Black Carbon e-Bulletin

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Protecting Climate, Health, and Crops: New Coalition Calls Time on Short-Lived Pollutants

If someone proposed that you could save close to 2.5 million lives annually, cut global crop losses by around 30 million tonnes a year and curb climate change by around half a degree C what would you do?

Act of course: and that is what six countries, in collaboration with the UN Environment Programme (UNEP), are doing under the Climate and Clean Air Coalition to reduce Short-Lived Climate Pollutants.

The targets of this new partnership, founded by Bangladesh, Canada, Ghana, Mexico, Sweden, the United States, and the United Nations Environment Programme (UNEP) are black carbon or 'soot', methane, and hydrofluorocarbons (HFCs) - methane in addition to being a powerful greenhouse gas is also known to aggravates the formation of pollutants such as tropospheric ozone.

More than a decade of painstaking science has now built a powerful case that can no longer be ignored.

Namely that swift action on the multiple sources of black carbon, HFCs, and methane can deliver extraordinary benefits in terms of public health, food security and near term climate protection.

Meanwhile assessments, including those coordinated by the UNEP and the World Meteorological Organization, indicate that in some extremely vulnerable areas the climate benefits may be even bigger.

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Real-time Assessment of Black Carbon Pollution in Indian Households due to Traditional and Improved Biomass Cookstoves

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Introduction

In developing countries, where traditional mud stoves and/or three stone fires are in wide use, the introduction of clean cooking technologies has gained momentum as a top-priority black carbon (BC) mitigation measure.

However, major disparities and gaps in knowledge remain, raising significant policy implications. First of all, considerable misunderstanding is caused by the liberal use of the term "improved" as a "catch-all" phrase for a range of biomass-fuelled cooking technologies, with varying prices. Up to now, there is no complete inventory of stove technologies that are truly improved, from the point of view of reduced BC concentration levels.

Secondly, as laboratory and field measurements of stove performance can differ dramatically, there is much uncertainty about how much reduction in BC concentration levels can be actually achieved by using alternative cooking technologies, under field conditions. These two issues, effective BC reduction technologies and true reduction potential, are critical for policy makers and for people who are involved in planning and budgeting stove dissemination programs.

In an attempt to address these knowledge gaps, this article presents findings from a series of real time, in-situ BC concentration measurements

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Also in this Issue

Editorial: Short-lived air pollutants: From science to on-the ground mitigation

Achim Steiner, Executive Director, UNEP

In 1972, the Stockholm Conference on the Human Environment created the United Nations Environment Programme (UNEP). As we mark UNEP's 40th anniversary, we have the opportunity to review four decades of environmental policy-making and the responsibility to look into the future of our shared environment.

During UNEP's 40-year journey, significant milestones have been achieved with regard the formulation and enforcement of international environmental law, breakthroughs in the collection and interpretation of environmental information and data, international policy development and implementation, and engagement of interest groups and stakeholders.

One milestone has been the way by which UNEP has brought to the forefront the emerging issue of short-lived climate pollutants (methane, black carbon, ozone and HFCs), and consequently built the science and capacity required to address this issue. From 1997 to 1999, a team of scientists led by Prof. Ramanathan (USA), Prof. Crutzen (Germany) and Dr. Mitra (India) conducted the Indian Ocean Experiment (INDOEX), documenting exhaustively for the first time the trans-continental and trans-oceanic Atmospheric Brown Clouds (ABCs) over continental South Asia and the Indian Ocean. ABCs, include short-lived climate pollutants.

In response to the INDOEX findings, UNEP, in collaboration with scientists and in consultation with governments, established the Project Atmospheric Brown Cloud (ABC) to address the emerging issue of ABCs in 2001. In the past 11 years, the project has made significant progress in enhancing science, capacity, and awareness.

The main finding of Project ABC, as docu-

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Published by the United Nations Environment Programme (UNEP) in collaboration with the Science Team of Atmospheric Brown Cloud (ABC)

Editorial ...

mented in a first-ever regional assessment report, is that ABCs and their interaction with the build-up of greenhouse gases have significant impacts on regional climate systems, including monsoons and the Himalayan glaciers, water budgets, agricultural production, and human health. The report also documented spatial distribution of ABCs and regional hotspots around the world. In 2011, global assessment of black carbon and tropospheric ozone and compilation of actions for controlling short-lived climate pollutants were completed. These efforts have helped to place short-lived climate pollutants high on the policy agenda at national, regional, and global levels. This culminated in the announcement of a climate and clean air coalition to reduce short-lived climate pollutants, by six countries in February this year. More countries are expected to join the coalition. UNEP has been asked to provide the secretariat to the coalition, to support the implementation of its ambitious programme. In addition to the Coalition, many governments have initiated national and regional programmes on short-lived climate pollutants.

Reducing emissions of short-lived climate pollutants require action from local up to regional levels. A top-down approach by itself is not sufficient, and should be complemented with actions at the grassroots level, involving individual villages and cities. We need knowledge-to-action projects and knowledge-action networks to transfer knowledge generated by scientists and countries, to local institutions, where such knowledge is much needed.

Scientists have suggested cost-effective technologies that are available, in order to reduce emissions of short-lived climate pollutants. A UNEP report, entitled *Near-term climate protection and clean air benefits: actions for controlling short-lived climate forces,* provides 16 control options that cover a wide range of sources of black carbon and methane emissions, from cookstoves and diesel engines to leaking gas distribution pipes and municipal waste.

For example, Project Surya, one of the most innovative cleaner cook stoves project in the world, has demonstrated significant benefits to sustainable development, though the use of improved cooking-lighting system in developing countries in South Asia and Africa. The beneficiaries of Project Surya reported health benefits, while a satisfied user in Kenya reported a 60 percent reduction in expenditure on firewood and kerosene to cook and light her home since using the improved cooking-lighting system. Project Surya's cooking-lighting system has reduced its contribution to climate forcers, and has also improved the health and financial standing of its users. These results provide evidence of what is possible. In the face of this promising outcome, we need to assist large-scale adoption of cleaner technologies in support of sustainable development. UNEP in collaboration with partners will continue to assist the member states and stakeholders to facilitate large scale-adoption of cleaner technologies.

Protecting Climate, Health, and Crops ...

In the Arctic and in mountain regions where glaciers are at risk from sharply rising rates of melting, temperature rises might be reduced by up to 0.7 degrees C up to 2040.

Action on HFCs will also assist in climate protection: A recent study coordinated by UNEP projects that by 2050 HFCs could be responsible for annual emissions equivalent to 3.5 to 8.8 Gigatonnes (Gt) of carbon dioxide (Gt CO2eq) - comparable to total current annual emissions from transport, estimated at around 6-7 Gt annually.

There is more good news: It is estimated that around half of the black carbon and methane emission reductions can be achieved through measures that result in cost savings over the lifetime of the investment.

This is because some of the measures—such as recovering rather than emitting natural gas during oil production—allow the methane to be harvested as a clean source of fuel.

Cutting black carbon emissions by, for example, replacing inefficient cookstoves and traditional brick kilns with more efficient ones also cuts fuel costs for households and kiln operators.

In April this year in Stockholm, the Climate and Clean Air Coalition Partners will take forward their plans to:

- Raise awareness of the urgency and benefits of taking actions to reduce emissions of these short-lived climate pollutants (SLCPs), which include black carbon, methane, and some shorter-lived hydroflourocarbons, or HFCs;
- Identify common approaches to take new action on these pollutants, and reinforce actions in other organizations such as the Arctic Council;
- Promote the development of national or regional SLCP action plans, and track progress;
- Mobilize funding commitments for SLCP mitigation of initially $10 million in 2012 and provide up-front finance to create enabling environments for action, including leveraging private sector investments in SLCPs mitigation.

Fast action on short lived climate pollutants can deliver quick wins in a world often frustrated by the glacial pace at which sustainability challenges appear to be being addressed.

In respect to climate change, it might assist in keeping a global temperature below 2 degrees C but only for so long.

Unless there is also decisive action on carbon dioxide, then reducing all sources of short lived climate pollutants will not spare the world and its people from dangerous climate change over the 21st century.

But it would be a failure of leadership not to seize the benefits so manifest in respect to the health of humans and the health of our world.

If someone proposed that you could save close to 2.5 million lives annually, cut global crop losses by 25 million tonnes a year and curb climate change by around half a degree C what would you do?

Act of course, and we invite countries across the globe to join this inspiring and transformational coalition that uniquely unites the interests of the developing and he developed world and above all the interests and future prospects for seven billion people, rising to over nine billion by 2050.

Real-time Assessment of Black Carbon ...

from a series of cooking experiments in household villages in northern India. The experiments used different improved biomass cooking stoves (ICs) that are commercially available, selecting those that were most affordable and with accessible clean-cooking options for large-scale adoption by poor and marginalized sections of society. The selected ICs can be broadly classified into two classes, based on the mechanism for air augmentation inside the combustion chamber. Three were natural draft (ND) stoves and two were forced draft (FD) stoves. A traditional mud cooking stove (used currently by most households in the region) was used as a baseline for the comparison.

This comparative evaluation of the BC mitigation potential of ICs is part of a larger interdisciplinary study known as Project Surya (www.projectsurya.org). Project Surya aims to quantify the climate and health impacts of large-scale adoption of cleaner cooking technologies in India and ultimately in other developing countries.

Methodology

At present, there is no universally accepted and implemented best practice/protocol for measuring black carbon concentration in rural households. The Controlled Cooking Test (CCT), a standardized cooking stove testing protocol, was used as basis for this study, in line with this paper's aim to assess the performance of stoves in real world conditions, although this may not necessarily be the stove developers' intention and/or proposed methodology. For the purpose of comparison, restrictions were kept to a minimum (that is, same quality and quantity of food ingredients, same fuel type, and same cook). The cooking experiments were conducted during non-cooking hours in the village (10:00 to 17:00 h), to avoid disturbing the family's daily cooking routine, and to prevent measurement contamination by smoke from adjacent households. To minimize the impact of ventilation (due to varied wind and temperature conditions which cannot be controlled in field settings), the trials were spread out over some days and were repeated at different hours.

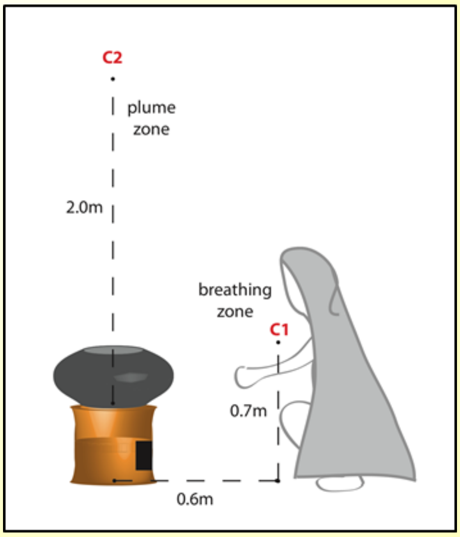

Figure 1: Breathing zone and plume zone

In order to assess the BC mitigation potential of ICs, real-time indoor BC concentrations were measured simultaneously, using micro-aethalometers (model AE-51; Magee Scientific, Berkeley, CA) at two points, C1 and C2 (Figure 1). A survey of 30 women, selected at random from different households in Project Surya village, revealed that most women preferred to squat in front of the stove, with an average breathing position of 0.6 m away from the stove and 0.7 m above the ground. Position C1 represents the concentration at the inhalation height of the stove user, a relevant data for first-order health impacts that are caused by exposure to BC. Position C2 was measured at 2 m directly above the stove burner to maximize plume capture. The measurement at C2 (the "plume zone") is the more relevant metric data (compared to C1) for climate considerations. The choice of height for the plume zone measurements was partially determined by equipment constraints: the AE-51 requires periodic filter changes, and a lower measurement height would have necessitated multiple filter changes (and subsequent data loss) during cooking sessions.

Results and Discussions

The mean indoor background BC concentration (C1) was recorded at 3.7 $\mu g.m^{-3}$ (±1.3, 95% C.I., n = 37 cooking experiments) in the absence of any cooking activity (and during off-peak village cooking hours). Differences in performance between the ICs and the traditional mud stove, in terms of BC concentration, are presented as box-plots in Figure 2. Using mean BC concentration values in either plume or breathing zone results in the same relative ranking of ICs in terms of BC reduction vis-à-vis the traditional mud stove (from worst- to best- performing, where higher BC indicates lower performance): ND2 < ND1< ND3 < FD2 < FD1. Consistency in inter-stove ranking of concentrations at C1 and C2 reduces the risk of experimental errors due to instrument,

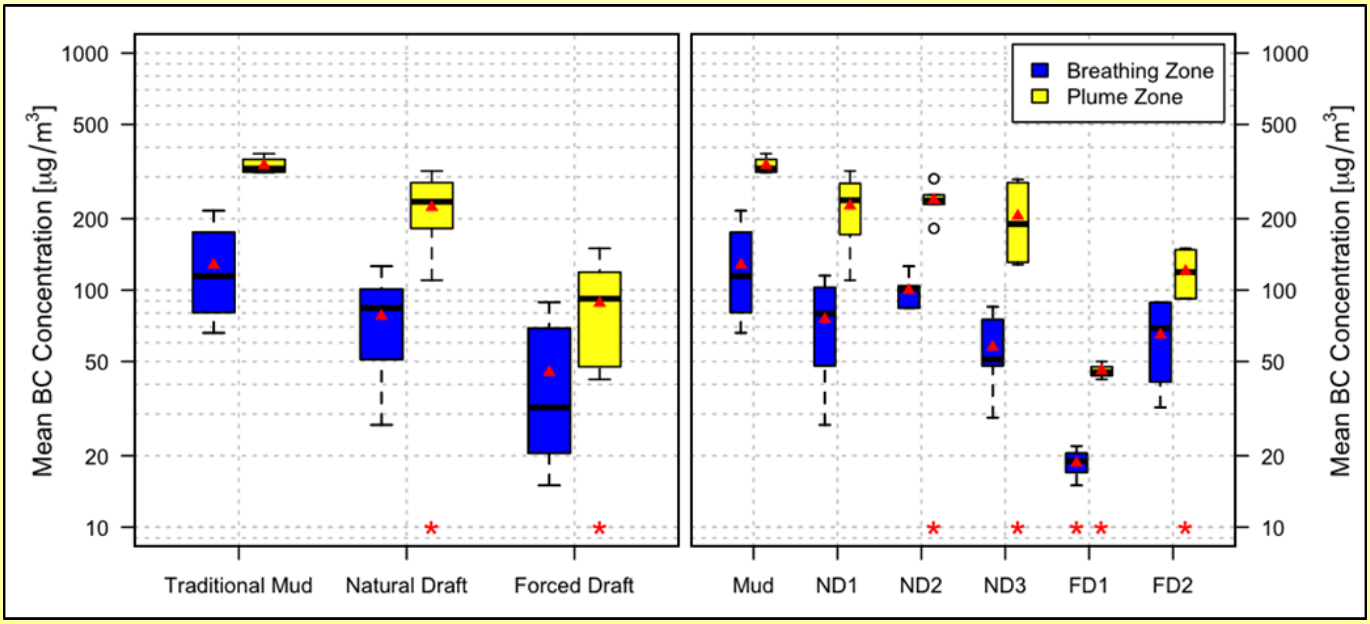

Figure 2: BC emissions of different cookstoves in breathing and plume zones (left) grouped by stove class and (right) displayed individually

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wind or ventilation issues.

In breathing zone C1, BC concentrations in the mud, ND, and FD stoves are 127.5±65.0 μg m^{-3}, 77.8±30.1 μg m^{-3}, and 45.0±31.9 μg m^{-3}, respectively. While ND and FD technologies reduce mean BC concentrations in comparison to the mud stove by 39% and 65%, respectively, these findings are not statistically significant (95% confidence level), due to the high variance of results in each stove class (overlap of the boxes, Figure 2, left). At C1, only FD1 showed a statistically significant reduction in BC concentration. In fact, mean BC concentrations at C1 during some ND cooking sessions were worse than the better-performing mud cook stove sessions (represented by overlapping of mud and ND box-plots in Figure 2, right).

In the plume zone C2, the mean BC concentration of the mud stove is 335± 29.2μg m^{-3}. The ND stoves have a mean BC value of 223 ± 66.7 μg m^{-3}, while the FD stoves have a mean BC value of 88.2 ± 45.7 μg m^{-3}, reducing BC concentration by 33% and 74%, respectively. The results indicate a significant performance difference, with FD outperforming ND stoves in BC mitigation. When the data are broken down by individual stove, as opposed to stove class (Figure 2, right), both FD stoves FD1 and FD2 register significant reductions in mean BC concentrations in C2 (86% and 64%, respectively, compared to the mud stove). While ND2 and ND3 register statistically significant mean plume zone BC reductions of 28% and 39%, respectively, the mean reduction of 32% for ND1 is not statistically significant (at 95% confidence level, represented by the overlapping of ND1 and mud box-plots). These findings support previous studies that have reported superior performance of forced draft stoves in significantly reducing BC/Particulate matter (PM) concentration levels.

The experiment also revealed striking intra-technology differences among stove models of a given technology class. Even when considering only hardwood cooking sessions in the standardized experimental setup, significant variance exists within the ND and FD classes. For example, among ND stoves, the mean BC reduction in the breathing zone varies widely (22% to 55%), and the mean BC concentration of ND2 is 73% greater than that of ND3. In comparison, there is less variation in plume zone concentrations as reductions in BC concentration (mean value) at the plume zone for ND1, ND2 and ND3 are 32%, 28%, and 39%, respectively. As with the ND stoves, variation of stove performance between the two FD stoves is greater in the breathing zone (85% and 49% BC reduction compared to the mud stove for FD1 and FD2, respectively) than in the plume zone (86% and 64% for FD1 and FD2, respectively).

Conclusion

The variation in performance among the five ICs tested in this study should raise caution about IC assumptions and terminology, particularly as the performance of some so-called "improved" stoves in the natural draft category may at times be poorer than that of traditional mud cooking stove. As far as metric considerations go, FD stoves can outperform ND stoves in terms of reduction in BC concentrations. FD stoves should be considered for dissemination in improved cooking stove programs worldwide, using climate metrics as part of the selection criteria. FD1, which emerged as the best performing IC in the experiment has been distributed to 438 households in the Project Surya area. It has been noted that BC concentrations from mud stoves range widely between 50 and 1000 μg m^{-3}, while the concentrations for FD1 range between 5 and 100 μg m^{-3}, or an order of magnitude lower.

Even in a standardized cooking environment (same food, fuel, cook, cooking space, and season), the wide variance in 'within technology' concentration measurements underscores the importance of considering stove-specific BC mitigation potential for policy decisions. Furthermore, additional field datasets on BC emissions/concentration levels from "improved cooking stoves" are required to account for the variance in food and user handing of stoves across the world.

Acknowledgements

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Ministerial Decision on Atmospheric Pollution in Latin America and the Caribbean

A decision on mitigating atmospheric pollution was approved by Ministers of the Environment from countries in Latin America and the Caribbean at the Eighteenth Meeting of the Forum of Ministers, held on 31 January to 3 February 2012, in Quito, Ecuador.

The decision, entitled "Atmospheric Pollution within the Framework of the Regional Intergovernmental Network" is a logical expansion of decisions on atmospheric pollution, reached at previous meetings of the Forum. The latest decision underlines the need to continue the work of the Regional Intergovernmental Network, and to develop an action plan that will address atmospheric pollution. Such an action plan will define the Network's orientation and will strengthen collaboration with relevant stakeholders who are actively promoting activities that contribute to air quality.

The decision will enable the Network's focal points to participate in a collective exercise to assemble and review information and resources for monitoring and assessing the impacts of atmospheric pollution in different countries in the region. This will provide the basis for developing an action plan, incorporating inputs on priority subjects and abatement opportunities. More details are available at the following link: http://www.pnuma.org/forumofministers/18-ecuador/html/documents.htm

Recent Initiatives on Short-Lived Climate Forcers

Meeting of Himalayas and Mekong Alliance

Under the banner of the Himalayas and Mekong Alliance (HIMEK), the International Union for Conservation of Nature (IUCN) convened a meeting among like-minded institutions to form an alliance that will address climate change mitigation issues in the Himalayas and Mekong Basin. The meeting was held on 1-2 March 2012 in Bangkok, Thailand. The alliance is aimed at fostering partnerships to promote regional cooperation and to gather knowledge, as well as identify collaborative mitigation strategies. It will work with individual countries to execute these strategies. In particular, the alliance will focus on short-lived climate forcers, especially black carbon. More details are available at the following link:
http://www.iucn.org/about/union/secretariat/offices/asia/?9456/Himalayan-and-Mekong-regions-unite-to-tackle-climate-change---The-HIMEK-Alliance-Workshop

Workshop on Short-lived Climate-warming Pollutants: Pathways to Action

Transfer of knowledge about short-lived climate-warming pollutants (SLCPs) was high on the agenda of a meeting convened by the Institute for Advanced Sustainability Studies (IASS) in Potsdam on March 19-20, 2012. Through the workshop, the IASS initiated a process that would facilitate knowledge transfer and formulation of policy measures to reduce SLCPs by implementing technological measures and socio-economic solutions, and by ensuring support for future research on the most crucial aspects of SLCPs.

Svalbard Declaration on Short-lived Climate Forcers

With the recent issuance of the Svalbard Declaration on short-lived climate forcers (SLCFs), Nordic countries plan to intensity efforts to reduce emissions of SLCFs, at the national, regional and global levels. The declaration was issued at the Nordic ministerial meeting on 26-27 March 2012 among environment ministers of Denmark, Finland, the Faroe Islands, Iceland, Norway, Sweden and Åland. The meeting was held in Svalbard, Norway. More details are available at the following link:
http://www.norden.org/en/nordic-council-of-ministers/councils-of-ministers/nordic-council-of-ministers-for-the-environment-mr-m/declarations-and-statements/svalbard-declaration-on-shortlived-climate-forcers

The Opportunity to Simultaneously Mitigate Air Pollution and Climate Change

On 27 March 2012 at the Planet Under Pressure conference in London (www.planetunderpressure2012.net), the International Geosphere-Biosphere Programme (IGBP, www.igpb.net) and International Global Atmospheric Chemistry project (IGAC, igacproject.org) launched a statement entitled "Time to Act: The Opportunity to Simultaneously Mitigate Air Pollution and Climate Change". The statement calls for an integrated approach to addressing air pollution and climate change if society desires to slow the rate of climate change and to protect human health, food/water security and ecosystems. The statement can be downloaded at igacproject.org/node/12.

Report on Black Carbon.

On 30 March 2012, the US Environmental Protection Agency released a report on strategies to reduce black carbon (BC). The report submitted to the US Congress concluded that while the indirect effects of BC via interactions with clouds remains uncertain, the direct climate effect of BC and the effect due to deposition of BC on highly reflective surfaces such as snow and ice, are best quantified and appear to be that of significant warming. To put this in perspective, the total direct effect of BC on a global scale is likely comparable to or greater than that of methane, a potent greenhouse warming gas, and possibly as much as half that of carbon dioxide by some estimates, the largest and one of the longest lived contributors to greenhouse warming. Yet unlike greenhouse warming gases such as carbon dioxide that reside in the atmosphere for centuries, BC resides in the atmosphere for days to weeks, thus presenting an opportunity to bring about immediate changes. BC has also been shown to have significantly impacted the Arctic and some snow-packed and glaciated areas in the Hindu Kush-Himalayan-Tibetan region, the source of water for millions of people. And as a significant contributor to particulate air pollution as well, especially in urban areas, BC has a significant adverse impact on human health, especially among women and children. Consequently, reducing BC emissions holds the promise of helping to slow the rate of climate change and improving air quality and human health for millions of people, in the near-term. More details are available at the following link: www.EPA.gov/blackcarbon

Regional Programme on Atmospheric Science and Policy

Discussions about a new regional programme on atmospheric science and policy at the International Center for Integrated Mountain Development (ICIMOD) took place during the inception Workshop for a SIDA funded initiative at ICIMOD titled "Reducing the Impacts of Black Carbon and other Short Lived Climate Forcers". The inception workshop was held on 1-3 April 2012. The regional programme will work to improve scientific understanding of complex atmospheric processes and changes in the Hindu Kush-Himalaya (HKH) region as well as provide knowledge support and coordination for effective policy formulation that takes into account the transboundary nature of the atmosphere. The new programme at ICIMOD will build up to host projects and sub-programmes in a number of areas including but not limited to short-lived climate forcers, air pollution, atmospheric brown clouds, long lived climate forcers, and chemical weather forecasting.

Training Workshop on Health Impact Assessment

With high concentrations of air pollutants in many large cities in South Asia, capacity building in assessing the consequent health impacts is a priority among member countries of the Malé Declaration on Control and Prevention of Air Pollution and its Likely Transboundary Effects for South Asia.

The assessment will meet the need for information on the effects of air pollutants on human health by providing locally gathered evidence to support action by governments to control particulate emissions.

To enhance the capacity of member countries in this regard, health impact assessment studies together with training workshops have been held. The most recent training workshop on health Impact assessment was held in Dhaka, Bangladesh on 9 January 2012, to follow-up on previous workshops and to review the results of studies on the scale and severity of the health impacts of air pollution.

The assessment methodology was applied in Dhaka to demonstrate the effect on the bronchial health of asthmatic school children. The first training workshop on health impacts was held in February 2007 and a follow-up training was held in October 2007. The third training workshop was organized in Kathmandu in March 2011 to prepare for health impact assessment studies in two other cities in South Asia.

Consultation on Black Carbon Mitigation (Part II)

Reduction of black carbon emissions in the industrial and transport sectors in South Asia was among the major topics at a consultative event, Soft Approaches for Achieving Co-benefits from Black Carbon Emissions Reduction. The event was co-organized and co-hosted by the United States Environmental Protection Agency's (U.S. EPA) Office of International and Tribal Affairs (OITA), the United Nations Environment Programme (UNEP), and the International Centre for Integrated Mountain Development (ICIMOD). It was held on 21-23 March 2011 in Kathmandu, Nepal.

Industrial sector

A major source of black carbon (BC) emissions is the brick kiln industry. Different technologies used in brick making include the following: Hoffmann kilns, Bull's Trench Kiln (BTK), clamp, Zig-Zag, VSBK, and Habla, all of which represent a spectrum of fuel efficiencies and amounts of BC emissions. Most kilns in use in developing countries are inefficient, such as the BTK and clamp kilns which produce high BC emissions due to poor combustion.

In the past, there have been attempts to promote fuel efficient and less polluting methods such as VSBK, Habla, and Zig-Zang kilns (Box 2). A combination of low cost and low tech improvements coupled with operational behavioral changes can easily minimize costs, reduce BC emissions, and ensure cleaner brick production. Such changes include enforcement of existing environmental regulations for brick kilns, building codes, and regulations that favor hollow bricks and promote training of operators, brick makers and brick buyers. There is also need to develop a cadre of local technology providers to provide technology and troubleshooting. Adequate financing should also be made available.

Box 2: Improved brick kilns offer economic and environmental benefits

Traditional Bull's Trench Kiln (BTK)

Zig-Zag Kiln

Modification of traditional Bull's Trench Kilns (BTK) to natural draught zig-zag firing offers attractive cost benefits, in terms of annual increase in revenue and quick payback period of less than a year. Significant environmental and economic benefits include:

- Reduced energy need- Coal consumption reduced by 15-25%
- Improved product quality-percentage of Class I bricks increased from 50-60% to >85%
- Reduced emissions- Emissions of particulate matter, soot, CO, and CO_2 reduced.

Source: Compiled from the presentation of O.P. Badlani and Sameer Maithel.

Transport sector

In the transport sector, diesel engines are major sources of BC emissions. Studies reveal that particulate emissions from diesel engines have significant warming impacts due to large amounts of BC. The number of diesel vehicle engines has been growing all over the Asia, and consequently the percentage of diesel use in the transport fuel mix has also been increasing. Diesel vehicles, including trucks, have relatively higher emissions rates. As a result, diesel emissions are expected to grow steadily in the coming years.

Some of the long-standing broad-based challenges that this sector faces are the following: inadequate policies for trucks with a large number of government agencies' involved in one way or another; truck fleets being highly fragmented with a majority being owner-driven trucks; much of the fleets consist of old trucks having poor maintenance practices while hauling practices typically result in a high percentage of empty hauls and overloaded hauls. An additional challenge is limited proven technologies that are available in and applicable to Asia, combined with fragmented supplier networks.

In terms of reduction in BC emissions, some of the comprehensive recommendations were related to standards and technologies. For example, it was suggested that sulfur levels in petrol and diesel fuel should be maintained at 50 ppm or lower; at least Euro 4-vehicle emission standards should be adopted; and fuel economy standards should be set for all vehicle types. With regard technologies, promotion of diesel particulate filters and other emissions control technologies that improve fuel efficiency was suggested.

Considering opportunities on a broader scale, many participants in the consultative event identified the need for a modal shift from private vehicles to public transportation, as well as the need for appropriate implementing tools. The consultative process recognized that the comprehensive, resource-intensive recommendations that were presented were supportive of low cost and low tech reduction of BC emissions, scale-wise and resource-wise. In addition, it took note of the need for behavioral and operational changes, including eco-friendly drivers' training, regular inspection and maintenance programs, and improved management, logistics, and modernization of fleets. For example, driver training programs can build the capacity of drivers to operate vehicles in a more fuel-efficient way, leading to significant gains in fuel efficiency and reduction of BC emissions (Box 3).

Box 3: Ahmadabad Municipal Corporation Initiative

Ahmadabad Municipal Corporation (AMC) has taken some initiatives to reduce fuel consumption and carbon emissions. These include training drivers and private operators regarding proper usage of municipal buses, that is, no idling, no overloading, timely clutching and declutching, and no unwanted accelerating and limiting of driving speed. In addition, maintenance technicians have been trained in proper engine tuning, keeping the fuel compressor as required for proper and full combustion, and keeping tire pressure to the optimum standard. These steps have proved very effective in saving fuel and reducing carbon emissions. This has also reduced air pollution levels in Ahmadabad. AMC has also converted all its petrol-fuelled vehicles into CNG vehicles. Older vehicles which are Euro 1-compliant have been replaced with Euro 3- and Euro 4-compliant vehicles.

Source: Compiled from the presentation of Vijaya Mistry.

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