BOREAL ENVIRONMENT RESEARCH 9: 109–125 ISSN 1239-6095
Helsinki 7 May 2004 © 2004

# Defining alternative national-scale socio-economic and technological futures up to 2100: SRES scenarios for the case of Finland

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Kaivo-oja, J., Luukkanen, J. & Wilenius, M. 2004: Defining alternative national-scale socio-economic and technological futures up to 2100: SRES scenarios for the case of Finland. *Boreal Env. Res.* 9: 109–125.

The basic ideas of scenario planning are to provide analyses of potential future trends and the preparations for the changes brought about by those future trends. Thus the FINSKEN project has developed new integrated scenarios that analyse the potential changes in environmental and socio-economic factors for Finland in the 21st century. This article provides long-run socio-economic scenarios for Finland as a contribution to the FINSKEN project. Its aim is to present and analyse future scenarios of Finland's population and economic development, as well as to apply relevant technological and social foresight studies approaches. In this article, four tailored storylines and worlds of future development are presented for Finland. These are related to the scenarios of the Special Report on Emission Scenarios (SRES) of the Intergovernmental Panel on Climate Change (IPCC). The storylines are based on expert interviews and material from official and expert documents. In addition, the authors operationalise the four storylines for the Finnish economy using the International Futures (IFs) for Terra world model. Furthermore, empirical results and model runs concerning the economic and social long-run transition paths of the Finnish economy are presented.

## Introduction

The aim of this article is to operationalise the global scenarios developed for the Special Report on Emissions Scenarios (SRES) of the Intergovernmental Panel on Climate Change (IPCC — Nakićenović *et al*. 2000) at a national scale for Finland, and to examine those scenarios to see if they are consistent with the IPCC's scenario framework. Such scenarios have not been presented before for Finland.

Global climate change has an effect on many aspects and dimensions of the world's socio-economic and ecological systems. Boreal forests are one of the most important dimensions of this complex inter-linked system, which therefore has a special interest for Finland. In this article we also analyse many other dimensions, which are important for policy planning. This is due to the fact that a multi-dimensional system can have crucial effects on forests through its many interactions and feedback loops, which gives rise

to the need for a multidisciplinary approach. In the IPCC process this type of multidisciplinary approach has also been seen as the only relevant point of departure and is reflected in its structure, which consists of three working groups; one concentrates on natural science questions and two have social science and technological approaches (IPCC 2001).

Anticipated climate change is expected to vary greatly from region to region and from season to season. The impacts of climatic change in any region depend on the specific changes that occur in that region. The same logic of that process is also relevant in socio-economic issues: the impacts of climatic change in any region depend on the specific socio-economic transition paths in that region, which are, however, dependent on interactions within the global socio-economic system. A transition can be described as a gradual continuous process of change in which the structural character of society (or a complex sub-system of society) transforms. The transition concept seems to be useful in describing broad, long-term and structural societal changes and for explaining their mutual connection (Martens and Rotmans 2002).

Sometimes structural changes in one or more parts of society are needed to realise long-term goals. Given the uncertainties associated with estimates for future human behaviour, it is impossible to predict long-run future events and structural changes with any confidence; rather it is customary to construct scenarios, which describe plausible future conditions.

The effective management of climate change on the national as well as international level requires close co-operation between the scientific community and the political sector (Wilenius and Tirkkonen 1998). According to that, Finnish climate strategy should be based on long-run scenario analyses and interlinked climate strategies. It is believed that this study will help the political sector and various stakeholders in the strategic discussions concerning the Finnish climate policy regime.

The basic idea of scenario planning is to provide an exploration of potential future change and the preparation for those changes. This article deals with long-run socio-economic scenarios for Finland up to 2100. The aim is to present and analyse future scenarios for Finland's population and economic development, as well as to apply relevant technological and social foresight studies approaches. The research work was produced in the context of the larger FINSKEN project in order to complement the natural science oriented scenarios and to provide a consistent set of scenarios using the same time frame and similar driving forces from the SRES scenarios of the IPCC.

In this article the basic ideas of the scenario accounting model of the SRES storylines for Finland are presented. In order to operationalise the four basic IPCC scenarios for the Finnish economy, a long-run scenario accounting model is utilised. For the basic modelling framework the IFs for Terra model, which was developed by Barry Hughes (developed in its present form for a EU/IST research project Terra2000, *see* www.terra-2000.org), was utilised. The details of the modelling framework are presented in the model documentation (Hughes 1999a, 1999b, 2000, 2002).

Scenario building, which is a way of constructing a discourse, can be based on mathematical models or e.g. expert interviews. Models can never produce value free "objective" pictures of reality. They are always framed, interpreted descriptions of selected parts of reality. The selection of model structure and variables, "the tuning" of the parameters and the decisions as to what is included, and in many cases even more importantly, what is not included in the model are the distinct choices of the modeller and they all bring normative components to the models. This is also true for the use of interviews in scenario building. This means that scenarios are the interpreted views of possible future development paths. "There are no views without viewpoints" as Gunnar Myrdal has said. (Myrdal 1967, Luukkanen and Kaivo-oja 1999)

To aid the analysis, the scenarios are interpreted as discourses. A discourse is related to (i) the context in which it is produced, i.e. the social practices, and (ii) the content of what is said, i.e. it produces a set of contents, concepts and categorisations. In the discursive field enunciative modalities define who is able to meaningfully express the ideas of a certain aspect.

The scenarios are related to the SRES scenarios of the IPCC and were built using the Interna-

tional Futures (IFs) model, information obtained from expert interviews and various documents concerning possible global and Finnish future development paths and trends.

The expert interviews included representatives from the significant areas of the Finnish economy and administration. The target of the interviews was to collect ideas about possible development paths, not to legitimate certain scenarios or results. The interviews created their own discourses and brought forward certain viewpoints and ideas. The people interviewed wanted to express their ideas confidentially and not to relate the ideas to their position or organisation. That is why the names of those interviewed and their organisations are not given.

Storylines related to possible future developments, empirical results and model runs concerning the long-run transition paths of the Finnish economy are also discussed, as are the methodological questions and challenges of scenario planning. However, this paper does not contain any strategic analysis of different scenarios and stakeholders. The paper is organised in the following way. The IPCC scenario framework is presented in the next section. In the third section the socio-economic scenarios and storylines for Finland are put forward. These are partly based on interviews with experts from the administrative and business sectors. The fourth section includes social and economic scenario analyses based on the above-mentioned IFs for Terra model, and the final section presents the conclusions of the study.

## IPCC scenarios and the basic scenario "family"

The huge uncertainties surrounding the future impacts of climate change make the need for informed societal debate and reflection urgent. Scenarios provide a mechanism for both reflective discussion and analytical evaluation procedures. The process of discussing different socio-economic scenarios of the future may help inform current decisions, as stakeholders come to better appreciate the long-term impacts of their decisions. Scenarios can be seen as a part of a learning process towards a more sustainable society (Kaivo-oja 2001). Scenario analysts reject the view that the future of humanity is in some sense pre-ordained or primarily determined by the external physical environment (environmental determinism). According to the scenario approach, humans are assumed to possess a significant degree of agency (i.e. self-determination and choice) in relation to what kind of future they prefer. In other words, the future can be shaped by conscious and deliberate choices made today.

The SRES features alternative storylines about the future. They are qualitative, holistic pictures of the general structures and values of the global society. They describe socio-economic conditions that might be produced by human choices regarding social and economic policy, reproduction, occupations and energy/technology use. The pace of population growth and economic development are set within and partially explained by the alternative tendencies of policies to support forms of global governance or localised self-sufficiency. There are four SRES storylines (Nakićenović *et al*. 2000).

The IPCC scenarios have also been regionalized in the European context in the ACACIA project (A Concerted Action Towards A Comprehensive Climate Impacts and Adaptations Assessment), which is a European attempt to bring combined, interdisciplinary, scientific expertise to bear on the climate change questions (Parry 2000). Over a three-year period it harnessed the knowledge of some 40 top experts on climatology, the environment and the human sciences from 12 EU countries. The aim of ACACIA was to draw up a scientific inventory of the likely scale of climate change in Europe over the coming century and of the concrete effects of these hypotheses for our continent's major regions. ACACIA elaborated four scenarios on the basis of a combination of the UKCIP (UK Climate Impact Programme) and SRES approaches.

The A1 storyline and scenario family describe a future world of rapid economic growth, a global population that peaks mid-century and declines thereafter, and the rapid introduction of new and more efficient technologies (Fig. 1). Innovation is rapid in this scenario. Some sectors (private healthcare, information technol-

| | |
|---|---|
| A1. World markets: Fast EU enlargement | B1. Global sustainability: Slow EU enlargement |
| A2. Provincial enterprise: Break-up of quasi-federal EU | B2. Local stewardship: No EU enlargement process, the EU exists |

**Fig. 1**. The four SRES scenarios of the IPCC and European policy arena (Berkhout *et al.* 1999, Parry 2000: pp. 40–45).

ogy, biotechnology and pharmaceuticals) will thrive whereas others will be vulnerable (heavy industry, manufacturing). States will lose external powers as their economies become increasingly integrated and globalised. Multinational firms will steadily achieve greater power; states will find they are increasingly unable to control economic activities within their own territories. This means that governance will rapidly replace national governments. EU social and economic policy will become increasingly harmonised in order to create a level playing field for multinational business to compete. The EU will promote voluntary agreements and market based instruments instead of regulation, which is regarded as a constraint upon growth and innovation. The major underlying themes are economic and cultural convergence and capacity building, with a substantial reduction in regional differences in per capita income. Berkhout *et al*. (1999) have described this scenario as the "Global Markets" scenario.

The A2 storyline and scenario family, describe a very heterogeneous world. The underlying theme is self-reliance and the preservation of local identities. In this scenario European enlargement stalls or proceeds extremely slowly. This may result in the break-up of the quasi-federal EU, as we now know it, due to greater conflict between the largest and most powerful member states. In this storyline, there is little coordinated integration of European policies. The retreat of the state continues to reflect the continuing popularity of consumerism and market-led values. Consequently, the bulk of service provision (including the running of schools and prisons) is undertaken by the market.

In this scenario political commitment to environmental management weakens and states and sub-state entities begin to adopt approaches depending upon what is viewed to be important locally. The environmental policy of the EU becomes increasingly heterogeneous in spite of industry's demand for a level playing field. Global environmental problems such as climate change are neglected politically as pressure grows in Europe to tackle sub-regional problems. Economic development becomes primarily regionally oriented and per capita economic growth and technological change is seen as more fragmented and slower than in other storylines. Berkhout *et al*. (1999) described this scenario as the "Provincial Enterprise" scenario (Parry 2000: pp. 42–44).

The B1 storyline and scenario family, describe a convergent world with the same global population that peaks in mid-century and declines thereafter as in the A1 storyline, but with rapid changes in economic structures toward a service and networked information economy, reductions in material intensity, and the introduction of clean and resource-efficient technologies. The emphasis is on global solutions for economic, social, and environmental sustainability, including improved equity, but without additional climate initiatives. Berkhout *et al*. (1999) have described this scenario as the "Global Sustainability" scenario. In it the political deepening of Europe proceeds at the same pace as the process of the widening of the EU beyond the existing EU-15 structure. The EU adopts a much more federal structure with a directly elected executive and a powerful Parliament. More and more state sovereignty is shifted to the EU and sub-national bodies to produce a democratic, multilevel system of governance. The enlargement proceeds much slower than under the "World Markets" scenario partly because of the perceived cost of bringing new entrants up to existing social and environmental standards.

According to this storyline, national governments stay powerful and the public sector takes care of education and health care services. Strong regulatory agencies, fully accountable to the public and with statutory remits to promote sustainability, ensure that the public interest is not sacrificed in the pursuit of private profit. Sectors like transport and energy, which have a critical role in achieving sustainable development, are the target of more state intervention. The EU adopts a strong process of setting product standards across Europe.

The B2 storyline and scenario family describe a world in which the emphasis is on local solutions to economic, social and environmental sustainability. It is a world with a continuously increasing global population, but at a rate slower than the A2 scenario, only intermediate levels of economic development, and less rapid and more diverse technological change than in the B1 and A1 storylines. While this scenario is also oriented toward environmental protection and social equity, it focuses strongly on local and regional levels. In this scenario, there is little role for the private sector. Many service delivery functions are returned to local authorities who are seen to be closer in political terms to citizens and hence more accountable. Local government replaces global governance. Berkhout *et al.* (1999) have described this scenario as the "Local Stewardship" scenario (Parry 2000: pp. 44–45).

## Socio-economic scenarios for Finland

As stated, the SRES scenarios are operationalised in this study for Finland. Basically there are two different approaches to plotting the scenarios; inductive and deductive (Schwartz and Ogilvy 1998). The inductive method is less structured and relies largely on experts' analyses. Typically the inductive approach has two variants. In one, an expert group brainstorms different events that are typical for different scenarios. In the other, the group agrees on what the "official future" will look like and then searches for influences that will cause the future to deviate substantially from that path. The deductive approach is based on the identification of two key factors, which describe the two most critical uncertainties. Typically this approach produces a $2 \times 2$ scenario matrix. In this study we adopted both the deductive and inductive approaches. As we know, the IPCC approach is based on a deductive $2 \times 2$ scenario matrix (Fig. 1). We enriched the deductive approach by introducing inductive logic in the form of expert interviews and official policy documents, which described the "official futures" of Finland. The inductive logic approach helped us to construct the futures scenario table for Finland. We also operationalised a $2 \times 2$ scenario matrix by using the IFs for Terra model, which produced the explorative scenarios explained later in the text.

In the previous section we presented the basic characteristics of the SRES scenarios. The fundamental reason why these scenarios were presented was that the interviewed experts strongly emphasised the necessity to contextualise the scenario analysis of Finnish society in the common European scenarios. Many experts stressed the point that Finland will follow general European policy trends as a member of the European Union. Some experts underlined the point that SRES scenarios seem to be based on the critical assumption that there will not be large wars or economic recession periods during the 21st century.

The interviewed experts pointed out that climate change cannot be seen as a major threat as such in Finland, but the effects of climate change on the world's socio-economic system and the related consequences for the Finnish system may be considerable. Many experts said that they consider the A1 type of development path the most plausible scenario path.

For the Finnish case four different scenarios were analysed: (i) "Global Markets Integrated Finland" (related to scenario A1), (ii) "Neoliberal Industrial Finland" (related to A2), (iii) "Sustainability Oriented Finland" (related to B1) and (iv) "Local Stewardship Finland" (related to B2). In the construction of the long run scenarios for the Finnish society, the IPCC scenarios, the official futures analyses of the Finnish Government, research documents and expert interviews were used as starting points (Futures Committee 2002, Kaivo-oja *et al.* 1997, Kaivo-oja 1999, 2001, 2002, Kaivo-oja and Suvinen 2001, Kaivo-oja *et al.* 2001, Carter *et al.* 2002, Expert respondents 2002, Tirkkonen *et al.* 2001, Wilenius and Puolanne 2002). For the consistent formation of storylines for long run scenarios, the Uusimaa-Helsinki Metropolitan areas' official scenario analyses and studies were also used (Uudenmaanliitto & YTV 1997), which were formulated on the basis of a large public participation process. On the basis of those futures, policy statements and analyses, interpretations of alternative development paths and the critical drivers of the Finnish society were constructed.

The analyses of different dimensions, which are important for the development of Finnish society during the next 100 years, will be presented in the next sections. The ideas were collected by interviewing experts in the Finnish public administration and Finnish business representatives in addition to scientific experts (Expert respondents 2002). Expert statements were analysed together with official policy statements. The expert interviews and the information gained from them provided baseline trend indications, which consequently formed the bases for the scenario projections. In the following sections some of the main driving forces of Finnish societal transformation are discussed in order to build the structure for the storylines of the selected interpretations of potential Finnish futures.

## Human capital as a critical driving force behind Finland

The development of human capital was seen as essential for the future of Finland. In the knowledge based information society the role of human capital increases when compared with the role of natural resources. A human capital deficit was seen as the main constraining factor in any socio-economic development. In this respect the functioning of the education system is crucial and sufficient investment in education was seen as the most important factor for future development (Expert respondents 2002).

On the basis of official policy statements, it was apparent that future development is focused on modern knowledge society infrastructures, which are more urban and concentrated than today's infrastructure in Finland. The borderlines between industries were predicted as being vague and transparent in the future and industrial integration will be the main trend (Expert respondents 2002). The key "official" vision of Finland is that it will be a competitive and modern knowledge society (Futures Committee 2002).

Official policy statements from the Finnish government imply that globalisation together with information and communications technology (ICT) and Internet networks will radically change the location and scale of economic activity in Finland. Investments in education and science and technology will be the key drivers of this modern knowledge society. The official vision of future development is that in Finland there will be 5–6 large urban centres and about 32 smaller regional centres (Futures Committee 2002).

An optimistic view of the future was of Finland as a university campus producing innovative design and theoretical intelligence and knowledge for products that would be mainly produced outside Finland. Knowledge workers will produce large value added benefits with little use of natural resources. A pessimistic view is that the human capital deficit becomes a restricting factor in the realisation of the growth potential (Expert respondents 2002).

## The future of industrial structures

The structure of Finnish industry has changed considerably due to the growth of the ICT sector. It is assumed that the restructuring of the sector will continue in the future, but there also exists an important trend of industrial integration. This refers to the trend whereby different industrial sectors increasingly utilise the products and services of the other sectors thus developing towards a more networked structure. The importance of the role of technical intelligence in the products will increase and more value-added benefits will be gained through the information component of the products. One example is the technical intelligence added to packaging materials. Specialisation is also one trend, where production is oriented towards making high value added special products that are tailored according to consumer needs (Expert respondents 2002).

The role of natural resources remains important in Finnish industry. The forest industry is a good example of this. The renewable forest resources in Finland are, however, restricted in volume and a large increase in their material production volume is not expected without a considerable increase in imported raw material. In the long run major new pulp and paper production investment may be oriented towards tropical areas. Production specialisation will however increase the value added of the forest industry in Finland. In the long run new information

technologies may challenge the use of paper as an information spreading channel and storage method. In the year 2002 the consumption of office paper decreased 2%–4% mainly due to increased use of information technology, but large reductions in paper consumption may not be visible in the near future. However, packaging material consumption seems to have also increased due to, e.g., new forms of marketing such as e-commerce (Expert respondents 2002).

Climate change was not seen as a serious threat to the Finnish forest industry by those interviewed. The possible slow changes in the tree species structure of Finnish forests will probably not cause any adaptation problems for the industry, which operates on the global scale. In any case, the role of imported wood material will increase in the near future, and this can compensate for local changes (Expert respondents 2002).

## The future of food production

In Finland population growth is slow and no major increases in environmental pollution are expected. This will result in steady circumstances for the future of food production in this respect. Comparatively clean soil and water are important factors for competitiveness and the increasing importance of organic farming, in which consumer preferences provide possibilities for growth. Climate change is, however, a concrete threat that affects the ecological conditions of food production resulting in adaptation problems.

The liberalisation of the world markets for agricultural products in the WTO's agreements and the enlargement of the EU poses a threat to the competitiveness of Finnish agriculture. Food processing in Finland is seen as becoming more polarised — large scale processing industry is paralleled with small local enterprises. Integration will also take place in food production, where functional food products, material technology, ITC, medicine production etc. will be important. Learning about food systems through aspects of transparency, interactivity and dynamics are seen as a possible future trend. GMOs (genetically modified organisms) are one of the main unanswered questions facing the future of food production (Wilenius and Puolanne 2002).

## The storylines for Finland's development

We have constructed possible Finnish development paths, which are related to the IPCC SRES scenarios but adapted to the Finnish context and constrained by the special Finnish circumstances within the global socio-economic system. The following names were given to these storylines to illustrate their main features (cf. Fig. 1):

— Global markets integrated Finland (related to A1).
— Neo-liberal industrial Finland (related to A2).
— Sustainability oriented Finland (related to B1).
— Local stewardship Finland (related to B2).

The main features of the scenario development paths are depicted in Fig. 2.

## The storyline for global markets integrated Finland

In this storyline Europe will be more and more integrated into global markets and Europe will be a key driving force of these global economic markets, although the role of Asian markets will increase. Finland will gain advantages from close co-operation with Russia, which will become a stronger economic power in Europe. Finland will network in many international networks and will be one of the key countries driving northern Europe. The population as well as labour force in Finland will increase steadily because of immigration, which is seen as vital for the increasing demand for labour.

The role of market forces is predicted to be strong and private companies will play an important role in the policy formulations and the co-ordination of public policies in this storyline. Economic growth will be high, but cycles of economic development will be turbulent and sometimes dramatically disturb the socio-economic systems. Sectors with the highest intellectual capital will be the most successful in

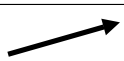
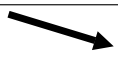
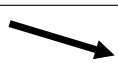
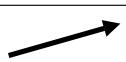
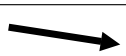
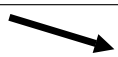
| | Global market integrated Finland | Neo-liberal industrial Finland | Sustainability oriented Finland | Local stewardship Finland |
|---|---|---|---|---|
| Population |  |  |  |  |
| Immigration |  |  |  |  |
| Labour force |  |  |  |  |
| R&D expenditure |  |  |  |  |
| Education expenditure |  |  |  |  |
| Regional centralization of housing |  |  |  |  |
| Mobility |  |  |  |  |
| Equality |  |  |  |  |
| Industrial agglomeration |  |  |  |  |
| Entrepreneurship |  |  |  |  |
| Unemployment |  |  |  |  |
| Regional polarization |  |  |  |  |
| Business taxation |  |  |  |  |
| Income taxation |  |  |  |  |
| Public health expenditure |  |  |  |  |
| Social security Expenditure |  |  |  |  |
| Military expenditure |  |  |  |  |
| Government debt |  |  |  |  |
| Renewable energy sources |  |  |  |  |
| Voting activity |  |  |  |  |
| The female share of the labour force |  |  |  |  |
| Labour participation |  |  |  |  |
| People networking |  |  |  |  |
| Carbon tax |  |  |  |  |

**Fig. 2**. Socio-economic scenarios for Finland.

Finland resulting in the increase of education expenditure.

In this storyline private companies are going to be active partners in the building of Finnish infrastructures. They are expected to invest a lot of financial resources in infrastructure projects. The privatisation of industries and infrastructures will continue and part of the schooling and health care system will be privatised. Consumers thus pay more fees when they utilise the infrastructure and other privatised services. The public sector provides only basic social security services and other social, health care and educational services. Hence societal policies will be set according to the acceptance of individual values and neo-liberalist competition policy. Voting activity should decrease as people are seen as not being very interested in politics. Regulatory systems and activities are minimal.

In this scenario unemployment does not decrease partly due to the increase of an uneducated labour force. Furthermore, equality between citizens is not a priority of social policies because the public infrastructure policies of Finland are based on the actual needs of private companies. The price of energy commodities is high and energy consumption follows economic growth trends. However, energy investments are partly directed towards renewable energy sources because of international environmental agreements and pressures.

In the field of transportation fast trains and motorways are built on a large scale and private transportation flows increase steadily, as does air transportation when citizens become wealthier.

With regard to housing infrastructure Finland's population is expected to be concentrated in certain areas and regional polarisation to have increased. The regional infrastructure is concentrated around the main cities of Helsinki, Tampere, Turku, Oulu and Jyväskylä, although some smaller towns will remain in other regions. The daily average distance to work increases and results in the steady increase of automobile transportation. Climate change may have an effect on the need for transportation infrastructure maintenance and repair.

Lastly the lifestyle of ordinary people is predicted to be commercial, efficient, fast, individual and concentrated on the spirit of private entrepreneurship. IT is seen as becoming an essential part of ordinary life and linked to that is the idea that the influential members of society are global knowledge workers, networked business people and globalised companies. Ultimately the "network-or-die" principle becomes the driving force of the society as the number of people networking increases. Overall the general development mode of Finnish society is market-driven in this storyline.

## The storyline of neo-liberal industrial Finland

The neo-liberal industrial Finland storyline is based on the economic minimisation of the public sector and the increasing power of market forces. In this storyline large industrial companies effectively dominate world politics. In such a situation the Finnish economy is concentrated on the mass production of industrial products mainly in the paper and pulp and metal industries, where Finland's comparative advantage is largest.

In this storyline, Finland implements large privatisation programmes, which lead to a minimal state structure. Private hospitals, schools and universities are realities in this scenario. Active multinational corporate structures are an important part of public policy-making process. Consumer fees are widely used in Finnish society in order to finance public sector services, whilst public sector infrastructure investments are minimal in this storyline. That leads to inefficient and fragmented public infrastructures, which are seen as not being well supported by very low tax levels. Unemployment is also a persistent problem owing to lower economic growth and the increasing automation of industrial production. One result of that is lower manual labour participation. Another negative factor is a population decrease that would be due to a weak social and family policy and a strict immigration policy.

Inequality, "cut-throat" competition, individualism and criminality are social problems in this kind of "risk society" storyline (Kaivo-oja 2001). However, the government invests a lot of its public budget on military expenditure because of increasing international conflict. Inequality,

and regional polarisation increase, in this scenario, with the result that work distances become longer and urban metropolitan areas develop in an uncoordinated way.

Societal values change to become individualistic and emphasise competition and the "survival of the fittest". These values are seen in widely polarised social and economic development as social security expenditure decreases. The "winners" of this society are global knowledge workers, large corporate leaders and the leaders of the "black market/grey economy". The number of people networking will increase though.

## The storyline for sustainability oriented Finland

Sustainability oriented Finland is based on economically and socially secure and stable development and avoids the risk society development path (Kaivo-oja 2001). In this storyline the European Union supports activities and investment, which promotes sustainable development. The public sector organisations develop a strong policy orientation towards sustainability and a close public-private partnership plays a crucial role in the formulation of policy. The focus of management is seen as shifting its exclusive attention from profit making and market share to quality and customer satisfaction. Economic growth is considerable, but not as high as in the 20th century or in scenario A1. Within public policy special attention is paid to international solidarity, the socio-cultural equity of education and economic possibilities.

Moreover, attempts to solve problems of population, poverty, militarisation, waste and environmental degradation, climate change, and food and energy shortages will be undertaken by new international governance systems. In consequence military expenditure in Finland decreases due to increased international stability. Common public interests and equity issues are analysed and public interests guide the goals of public policy making. Ecological tax reforms are implemented and the incentive systems of the Finnish society are planned with the aim of promoting sustainable life styles for ordinary citizens. In concert with that, green management methods are used in companies. Resources are used for public health expenditure and social security systems producing health, energy, food and social security systems that meet high international standards.

As public infrastructure is in good shape and special attention is paid to the development of sustainable infrastructure innovations, regional polarisation does not take place. This scenario is a consequence of active policies, which balance the economic and social differences of regional development throughout the whole country making Finland one of leading sustainable knowledge societies of the world.

Good public infrastructure creates railway transportation and good bicycling facilities, which are developed on a considerable scale in both urban and rural communities. Commuting times and distances do not increase and even decrease because infrastructure is centralised and efficient. Furthermore, strong, public sector organisations focus on national, common interests, strong participatory democracy and a balanced welfare state policy. International environmental agreements and national laws help guide development towards sustainability.

## The storyline for local stewardship Finland

In this storyline the global economy is unbalanced and there are strong economic crises in different regions of the world. Hence this storyline is based on the necessity of strong local communities. The scenario predicts that local communities will network and work together in many areas of human life as a response to international insecurity. Grassroots movements will play important roles in regional development and create a power base for regional administration. Thus, political institutions become regionally oriented and fragmented and there is no strong regional integration in Europe. "Ad hoc" types of activities are typical instead of co-ordinated activities.

Economic growth will develop at a low level and there will be all kinds of local crises in this storyline. Entrepreneurship decreases because of unstable international and national situations. The so-called "unofficial economy" is a part of this storyline development because the unem-

ployment rate is high and there are not many dynamic elements for socio-economic development. Therefore a lot of resources are used for social security expenditure owing to the fact that there are large societal problems. As public decision-making is understood to lack consistency and coherence in this scenario local social networks are very important in this kind of fragmented society.

The public sector is expected be weaker than today, provides only a low standard of public services and has lower investment in public infrastructure development. Additionally, energy sector investment, transportation investment and other infrastructure investments are minimal and weaken the infrastructure considerably. As a result local communities must rely on local renewable energy production and local infrastructure solutions in the future. The national railway and road transportation network develops haphazardly and only a reduced transportation network can be maintained.

If these societal conditions occur, large cities will have increasing problems and urban decay, while small and medium sized towns will be more successful. Although the values of society are somewhat fragmented, there is a strong local community. Issues like participation, local entrepreneurship and self-reliance will be the starting points of local development and this benefits local entrepreneurs, local community leaders and the co-ordinators of local networks.

## Long-run scenarios for Finland

In the research we have analysed and operationalised country level-scenarios whilst relating them to the global SRES scenarios of the IPCC and the above formulated storylines for potential Finnish development paths. According to the expert interviews the Finnish population/economy seems not to be directly vulnerable to future environmental changes but indirectly to changes in the international economy and policy, which will be affected by climate change. The adverse effects of climate change on the large populations in developing countries may constitute a larger threat to Finnish society due to global instability than direct temperature or sea level changes in Finland. According to expert interviews, for example, the globalised Finnish paper and pulp industry does not see the possible change of tree species structure as a threat to its internationalised raw material supply (Expert respondents 2002). Good examples of possible threats caused by global instability are the consequences of the September 11th attack on the World Trade Center in New York.

We carried out several simulation runs with the model to produce several different scenarios and selected the most policy relevant, plausible and consistent ones, i.e. those which resonated best with the statements of the interviewed experts and the background literature. For the scenario analyses we selected variables that are policy relevant, i.e. variables which the Finnish government can affect by policy choices. Such variables are, for example:

— Immigration policy, which affects population growth and structure.
— Government expenditure on research and development and government expenditure on education, which have a long term effect on the competitiveness of Finnish industry.
— Government expenditure on public health and social security, which affect demographic factors and the welfare and social stability of society.
— Government expenditure on the military, which depends on the security and stability of international relations.

In the analyses, we have utilised the IFs for Terra world model, which provides a framework for consistent scenario simulations (*see* Hughes 1999a, 1999b, 2000, 2002, for a detailed description of the model).

International Futures is a global modelling system. The extensive database underlying it includes data from 166 countries over as much of the period since 1960 as is possible. The modelling system has a "pre-processor" that cleans and reconciles data from a variety of sources and across a variety of units, then aggregates it into initial conditions and parameters for whatever geographic representation of the world the user desires. The model itself is a recursive system that can run without intervention from its initial

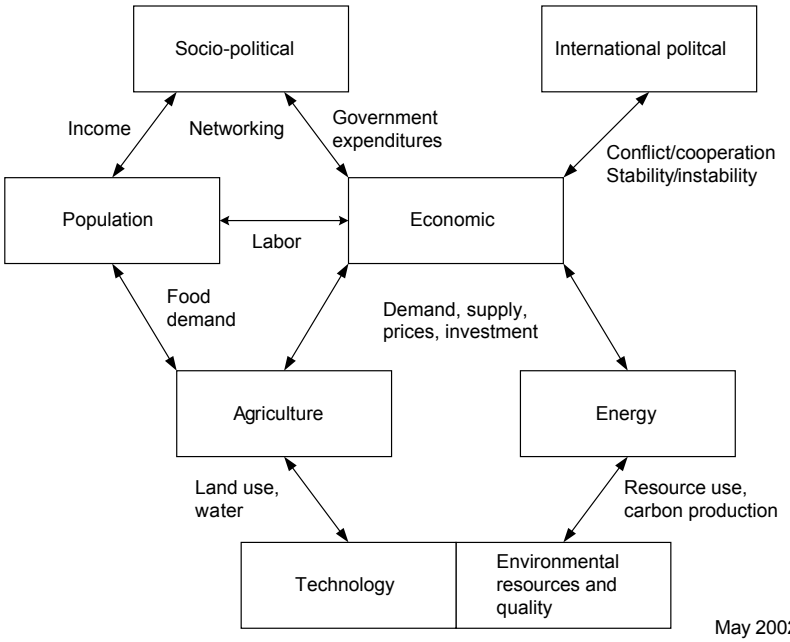



**Fig. 3**. An overview of International Futures (IFs) for TERRA.

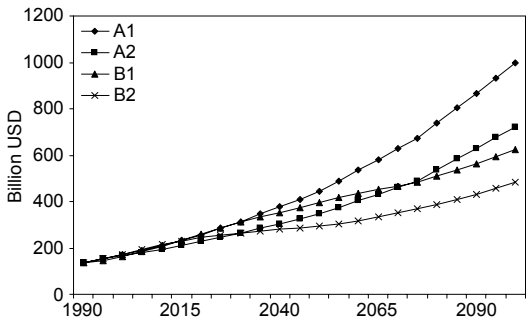



**Fig. 4**. Gross domestic product in Finland; downscaling of the IPCC SRES scenarios for Finland, 1990–2100, assuming uniform regional growth rates. Source: Gaffin *et al.* (2004). For explanation of symbols, *see* text.

year (2000); the model interface facilitates interventions flexibly, however, across time, issue, and geography.

The major conceptual blocks of the International Futures system are presented in Fig. 3. The elements of the technology and environmental blocks are, in fact, scattered throughout the model. The different modules of the IFs for Terra model are described in the Appendix.

In this section, we present some examples of long-run scenarios for Finland as an illustration of possible future development paths. We present the results of the scenarios mainly up to 2030 in order to illustrate the main differences in the trends of socio-economic development. The socio-economic system is so complex that model results for a longer time horizon will not give much relevant additional information. We have carried out the scenario comparison based on a baseline scenario and compared the variations between the different storylines presented earlier by changing the policy relevant parameters of the model.

We use the following symbols in the figures to refer to the different storylines:

0 = Reference scenario.
A1 = Global markets integrated Finland.
A2 = Neo-liberal industrial Finland.
B1 = Sustainability oriented Finland.
B2 = Local stewardship Finland.

## Economic trends

Scenarios of gross domestic product for Finland have been downscaled from the IPCC SRES scenarios by Gaffin *et al.* (2004) (Fig. 4). The downscaled SRES scenarios assume a uniform

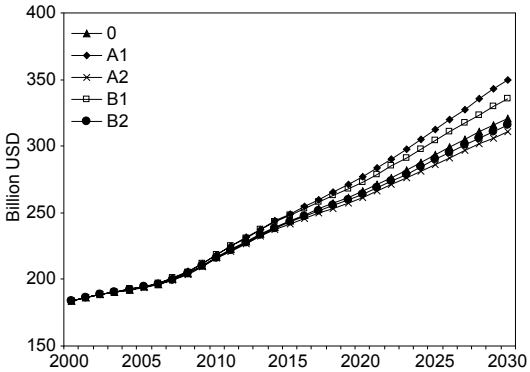



**Fig. 5**. Gross Domestic Product (GDP) in different scenarios for Finland, 2000–2030, calculated using the IFs for Terra model. For explanation of the symbols, *see* text.

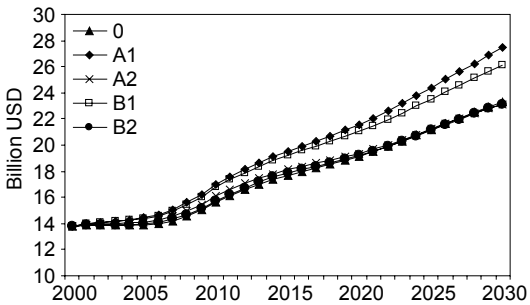



**Fig. 7**. Government expenditure on education in different scenarios. For explanation of the symbols, *see* text.

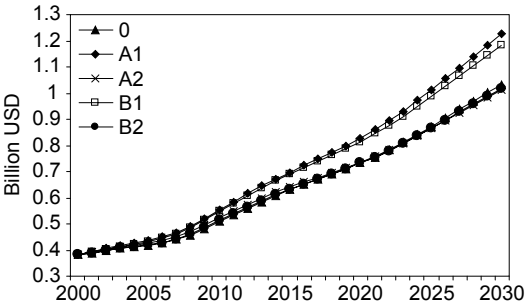



**Fig. 6**. Government expenditure on R&D in the different scenarios. For explanation of the symbols, *see* text.

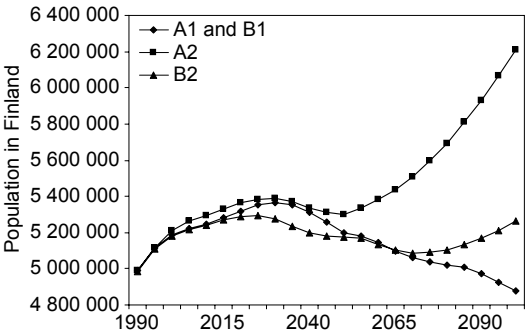



**Fig. 8**. Population in the downscaled IPCC SRES scenarios for Finland, 1990–2100, assuming uniform regional growth rates. Source: Gaffin *et al.* (2004). For explanation of the symbols, *see* text.

regional (in this case OECD) growth level without taking into account the national and structural differences of the economies.

To illustrate the different storylines, we have calculated the GDP development using the IFs for Terra model (Fig. 5).

The differences in GDP development in the scenarios are mainly caused by the differences in government expenditure on R&D (Fig. 6) and education (Fig. 7), which have an impact on the structure of economic development as was stated in the expert interviews. Here government expenditure is thought to be a response to the trends in global development and national priorities as illustrated in the storylines. According to the expert interviews the education and R&D expenditures are important factors for information society development and the backbone for securing the international competitiveness of the business sector.

## Social trends

The trends in migration policy in Finland are not thought to affect the results. There are not large differences between scenarios except for the downscaled A2 scenario, which seems quite unrealistic if radical changes in migration are not assumed (Fig. 8). The difference is a result of downscaled regional population growth without any national characteristics.

In the IFs for Terra model population growth depends on the age structure, related fertility, use of contraceptives and mortality, which is affected by, e.g., the spread of AIDS. Without any special changes the peak level of Finnish population is reached in the year 2020 and then the population starts to decrease. The main driver in Finnish population is, however, immigration policy. We have anticipated that in the open world markets scenario individual countries will not make any specific restrictive immigration measures, which

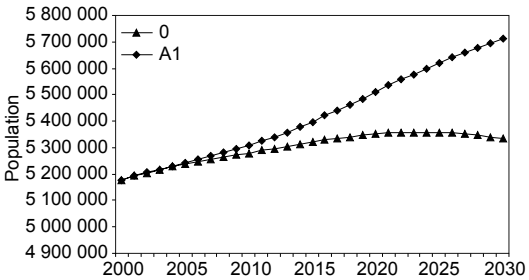



**Fig. 9**. Population in the reference and A1 scenarios operationalisation for Finland in 2000–2030. For explanation of the symbols, *see* text.

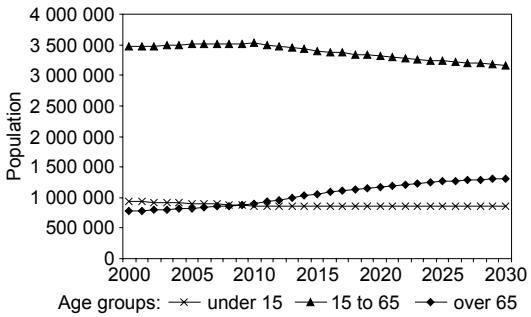



**Fig. 10**. Population structure in the reference scenario operationalisation for Finland.

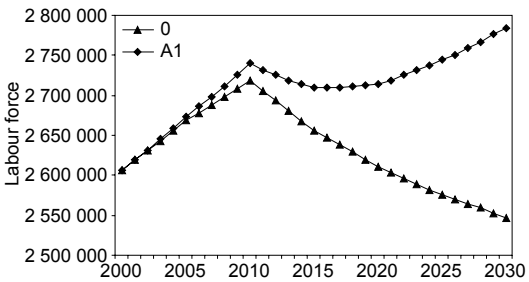



**Fig. 11**. Labour force in the reference and A1 scenarios operationalisation for Finland. For explanation of the symbols, *see* text.

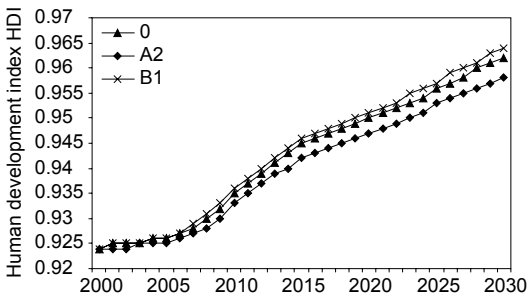



**Fig. 12**. Human Development Index (HDI) in different scenarios. For explanation of the symbols, *see* text.

results in economic based immigration from less favoured economic areas. The difference between the reference scenario and the world market scenario based on the IFs model (other scenarios are similar to the reference scenario) is presented in Fig. 9.

The scenario run of the IFs for Terra model concerning population structure clearly indicates that fewer children are being born and that the Finnish population is becoming dominated by older age groupings (Fig. 10). The changing age structure is important for the social and economic functioning of society and requires government responses in health care, social security, education etc.

The decline in the labour force after the year 2008 indicates the structural change of the age structure of the Finnish population (Fig. 11). Immigration will have a remarkable effect on the population structure and the labour force as can be seen in the A1 scenario, which is compared with the reference scenario in Fig. 11 (other scenarios are similar to the reference). Labour productivity is an important factor for economic activity and it increases considerably due to the increased educational level.

Different aspects of human development (such as education, life expectancy and gender equity) can be assessed with the Human Development Index (HDI) developed by the UNDP (Human Development Report 2002). In the Finnish case educational expenditure has the main impact on HDI (Fig. 12).

## Summary and reflections

In this paper we have operationalised some basic SRES scenarios for the Finnish economy using different variables. We want to underline the basic assumptions of the SRES scenarios, which have the character of baseline scenarios. The basic motivation of scenario analysis in this study is to integrate socio-economic scenarios and climate scenarios. In this article we have provided analyses which are based on expert interviews, official and expert documents and the consistent model-

ling framework of IFs for Terra. Our approach tries to offer a more sophisticated and dynamic account of the potential feedback between natural and human systems than top-down assessments, which also have an important role in climate change policy analyses. By combining socio-economic and climate scenarios we have tried to present a dynamic image of the future for the various stakeholders in the Finnish economy. This allows stakeholders to envision the changes possible within their own sectors and their specific responses to the issues presented.

The IPCC scenarios constitute a central policy discourse for national decision makers and stakeholders in the climate policy field in most countries. In the decision making process it is common that some discourses and related scenarios become more dominant in the strategy process. It is relevant to understand the importance of the constitution of different policy discourses and regimes and to analyse the backgrounds and critical elements in the process of discourse construction.

The analysis of the ACACIA project (Parry 2000) concluded that certain systems, independent of climate change, will thrive under some scenarios and will be inherently more vulnerable in others. Adaptive strategies are likely to differ across the four scenarios. In addition, the manner in which society values different parts of the human and physical environment is markedly different under the different scenarios, with clear implications for adaptation policies. Our scenario analysis is in line with this conclusion. The adaptive capacity of particular sectors and levels of governance in Europe and Finland to the impact of climate change is crucially dependent upon which of the four scenarios we choose to view the future with. For example, some sectors of the economy and certain levels of governance will thrive under some scenarios but will be inherently more vulnerable under others, independent of any additional pressure imposed by the gradually unfolding impact of climate change.

The expert opinions from the Finnish administration and business sector offer interesting views of possible future development paths. It seems that climate change is not seen as a major threat as such in Finland, but the effects of climate change on the world's socio-economic system and the related consequences for the Finnish system may be considerable.

We must strongly emphasise that scenarios are not predictions or forecasts, but the scenarios provide useful tools for transition path analysis. We are not trying to forecast the political and social events of the next decades till the year 2100. Instead we have tried to outline the major possible transition paths of the future on the basis of four SRES scenarios. This paper does not contain strategic analysis concerning different scenarios and stakeholders. We do, however, acknowledge that this kind of long run strategic process should be organised in Finland. The scenarios presented in this paper could form a starting point for a sustainability strategy formulation process in Finland, which would involve understanding the strategy context, identifying alternatives, developing alternatives, choosing from amongst alternatives and executing the chosen sustainability strategy. We hope that this study helps the political sector and various stakeholders in the strategic discussions concerning the Finnish climate policy regime.

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*Received 5 August 2003, accepted 18 March 2004*

**Appendix**. Modules of the International Futures (IFs) for TERRA system

**Population module**:
- — represents 22 age-sex cohorts up to age 100+
- — calculates change in fertility and mortality rates in response to income, income distribution, and analysis multipliers
- — computes average life expectancy at birth, literacy rates, and overall measures of human development (HDI) and the physical quality of life
- — represents migration and HIV/AIDS
- — includes a sub-model of formal education across primary, secondary, and further levels

**Economic module**:
- — represents the economy in six sectors: agriculture, materials, energy, industry, services, and ICT
- — computes and uses input-output matrices that change dynamically with development levels
- — is a general equilibrium-seeking model that does not assume exact equilibrium will exist in any given year; rather it uses inventories as buffer stocks and to provide price signals so that the model chases equilibrium over time
- — contains an endogenous production function that represents contributions to growth in multifactor productivity from R&D, education, worker health, economic policies ("freedom"), and energy prices (the "quality" of capital)
- — uses a Linear Expenditure System to represent changing consumption patterns
- — utilises a "pooled" rather than the bilateral trade approach for international trade
- — includes a social accounting matrix (SAM) envelope that ties economic production and consumption to intra-actor financial flows

**Agricultural module**:
- — represents production, consumption and the trade of crops and meat; it also carries ocean fish catches and aqua-culture in less detail
- — maintains land use information for crop, grazing, forest, urban, and "other" categories
- — represents demand for food, for livestock feed, and for the industrial use of agricultural products
- — is a partial equilibrium model in which food stocks buffer imbalances between production and consumption and determine price changes
- — overrides the agricultural sector in the economic module unless the user chooses otherwise

**Energy module**:
- — portrays the production of six energy types: oil, gas, coal, nuclear, hydroelectric, and other renewables
- — represents the aggregate consumption and trade of energy
- — represents known reserves and ultimate resources of the fossil fuels
- — portrays changing capital costs of each energy type with technological change as well as with draw-downs of resources
- — is a partial equilibrium model in which energy stocks buffer imbalances between production and consumption and determine price changes
- — overrides the energy sector in the economic module unless the user chooses otherwise

**Socio-political sub-module**:
- — represents fiscal policy through taxation and spending decisions
- — shows six categories of government spending: military, health, education, R&D, foreign aid, and a residual category
- — represents changes in the social conditions of individuals (like fertility rates or literacy levels), the attitudes of individuals (such as the level of materialism/post-materialism of a society from the World Value Survey), and the social organisation of people (such as the status of women)
- — represents the evolution of democracy
- — represents the prospects for state instability or failure

**International political sub-module**:
- — traces changes in power balances across states and regions
- — allows the exploration of changes at the level of interstate threat
- — represents possible action-reaction processes and arms races with associated potential for conflict among countries

**Implicit environmental module**:
- — is distributed throughout the overall model
- — allows the tracking of remaining resources of fossil fuels, of the area of forested land, of water usage, and of atmospheric carbon dioxide emissions

**Implicit technology module**:
- — is distributed throughout the overall model
- — allows changes in assumptions about rates of technological advance in agriculture, energy, and the broader economy
- — explicitly represents the extent of the electronic networking of individuals in societies
- — is tied to the governmental spending model with respect to R&D spending