Interdisciplinary environmental research - focus on environmental research cooperation with China

Prof. Rolf D. Vogt
Dept. of Chemistry,
MILEN-UiO
We have a challenge
Drivers

Paper consumption

Tons (million)

1750 1800 1850 1900 1950 2000

Pulp and paper international (1993)
IGBP synthesis: Global Change and the Earth System, Steffen et al 2004

Sybil Seitzinger, IGBP
Pressures

Domesticated land

% of total land area

1750 1800 1850 1900 1950 2000

IGBP synthesis: Global Change and the Earth System, Steffen et al 2004

Sybil Seitzinger, IGBP
Responses

Biodiversity loss

Species Extinctions (thousand)

IGBP synthesis: Global Change and the Earth System, Steffen et al 2004

Sybil Seitzinger, IGBP
Understand the links

Drivers

Pressures

Dispersion

Long range transport

Transformation

State of the environment

Development of new technology

Responses

Abatement measures

Legislation

Effects & Interactions
A pollutant has often multiple effects on different scales

<table>
<thead>
<tr>
<th></th>
<th>GLOBAL Climate change</th>
<th>REGIONAL</th>
<th>LOCAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Acid rain</td>
<td>Tropospheric ozone</td>
</tr>
<tr>
<td>CO₂</td>
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<td></td>
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<tr>
<td>CH₄</td>
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<td></td>
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<tr>
<td>N₂O</td>
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<td></td>
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<tr>
<td>SO₂</td>
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<td></td>
<td></td>
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<tr>
<td>NOₓ</td>
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<tr>
<td>NH₃</td>
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<tr>
<td>NMVOC</td>
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<td></td>
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<tr>
<td>CO</td>
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<tr>
<td>Aerosol</td>
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<td>Heavy metals</td>
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</tbody>
</table>
An abatement measure has often multiple effects (Co-benefits/negative side-effects)

<table>
<thead>
<tr>
<th>Abatement</th>
<th>Main Target</th>
<th>Global</th>
<th>Regional</th>
<th>Local</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased energy efficiency</td>
<td>CO₂</td>
<td>Climate</td>
<td>Acid rain, Eutrophication</td>
<td>Dust, Heavy metals</td>
</tr>
<tr>
<td>Fuel substitution: Coal → Oil → Gas</td>
<td>SO₂, CO₂, NOₓ</td>
<td>Climate</td>
<td>Acid rain, Eutrophication</td>
<td>Dust, Heavy metals</td>
</tr>
<tr>
<td>Removal of black carbon emissions</td>
<td>PM</td>
<td>Climate</td>
<td>Acid rain, Eutrophication</td>
<td>Dust, Heavy metals</td>
</tr>
<tr>
<td>Removal of SO₂ and/or particles</td>
<td>SO₂</td>
<td>Climate</td>
<td>Acid rain,</td>
<td></td>
</tr>
<tr>
<td>Renewable energy- biomass</td>
<td>CO₂</td>
<td>Climate</td>
<td></td>
<td>Acidification</td>
</tr>
<tr>
<td>Renewable energy- sun/wind/wave</td>
<td>CO₂</td>
<td>Climate</td>
<td></td>
<td>Visual</td>
</tr>
</tbody>
</table>
E.g. Increased energy efficiency at a coal-fired power station

- **Global effects**
  - Climate change (CO$_2$, CH$_4$)

- **Regional effects**
  - Acid Rain (SO$_2$, NOx)
  - Tropospheric ozone (NOx, VOC)
  - Eutrophication (NOx)

- **Local effects**
  - Health (particles, heavy metals, SO$_2$, O$_3$)
  - Materials (SO$_2$, ozon)
  - Vegetation (ozon, SO$_2$, particles)

- **Other effects (e.g. employment)**
Most abatement actions have also negative side effects

- Many examples:
  - Freon in spaycans → Hole in the ozonlayer
  - Biofuel → food shortage
  - Windpower → visual pollution, stakeholder conflicts
  - Removal of particles in fluegasses → increased acidification
  - Energy-saving light bulbs → emission of mercury
  - Electrical cars → increased global CO$_2$ emission?
  - Reduced acid rain → increased eutrophication
  - And others – we never learn..
A necessary basis for good decision-making and effective environmental policies in the increasingly complex and integrated environmental challenges.

The researchers' role is to provide such expertise.
Sustainable development

- Enable decision makers to establish knowledge based abatement strategies on environmental challenges thereby ensuring a sustainable development.

Sustainability implies positive solutions for all components. Needs for environmental protection are balanced against limitation posed by social harmony and economic production.

- To obtain this knowledge, integrated assessment studies of the ways pollution and inadequate resource management affect the environment and humans are required.
Call for Trans-disciplinary environmental knowledge assessment
Drivers: Population growth, consumption, energy, travel

Pressures: Side effects of drivers (Emissions to air and water)

State: Resources, Pollution, Chemical & Biological state of Water, Air, Soil

Impacts: Climate change, eutrophication, vegetation damage

Nature’s Response: Changed biodiversity, change in eco-system services, feedback mechanisms

Society’s Response: Adjustments, environmental protection, adaptation, environmental technology, policy, legislations, taxes
Drivers for Interdisciplinary in environmental knowledge development

- Increased societal legitimacy and improved research relevance
  - Environmental research must meet societal challenges
- Problems discovered by knowledge
  - Need to be solved with knowledge
- Problems caused by knowledge,
  - "can't be solved by using the same kind of thinking we used when we created them"

- Generates opportunities for scientific innovation through cross-fertilisation and knowledge integration (the essence of inter-disciplinarity)
- Scientific curiosity is driven by scientific skepticism - more prone to be held by outsiders than in the midst of a disciplinary ‘hard core’
Building bridges

- Bridging disciplines
- Bridging approaches: modeling and observations – common research site
- Bridging spatial scales – improved data power
- Bridging time scales and weather extremes
- Deterministic and probabilistic approaches
My message

- Abatement actions in Norway have an important signal effect but bear little global significance.
- It is what is happening in China that is our global challenge.
- If we are to have any chance to abate our global challenges we need to address what is happening in China.
Asia and especially China are increasing their energy consumption.

- In China the energy consumption has doubled since 2001
  - In 2010 it accounted for 19.5% of the world energy consumption
  - 70% of the energy need is met by burning of coal
    - 40% of the global consumption of coal is in China
China is the largest emitter of CO$_2$

China has since 1990 doubled its contribution to the world's total CO$_2$ emission

Myhre et al., 2009
China is emitting most SO$_2$

- China is emitting 25 mill tons SO$_2$ and is thereby the worlds greatest source of SO$_2$

China is increasing their emission of NOx og NH3

Fra Wang et al. 2002

Fra Bao L.F. & Tang D.G. 2004
China is responsible for most of the emission of Hg

Antropogene Hg emissions

Globale menneskeskapte Hg utslipp

Fig. 1. Global anthropogenic emissions (tons/year).

http://www.utoronto.ca/imap/collections/air_quality/maps/Mercury-global-emissions.jpg
Per capita emissions in China are \( \frac{1}{6} \) of USA.
Does this mean that we have to pollute in order to have a good life?

Clear link between GDP and CO₂ emission

PPP = Purchasing Power Parity
China – the land of opportunities

- Chinese authorities
  - Emphasize environment and sustainable development in front of economic growth
    - They have the ability and capacity to implement and conduct necessary abatement actions
- Global crowbar in the environmental gridlock
  - Example for other developing countries
The main problem is the increase in welfare

- Causes an increase in consumption
  - Demand for comfortable indoor climate
  - Drive their own car

9% yearly increase in GNP
China has many serious local and regional environmental challenges

- Poor air quality
- Garbage
- Deserification
- Water pollution
- Erosion

Levels of particles and SO₂ in the cities are among the highest in the world.

60-70% of the surface waters has so bad water quality that it is useless.

380,000 km² (~Norway) of China is influenced by desertification.

> 17% of China has large problems with soil erosion.
Climate change is predicted to cause increased dought in north and increased flooding in south.

- Water consumption has increased by 5 times since 1949
- Overconsumption of groundwater – empty in 30 years?
Local ↔ regional ↔ global problems

By addressing local and regional environmental challenges in China we are able to get Chinese decision makers to implement necessary abatement actions.

- The arguments are different
- but the effect is the same
The 12th Five Year Plan

Chart 10. A road-map for the 12th Five-Year Plan (2011-15)

Accelerating transformation of China’s economic growth model to focus more on quality & sustainability of growth (Likely to target lower GDP growth in 2011-2015)

- Higher domestic demand (esp. consumption)
- Lower carbon intensity (40-45% reduction by 2020)

Table 35. The new Magic 7

<table>
<thead>
<tr>
<th>Emerging strategic industries</th>
<th>Main content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy-saving and environmental protection</td>
<td>Energy efficiency, advanced environmental protection, recycling</td>
</tr>
<tr>
<td>Next generation information technology</td>
<td>Next-generation communications networks, Internet of things, network convergence, new flat panel display, high-performance integrated circuits and high-end software</td>
</tr>
<tr>
<td>Bio-technology</td>
<td>Bio-medicine, bio-agriculture, bio-manufacturing</td>
</tr>
<tr>
<td>High-end manufacturing</td>
<td>Aeronautics &amp; astronautics, marine engineering equipment, high-speed rail, high-end smart equipment</td>
</tr>
<tr>
<td>New energy</td>
<td>Nuclear, solar, wind, biomass</td>
</tr>
<tr>
<td>New materials</td>
<td>Special function and high-performance composite materials</td>
</tr>
<tr>
<td>Clean-energy vehicles</td>
<td>Plug-in hybrid vehicles and pure electric cars</td>
</tr>
</tbody>
</table>

Source: State Council (http://www.gov.cn/zhld/2010-09/06/content_1698804.htm)
Research and education

- China has become a research giant, which systematically is reforming its research, innovation and higher education as the main driving forces for economic development.

- CAS spent 20 billion RMB in 2009, "seven times more than in 1998. National Natural Science Foundation will this year increase its budget by 70% from 10 billion last year."
The land of opportunity

- From coal to gas in the cities
- Water power
- Actions to remove cars
- Eco cities
- 4th largest wind energy producer
- First plug-in hybrid
Beijing’s metro 2002-2009

Until 2002:

Today
SINCIERE
Sino-Norwegian Centre for Interdisciplinary Environmental Research

- Sponsored by:
  
  [CIENS]
  Forskningscenter for miljø og samfunn
  Centre for Interdisciplinary Environmental and Social Research

  [UNIVERSITY OF OSLO]

  [The Research Council of Norway]
Our SINCIERE Vision:
To act as a catalyst and mediator for cooperation between China and Norway within the field of environmental research
- Facilitate interdisciplinary and policy relevant research and serve as a node for a broad network of associated institutions.
欢迎指导！

Thank You

谢谢！