FINSKEN Developing consistent global change scenarios for Finland

FIGARE 1999-2002

What are global changes?

The past centuries have witnessed a rapid increase in human population as a result of economic development and the successful exploitation of natural resources. However, the price of these human advances has been the accelerated degradation of the natural environment. Pollution of the atmosphere, soil, inland waters and oceans is a widespread phenomenon, with associated problems that include urban smog, acid rain, climate change, sea-level rise and stratospheric ozone depletion. We term these changes "global changes", because they affect all areas of the globe and because they touch upon all aspects of the relationship between human development and environmental change.

What are global change scenarios?

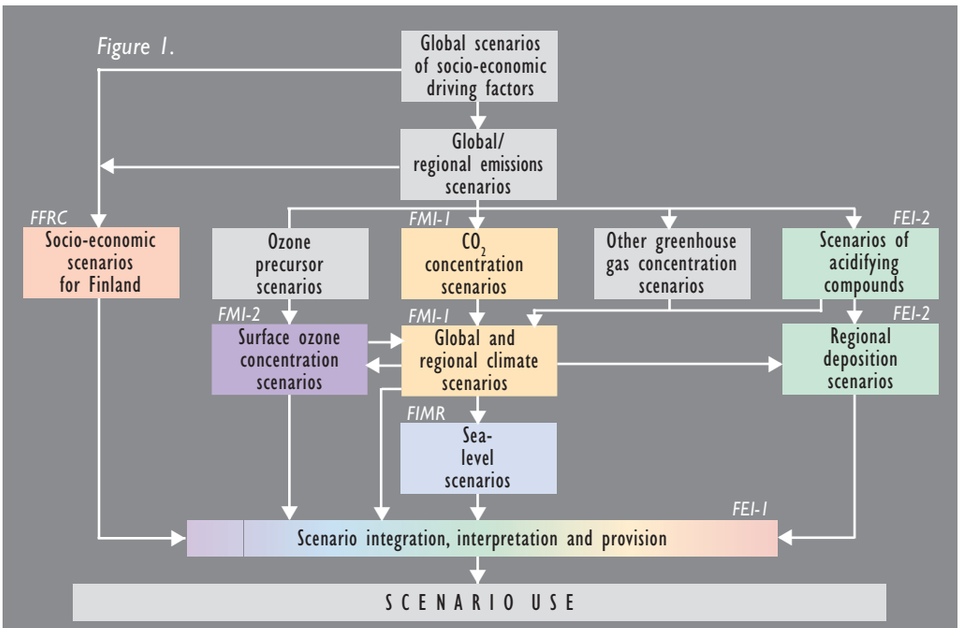
Environmental changes are continuing and, in many cases, accelerating. They pose a threat to human health and well-being, to natural ecosystems and biodiversity, to water quality and availability, and to food and fibre production. In order to judge the likely future implications of these changes, and to explore options for reversing or slowing ongoing trends, it is necessary to improve our understanding of current trends and to project them into the future. Since most environmental changes are strongly linked to socio-economic driving factors, it is necessary first to investigate how these may change in the future. Given the enormous uncertainties associated with estimates of future human behaviour, it is impossible to predict the future with any confidence; rather it is customary to construct "scenarios", which describe plausible future conditions. The environmental changes that result from these driving factors can then be estimated along a chain of dependencies, as shown in *Figure 1*.

What scenarios are being developed in FINSKEN?

Figure 1 illustrates how, for a given set of socio-economic assumptions, we can calculate a range of plausible scenarios of emissions of greenhouse gases and aerosols into the atmosphere. Similarly, for a given emissions scenario, it is possible to estimate the concentrations of gases and aerosols in the atmosphere, their effect on the radiation balance of the Earth, and their effect on the climate and, subsequently, on sea level. Projections are uncertain at each link of the chain, so that sets of scenarios need to be developed that represent the range of uncertainty at each level.

The FINSKEN project aims to develop state-of-the-art projections of changes in environmental and related factors in Finland during the 21st century and beyond. FINSKEN will consider both possible changes in average conditions (e.g. average annual temperature or sea level) as well as changes in the types of extreme events that can have important impacts (e.g. heat waves, cold waves, droughts, inland and coastal flooding).

Figure 1.



*The chain of dependencies in estimating global scenarios. Components studied in the FINSKEN project are labelled with acronyms of responsible institutes: Finnish Environment Institute **FEI**, Finnish Futures Research Centre **FFRC**, Finnish Institute of Marine Research **FIMR**, Finnish Meteorological Institute **FMI**.*

What is FINSKEN?

- *FINSKEN is a project in the Finnish Global Change Research Programme FIGARE.*
- *The full title of the project is "Developing Consistent Global Change Scenarios for Finland".*
- *FINSKEN runs from October 1999 to September 2002 and*
- *is jointly funded by the Academy of Finland, 67 % and the Ministry of Transport and Communications, 33 %.*

The scenarios to be developed include:

- **Socio-economic and technological scenarios**
  - population • economic growth
  - human welfare • emissions
- **Atmospheric composition scenarios**
  - carbon dioxide • ozone
  - sulphur and nitrogen compounds
- **Acid deposition scenarios**
- **Climate scenarios**
  - temperature • precipitation
  - atmospheric circulation
- **Sea-level scenarios**

Examples of these scenarios are shown in the boxes overleaf.

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How will FINSKEN scenarios be different?

One of the key objectives of FINSKEN is to develop scenarios that are mutually consistent. Many environmental changes are conventionally studied independently when actually they have a close dependence on other changes (e.g. climate change may affect patterns of acid deposition). One method of encouraging consistency is for all scenarios to be based on the same underlying socio-economic driving factors. Given the global or trans-national scope of environmental changes, they should also be consistent with projections widely accepted internationally. To achieve this, a number of global emissions scenarios recently developed by the Intergovernmental Panel on Climate Change *IPCC* Special Report on Emissions Scenarios SRES are being adopted as core projections in FINSKEN.

Socio-economic scenarios

Global scenarios of future socio-economic and technological developments paint radically different pictures of the future (see *Figure 2*). Some scenarios describe increasing globalisation, others more regional and local solutions, some scenarios posit consumerism, others emphasise the role of community.

How might these scenarios be interpreted at a national scale in Finland? Can they be reconciled with official demographic and economic projections used in decision making?

Socio-economic scenarios for Finland are being developed at the Finnish Futures Research Centre, Turku (FFRC).

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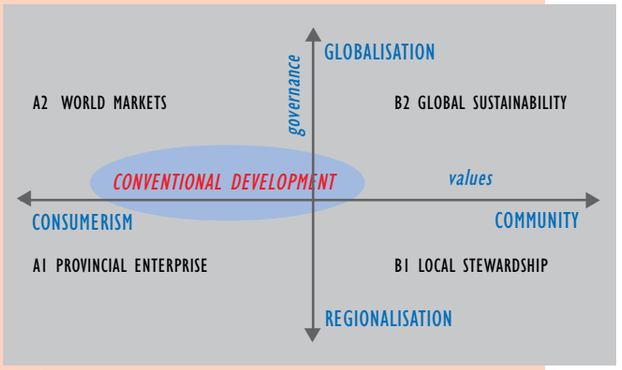

Fig. 2.
Four spatial futures scenarios.
Source: Adapted from UK-DETR, 1999

Carbon dioxide and climate scenarios

Atmospheric carbon dioxide concentrations rose rapidly during the past century, due to fossil fuel combustion and land use change, but can we expect these trends to continue? What concentrations can we expect in the future? Some previous estimates are shown in *Fig. 3.*

Mean annual temperatures in Finland have risen slightly during the past century *Fig. 4*, but will this warming accelerate in the future as atmospheric concentrations of CO_2 and other greenhouse gases increase? During the Finnish Research Programme on Climate Change *SILMU* some projections were made for the 21st century *Fig. 4*, but are these still valid? How may other weather variables such as precipitation and cloudiness change? Will there be more extreme weather than at present?

Research into CO_2 concentration and regional climate change scenarios is being conducted at the Finnish Meteorological Institute (FMI-I).

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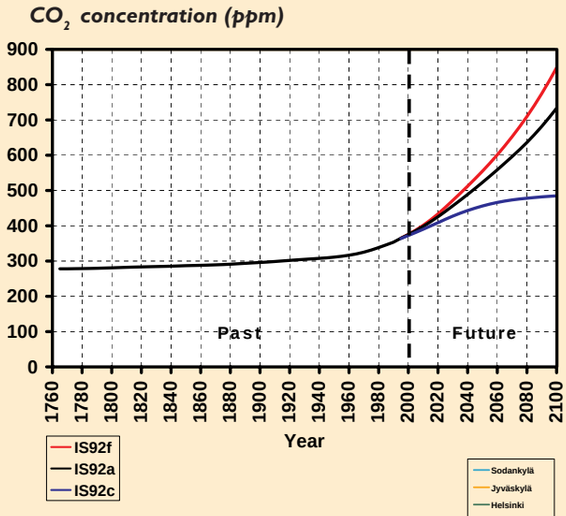

Fig. 3.
Global atmospheric carbon dioxide concentration, 1765 - 2100. Values up to 1958 are estimated from ice cores; from 1958 - 1995 are measured directly, and from 1995 - 2100 are estimated by the MAGICC model under the IS92a, IS92c and IS92f emissions scenarios.
Source: Based on Carter et al., 1996.

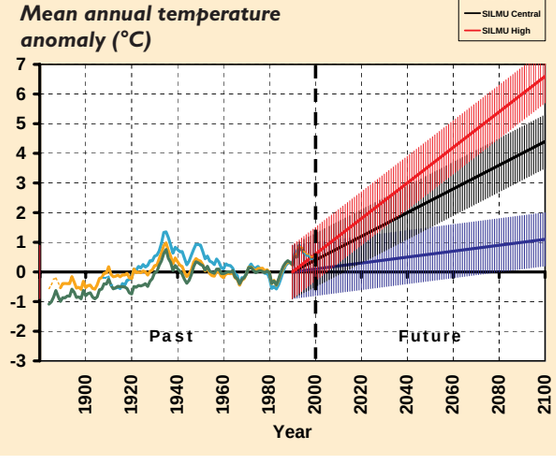

Fig. 4.
Mean annual temperature in Finland, 1884 - 2100. Past observations are 10-year running means at Sodankylä (from 1908), Jyväskylä and Helsinki (data from Finnish Meterological Institute). Future scenarios (from 1990) are for all Finland (Carter et al., 1996); shaded regions superimpose historical inter-decadal variability (±2 SD) on future projections. All values are relative to 1961-1990.

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Sea-level scenarios

On average the global sea level has risen by about 10 - 15 cm during the past century, but in Finland the land is still rising following the disappearance of ice after the last glaciation. The net effect has been a fall in relative sea level *Fig. 5*. This fall has slowed in recent decades, but this is probably a regional effect in the Baltic Sea of changes in wind climate, as similar trends are not evident on Atlantic coasts. Previous projections suggest that accelerated global sea-level rise may reverse the historical downward trend on the southern coast of Finland *Fig. 5*. Are these projections still valid? And how would possible future changes in atmospheric pressure or in storm intensity affect the risk of coastal inundation?

Sea-level changes are being investigated at the Finnish Institute of Marine Research (FIMR).

Sea level at Hanko (m)

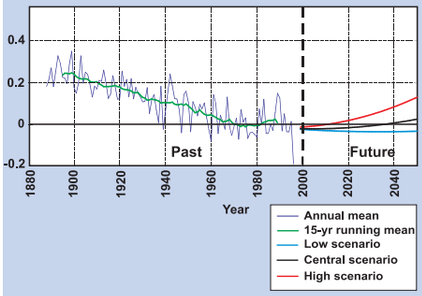

Fig. 5.
Sea level at Hanko, southern Finland, 1888 - 2050 relative to 1966 - 1980. Values up to 1997 are from tide gauge measurements; estimates to 2050 assume a continued steady rise of the land combined with IPCC high, central and low estimates of global sea-level rise for a Business-as-Usual emissions scenario (Warrick and Oerlemans, 1990).
Source: Based on Kahma, 1997.

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Scenarios of acidifying compounds

Recent policy measures to control emissions of sulphur and nitrogen compounds into the atmosphere are expected to lead to reductions in deposition over Finland *Fig. 6* and in acid loading of ecosystems and inland waters. Will these trends continue for all acidifying compounds in the extended future under alternative emissions scenarios? How much will the patterns of deposition be modified by possible changes in atmospheric circulation due to climate change?

The development of deposition scenarios is being carried out at the Finnish Environment Institute (FEI-2).

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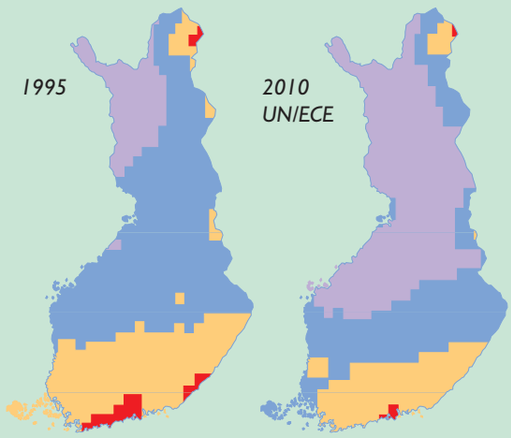

Fig. 6.
Total deposition of sulphur compounds over Finland, modelled for observed emissions (1995) and under an emissions control scenario for 2010.
Source: Based on Syri et al., 1999; UN/ECE, 1999

Scenarios of surface ozone concentrations and exposure

Surface ozone levels have been rising slowly in Europe during the 20th century (e.g. see *Fig. 7*) and exposure to ozone is thought to have caused declines in vegetation productivity and crop yields.

How are surface ozone levels projected to change under different emissions scenarios? How might climate change affect the concentrations of ozone and the sensitivity of vegetation to ozone exposure?

Surface ozone is the focus of research at the Finnish Meteorological Institute (FMI-2).

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Ozone concentration at Utö (µg/m³)

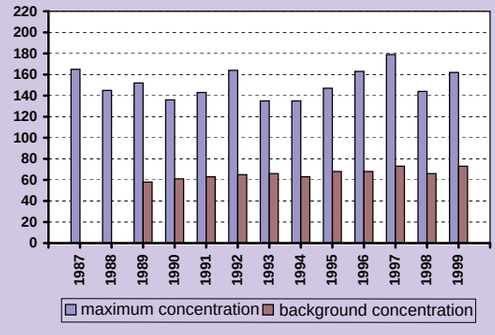

Fig. 7.
Annual maximum and background ozone concentration at Utö, Finland, 1987 - 1999. Background concentration is the annual median of ozone concentration on "clean days" (total nitrate concentration below 0.1 micrograms N per cubic metre). Background ozone concentrations are missing for 1987 - 88 because nitrate values are not available.
Source: Laurila and Hakola, 1999.

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Scenario integration

There is a range of tools available to investigate the implications of a given set of emissions scenarios for various environmental changes. These usually involve mathematical models – some very simple and others highly complex – but may also require elements of expert judgement. Information from all of these sources will be required in FINSKEN. In addition, a further class of models that attempt to account for the interactions and feedbacks between many different environmental changes – integrated assessment models – will also be used to help ensure consistency in the scenarios.

The methodological aspects of scenario development and all results will be documented by the project researchers in peer-reviewed reports and journal articles. Documentation about the scenarios and background data will also be made available to potential users via the FINSKEN Web site. In addition, workshops are planned in which the scenarios are presented and users are invited to provide feedback on their utility.

The co-ordination of FINSKEN is being undertaken at the Finnish Environment Institute (FEI-1).

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Publisher	Finnish Environment Institute
Editor	Timothy Carter
Printer	Miktor
Paper	Finnish swan-labeled 441 194 Printed matter
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