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IIAS tool for air quality management

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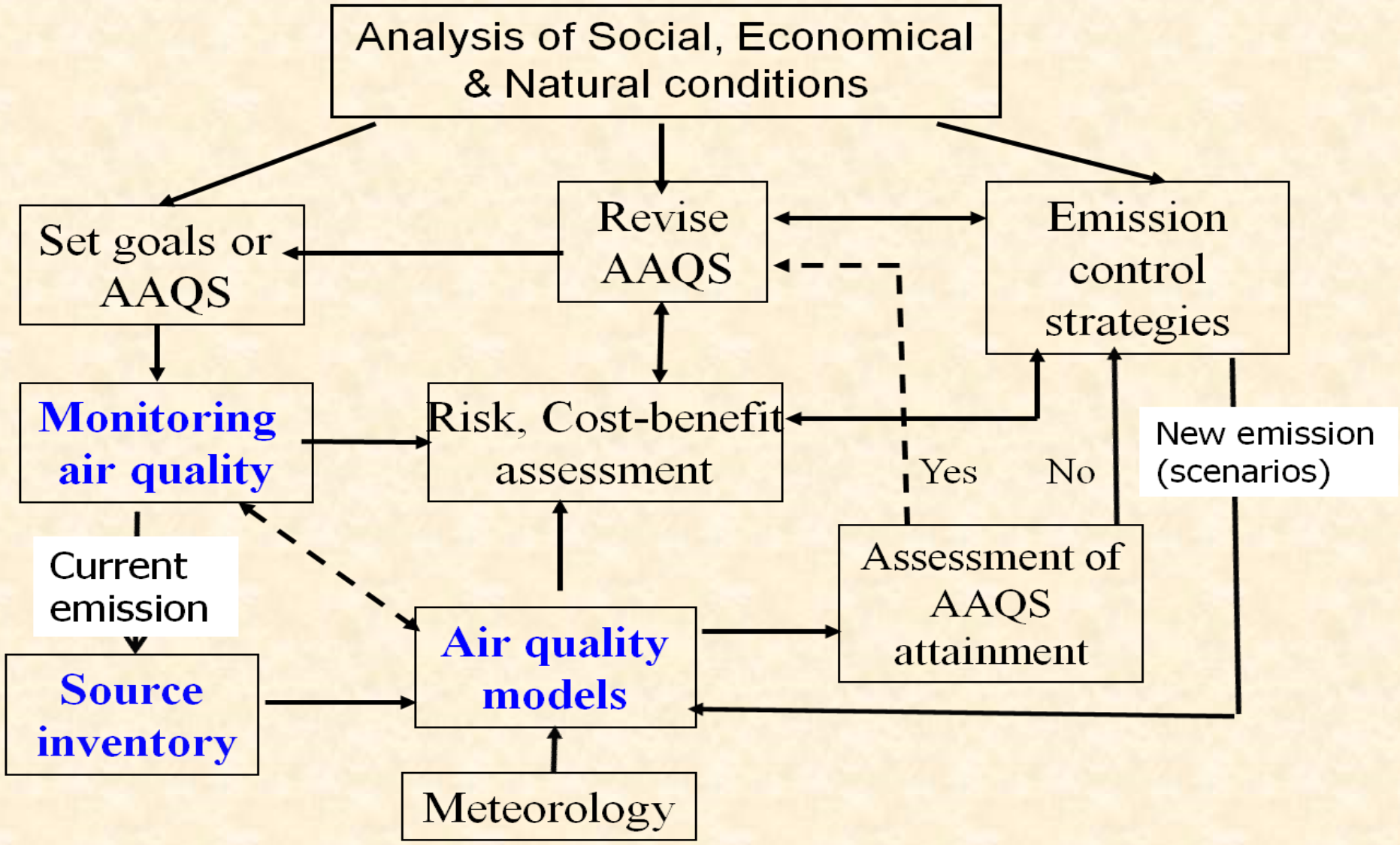
Presentation highlights

- Integrated Air quality Management
- IIAS
  - Current status
  - Model application: demonstration
- Ways forward

Integrated AQM



Kim Oanh, 2012

Compiling Emission Inventory

Biomass Open Burning

Point Sources

Area Sources

Non-Road Mobile Sources

On Road Mobile Sources

Inventory

Top-down approach

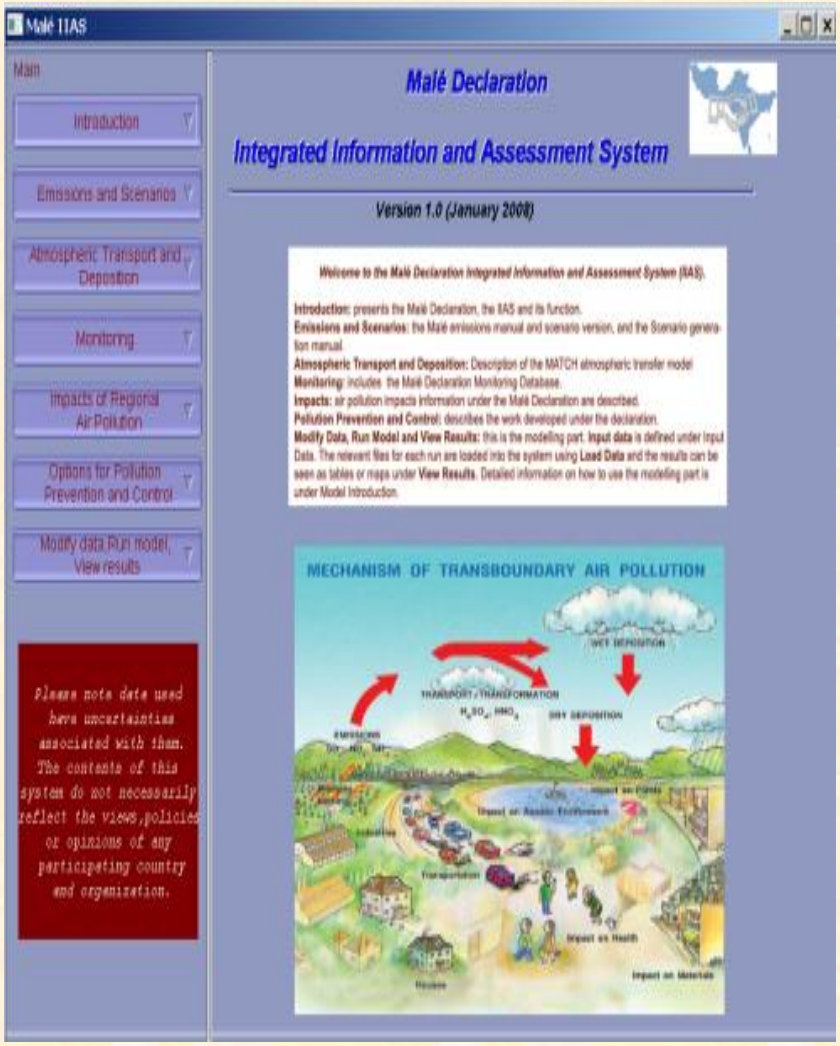
Bottom-up approach

Emission Inventory - a comprehensive listing by sources of air pollutant emissions in a geographic area during a specific period

Kim Oanh, 2012

Overview on IIAS

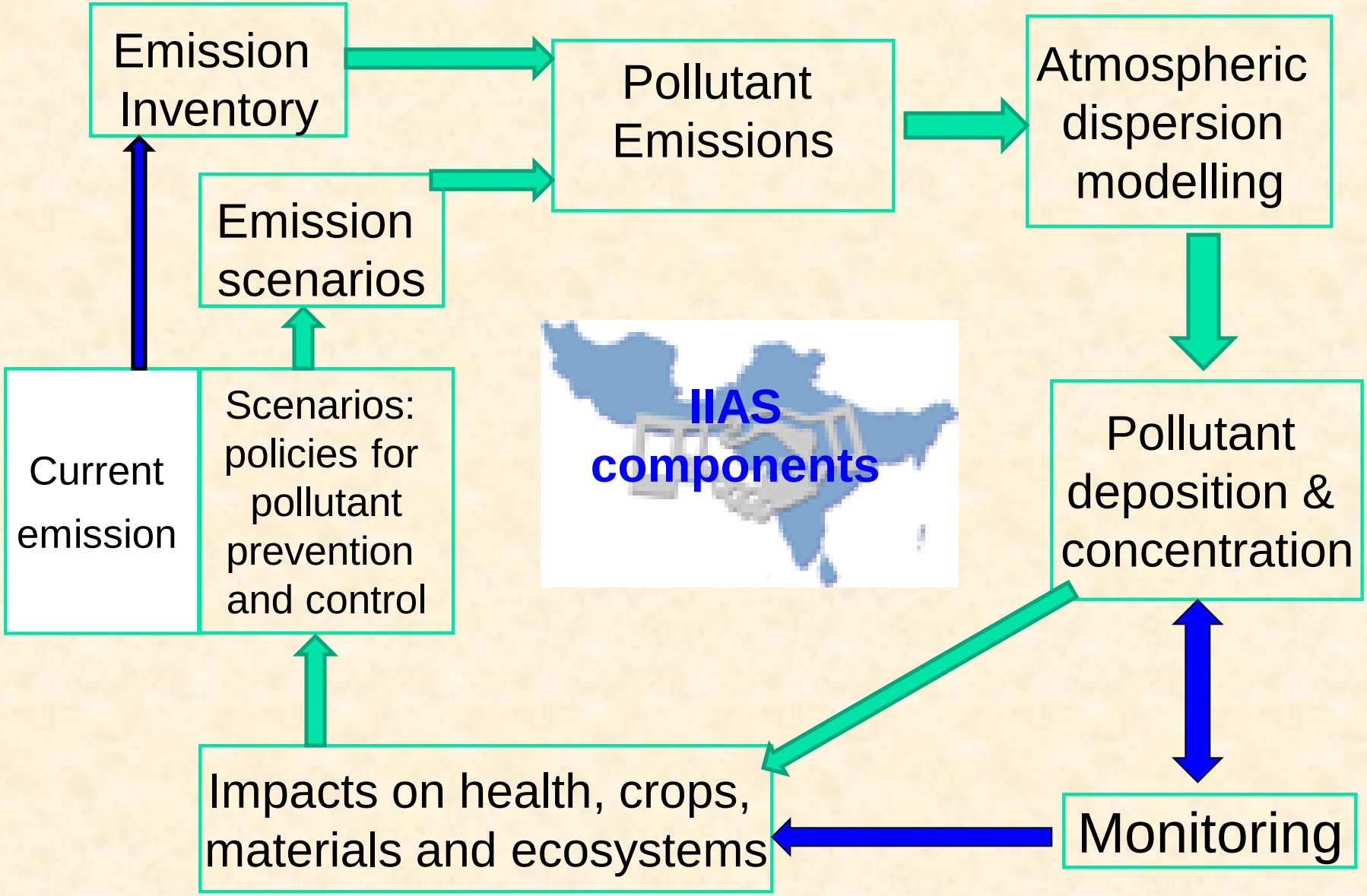
- Malé Declaration Integrated Assessment Model (IAM): initiated in 2001 by SEI, UNEP RRC.AP and SMHI
- User interface was prepared by UNEP.RRCAP
- New name is Integrated Information and Assessment System (IIAS) to add more information and monitoring database



About IIAS

- Aim: to integrate different Malé Declaration activities, manuals and data and provide additional information
- Is a tool to investigate the linkages between emissions, concentrations and deposition of major pollutants and compare to monitoring values
- Is a tool to look at the risks of impacts of the regional-scale air pollution to different receptor types (crops, people etc.)
- Is a tool to investigate the implications of scenarios including different policy interventions

Source: adapted from Kuylenstierna (2008)

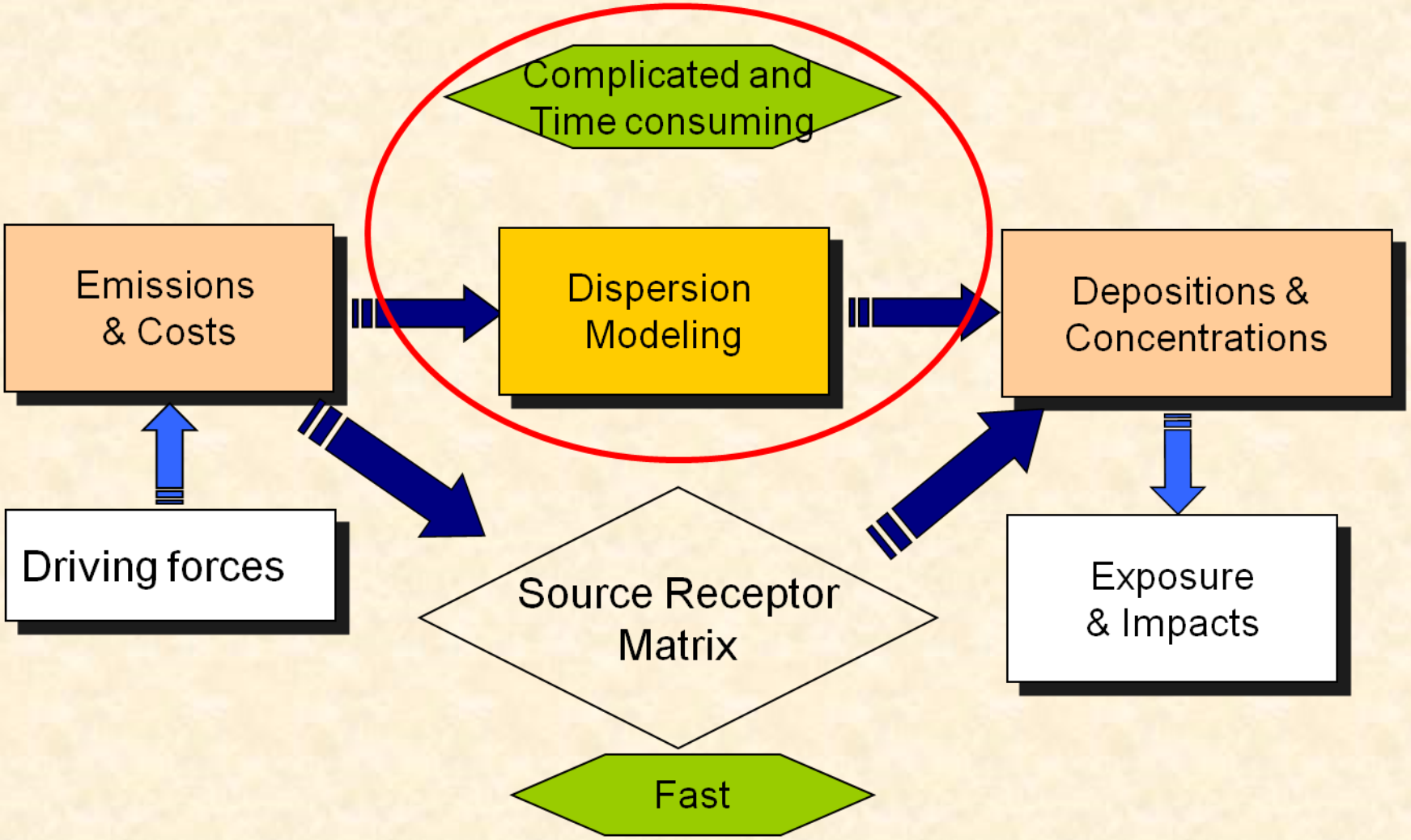


Source: adapted from Kuylenstierna (2008)

IIAS: current status

- Default emission data: EDGAR emission (1995) and Malé baseline emission (2000)
- SMHI MATCH chemistry transport model simulations for both default emission databases ➔ concentrations and depositions output across South Asia at $1^{o}x1^{o}$
- Meteorology data for MATCH running were taken from global forecast by dynamic model for the years of simulations: 1995 and 2000
- MATCH produced transfer coefficients (ratio between concentrations and emissions) for the domain to allow estimation of concentrations and depositions if the emissions changes ➔ used for impact assessment
- At present only acidification risk assessment is considered under the impact assessment

Use of Transfer Matrix



Kim Oanh, 2010
(AIT modeling course lectures)

Emission input data and emission regions of Male' countries

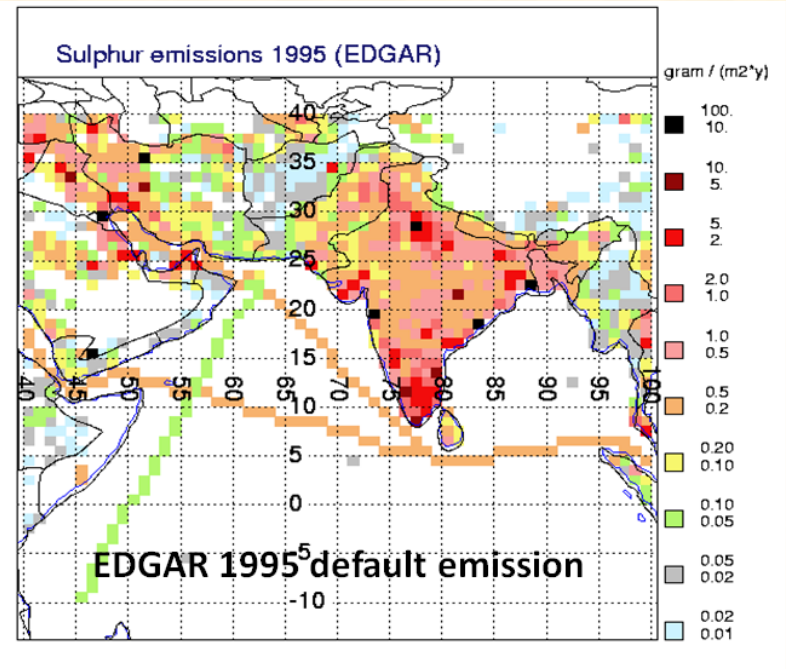
Default emission data:

1. Emission Database for Global Atmospheric Research (EDGAR): year 1995 for (SOx, NOx) and 1990 for NHx (no PM data), 1 x 1 degree (http://themasites.pbl.nl/en/themasites/edgar/emission_data/index.html)

2. Male' emission with base year of 2000 (SOx, NOx, NHx and $PM_{2.5}$)

Emission region IAM code	Emission region name	Provinces or states included within the emission region
BDAA	Bangladesh	Whole country
BTAA	Bhutan	Whole country
INCC	India Central	Madhya Pradesh + Chhattisgarh
INEC	East-Central	Bihar + Jharkhand
INEE	India East	Assam – NE Highlands (Arunchal Pradesh; Manipur; Meghalaya; Mizoram; Nagaland; Sikkim; Tripura)
INNC	India North-Central	Uttar Pradesh + Uttaranchal
INNN	India North	Chandigarh - Punjab; Himachal Pradesh -Jammu and Kashmir; Haryana; Delhi
INSC	India South-Central	Andra Pradesh; Karnataka - Goa
INSE	India South-East	West Bengal + Calcutta; Orissa ; Andaman and Nicobar islands
INSS	India South	Kerala - Lakshadweep; Tamil Nadu - Pondicherry
INSW	India South-West	Maharashtra; Dadar and Nagar Haveli -Daman and Diu + Bombay
INWC	India West-Central	Gujarat; Rajasthan
IREE	Iran East	East Azarbayejan; West Azarbayejan; Ardebil; Ilam; Tehran; Chaharmahal & Bakhtiyari; Khuzestan; Zanjan; Qazvin; Qom; Kordestan; Kermanshah; Kohgiluyeh & Boyerahmad; Gilan; Lorestan; Mazandaran; Markazi; Hamadan
IRWW	Iran West	Esfahan; Bushehr; Semnan; Sistan & Baluchestan; Khorasan; Fars; Kerman; Golestan; Hormozgan; Yazd
MVAA	Maldives	Whole country
NPAA	Nepal	Whole country
PKEE	Pakistan East	Northwest Frontier Provinces - FATA -Islamabad; Punjab (incl. Lahore)
PKWW	Pakistan West	Sindh (incl. Karachi); Baluchistan
LKAA	Sri Lanka	Whole country

Linkage of Emission scenario, MATCH and IIAS



Adapted from Kuylenstierna (2008)

MATCH for a base year

Gridded concentration and deposition fields

Development of transfer coefficient: ratio of deposition or concentration to emission per grid

Transfer coefficient for IIAS input

IIAS

New fields of deposition & concentration as output of IIAS

Impacts

Gridded emission of region (Emission to Grid coefficient)

Scenarios

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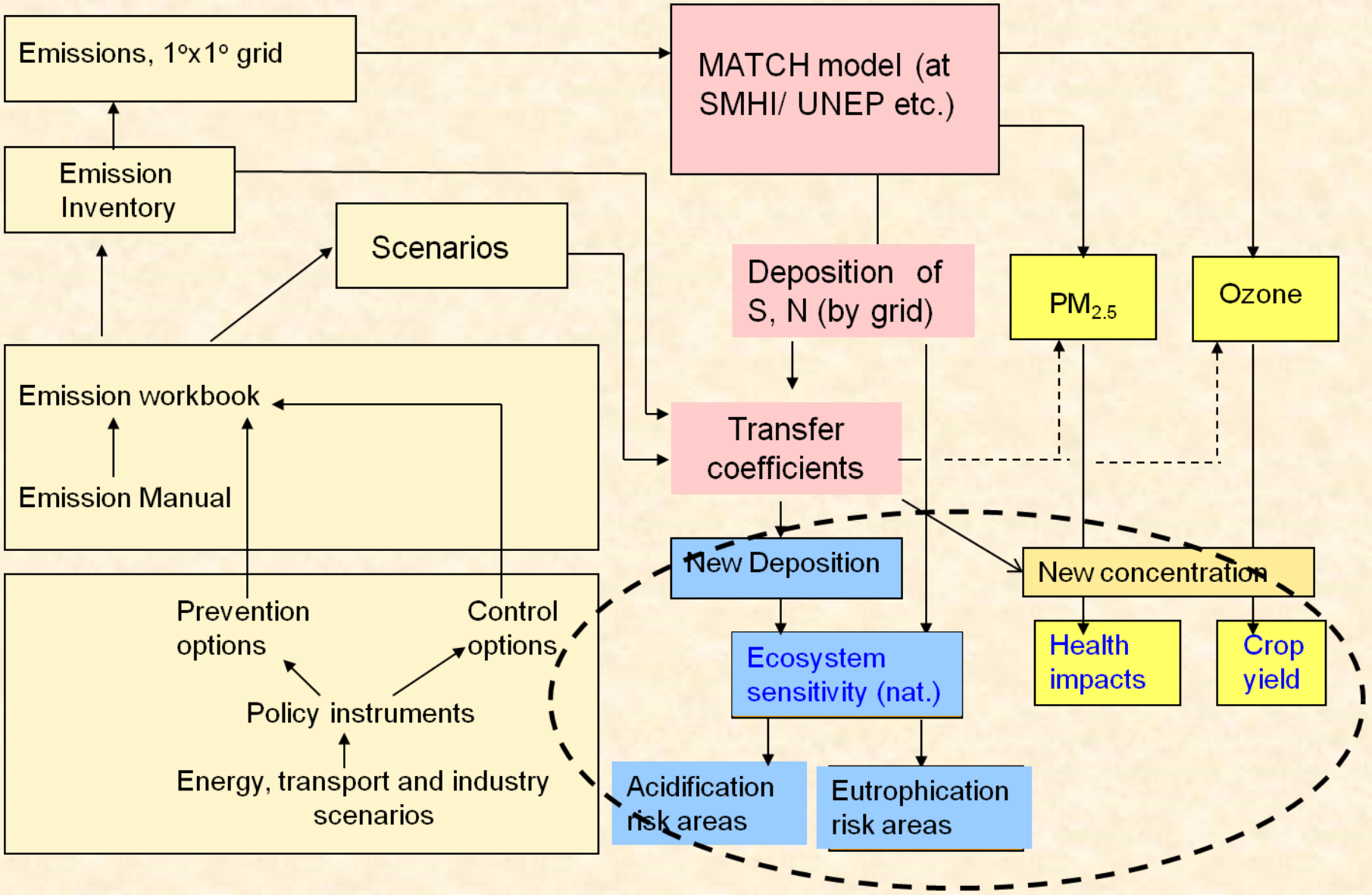
Multiple Effects of Air Pollution Covered in IIAS



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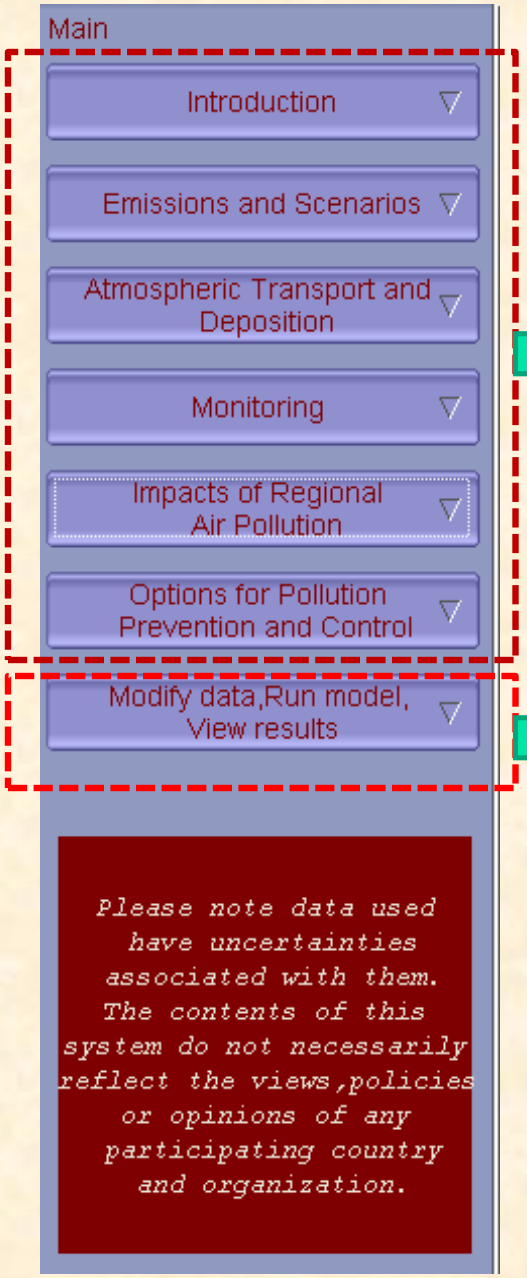
Recent development

- Current version is IIAS v1.1 2012
- This version has been updated by:
  - SEI in May 2012: calculation formula consistency
  - AIT in May 2012: Male's monitoring data (graphs)

Model application

- Model structure
- Steps of model application
- Demonstration: testing impacts of simple scenarios on acidification risks



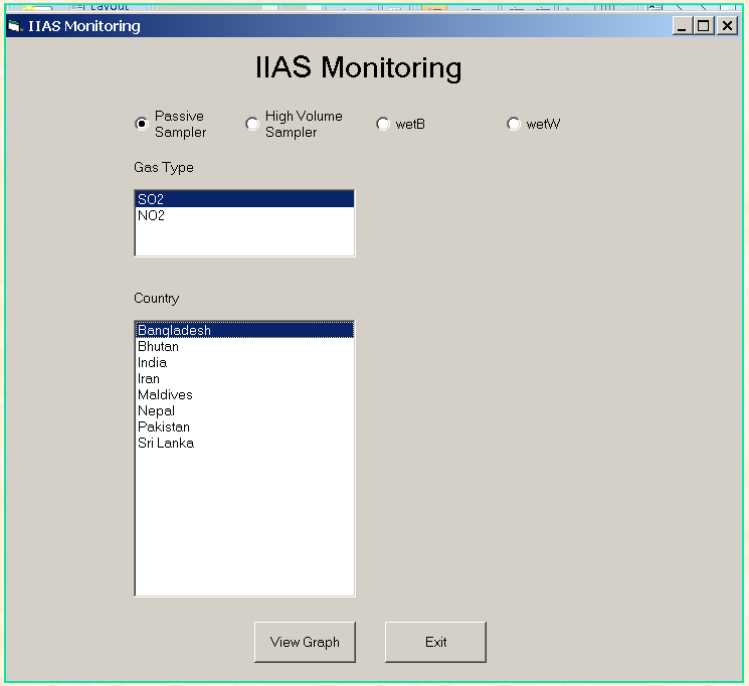
Model structure: overview

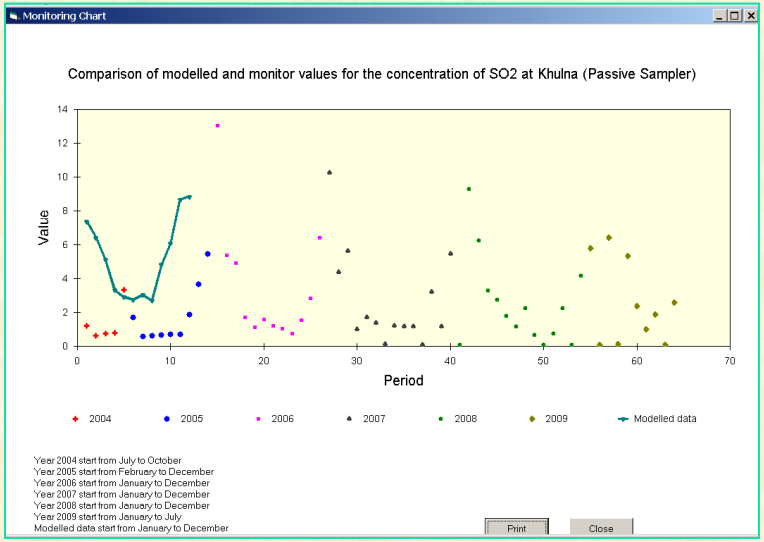
Provides information database for various issues i.e. model documentation, background info on emission, scenarios, atmospheric transport and impacts of regional air pollution and examples of some good practices (in pdf). Monitoring database are presented in charts (EXCEL base)

IIAS model main menu: to modify data (emission), run the model and view the results
Latest version: version 1.1 (May 2012)

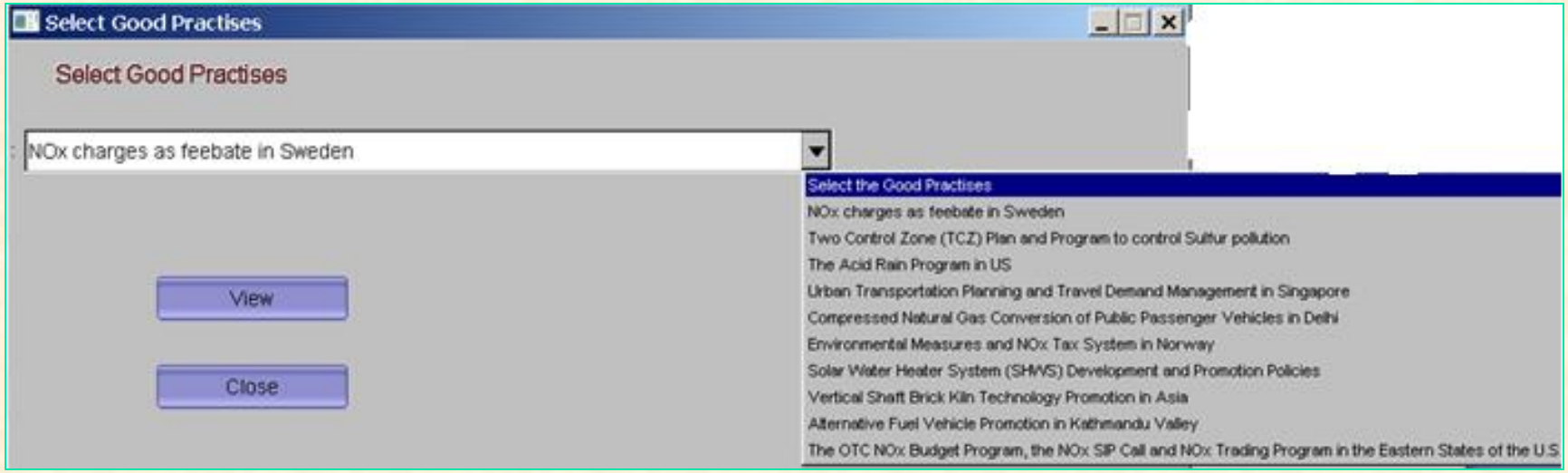
Model structure: monitoring database

- Brief information on monitoring of air pollution in South Asia
- Introduction to Male's monitoring network and manual
- Existing/available database of Male's monitoring
  - Data from 7 countries (Bangladesh, India, Iran, Maldives, Nepal, Pakistan, Sri-lanka)
  - Monthly data on SO_2, NO_2, wet deposition (passive sampler, high volume sampler)
  - Graphs are presented together with MATCH model results for selected grids compatible to particular sampling locations





Model structure: information on options for pollution prevention and control



- Provides information for user on policy instruments for air pollution prevention and control in South Asia
- A link to RAPIDC Handbook on Policy Option for Pollution Prevention and Control is also provided (chapter 3)
- Several “good practices” are also provided to provide number of success stories of implemented pollution prevention and control
- Information is yet to be fully completed

Main IIAS module: 3 sequential parts

User defined input data:

- Modify emission input data by scaling (EDGAR, Male') and create modified emission file ➔ save the file under a direction name
- Create user defined options, if necessary, for critical load range values ➔ save the file under the newly created direction

2. Load input data (default or user defined)

- Selection of the modified emission file (earlier saved)
- Selection modified critical load file

3. View results

- Deposition (NOx, NHx, SOx, base cation)
- Concentration (SO_2, NH_3, $PM_{2.5}$, O_3)
- Acidification risk (exceedance of the critical load)

Case Study

1. Run for base case with Male' 2000 baseline emission data
   - Produce fields of concentration (NO_2, SO_2) and deposition (NOx, SOx) for base case (2000)
   - Produce exceedance of critical load map for base case (2000)
2. Run for future emission of 2040 based on Representative Concentration Pathways (RCPs) emission scenario
   - Produce fields of concentration (NO_2, SO_2) and deposition (NOx, SOx) for 2040
   - Produce exceedance of critical load map for 2040

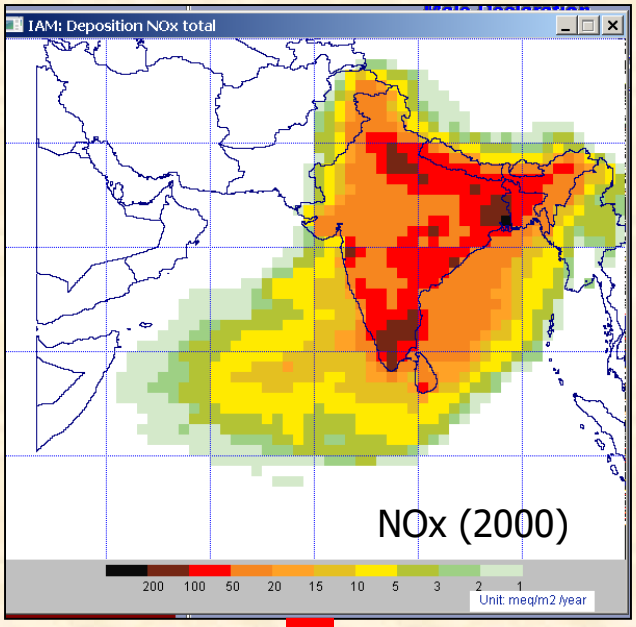
RCP8.5 emission for Asian Region (produced from MESSAGE model)

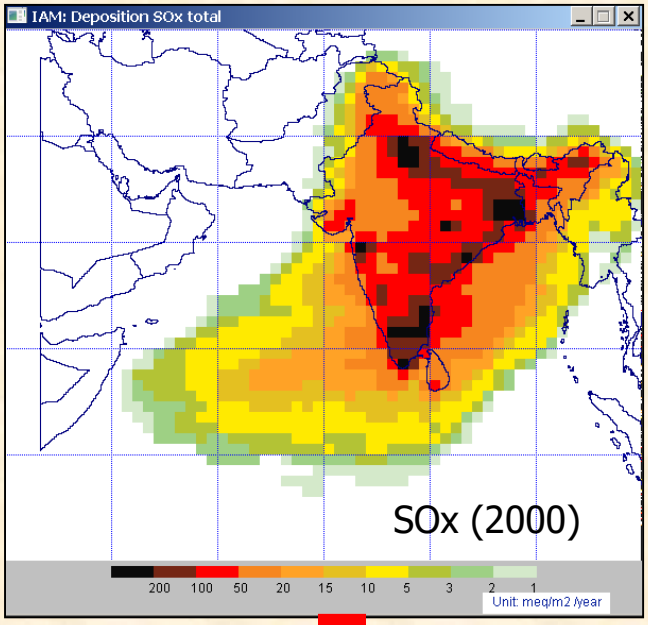
Emission	2000 (Tg/yr)	2040 (Tg/year)	Change (%)
NO_2	26.3	34.8	32.3
SO_2	64.8	55.6	-14.2
NH_3	41.8	54.4	30.1
BC	6.1	5.1	-16.4

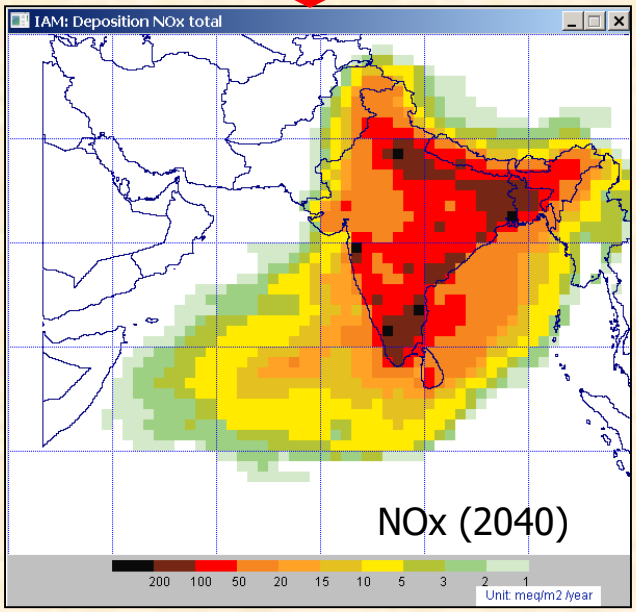
Source: analysis the data from http://www.iiasa.ac.at/web-apps/tnt/RcpDb/dsd?Action=htmlpage&page=download

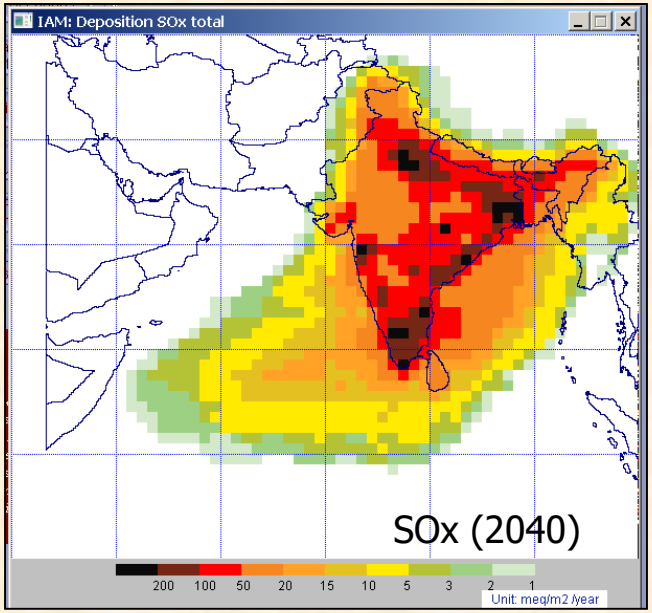
- % Change obtained from RCP8.5 emission database will be used for our exercise
- Percent change will be assumed to be homogenous for all Male Declaration member countries
- Percent change for BC is assumed to be applicable for $PM_{2.5}$

RCP8.5 Results: Deposition

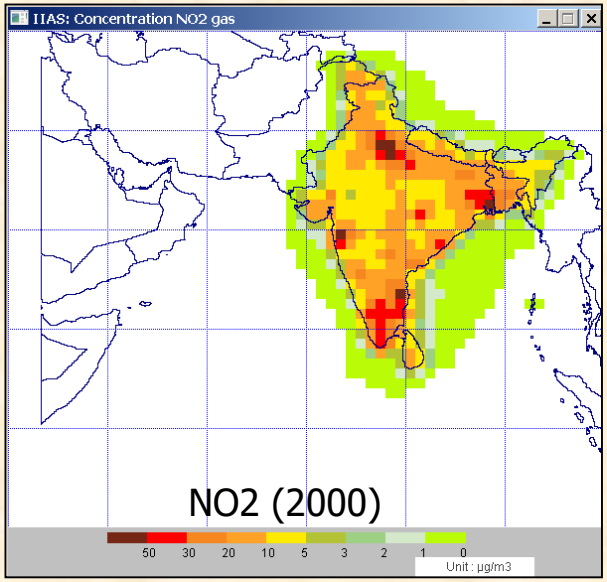


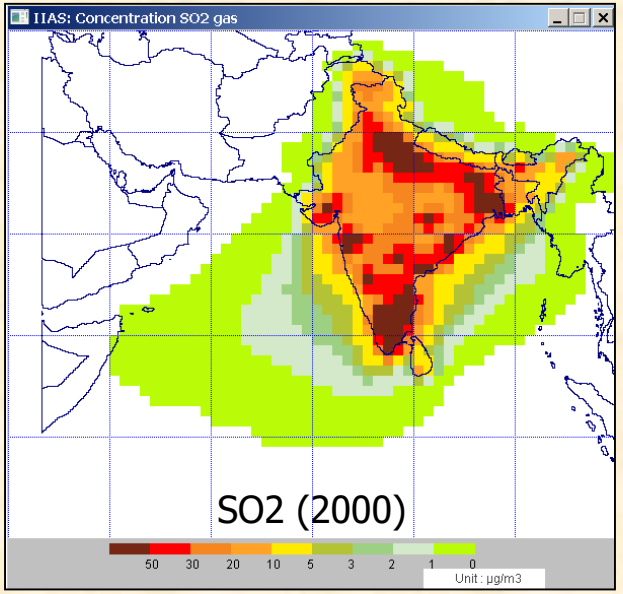


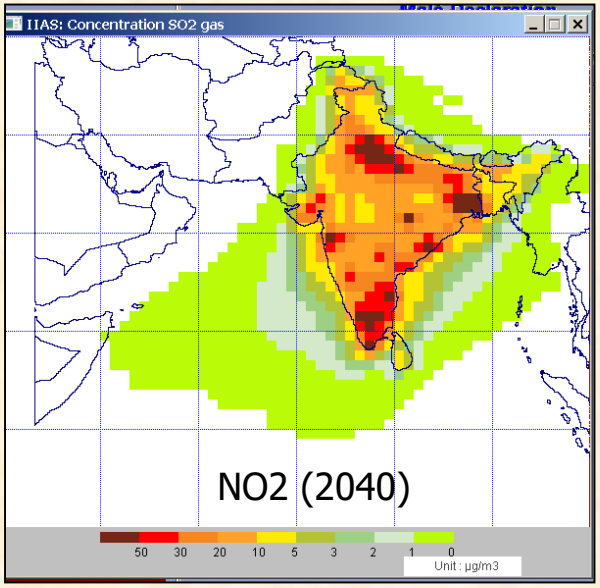


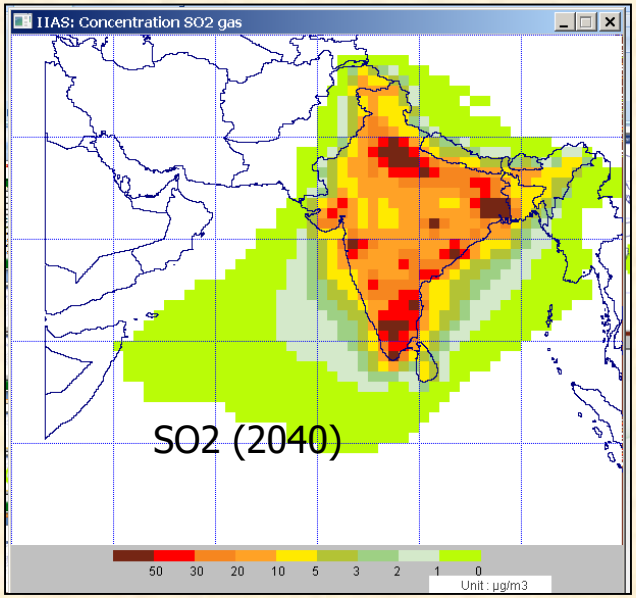


RCP8.5 Results: Concentrations

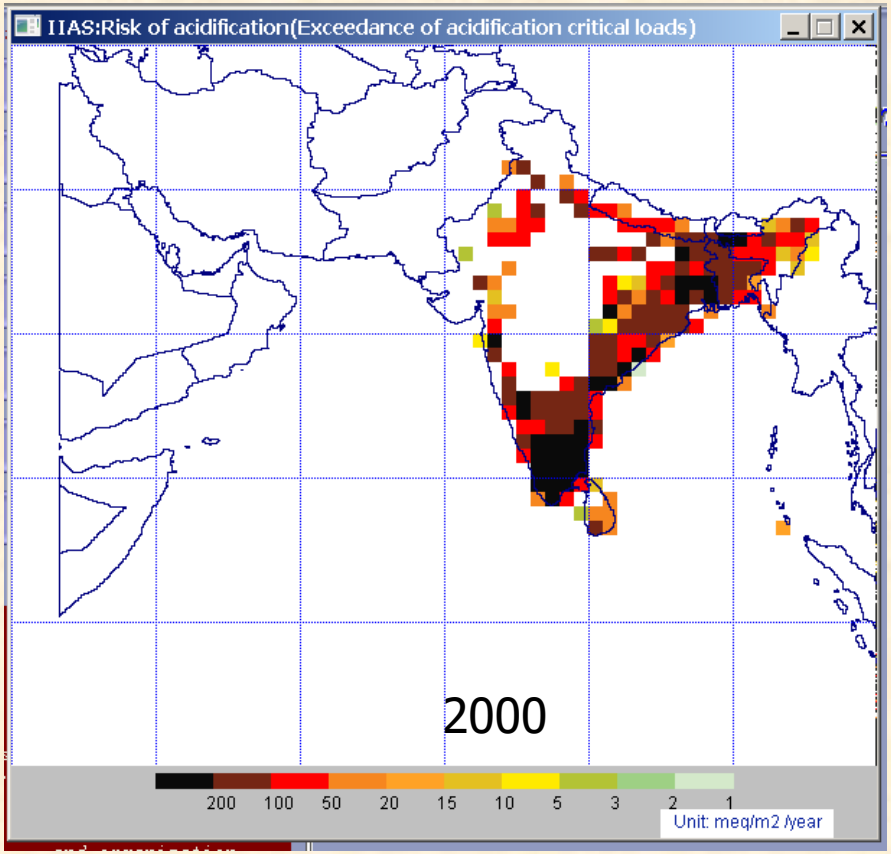


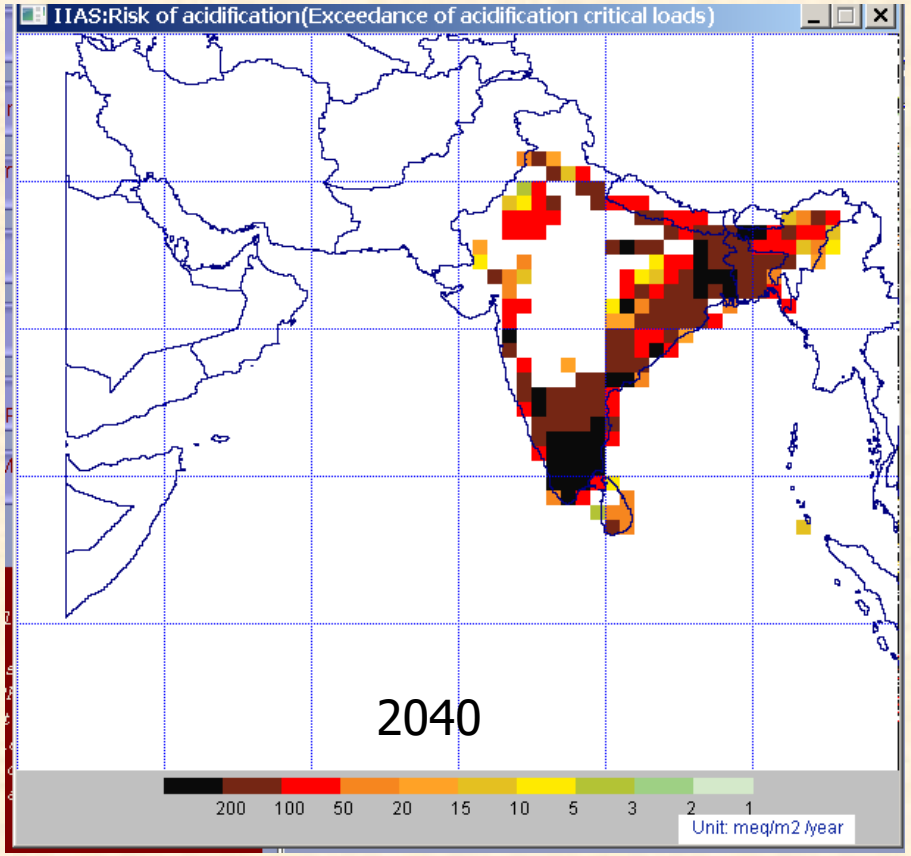






RCP8.5 Results: Acidification Risks





Summary

IIAS combines different elements of regional air pollution impacts into one tool to analyze the impacts of emission control ➔ potential comprehensive tool for policy making

- Monitoring, emission inventory, atmospheric dispersion and the impact assessment are linked in IIAS
- IIAS allows a rapid assessment of potential impacts of emission changes in the region without running complex 3D chemical transport and meteorology modeling system
- Some limitations to be overcome in the future development:
  - Assumption on linearity in the transfer coefficients over wide variation ranges of different pollutants
  - Coarse grid scale (~100x100 km^2) ➔ can not capture the changes in sub-grid areas

Ways forward: improvement

- Update of EI database for a more recent base year and for finer grids
- Rerun MATCH with new Meteorological data for the new base year or long-term average ➔ produce updated transfer coefficients for Male's countries on finer grids
- Add other pollutants: ground ozone simulation should be done by running MATCH and Met. models to directly produce concentrations
- **"Under construction"** parts need to be completed, i.e. risk assessment for health and crop yield
- Sector-wise EI database to be incorporated: users can test emission scenarios for important sectors, such as residential, transport, waste open burning, etc.

Thank you for your attention