Paper II.2

BLACK CARBON AND ITS RELEVANCE FOR INDIA

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1. The science

Black Carbon (BC), a component of soot, is a potent climate-forcing agent. Black carbon can be found in Atmospheric Brown Clouds (ABCs) for which there are a number of hotspots around the world.[i]

The radiative forcing (RF) of BC was estimated by the IPCC at 0.44 +/- 0.25 Watts / sq. m[ii]. Following separate estimates by Hansen and Jacobson ranging from 0.64 to 1.05[iii], Ramanathan now estimates the RF of BC to be 0.9, some 55% of the RF of CO2,[iv] and with the snow/ice albedo effect the RF rises to 1.0-1.2[v].

One ABC hotspot relates to the Indo-Asian-Pacific plume. The impact of BC may equal that of CO2 on the Hindu Kush – Himalayan -Tibetan Plateau (HKHT) glaciers, where the temperature, according to one estimate, has risen 1 degree on the Tibetan side of the Himalayas, precipitating glacier melting[vi].

2. The benefits of reducing Black Carbon

There are a number of benefits to India associated with reducing BCs namely

a) Indian glaciers: it would help reduce the threat of floods and droughts that can be expected to ensue as a result of a major retreat / disappearance of the major Himalayan glaciers
b) Indian monsoon: it would help reduce the risk of a major reduction in the rainfall from the Indian monsoon. Rainfall over the northern half of India has decreased, and the number of rainy days for all India is also decreasing, although the frequency of intense rainfall is increasing, leading to more frequent floods. The heavily populated Indo-Gangetic Plain is especially vulnerable. Rainfall over the Indo-Gangetic Plain has decreased by about 20 per cent since the 1980s. With the onset of the monsoon, the reduced surface temperatures in the Bay of Bengal, Arabian Sea, and over India that extend to the Himalayas act to reduce monsoon rainfall over India itself, with some small increases over the Tibetan Plateau[vii]. ABC-induced dimming is considered as the major causal factor for the rainfall decrease in India.[viii]
c) Health benefits: reducing BC emissions provides strong co-benefits for public health, with the potential to save up to 400,000 lives a year that otherwise would be lost to air pollution (both indoor and outdoor)[ix], [x]. It also provides significant benefits to agriculture, reducing the harmful impact of BCs on plants, thereby improving crop fertility[xi].
d) Immediate effect: BC remains in the atmosphere for only a few days to weeks, whereas CO2 has an atmospheric lifetime of more than 100 years. Therefore action to reduce BC emissions can have an immediate beneficial effect.

3. Science contested

The Atmospheric Brown Cloud science was challenged in 2002 when the first UNEP paper was published.[xii] In November 2008, when the follow on paper focusing on Asia was published, there were echoes in the press of the original 2002 challenges, though no new evidence that the analysis is incorrect. The November report provided several examples of evidence of black carbon in the Tibetan glaciers.

Professor Ramanathan, the climate scientist in charge of the UNEP study, has pointed out that the report has authors from many Asian countries [including India, China, Korea, Japan, among others] and was reviewed by experts from China, India and other parts of the world.[xiii]

4. Action to address the uncertainty

In order to understand more about the causes and consequences of the retreat of the Tibetan glaciers, several research projects are being launched, including

a) To quantify Himalayan glacier melt by Atmospheric Brown Clouds by in-situ Black Carbon and snow albedo monitoring[xiv].
b) To study how India could adapt to significant reduction or total loss of the Himalayan glaciers (EU-India study)

These projects are highly relevant, each designed to determine a key aspect of the issue. The key question is whether to wait for the outcome of these studies before taking any action, or whether the case for action is sufficiently clear now to launch some early steps.

5. International actions being contemplated to reduce the drivers and risks associated with Black Carbon

A series of international steps to reduce BC drivers have been proposed by the Institute for Governance and Sustainable Development (IGSD) and the International Network for Environmental Compliance and Enforcement (INECE)[xv], including

a) An initial list of options at the international and regional levels
b) Other policy processes that can be used to address black carbon immediately, including
    i. Establishing a global funding source, similar to the Global Fund for HIV/AIDS, Tuberculosis and Malaria (GFATM), which would advocate for, and directly fund, initiatives that reduce BC emissions, by using grants, loans and/or matching funds incentives.
    ii. Encouraging bilateral efforts to reduce BC emissions, which could involve both government cooperation and public-private cooperation as under the Asia Pacific Partnership.
    iii. Using World Bank Climate Investment Fund to help reduce BC.
    iv. Emphasizing climate benefits and other synergies of reducing BC with the World Health Organization's efforts to reduce indoor air pollution and improve the health of women and children.
    v. Emphasizing importance of BC for achieving the MDGs.
    vi. Pursuing and accounting for the benefits of BC in the World Summit for Sustainable Development's (WSSD) efforts to provide access for the poor to clean energy resources."
c) Many countries have existing national laws that can be used to start regulating BC emissions, including laws that address particulate emissions. Some examples include:
    i. Banning or regulating slash-and-burn clearing of forests / savannahs;
    ii. Enforcing regulations limiting seasonal agricultural burning, especially during spring ice-melt;

iii. Requiring reductions in warming agents such as black carbon when emissions of cooling agents such as sulphates are reduced; otherwise air pollution reduction efforts can greatly exacerbate climate change;
iv. Requiring shore-based power/electrification of ships at port; regulating idling at terminals; mandating fuel standards for ships docking at port
v. Requiring regular vehicle emissions tests, retirement, or retrofitting (e.g., adding particulate traps), including penalties for failing to meet air quality emissions standards, and heightened penalties for on-the-road "super-emitting" vehicles;
vi. Limiting the use of chimneys and other forms of biomass burning in urban and non-urban areas;
vii. Requiring permits to operate industrial, power generating, and oil refining facilities and periodic permit renewal/ equipment modification;
viii. Requiring filtering technology and high-temperature combustion (e.g. super-critical coal) for existing power generation plants, and regulating annual emissions from power generation plants

Enforcement of these and related existing national laws, along with appropriate compliance assistance, would promote near term climate mitigation, as well as strong co-benefits. The International Network for Environmental Compliance and Enforcement recently issued a *Climate Compliance Alert on Black Carbon.*[xvi]

Further, there are a number of opportunities to support adaptation to black carbon-related impacts on Himalayan systems:

a) Coordination of scientific information on observed and anticipated impacts of glacier melting and monsoon changes, for example, through a regional knowledge base.
b) Support to Indian efforts to protect Himalayan ecosystems through anticipatory disaster risk reduction, water storage and flood control, land-use planning, and community-based livelihoods adaptation, as described in the National Action Plan on Climate Change's Mission 5: Sustaining the Himalayan Ecosystem

6. Reducing black carbon emissions in India

Recent studies suggest that a significant part of BC emissions in South Asia are caused by domestic cooking[xvii],[xviii],[xix]. A key way to reducing BC emissions in India therefore could be via the successful introduction of BC-free cooking; health and convenience will drive such a transition when affordable, reliable alternatives are available[xx]. This is not an easy field however and has been tried many times over recent decades with limited success. There is a current improved chulha programme within the Ministry of New and Renewable Energy (MNRE) and many separate programmes including the BP sponsored OORJA stove[xxi], using biomass pellets, and the ARTI programme sponsored by Shell[xxii].

To be completely clear as to the BC reduction benefits of switching to a BC-free cooking method, Project Surya[xxiii] has been designed with towers around the area where the switch is to be made so as to be able to measure the level of BC in the air when using the traditional biomass basis and when all cooking has been switched to BC-free methods. Following the 2009 pilot phase, Phase 1 is scheduled for 2010-12 and will involve 2 rural areas (15,000 each) costing $4 M (for two years) per rural area. The size of the population and the area will be large enough to measure and determine the impact of the intervention on the soot reductions and soot heating of the atmosphere and climate. On behalf of Surya, UNEP has submitted a proposal to European Council for $2.73 million.[xxiv]

An alternative approach, involving the promotion of pyrolysis and gasification stoves and the production of biochar is addressed in a separate paper.

If India were to take a systematic approach to the issue, a first step could be to prepare an analysis, at the district level, of the sources of energy used. This would need a validation process and sampling might be more reliable than any other method. Based on this analysis, a plan could be prepared focussing on the priority areas and gradually seeking to address the whole country. A private approach could be used if the cost were low enough. An entirely public approach could be adopted but would be expensive and could prove less effective than a Public/Private partnership approach.

The balance of 20-30% of emissions is via transport and other more industrial processes. The replacement of diesel with cleaner solutions, and introducing / transferring technology for reducing soot emissions from coal combustion in small industries could have major impacts on the radiative forcing due to BC. India has shown the way with the example of the switch of New Delhi busses to CNG[xxv]. Are the other technologies that have been applied in Europe that could be transferred to support this conversion? Similarly is there experience relating to standards for vehicles, experience with clean air legislation, laws and implementation, research, clean fuels that could be transferred?

7. A way forward?

As a first step the EU needs to support Phase 1 of the Surya project, to help measure the effectiveness of reduction measures, and provide a firm base for any subsequent action.

India might consider developing a comprehensive plan to communicate the problem of Black Carbon and an action plan to radically reduce emissions.

There is significant scope for the EU to provide assistance both in relation to a cook stove replacement programme and a range of other measures relating more to transportation and industry.

As the issue of the melting of the HKHT glaciers affects many countries in the region, India might consider calling a meeting of the countries impacted by glacial melt (the Asian Rivers Group), perhaps in partnership with ICIMOD, to address whether there is any concerted action that the countries might wish to take to reduce the risk of serious drought and flooding.

There is also significant scope for the EU to support Indian initiatives to strengthen and share scientific information on melting Himalayan glaciers and changing monsoons, and to implement adaptation measures to sustain Himalayan systems and their communities.

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[i] UNEP Atmospheric brown clouds - Regional assessment report with focus on Asia SUMMARY, Nairobi 2008

[ii] IPCC, *Changes in Atmospheric Constituents and in Radiative Forcing*, in CLIMATE CHANGE 2007: THE PHYSICAL SCIENCE BASIS. CONTRIBUTION OF WORKING GROUP I TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 129, 132 (2007), *available at* http://www.ipcc.ch/ipccreports/ar4-wg1.htm. (Magnitudes and uncertainties added together, as per standard uncertainty rules).

[iii] Zaelke, D, Reducing Black Carbon May Be the Fastest Strategy for Slowing Climate Change IGSD/INECE Climate Briefing Note, December 2008, p 9

[iv] Zaelke, D, Supra note iii, p 2

[v] Zaelke, D, Supra note iii, p 9

[vi] Ramanathan, V. and Carmichael, G, *Global and regional climate changes due to black carbon*, 1 NATURE GEOSCIENCE 221-22 (23 March 2008)

[vii] Meehl, G. et al *Effects of Black Carbon Aerosols on the Indian Monsoon*, J. Climate (accepted).

[viii] UNEP supra note i
[ix] Smith, K. *National burden of disease in India from indoor air pollution*. Proc. Natl Acad. Sci. USA 97, 13286–13293 (2005).
[x] Sridharan, P. V. & Pachauri, R. K. *Looking Back to Think Ahead: Green India 2047 New Delhi* (Tata Energy Research Institute, 1998).
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[xiii] MINT, 24/11/08
[xiv] http://www-ramanathan.ucsd.edu/Project%20Surya/Himalayan-glacier-melt-proposal.pdf
[xv] Zaelke, D. Supra note iii
[xvi] http://inece.org/climate/INECEClimateComplianceAlert_BlackCarbon.pdf
[xvii] Ramanathan, R. and Carmichael, G. supra note vi
[xviii] Reddy, M. & Venkataraman, C. Atmos. Environ. 36, 677 (2002) in Gustafsson, O. *Brown Clouds over South Asia: Biomass or Fossil Fuel Combustion?* Science 323,495 (2009)
[xix] Reddy, M. & Venkataraman, C.: Supra note xviii, 699.
[xx] Jacobson, M. Testimony for the Hearing on Black Carbon and Climate Change, U.S. House Committee on Oversight and Government Reform 12 (18 October 2007), *available at* http://oversight.house.gov/documents/20071018110606.pdf
[xxi] http://www.livemint.com/2007/07/03141551/Smokeless-biomass-stoves-launc.html
[xxii] http://www.arti-india.org/content/view/44/42/
[xxiii] Ramanathan, V., & Balakrishnan, K. *Project Surya, Reduction of Air Pollution and Global Warming by Cooking with Renewable sources* Scripps Institution of Oceanography University of California, San Diego, Sri Ramachandra Medical College and Research Institute, Chennai, India
[xxiv] http://www-ramanathan.ucsd.edu/Project%20Surya/Himalayan-glacier-melt-proposal.pdf
[xxv] Reynolds, C. & Kandlikar, M. *Climate Impacts of Air Quality Policy: Switching to a Natural Gas-Fueled Public Transportation System in New Delhi*, ENVIRON. SCI. TECHNOL. (forthcoming 2008)