Interdisciplinary environmental research
- Capitalizing on thematic breadth

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

Paper consumption

- 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
Biodiversity loss

Species Extinctions (thousand)

1750  1800  1850  1900  1950  2000

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

Responses

Abatement measures

Legislation

Effects & Interactions

Development of new technology

State of the environment
A pollutant has often multiple effects on different scales.

<table>
<thead>
<tr>
<th></th>
<th>Climate change GLOBAL</th>
<th>REGIONAL</th>
<th>LOCAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Acid rain</td>
<td>Tropospheric ozone</td>
<td>Health</td>
</tr>
<tr>
<td>CO₂</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH₄</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N₂O</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SO₂</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NOx</td>
<td>?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NH₃</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NMVOC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aerosol</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heavy metals</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Abatement measures often have 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>

Impact
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..
Holistic approach

- 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
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
Types of Collaboration

- **Multi- or pluridisciplinary**
  - The combination of several disciplines that are concerned with one problem, but without intentional integration

- **Interdisciplinary**
  - The integration of two or more disciplines to solve problems

- **Transdisciplinary**
  - Development of integrated knowledge and theory among science and society
Types of Collaboration

- **Multi- or pluridisciplinary**
  - The combination of several disciplines that are concerned with one problem, but without intentional integration.

- **Interdisciplinary**
  - The integration of two or more disciplines to solve problems.

- **Transdisciplinary**
  - Development of integrated knowledge and theory among science and society.
**DPSIR – philosophy**

**Conceptual framework**

- **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’
Need for cooperation

- Environmental research is readily criticized because we do not control all factors that affect our data.

- Small research projects with limited funds failed to produce all the necessary data:
  - Climatic conditions
  - Vegetation, soil, bedrock, water chemistry
  - Land use, practice and history
  - ...

- Interpretation of conditional parameters
  - Little information comes out of studying my sample taken in my stream and prepared in my way, analyzed on my analytical instrument using my method.
Building bridges

- Bridging disciplines - the CIENS concept
- Bridging approaches: modeling and observations – common research site
- Bridging spatial scales – improved data power
- Bridging time scales and weather extremes
- Deterministic and probabilistic approaches
Some experience

- **Common goal** is necessary for good cooperation
  - Model work promotes the interdisciplinary collaboration by concretizing the common goal
- Important to have clear **roles and respect** "for the individual's academic integrity and platform"
  - Respect for differences in approach: **Deterministic - exploratory**
- **Polymath** hampered by lack of **polyglot**
Some experience cont.

- Cooperation is best achieved through **physical co-location**
  - Common research site make it possible to generate sufficient data
  - Easier to work together "out there" than at home
- **Coupling** Nature - Social Sciences and users:
  - Leads to that we are better able to ask the right questions and see the relevance of our studies
  - Facilitates the **practical** work in the field through collaboration with local stakeholders
  - Enable us to indentify the **relationship** between land use / activity and environmental parameters
TAKK FOR OPPMERKSOMHETEN..