



## Atmospheric Brown Cloud (ABC) Programme

**Achievements and Future Vision**

**7<sup>th</sup> Regional Stakeholders cum Coordination Meeting**  
18-19 May 2013  
Dhaka, Bangladesh

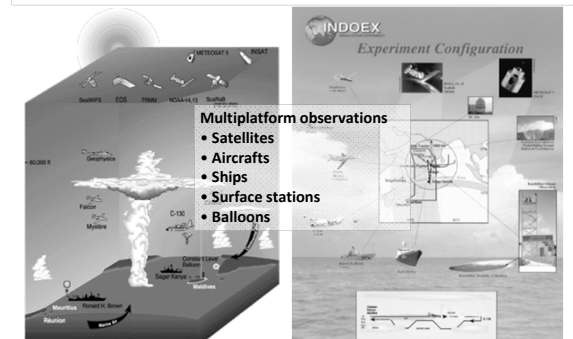
**ABC Secretariats**

<http://www.rrcap.ait.asia/abc/>

### Outline

- Background
- Achievements
- Ongoing activities
  - Observation and capacity
  - Impact assessment
  - Mitigation
    - ✓ Project Surya
    - ✓ ABC precursor emission inventory of Nepal
- Future plan
  - ✓ National mitigation programme

### Indian Ocean Experiment (INDOEX, 1999) - an inception of ABC Programme



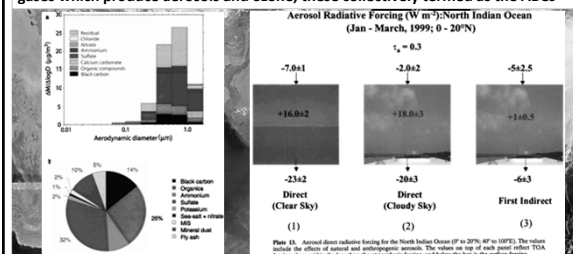
**Multiplatform observations**

- Satellites
- Aircrafts
- Ships
- Surface stations
- Balloons

Ramanathan et al, 2001, JGR

### Atmospheric Brown Clouds (ABCs) over South Asia

Widespread layers of brownish haze of regional scale plumes of air pollutants, consisting of mainly the aerosol particles (such as black carbon) and precursor gases which produce aerosols and ozone, these collectively termed as the ABCs



**10-20 % reduction in the solar radiation reaching to earth resulting the significant heating of the atmosphere**

Ramanathan et al, 2001, JGR

### Atmospheric Brown Cloud (ABC) Programme

Following the INDOEX results, UNEP the commissioned the ABC Programme in 2001:

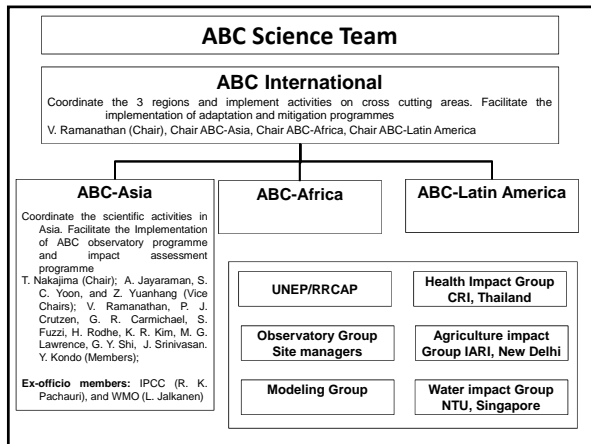
- To further investigate the impacts of ABCs on climate, precipitation, agriculture, and health.
- To equip the policy makers with science-based information for reducing the emissions of ABCs to tackle climate issues.

**Objectives**

- **Observations:** Establishment of a network of ground based observatories equipped with advanced measured facilities across the Asia-Pacific for data collection.
- **Impact assessment:** Assessment of the impacts of ABCs on climate, agriculture, water, and health using the observed data and models.
- **Awareness and mitigation:** Provide science-based information to policy makers for the reduction of emissions of ABCs.

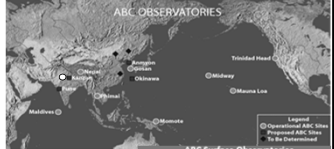
### ABC Programme

ABC-Asia	ABC-Africa	ABC-Latin America
<ul style="list-style-type: none"> <li>• Observatories</li> <li>• Impact Assessment</li> <li>• Mitigation</li> <li>• Knowledge Management</li> <li>• Awareness and Consensus on Policies</li> </ul>	<p>Whitepaper containing detail plan drafted</p> <ul style="list-style-type: none"> <li>• Identified potential observation sites.</li> <li>• Mitigation programme started</li> </ul>	<p>Whitepaper containing detail plan drafted</p>
<ul style="list-style-type: none"> <li>• ABC Steering Committee</li> <li>• ABC-International Science Team</li> <li>• ABC-Asia Science Team</li> <li>• ABC-Africa Science Team (yet to form)</li> <li>• ABC-Latin America (yet to form)</li> </ul>		



### ABC Programme (Phase I & II)


- Observation:** Established a network of ground based 12 (or more) observatories with state-of-the-art facilities for measurements aerosols and trace gases. About 250 scientists are working for the ABC Programme.
- Impact assessment:** Carryout Intensive Modeling Analysis (AMI) using 12 different models to assess the potential impacts of ABCs on agriculture, water, and health using the data from the monitoring stations.
- Awareness and response measures:** Commissioned Project Surya to study and mitigate ABC emissions from biofuel.



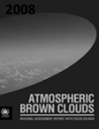
**ABC Surface Observatories**

- China Observatories (4 observatories to be affiliated to project ABC)
- Indian Climate Observatory - Pune
- Japan Climate Observatory - Okinawa
- Korea Climate Observatory - Gosan
- Argentinian Climate Observatory-Central Asia
- Moldavia Climate Observatory - Haimanadino
- Norwegian Climate Observatory - Gass
- Nepal Climate Observatory - Godavari
- Nepal Climate Observatory - Pyralam
- Thailand Climate Observatory - Phitsanulok
- Thailand Climate Observatory - Phitsanulok
- Observatory - Karakorum
- Observatory - Monobh
- Observatory - Midway
- Observatory - Mauna Loa


**Aerosol properties**  
**Precipitation chemistry**  
**Gaseous species**  
**Solar radiation**  
**Meteorological parameters**



2002

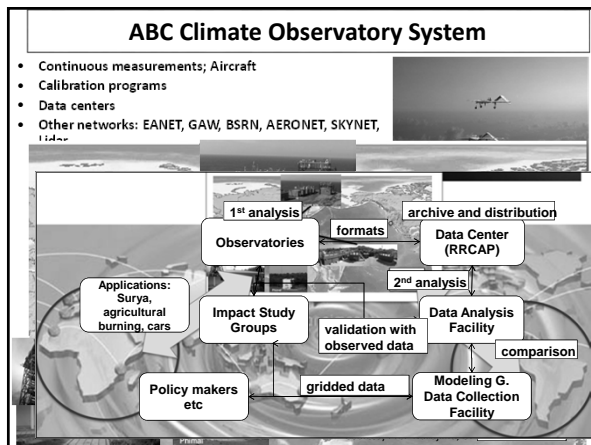


2008

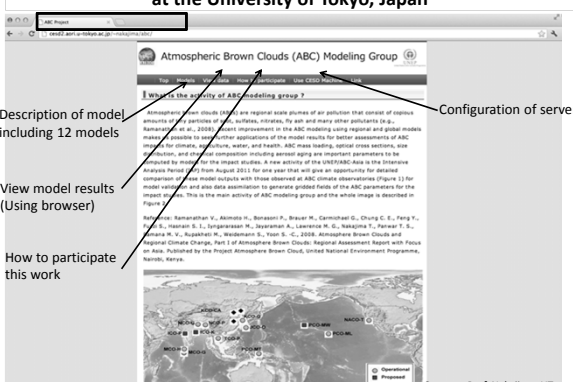


2013 (to be print)

About 180 scientific articles



### Building web system for ABC modeling group at the University of Tokyo, Japan

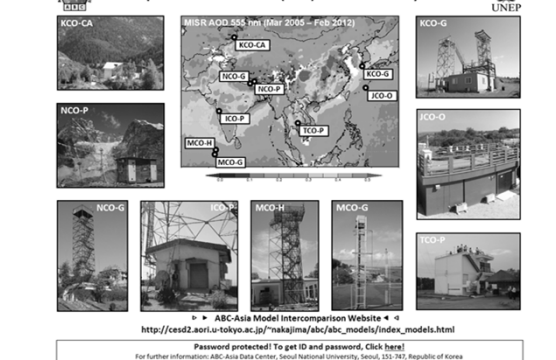


Annotations on the screenshot:

- Description of model including 12 models:** Points to the 'What is the activity of ABC modeling group?' section.
- View model results (Using browser):** Points to the 'Atmospheric Brown Clouds (ABC) Modeling Group' header.
- Configuration of server:** Points to the 'How to participate this work' section.

Courtesy Prof. Nakajima, UT

### Atmospheric Brown Clouds (ABC)-Asia Data Analysis Center



UNEP

MISR AOD 555 nm (Mar 2005 - Feb 2012)

ABC-Asia Model Intercomparison Website

[http://cesz2.aori.u-tokyo.ac.jp/~nakajima/abc\\_models/index\\_models.html](http://cesz2.aori.u-tokyo.ac.jp/~nakajima/abc_models/index_models.html)

Password protected! To get ID and password, click here!

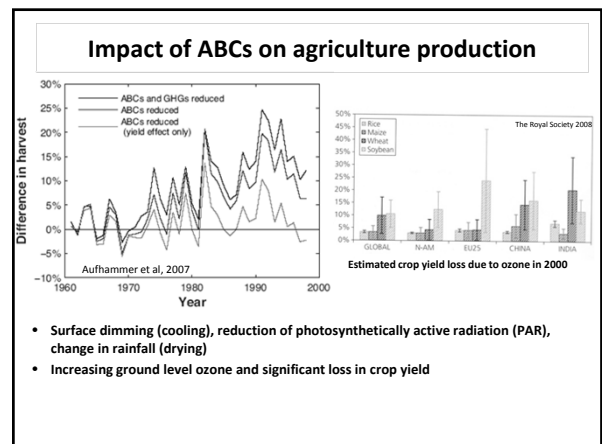
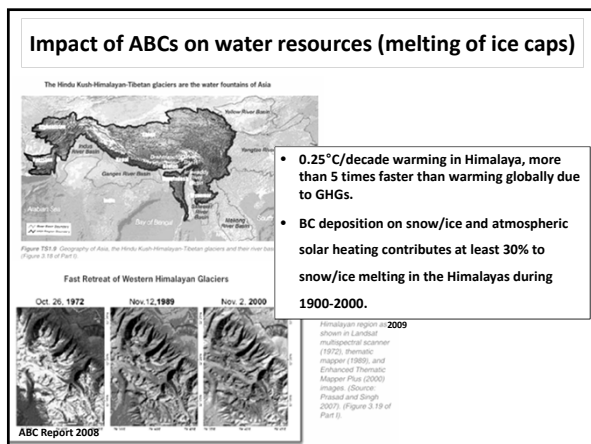
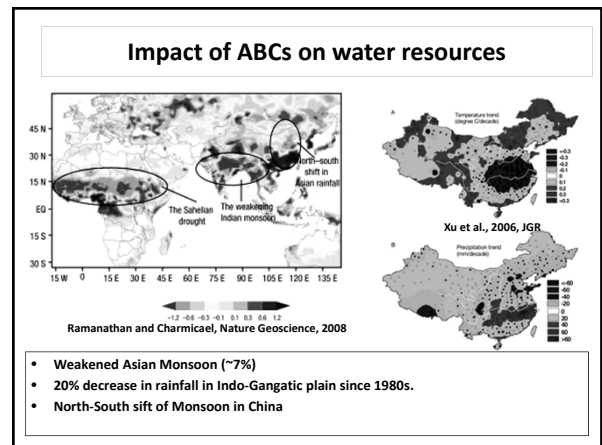
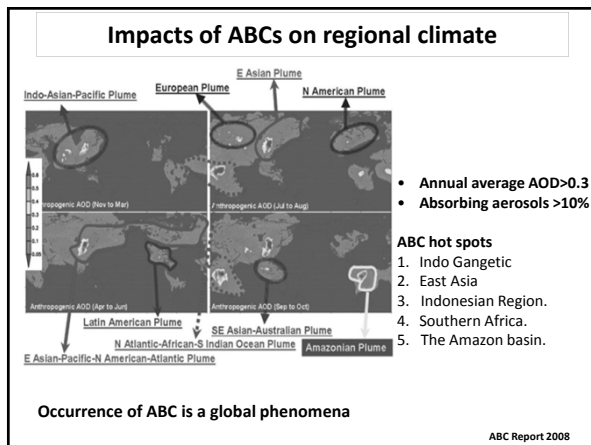
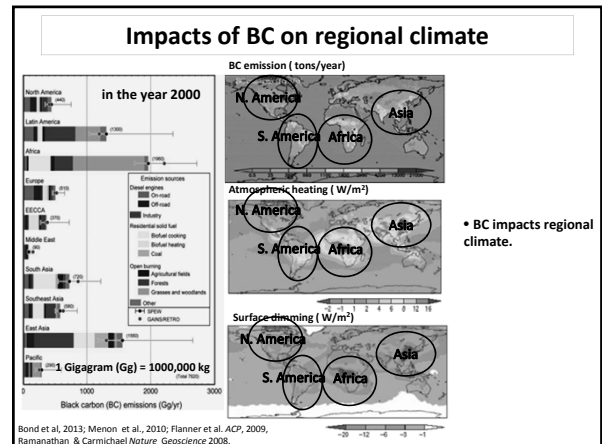
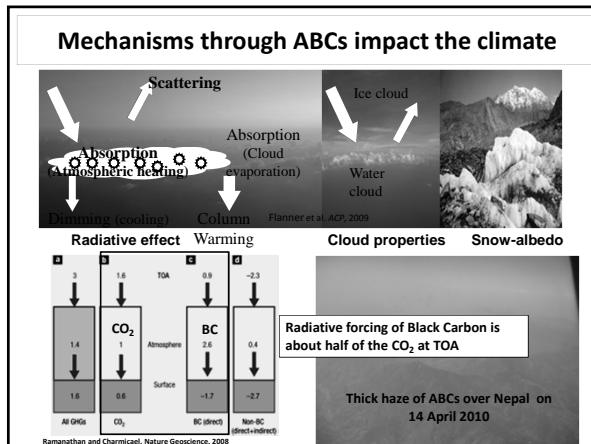
For further information, ABC-Asia Data Center, Seoul National University, Seoul, 151-747, Republic of Korea  
Email: tangwook@snu.ac.kr

**Seoul National University, Korea (<http://aerosol.snu.ac.kr/>)**

### 12 registered models to ABC modeling activity

- Global models (5)**
  - SPRINTARS (T. Nakajima and D. Goto, University of Tokyo and National Institute for Environmental Studies, Japan)
  - GEOS-Chem (R. J. Park, Seoul National University, Korea)
  - BCC\_AGCM2.0.1 (H. Zhang and Z. Wang, National Climate Center of China Meteorological Administration, China)
  - EMAC (M. G. Lawrence, Institute for Advanced Sustainability Studies, German)
  - MATCH (M. G. Lawrence, Institute for Advanced Sustainability Studies, German)
- Regional models (5)**
  - CMAQ (C. H. Song, Gwangju Institute of Science and Technology, Korea)
  - STEM (G. R. Carmichael, Iowa University, US)
  - WRF-Chem (S.-C. Yoon, Seoul National University, Korea)
  - EMTACS (M. Kajino, Meteorological Research Institute, Japan)
  - CMAQ (F. Meng, Chinese Research Academy of Environmental Sciences, China)
- Radiative transfer model (2)**
  - MACR: (C. E. Chung, Gwangju Institute of Science and Technology, Korea)
  - FGOALS2\_s (J. Li and Q. Bao, Institute of Atmospheric Physics, Chinese Academy of Sciences, China)

ABC modeling group



### Impact of ABCs on health

**PM Inhalation**

- Lungs**
  - Inflammation
  - Accelerated progression and exacerbation of COPD
  - Increased respiratory symptoms
  - Altered pulmonary surface
  - Reduced lung function
- Heart**
  - Altered cardiac autonomic function
  - Increased diastolic reactivity
  - Altered cardiac repolarization
  - Increased myocardial ischemia
- Blood**
  - Altered rheology
  - Increased coagulability
  - Translocated particles
  - Proinflammatory thrombus
  - Reduced oxygen saturation
- Systemic Inflammation**
  - Increased CRP
- Oxidative Stress**
  - Proinflammatory mediators
  - Endothelial & platelet activation
- Vasculature**
  - Atherosclerosis, accelerated progression of and exacerbation of peripheral vascular disease
  - Endothelial dysfunction
  - Vasoconstriction and hypertension
- Brain**
  - Increased neurovascular ischemia

Excess deaths per million

Source	Developing countries	Developed countries
Urban outdoor air pollution	~100	~10
Indoor smoke from solid fuels	~300	~0

Gieshop et al, 2009

Pope and Dockery 2006

- ABC exposure is likely associated with significant health effects, for example, about 400,000 to 500,000 deaths a year in India and China each in indoor and outdoor exposure.
- PM<sub>2.5</sub> with BC in it is more toxic compared to without BC (smith et al., 2008)

### Estimated benefits of BC and CH<sub>4</sub> reduction

**Climate change**

Global mean avoided warming in 2050 (°C)

**Human health**

Annually avoided premature deaths (millions)

**Food security**

Annually avoided crop yield losses (total maize, rice, soybean and wheat, millions tonnes)

- If identified measures implemented by 2030, it may reduce global warming by 0.5°C in 2050 half the warming projected and would improve the chance of not exceeding 2°C target, if CO<sub>2</sub> is also aggressively addressed with SLCPs.
- Substantial regional climate benefits, e.g. temperature reduction in Arctic and Himalayas
- Substantial health and crop benefits - avoid 2.4 million premature deaths, mainly in developing countries and loss of 52 million tonnes of maize, rice, wheat and soybean each year

UNEP/WMO (2011)

Benefits from BC the mitigation in 2030 compared to reference scenario.

### Reduction of ABCs from biofuels (Project Surya)

**Biofuels**

Rural Cooking

Gas 15%, Coal 10%, Biomass 10%, Charcoal 5%, Fire wood 55%

a) Baseline BC AOD for 2004/05

b) BC AOD without biofuels

Biogas plants converts organic waste into gas

Parabolic solar cooker

Ramanathan and Balakrishnan, 2007, Ramanathan and Carmichael, 2008

### Mitigation of ABCs through improved technology

India: Indo-Gangetic region

Project Surya: Pilot study within the ABC Programme on BC emissions from biofuels

Traditional mud stove

Combustion improved cook stove

Reported 40% reduction in BC concentrations

Stove 16.6 (µg.m<sup>-3</sup>)

Indoor mean mud stove 27.7 (µg.m<sup>-3</sup>)

BC concentration (µg m<sup>-3</sup>)

Local Time, Hour

Project Surya Report 2010

Hours

### New Pilot: Would Financial Rewards improve Adaptation?

project surya

Surya Carbon Credit Pilot Project (C2P2)

**Comprehensive Rules System**

- Baseline Emissions scenarios
- Establish GHG Crediting factors including for BC
- Program eligibility guidelines
- Monitoring & verification procedures- Wireless devices
- Aggregation procedures.

**Project Approval**

Project Surya approval in existing carbon market program (CDM, VCS, private transactions)

**Project Monitoring & Verification**

(using mobile wireless technology)

Project Surya Carbon Credit Issuance and Registration

Electronic Trading Platform

Project Surya Electronic Carbon Market Registry

Figure 1. Field temperature trace of cooking monitored by the Stove Monitoring System. Gray bars indicate estimated cooking time.

Slide from Prof. Ramanathan's Presentation (ABC Meeting)

### Emission Inventory of ABC Precursors of Nepal

Prepared by Prof. Ram M. Shrestha

Combustion in Energy Sector

Fugitive Emissions from Fuel

Emissions in Manufacturing Industries (process)

Crop Residue Open Burning

Forest Fires

Solid Waste Open Burning

Others

Activity Data (A)

Emission Factors (FF)

Total Emissions (E)

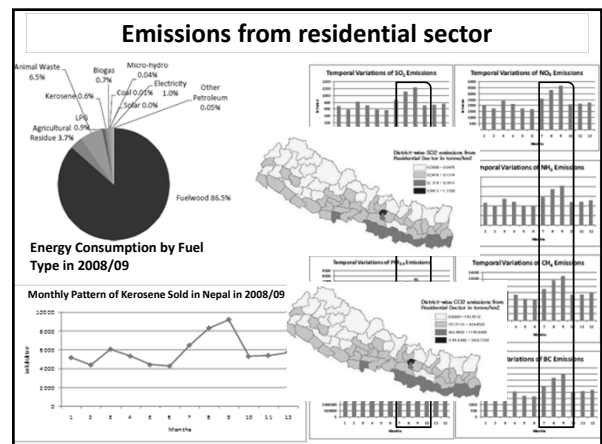
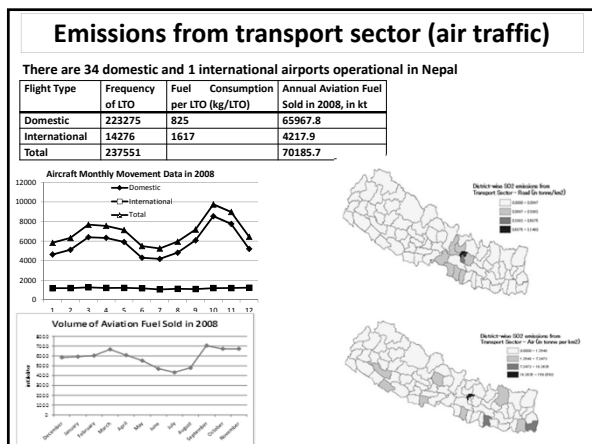
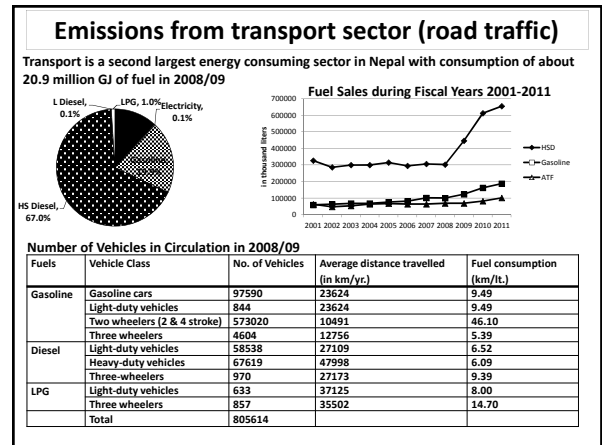
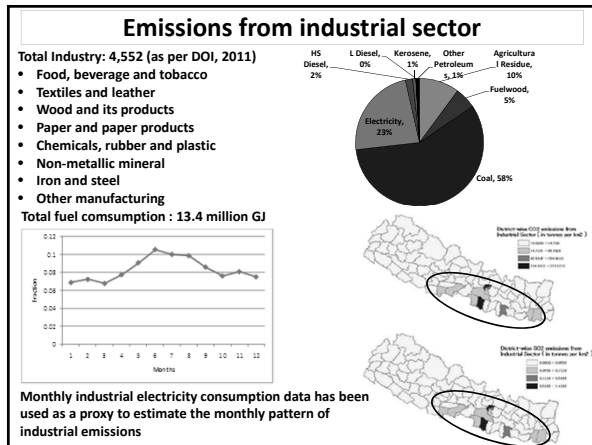
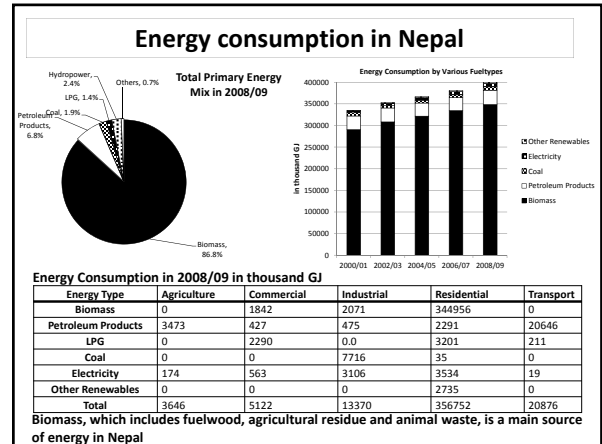
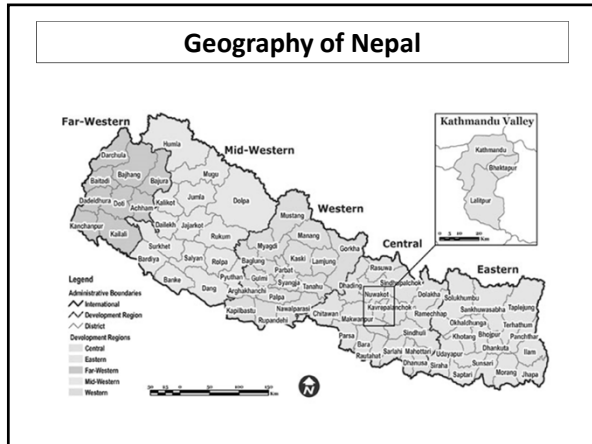
$E = A \times FF$

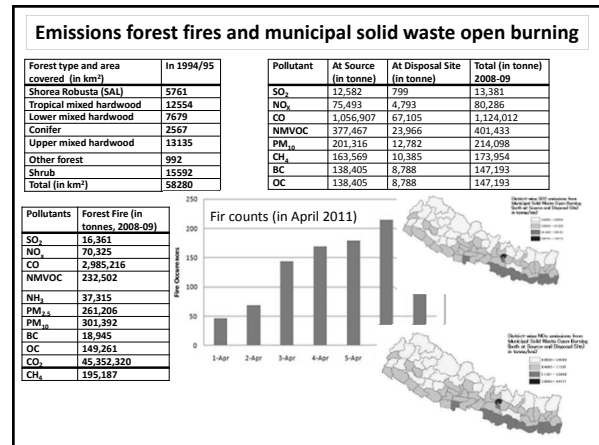
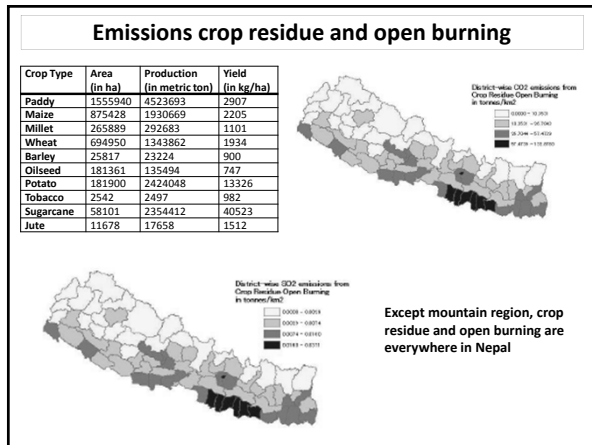
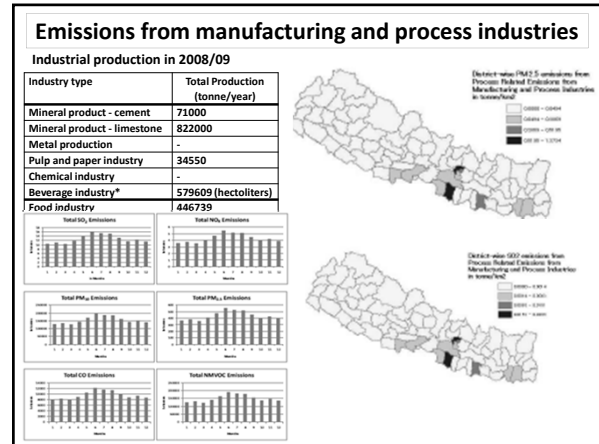
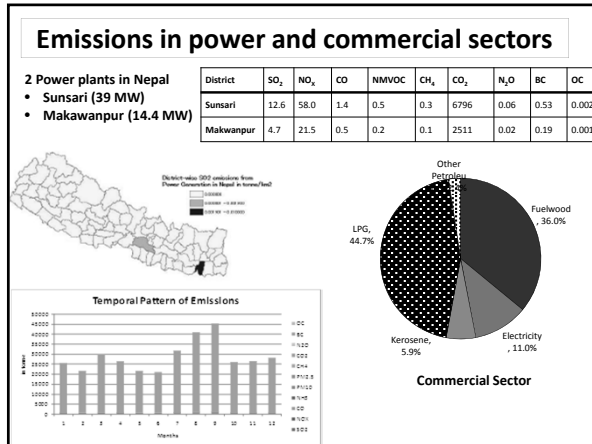
Proxy Factor

Temporal variation of Emissions

Spatial variation of Emissions

Overall Framework of Emission Inventory in Nepal





### Summary of Emissions (in Tonnes) in 2008-09

Pollute	Energy		Manufacturing/Con		Transport		Residential		Commercial		Agriculture		Fug		Process		Crop Res. BB		Forest Fire		Municipal	
	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II
SO <sub>2</sub>	17.2	31.0	5934	13940	183376	185236	5964	13120	16	16					152	837	480	10361	13391			
NO <sub>x</sub>	79.4	79.4	3798	830	40494	31020	27795	14925	236	154	300	300			52	4102	2470	70225	80286			
CO	1.9	1.9	9217	7212	262041	100008	167904	2513200	7954	15293	34	34			113328	230515	129701	2985216	1124012			
NMVOOC	0.6	0.6	346	543	59336	19417	-	-	-	-	11	11	270	1806118	12359	12359	232502	401433				
NH <sub>3</sub>	-	-	0.2	0.1	-	3787	15561	15561	542	542							5862	5382	37915			
PM <sub>10</sub>	1.0	1.0	23540	23419	3787	3787	90725	140221	434	578	12	12	46	1864579	13291	7517	261206	214098				
PM <sub>2.5</sub>	0.7	0.7	29469	23582	3770	-	58081	94061	197	197	16	16	24	1257	12991	7169	301392					
CH <sub>4</sub>	0.4	0.4	206	141	2191	512	98140	200190	563	1098					13558	12516	191187	173954				
CO <sub>2</sub>	9307	9307	1568135	880124	332873	332873	3020729	31409183	134052	344826							2929213	2856217	45352320			
N <sub>2</sub> O	0.1	0.1	30	20	52	52	1313	1827	8	12												
BC	0.7	1.0	661	30	2185	4792	26848	7728	371	53			13	10			1390	1132	18945	147193		
OC	0.203	0.8	582	186	7234	8656	65594	138211	191	800	14	14	7				6787	3986	148261	147193		

Forest fires and open biomass burning of municipal solid waste needs attention

### Emission estimates for Nepal: key points

- Emissions of ABC precursors are estimated for Nepal in 11 sectors for 12 pollutants.
- Biomass is a main source of energy in Nepal.
- Most of the emissions sources are located in plain (also called, Terai) region.
- Emissions from industrial sector are estimated higher in Jun-Jul-Aug, while Aug-Sept from residential sector.

