ONE ATMOSPHERE Regional Cooperation to Address Air Pollution & Climate Change in South Asia

State Annual Province and a second second

Arnico K. Panday Senior Atmospheric Scientist & Programme Manager *ad interim*, Atmosphere International Centre for Integrated Mountain Development (ICIMOD) Kathmandu, Nepal

10th South Asia Economic Summit, Kathmandu, Nepal, 15 Nov. 2017

FOR MOUNTAINS AND PEOPLE

Contents

State And And Annual Person communication and a second second second second second second second second second

1. The changing atmosphere: Drivers and consequences

- 2. Co-Benefits, not trade-offs
- 3. The need for regional cooperation
- 4. The role of ICIMOD

Contents

Station and Announcement and a second state of the second state of the second state of the second state of the

1. The changing atmosphere: Drivers and consequences

- 2. Co-Benefits, not trade-offs
- 3. The need for regional cooperation
- 4. The role of ICIMOD

Global average temperatures have been increasing



The fastest rate of increase has been at the poles and the high Himalaya & Tibetan Plateau.



The biggest driver of global climate change is carbon dioxide (CO_2) . Now at its highest levels in 800,000 years.



- CO₂ once emitted into the atmosphere remains there for a century or more. It is "long lived"
 - It is well mixed around the earth.
 - Where it is emitted does not affect its impact.
- "Short-lived climate pollutants" include methane, ozone and black carbon.
 - Black carbon has an atmospheric life time of a few days to a few weeks before it is washed out by rain.
 - Highest impact near source.

Black Carbon (BC)

ICIMOD

- Dark particles in the atmosphere, emitted during incomplete combustion
- Impacts on:
 - Respiratory health (carcinogen!)
 - Climate
 - Visibility

SECOND BIGGEST IMPACT ON CLIMATE AFTER CO₂

South Asia: One of the world's biggest BC source regions

The Hindukush Himalaya: Biggest storage of frozen water outside Arctic & Antarctic.



1.3 billion people live downstream

www.icimod.org

The Himalaya are changing!





CO₂, BC and dust all contribute to melt Himalayan snow and ice



Photo: Fritz Berger (ICIMOD archive)

Photo: A. Panday

Still investigating what fraction of the melting is due to:

- Greenhouse gas induced warming
- Black carbon warming the air
- Black carbon deposition onto white surfaces
- Changes in precipitation due to aerosol effects

Rising Sea levels

• If all the polar ice melts, sea levels will rise 70 meters

ICIMOD



Climate change also affects the monsoon => food security

Photo © Arnico Panday, ICIMOD

Not just CO₂ induced warming, but also smoke particles affect the monsoon

Microphysical processes => Regional scale impacts on Precipitation timing and location

ICIMOD

Around half of South Asia's black carbon is from cooking



Indoor air pollution





Poor ventilation leads to very high pollution levels.

From cooking with firewood or animal dung



Health effects of indoor air



Exposure to the smoke from a day's cooking



(Warwick et. al, 2004)

ICIMOD

(courtesy Dr. Arjun Karki)



Photo © Jitendra, ICIMOD

Photo © Arnico, ICIMOD





ICIMOD



Photos © Arnico Panday, ICIMOD (top left & bottom & DoEnv (top middle and top right)







Forest fires

How many small agricultural residue fires are there daily?



ICIMOD

A clean air filter



The same filter, after 24 hours of having a pump pull Kathmandu Valley air through it



This is what we are breathing!

Courtesy: Jin-Soo Park, NIER. Filter sample collected at Bode, north of Thimi in January 2013

New Delhi

Photo © Arnico Panday, ICIMOD



Haze from the plains often penetrates deep into Himalayan valleys



Not all of Kathmandu's pollution is local!

ICIMOD

Photo © Arnico Panday, ICIMOD

ICIMOD



View from Hattiban Resort, on 28 February 2013 (L) and 2 March 2013 (R)

Regional haze

Photos © Arnico Panday, ICIMOD





ICIMOD



Realization: Air pollution is a problem in Nepal beyond the cities!

180 -Ratnapark (PM2.5) Lumbini (PM2.5) -Chitwan (PM2.5) 160 140 micrograms per cubic meter 120 100 80 60 40 Nepal WHO 20 0 10/27/2016 10/20/2016 11/17/2016 11/3/2016 1/5/2017 |/19/2017 2/2/2017 8/18/2016 8/25/2016 9/1/2016 9/8/2016 9/15/2016 9/22/2016 10/6/2016 0/13/2016 11/10/2016 .1/24/2016 12/1/2016 12/8/2016 2/15/2016 2/22/2016 1/26/2017 9/29/2016 12/29/2016 1/12/2017 2/9/2017 2/16/2017

ICIMOD

• During the dry season Lumbini is often MORE polluted than Kathmandu & Chitwan.

• PM2.5 values are FAR above WHO's and even Nepal's more lenient standards.

Model results: where does the pollution in Lumbini, Nepal, come from?

Model simulation for April-May-June 2013



ICIMOD

Winter fog over the Indo-Gangetic Plains

- Past 2 decades have had much more winter fog across Indo-Gangetic Plains than before.
- Covers large area, often lasts many days.
- Affects lives of several hundred million people, esp. poorest.
- No scientific consensus yet on roles played by pollution (CCN) versus changing moisture availability (winter irrigation).



ICIMOD









Contents

State and a second of the second s

- 1. The changing atmosphere: Drivers and consequences
- 2. Co-Benefits, not trade-offs
- 3. The need for regional cooperation
- 4. The role of ICIMOD

Cleaner brick kilns

ICIMOD

- Nepal earthquake provided opportunity for cleaner reconstruction of broken kilns.
- Seed funding, design manuals; Kiln owners invested own funds.
- By now all of Kathmandu Valley's kilns converted to zigzag firing with improved insulation.
- Significant reductions in coal use & emissions, while producing better bricks.
- Design spreading elsewhere in Nepal and to Pakistan.







Conversion from kilns with straight-line firing to zig-zag



Co-Benefits, not tradeoffs

Improved brick kilns:

Reduced coal consumption
Reduced CO₂ emissions (climate benefit)
Reduced operating cost to owner (economic benefit)
Reduced emission of fine particles
Reduced air pollution (environment benefit)
Reduced black carbon emissions (climate benefit)
Improved worker conditions (health benefits)

|C|N

Switching to clean cooking:

- Better health for women and children (health and economic benefits)
- Environment and climate benefits

Mitigating CO₂ & SLCPs



Image © Drew Shindell, CCAC Scientific Advisory Committee

ICIMOD

Pathways to 1.5 degrees

ICIMOD



Image © Drew Shindell, CCAC Scientific Advisory Committee

Contents

State and a second state and the state of th

- 1. The changing atmosphere: Drivers and consequences
- 2. Co-Benefits, not trade-offs
- 3. The need for regional cooperation
- 4. The role of ICIMOD

ICIMOD

Mitigating air pollution and climate change in our region requires evidence-based policymaking:

- That takes into account the complex science processes at multiple scales
- That takes a regional perspective

Requires collaboration and data sharing by scientists across the region, leading to scientific consensus.

Nov 27-30: Workshop and Science-Policy Dialogue on air pollution, climate and health at ICIMOD.

Contents

State and a second of the second s

1. The changing atmosphere: Drivers and consequences

- 2. Co-Benefits, not trade-offs
- 3. The need for regional cooperation
- 4. The role of ICIMOD

ICIMOD International Centre for Integrated Mountain Development

<u>Mission</u>:

To enable sustainable and resilient mountain development for improved and equitable livelihoods through knowledge and regional cooperation



Intergovernmental organization

<u>8 member</u> <u>countries:</u> Afghanistan Bangladesh Bhutan China India Myanmar Nepal Pakistan

ICIMOD'S role: Linking Science-Policy-Practice



- A. Improving knowledge about **emissions:** inventories, socioeconomic drivers.
- **B. Atmospheric processes and change:** Observatories, field campaigns, modeling.
- **C. Quantifying impacts**: On climate, cryosphere, water resources, agriculture, tourism, livelihoods, health.
- D. Assessing mitigation options relevant to the region.
- E. Capacity building: Supporting PhD students, hosting short courses.
- F. Outreach and network building.
- **G.** Policy recommendations at national, regional and global levels.



Air quality monitoring stations







Ratnapark



Lumbini



Dhulikhel



Chitwan



Thimphu



Pasakha



Climate & Clean Air Coalition

ICIMOD

Bangladesh, Maldives & Pakistan are members

The atmosphere in South Asia is more integrated than probably any other entity.

Air pollutants and climate forcers cross local and national and state boundaries, go in and out of people's homes and lungs.

Impacts of climate change and air pollution are interconnected.

So are the solutions.

Thank you

ICIMOD















Department for International Development

What are the main pollutants? Particulate Matter (PM)

 $PM_{2.5}$ = Fine Particulate Matter (mostly smoke & secondary particles) PM_{10} = Respirable Particulate Matter (also contains a lot of dust)



ICIMOD

ICIMOD

The biggest driver of global climate change is carbon dioxide (CO_{2})



What are the main pollutants? **Ozone**

ICIMOD



- Essential in upper atmosphere to keep UV out.
- Lower atmosphere: GHG and toxic pollutant.
- Not emitted, but formed in atmosphere through photochemical reactions involving hydrocarbons and nitrogen oxides.



Figure 1. The effect of air filtration on Pakistan wheat variety Chak-86 during the 1992-1993 growing season close to Lahore, Pakistan. The plant on the left has been grown under conditions where O_3 has been filtered from the air, the plant on the right under the ambient O_3 concentrations present at the location. (Courtesy of Prof. Abdul Wahid)



Figure 5. Projected changes in annual surface O₃ assuming enforcement of current emission control legislation between 2000 and 2030. (Adapted fram Dentener and others, 2006).

But MODIS still gives a sense of the extent of the fires and smoke

