Environmental problems of North-Finland

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**North-Finland**

<table>
<thead>
<tr>
<th>Region</th>
<th>Capital</th>
<th>km²</th>
<th>% of country</th>
<th>Pop.</th>
<th>% of country</th>
<th>Pop. density</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northern Ostrobothnia</td>
<td>Oulu</td>
<td>37,149</td>
<td>11</td>
<td>384,900</td>
<td>7,1</td>
<td>10.4/km²</td>
</tr>
<tr>
<td>Kainuu</td>
<td>Kajaani</td>
<td>24,452</td>
<td>7,2</td>
<td>83,400</td>
<td>1,5</td>
<td>3.4/km²</td>
</tr>
<tr>
<td>Lapland</td>
<td>Rovaniemi</td>
<td>98,984</td>
<td>29</td>
<td>184,000</td>
<td>3,4</td>
<td>1.9/km²</td>
</tr>
</tbody>
</table>
## Industry value-added

<table>
<thead>
<tr>
<th>Area</th>
<th>Industry value-added</th>
<th>% of whole country</th>
<th>Value added/pop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole Finland</td>
<td>32 b€</td>
<td>100</td>
<td>5 939</td>
</tr>
<tr>
<td>1. Helsinki area</td>
<td>7.4 b€</td>
<td>23,2</td>
<td>4 806</td>
</tr>
<tr>
<td>2. Tampere region</td>
<td>3.5b€</td>
<td>10,8</td>
<td>7 087</td>
</tr>
<tr>
<td>3. Turku region</td>
<td>2.3 b€</td>
<td>7,3</td>
<td>5 096</td>
</tr>
<tr>
<td>4. Oulu region</td>
<td>2.2 b€</td>
<td>6,9</td>
<td>5 772</td>
</tr>
<tr>
<td>14. Lapland</td>
<td>9.5 M€</td>
<td>3</td>
<td>5 204</td>
</tr>
<tr>
<td>19. Kainuu</td>
<td>3 M€</td>
<td>0,9</td>
<td>3 609</td>
</tr>
</tbody>
</table>
North-Ostrobothnia

Where inspiration turns to innovation
Industry profile

- Metal industry and the forest sector are important in the area of size of labor force and value production.
- The other significant industries are chemical, machinery, industrial instruments and electrical products industries.
- Biotechnology has also become an important area in the industrial sector with much stress being given in biomaterials, diagnostics, and industrial enzymes.
Metallurgy industry

- **Major source of CO₂ emissions**
- **Top-level carbon efficiency:** estimate that they operate at minimal carbon use levels
  - E.g. Ruukki produces 400 000 t less CO₂ compared to European average
- **Produces significant amounts of particulate emissions and SO₂**
  - Linked to higher occurrence of childhood respiratory diseases in Ruukki area
- **UN global compact signatory, Ruukki at the top of its peers in the Dow Jones Sustainability Index**
  - Tend to emphasize the sustainability of the **product**
The forest sector

- Forest sector is of key importance to Finland
- The term forest sector means forestry and forest industries combined
- In economic terms it makes particular sense to consider the Finnish forest sector as one entity
- Forestry and the industry within Finland are closely intertwined, neither of them could exist without the other:
  - Forest industries guarantee a reliable buyer for the timber grown
  - Forest industries rely on profitable and productive forestry
- ¾ of forest industry’s value added comes from p&p and ¼ from wood products industries
The chemical industry

首先，化学工业的诞生是出于必要，以提供其他行业的原材料

其次，生产化学品但也要为其他行业提供解决方案

大多数行业根据制造的输入和输出进行描述，这在化学工业中很难做到

我们将化学工业描述为通过化学反应制造产品，而这些产品没有营养目的

化学工业的关键问题是有机溶剂或挥发性有机化合物（VOCs）的种类和数量，以及产生的大量废水

化学工业的环境表现得到了显著改善，但社会通常只看到化学工业的负面输出

化学行业也常常不公开使用的化学种类和数量，以及产生的排放量

The key concern of chemical industry is the variety of organic solvents or Volatile Organic Compounds (VOCs) used and the large amounts of wastewaters generated.

The environmental performance of chemical industry has improved considerably, yet society generally perceives only the negative output of the chemical industry.

The chemical sector is also somewhat characterized by not being forthcoming about the types and amounts of chemicals used and stored and the amounts of emissions generated.
ICT Oulu - The first Ubiquitous City of the World

- Oulu is home to over 700 ICT companies
  - ICT companies employ more than 15,000 people in Oulu
  - Total revenue is about $6.7 billion
- World's leading centers of mobile communications technology and applications
  - At the forefront of system integration expertise and telecommunications development
  - Become the R&D capital of the wireless world
- Uniquitous (UBI) systems create an environment for residents in which quite new types of interactive services are offered.
- Oulu acts as a test city where enterprises can experiment with the functionality of future products and services in both the actual environment and in real situations. (Oulu Urban Living Labs)
Oulu ranked as one of the world’s top 28 cities in IT
Health-Bio in Oulu: Bio meets Nano and IT

- About 50 companies; Revenue of Oulu-based SME's 60 million €; Employs approximately 1,000 people
- Platforms for pharmaceutical industry, personalized medicine and clean technology
  - This means connecting business with research…
- Oulu has internationally recognised background in molecular medicine and biochemistry.
- Platform services: biocomputing and bioinformatics, cell simulation models, protein crystallography, mass spectrometry, biocatalysis, enzyme design…
Oulu, the smartest city in Europe…

❖ Over the past 200 years, Oulu has seen industries come and go, from tar and wood in the age of sail to leather goods, fishing and heavy equipment manufacturing.

❖ When heavy industry went into steep decline, the Nokia Research Center and small-to-midsize enterprises (SMEs) became Oulu's biggest employers.

❖ But city leaders remained alert to 'the Nokia threat'—employment concentrated in a single large company—and founded the Oulu Technology Park to incubate more SMEs.

❖ Despite the financial crisis that hit in 2007, Oulu has managed to create 18,000 jobs in high technology, thanks to risk-taking in education and strong public-private collaboration.

❖ The government of Oulu has also created an intensive culture of use for information and communications technologies.

Ref.: Intelligent Community Forum
Case: Oulu, Nuottasaari industrial complex

- Area comprises of several industries working in a semi-synergistic way (pulp & paper, chemical industries, power generation)
- All activities require environmental permits and are strictly regulated
- Emissions to air and water are controlled, wastewaters are treated and the sea water quality in the surrounding is satisfactory
- Most of them have conducted risk assessment research and taken preventive activities
- Some key potential risk areas recognized are the storage of chemicals and transportation in the area
About risks…

- Information on environmental risks and adverse effects is uncertain

- Industrial activities can cause widespread public fear of environmental pollution; provision of environmental ethically negative activity, concern for environmental sustainability, the potential long-term effects of emissions from exposed workers and residents of state of health, etc…

- Outtake from an environmental permit text: “environmental risks are culturally bound reality, in which phenomena are understood as problems set a specific time in a given context and with a commensurability that is always subjective”
The two sides of air

- The largest source of particulates from Rautaruukki Raahe
- \( \text{SO}_2 \) from steel manufacture and peat powered power plants
- \( \text{NOx} \) from transport and energy production
Dispersed pollution: the last remaining water pollution problem in Finland??

- Industry
- Municipalities
- Other

Phosphorous: point sources

Nitrogen: point sources
Groundwater & drinking water

- Municipal freshwater delivery in North Ostrobothnia is based on groundwater – everywhere, except in Oulu, where we use surface water.

- Almost all N-O groundwater is soft and acidic.

- In some areas problem of high Fe and Mn content.

- Several threats (industry, landfills, wastewater, chemical and oil pollution, road maintenance, manure spreading on land…)

- But everywhere, the drinking water is excellent.
CIRCULATION OF WATER

Raw water is purified and transferred to household use, after which it returns as sewage to the sewage treatment plant.

H_2 OULU

OULUJOKI RIVER

PUMPING STATION

SCREENING

MIXING AND SEDIMENTATION

FILTRATION

INTERMEDIATE BASIN

UV-DISINFECTION

CLEAR WATER BASIN

WATER TOWER

FINAL ADDITION OF PURIFYING CHEMICALS

OZONIZER

ACTIVE CARBON FILTERING

WASHING AIR, WASH-WATER

CARBON Dioxide, CHLORAMINE, IODINE

WASH WATER

NETWORKS

Water pipes 970 km
Sewage sewers 635 km
Rainwater sewers 310 km

Sewage pumping stations 167 pcs
Rainwater pumping stations 125 pcs

GULF OF BOTHNIA

POST FILTRATION UNIT

ACTIVE SLUDGE TREATMENT

MIXING AND AERATION

POST SEDIMENTATION

PRE-SEDIMENTATION

MIXING AND FLOCCULATION

SAND EXTRACTION

INCOMING WASTEWATER

BAND SCREENING

WASHING WATER FROM THE FILTERS

CLEANED SLUDGE

RETURN SLUDGE

SLUDGE DRYING

MIXING TANK

KEMICOND

REJECT WATER

COMPOSTING, USE AS SOIL CONDITIONER AND CULTIVATION BASE

LIME, FERROUS SULPHATE

POLYALUMINUM CHLORIDE

METANOL
Municipal solid waste management

- Municipal solid waste management is a basic service that consists of collection, transportation and treatment systems provided by municipalities, waste management companies and producer responsibility organizations. Waste transportation can be organized by municipalities or by using contractual waste transportation.
Reception points for recoverables

- every reception point has separate containers for paper, cardboard, glass, plastic and metal
- almost 70 reception points (Ekopiste) in Oulu Waste Management’s operation region
Sorting of household waste

Detached houses and other small houses, 1-3 households

Kerbside collection:
- mixed waste
- bio-waste: compost whenever possible.

To local reception points:
- paper
- glass
- paperboard cartons
- metals
- plastic
Sorting of household waste

Terraced houses and others with 4-10 households

Kerbside collection:
- mixed waste
- bio-waste: composting also allowed
- paper
- paperboard cartons

To local reception points:
- glass
- metals
- plastic.
Sorting of household waste

Blocks of flats and large terraced houses with 10 households or more

Kerbside collection:
- mixed waste
- bio-waste: composting also allowed
- paper
- paperboard cartons
- glass
- metals

To local reception points:
- plastic.
Oulu Waste Management (Oulun Jätehuolto)

- Oulu Waste Management is a public-service company of the city of Oulu.
  - responsible for waste treatment, coordination of waste transport and waste education and supplementary services for both to private customers and companies.
  - private customers can use reception points and landfills, recycling center and consultation services.
  - funded by the fees collected from the delivery of waste to the Rusko Waste Management Centre and funds received from the sale of methane gas produced in waste management centre and from other services.
- The operation region of Oulu Waste Management includes 16 municipalities with over 275 000 residents (106 000 households).
Rusko Waste Management Centre

- Rusko Waste Management Centre consists of 93 hectares of protected park area of which 5.5 hectares are in use for landfilling of mixed waste and construction waste
  - operations like reuse stations, hazardous waste storing, composting and for office use.
  - reusable and recyclable domestic waste and hazardous waste to the free reception station
  - about 300-350 customers visit waste centre every day.

- Separately collected bio-waste is handled in composting plant with three specially designed composting drums

- Landfill produces methane which is utilized to produce electricity and heat energy.
Oivapiste
Rusko Waste Management Centre
Amounts of recoverables in Oulu area

- Energy waste: 345,320 kg in 2009
- Paperboard: 632,380 kg in 2009
- Plastic: 763,740 kg in 2009
- Cardboard: 229,680 kg in 2009
- Glass: 1,214,300 kg in 2009
- Paper: 3,420,900 kg in 2009
- Metal: 1,162,270 kg in 2008
MSW statistics

- Mixed waste: 59%
- Paper and board: 14%
- Biowaste: 11%
- Glass: 3%
- Metal: 2%
- Wood: 2%
- Plastic: 1%
- WEEE: 2%
- Others: 5%

(Statistics Finland)
Journey of recyclables

- Bio-waste composted in Rusko
  - landscaping and construction work at the waste centre in Oulu

- Part of the MSW and plastic is used for REF fuel (*REcovered Fuel*)
  - used in heating plant in Kajaani or in Anjalankoski, Kokkola and Pietarsaari.
  - In future, energy waste will be incinerated in waste power plant in Laanila, Oulu.

- Metal
  - raw material in industry in Tornio, Raahe and Heinola
Journey of recyclables

- **Waste paper**
  - raw material for newspaper, catalogs, toilet paper and kitchen paper in Kaipola

- **Cardboard**
  - raw material for coreboard, packing board and corrugated cardboard in Pori.

- **Glass**
  - earthwork of landfills in Oulu
  - raw material for the preparation of thermal insulation material, glass bottles and glass packages and window glass in Forssa
Kainuu

The Finnish side of the green belt
The state of the environment in Kainuu

- Kainuu's natural environment is characterized by numerous waterways, large forest areas, ridges, hills and swamps.

- State of the environment can be described with the concepts of purity and naturalness.

- The soil is mainly moraine, which is broken by occasional outcrop.

- Water bodies are naturally dystrophic and slightly acidic due to the marsh environment.

- Kainuu has a good air quality and emission sources are few.
Waste management in Kainuu

- Kainuu used to have 56 municipal solid waste landfill sites. In the late 1990s, there were only 24 landfill sites left. Currently, there is only one landfill in operation in Majasaarenkangas.

- This trend is similar also in other areas of North-Finland.

- Involves the centralization of waste treatment, which will entail longer transportation distances.

- Also the re-interpretation of the landfill ban from biodegradable to organic will ban apart from biowaste and paper also plastics from landfills.

- There is an increased interest in professional circles in the incineration of mixed waste.

- Experts warn that while there is a good market for high quality energy waste, but the lack of economic incentives in the incineration of low quality waste will discourage investors.
Water in Kainuu

✧ Kainuu has a total of 260 classified groundwater areas
   ✧ Category I (an important groundwater area) are 53 areas
   ✧ Class II (suitable for water supply ground water area) 161

✧ Groundwater quality is generally good. Ground waters are slightly acidic, pumping stations are in use alkalization

✧ The biggest risk to groundwater purity are related to earth-material removals and transport

✧ The impact of road salting on groundwater has also been noticed

✧ In addition, on important ground water areas are dozens of landfills, gas stations, light machinery repair workshops, and cemeteries located

✧ Only a few cases of groundwater pollution is due to solvents

✧ Industrial waste water are discharged through the river Kajaani to Lake Oulu

✧ Oulu Lake is also burdened by water and material flows from local water catchment areas of agriculture and forestry as well as industrial, urban and peat extraction
Peat – now is it renewable or not?

- Finland considers it “slowly renewing biomass fuel” – 1 000 – 5 000 yrs…
  - IPPC does not consider peat as fossil fuel
- The Minister for Environment wants to increase its tax and considers that peat-based energy generation is not going to be profitable in 10 years
  - Earlier he wanted to phase out peat in 20 years
- He chastised peat production especially for water pollution, esp. siltation damages
  - Peat producers argue that they are responsible for only a fraction of water pollution and blame agriculture
- Pro-peat advocates argue that yet only a fraction of peat reserves have been exploited
  - Estimate the amount is equivalent twice North Sea oil reserves
A “special” form of biofuel

✦ The Finnish climate favours bog and peat formation

✦ The CO$_2$ emissions of peat are higher than those of coal

✦ Agricultural and forestry-drained peat bogs actively release more CO$_2$ annually than is released in peat energy production in Finland

✦ Peat extraction is also seen by some conservationist as the main threat to mire biodiversity

✦ It is a common practice to forest used peat bogs instead of giving them a chance to renew, leading to lower levels of CO$_2$ storage than the original peat bog

✦ Good experience with fertilizing exploited peatland with peat ash
  ✦ Although Cd and As concentrations could increase - skip the berries and mushrooms next year
Lapland

The land of the midnight sun
Lapland in figures

- Area about 100 000 km$^2$
- 600 km high, 300 km wide
- 183 000 inhabitants
- Population density 2/km$^2$
- Tourists yearly 2,2 Million
- 21 municipal areas
- Rovaniemi largest with 60 000 inhabitants
- 4 cities (Rovaniemi, Kemi, Tornio, Kemijärvi)
National parks and skiing centres in Lapland
The mining boom in Finland

- Well-being depends on minerals and metals, and some critical metals have been available only outside of EU
- 2/3 of those minerals & metals recognized in Europe as critical are either mined or potentially available in Finland
- Reason for this is the old age of the Fennoscandia bedrock
- Several new mines to open, especially in Lapland
- The investment are from several hundreds to even millions of euros
Metal mining in Finland 1950-2006 and prognosis for 2015

Great potential in the Finnish bedrock!
Railways today
Finnish railway development plans (or dreams?)

- Railroad to Hannukainen iron ore mine, 20 km, would cost 10 M €
- Basic renovations during 2008-2012
- Replacing concrete blocks 2011-2013
- Controversial reactions, would be $10^9$ € investment
- North sea connection $10^9$ € investment
- 200 M € investment, Russians not interested

Under work
Under examination
To be discussed
Environmental “issues“ at Talvivaara

- Uses bioheapleaching process
  - Metals are leached from ore using a bacterial action
  - Heralded as a green mining operation
- The mine waters contaminated neighboring lakes
  - The water has turned salty due to sodium sulfate discharges
- The company admits that they have not been able to correctly assess the amount of sulphates
  - Actual emissions were 60 times higher than estimates
- Local population as well as environmental organizations have called for Talvivaara mine to suspend operations for the failure to adhere to its permit conditions
- There has also been a death of an employee, they suspect hydrogen sulfide, as high concentrations were measured in the place he worked
- There is also the controversial government resolution to grant permission for uranium enrichment, even though several ministers voted against
- Rather perplexing situation that uranium enrichment licensing has been granted in principle, where even the current operations of the mine did not adequately follow its stated environmental conditions
Land-use conflicts

- In Western democracies individuals should have the right to participate in decision-making processes that concern important aspects of their lives
- Failing to manage common natural resources is one of the most paradigmatic examples that social dilemmas can produce
  - ‘The Tragedy of the Commons’ (Hardin 1968)
- Examples:
  - Nature conservation vs. reindeer husbandry
  - Forestry vs. reindeer
  - Hydro-power vs. fish migration
  - Mining vs. tourism
Is the Arctic still pristine?

- Arctic (abiotic) environments generally exhibit lower levels of contamination than regions closer to major sources e.g. Europe.

- Certain characteristics of the Arctic (cold, ice and snow cover, extended periods of darkness) mean that the Arctic has the potential to accumulate environmental contaminants, including Persistent Organic Pollutants (POPs) and mercury.

- The Arctic possesses unique food webs, including a number of key species that utilize fat reserves for energy storage and insulation.

- This resulted in a paradox whereby, despite generally low levels of contamination in air, soils or water, Arctic species high in the food-chains accumulate very high concentrations of certain contaminants.
Climate-induced changes in contaminant cycling

- Until recently, information about Arctic pollution issues has received limited attention outside of the region.
- Climate change has added a new dimension, increasing the relevance of this information for people also outside the Arctic region.
- The melting of arctic ice meant that a barrier has been removed, and contaminants locked in arctic ice are released back into the environment.
- Long-range transport of contaminants and re-distribution of contaminants in the sensitive Arctic environment already exhibits clear impacts.
- For example dioxins, PCPs, HCHs, DDTs, Hg, Cd, Pb and PFAs are studied.

(Ref.: ArcRisk, AMAP, ACIA)
North sea passage

Challenge or opportunity?

Just a thought: Lapland has 85% of the circumpolar area’s tourist bed facilities
Challenges of waste management in Lapland

- Waste management evolved slower than elsewhere in Finland, due to long transportation distances to treatment facilities.
- Wastes are primarily headed for landfill, as producer associations do not invest in developing recovery of recyclables in Lapland.
  - They fulfill their mandatory recovery quota in the South.
- In addition, due to tightening environmental standards, the number of landfills has reduced from 94 in 1992 to 15 in 2004 and, eventually, 3 in 2007.
  - Rovaniemi, Simo, Tornio.
- Mixed waste could travel up to 600 km to landfill.
- There are no waste incineration facilities in Lapland.
  - Tornio’s Outokumpu steel works’ power plant has the permit to co-incinerate their own energy waste (wood, plastic, cardboard, paper), up to 100 t/day but only trials have been done.
Developments in waste management in Lapland

ציגNESS: During the last decade collaboration among municipalities in waste management improved,

 Thief: There are currently three cross-municipal waste management companies

 The only regions that do not belong to any of them are Kolari, Posio, Simo, Utsjoki

 Also a number of “Ekopiste” collection places have been built

 Notwithstanding, the amount of waste produced in Lapland is 362kg/cap as compared to the 212 kg/cap. Finnish average
Legislative pressures

- The Landfill Directive requires the diversion of biodegradable wastes from landfills.

- Bio-waste Strategy of Finland prescribes that the amount of bio-waste going to landfill in 2016 shall not exceed 25%.
  - There is no data on the percentage of bio-wastes in MSW in Lapland, but it is estimated that over 2/3, some 44 600 tons end up in landfill.

- Lapland’s waste plan (19.12.2011) points out the need to improve the waste management of tourist centers, as well as the diversion of bio-waste from landfill.

- It is also stated that Lapland can only reach the 70% recovery target by increasing the energy recovery of wastes.
  - Trials of incineration of MSW (10% mix with traditional fuel) done.
  - Impurities in mixed waste (esp. glass and metal) lead to technical problems in the burning process.
Case study: Kolari, Lapland

- A popular tourist resort in the West region of Lapland, at the border of Sweden
- In 2010, 3,796 inhabitants and 136,279 tourists
- A sustainable waste management strategy combined with carbon-neutral energy would provide to a green tourism image of the area
- Challenges provided by the seasonality of wastes
  - Skiing season attracts most tourists
  - Some “ruska” (=colourful autumn) tourism
  - Christmas/new years eve holiday season
Waste amounts in Kolari, 2008-2011
W2E for Lapland?

- It is expected that waste-to-energy (W2E) technologies would provide a solution to both the waste and energy problems
  - Recommended the co-treatment of bio-waste and wastewater sludge
- Assessment for the economics of such facility in Kolari has been made by a consulting company (Metener Oy) in 2009
  - Bio-waste is treated by anaerobic digestion in a thermophilic process
  - The gas is used in CHP facilities or purified to be used as a transport fuel
  - The digestate is composted and used for soil remediation
- Seasonality is a challenge and an opportunity
  - The winter high season, when the excess heat can be utilized
  - However, a year-long continuous operation would require inputs from elsewhere in low season
- Ultimately, the solution could be smart energy grids!