Understanding Human and Ecosystem Dynamics in the Arctic: the Imandra Watershed Project (Kola, Russia)

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Geolocation

- Watershed area - 12 300 km²
- Population - 300 000 people
- Relatively warm - no permafrost
- Tundra and Northern Taiga
- Severe environmental degradation
- Mining, smelters, Ni, Fe, Cu, Apatite, etc.
Project Goals

• What are the effects of industrial and human activity on the ecological health or resilience of the watershed?
• What data is available, what data is needed?
• How to apply integrated modeling for consensus-building in the region?
• What are the possible scenarios for future economic and social development of the region under changing global conditions?
Ecological studies

Data sets compiled (1978 -> ):
- Climatic data
  - Temperature, precipitation, humidity
- Hydrology data
  - Flows, water levels
- Water chemistry
  - Nutrients, metals (Fe, Cu, Ni, Mo, Co, Hg, sediments, discharges)
- NPP
Ecological studies

Severonikel: wastewater discharge rate

Ni discharged
Decrease in Ni concentration in the Lake

Distribution of Ni

<table>
<thead>
<tr>
<th>mg/m³</th>
<th>0 - 5</th>
<th>5 - 10</th>
<th>10 - 15</th>
<th>15 - 20</th>
<th>20 - 30</th>
<th>30 - 40</th>
<th>40 - 50</th>
<th>50 - 60</th>
<th>60 - 80</th>
<th>80 - 100</th>
<th>100 - 110</th>
</tr>
</thead>
</table>

1992

2001
Socio-economic studies

Data sets compiled (1930-> 1995 -> ):
- Main socio-economic indicators
  - Population and labor
  - Living standards
  - Volume of industrial production
- Transport
- Investments
- Emissions
- Trade indices
Recent socio-economic trends

- ~70 000 people have left the region since 1991 (~20%), mostly of working age
- Real purchasing power declines, for pensioners it fell 2.3 times
- Sharp increases of export of nickel, aluminum and other metals brought the world prices to a decline: for nickel by 13%, aluminum - by 28%
- The nuclear power station is to be shut down in 10 years
- Ecological gains are human losses
Recent socio-economic trends
Population dynamics

- Production of Apatite
- Apatity & Kirovsk population

- Net migration
- Births
- Deaths

<table>
<thead>
<tr>
<th>Year</th>
<th>Mln. tons</th>
<th>x 1000 people</th>
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<tbody>
<tr>
<td>1925</td>
<td></td>
<td></td>
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<tr>
<td>1935</td>
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<td>1945</td>
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<td>1985</td>
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<tr>
<td>1995</td>
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</tbody>
</table>
Population dynamics

Kandalaksha

Net Migration
Births
Deaths
Water Quality

Graph showing the change in P (tonns), Sediments, N (tonns), and Cl (tonns) from 1984 to 1999.
Workshop process, Apatity, Russia, May 14 – 18, 2001

• Day 1. Field trips – getting the feeling of the region and its problems
• Day 2. Presentations by stakeholders
• Day 3. What do we know? - Science and data
• Day 4. What we do not know? - Brainstorming in breakout sessions
• Day 5. Planning for the future. Who is doing what?
Workshop process
October, 27-November, 3, 2001

Apatity
Monchegorsk
Polyarnii Zori
Kandalaksha
How to link science and decision making?

- Transparency and openness of the modeling process
- Model as a tool for consensus building
- The process is more important than the result
Questions:

- What affects your life quality?
- How do you see your city in 10, 100 years from today?
- How decisions are made and can you influence them?
- What do we know about our regional system, what could be the variables in the model?
- What development strategy is most desirable? What scenarios can you think of?
- How can we make development sustainable?
Apatity

- Major players: Kola Science Center, Apatit Enterprise
- 54 people present
- Topics discussed:
  - Majority prefers to emigrate, but have no means to do it
  - NGOs important but almost non-existent
  - Ecotourism important but unreliable
  - Public needs information
  - Ecological education inadequate
  - Quality of life is the priority
Monchegorsk

- Major players: Severo-Nickel Enterprise
- 19 people present
- Topic discussed:
  - The enterprise controls everything
  - People are afraid to have an opinion
Polyarnii Zori

- Major player: Kola Nuclear Power Station
- 30 people present, mostly high school students
- Topics discussed:
  - Ecological education in school
  - The city entirely depends on the Station - there is no alternative
  - The Station supports the city and takes good care of the environment.
Kandalaksha

- Major players: many
- 53 people present
- Topics discussed:
  - Environmental conditions and culture
  - Need for a tax reform
  - Emigration is a hard problem
  - Youth organizations are dead
  - Economic problems should be solved first of all
Participatory Integrated Modeling Approach

- Data models that are based on measurements and experiments
- Qualitative, conceptual frameworks of systems and processes involved
- Quantitative numeric models that are used to formalize our qualitative models
- Mathematical methods and models used to analyze the numeric models and interpret the results
- Decision-making models that transform our values and knowledge into actions
Modeling

ECOSYSTEM

ECONOMIC SYSTEM

SOCIAL SYSTEM
Modeling

- Economic System
- Social System
- Ecologic System
- INSTITUTIONS (social capital)
- RESOURCES (natural capital)
- INFRASTRUCTURE (built capital)

AIR
LAND
WATER
Modeling

- SOCIETY
- POPULATION
- EMPLOYMENT
- EDUCATION
- HEALTH

- Economic System
- Ecosystem

- QUALITY OF LIFE
Modeling
Questions with no answers... yet

• What should be the path to sustainable livelihood if that is the vision for the future?
• If extractive industries are not sustainable, what can replace them?
• What kind of economies can be sustainable and self-sufficient in the harsh northern climate?
• What kind of quality of life is most desired by the local population?
Plans for future

• Sediment core analysis - temporal dimension
• TMDLs - spatial dimension
• Specific relationship between environmental knowledge, attitudes, beliefs and policy changes in the societies
• Possible future development scenarios under global change
http://xserver.aaas.org/international/eca/kola
http://imandra.ksc.ru