographic and socioeconomic factors (sex, age, education level, job, and marital status) as well as place of death, method of suicide, and season, through stratified subgroup analyses. Among five pollutants, NO2 showed the strongest association at immediate lags (percent change in odds ratio; PM10: 1.2% [95% CI, 0.2%, 2.3%]; NO2: 4.3% [95% CI, 1.9%, 6.7%]; SO2: 2.2% [95% CI, 0.7%, 3.8%]; O3: 1.5% [95% CI, −0.3%, 3.2%]; and CO: 2.4% [95% CI, 0.9%, 3.8%] per interquartile range increase at lag0). In subgroup analyses by socioeconomic factors, stronger associations were observed in the male sex, the elderly, those with lower education status, white-collar workers, and the married; the largest association was an 11.0% increase (95% CI, 4.1%, 18.4%) by NO2 among white-collar workers. We add evidence of effect modification of the association between air pollution exposure and suicide risk by various demographic and socioeconomic factors. These findings can serve as the basis for suicide prevention strategies by providing information regarding susceptible subgroups.

Lee, Hyewon, et al. "Ambient air pollution and completed suicide in 26 South Korean cities: Effect modification by demographic and socioeconomic factors." Science of The Total Environment 639 (2018): 944-951.

Urban SLCPs

Description: This section includes articles addressing SLCP emissions, trends, and measures specifically in urban environments

Impact of residential combustion and transport emissions on air pollution in Santiago during winter

Santiago (33.5°S, 70.5°W), the capital of Chile, is frequently affected by extreme air pollution events during wintertime deteriorating air quality (AQ) and thus affecting the health of its population. Intense residential heating and on-road transport emissions combined with poor circulation and vertical mixing are the main factors responsible for these events. A modelling system composed of a chemistry-transport model (CHIMERE) and a meteorological model (WRF) was implemented to assess the AQ impacts of residential and transportation sources in the Santiago basin. A two-week period of July 2015 with various days with poor AQ was simulated focusing on the impact on AQ with respect to fully inhalable particles (PM2.5) and nitrogen oxides (NOX). Three emission scenarios, within the range of targeted reductions of the decontamination plan of Santiago, were tested; namely 50% reduction of residential emission, 50% reduction of transport emissions and the combination of both. An additional scenario decreasing transport emissions in 10% was carried out to examine whether a linear dependence of surface concentrations on changes in emissions exists. The system was validated against surface and vertically resolved meteorological measurements. The model reproduces the daily surface concentration variability from the AQ monitoring network of Santiago. However, the model not fully captures the emissions variations inferred from the observations which may be due to missing sources such as resuspension of dust. Results show that, during the period studied, although both residential and transportation sources contribute to observed AQ levels in Santiago, reducing transport emissions is more effective in terms of reducing the number of days with pollution events than decreasing residential combustion. This difference in impact is largely due to the spatial distribution of the emission sources. While most of the residential combustion is emitted in the outskirts of the city, most of the transport emissions occur within the city, where most of the stations from AQ monitoring network of Santiago are located. As can be expected, the largest improvement of AQ in Santiago is achieved by the combined reduction of emissions in both sectors. Sensitivity analysis with 10% reduction in transport emissions reveals a linear behavior between emissions and concentrations for NOX and approximate linear behavior for PM2.5. The absence of secondary aerosols formation and dust resuspension in the current simulation could explain this deviation from linearity for fine particles. Nevertheless, it suggests that the results can be used for mitigation policies with emissions reductions below the 50% used in this study.

SLCPs & Vulnerable Regions

Description: This section includes articles addressing SLCP impacts on vulnerable regions or studies discussing the specific vulnerabilities of regions to SLCPs.

Current and Future Arctic Aerosols and Ozone From Remote Emissions and Emerging Local Sources—Modeled Source Contributions and Radiative Effects

The Arctic is influenced by air pollution transported from lower latitudes, and increasingly by local sources such as shipping and resource extraction. Local Arctic emissions could increase significantly in the future due to industrialization in a warming Arctic and further influence Arctic climate. We use the regional model Weather Research and Forecasting, including chemistry, to investigate current (2012) and future (2050) sources of Arctic aerosol and ozone pollution and their radiative impacts, focusing on spring and summer emissions from midlatitude anthropogenic sources, biomass burning, Arctic shipping, and Arctic gas flaring. Results show that remote anthropogenic and biomass burning emissions are likely to remain the main source of Arctic pollution burdens and of black carbon (BC) deposition over snow, and the main contributors to direct aerosol and ozone

radiative effects in the Arctic. However, local Arctic flaring emissions are already a major source of BC in northwestern Russia, with a direct radiative effect of ~25 mW/m2, and Arctic shipping is a strong current source of aerosols and ozone during summer in the Nordic Seas. We find that the direct effect of ozone and aerosols from summertime Arctic shipping is respectively negative (due to frequent temperature inversions) and positive (because of the high surface albedo) in our simulations, two new results. With the development of diversion shipping through the Arctic Ocean in summer 2050, Arctic shipping emissions could become the main source of surface aerosol and ozone pollution at the surface, with strong associated indirect effects of −0.8 W/m2, while flaring would remain an important BC source.

Marelle, Louis, et al. "Current and future Arctic aerosols and ozone from remote emissions and emerging local sources‐modeled source contributions and radiative effects." Journal of Geophysical Research: Atmospheres (2017).